

Value Chain Analysis and Market Assessment of Bamboo Products in Kenya

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It has been a great challenge to undertake this study and have more insight into the complex but very interesting world of bamboo. We hope this study will be a good knowledge document and can be referred to as a tool for the further development of the bamboo sector in Kenya.

Authors

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Acronyms

AGOA	African Growth Opportunity Act	KEBS	Kenyan Bureau of Standards
AMSL	Above Mean Sea Level	KEFRI	Kenya Forestry Research Institute
APC	African Plantation Capital	KETRACO	Kenya Electricity Transmission Company
B2B	Business to Business	KFS	Kenya Forest Service
BTC	Bamboo Trading Company	KIPI	Kenya Industrial Property Organisation
CAL	Calories	KPLC	Kenya Power and Lighting Company
CAGR	Compound Annual Growth Rate	KSh	Kenyan Shilling
Cm	Centimeter	kVA	Kilo-Volt-Ampere
COMESA	Common Market for Eastern and Southern Africa	M	Meter
CPTC	Common Production and Training Centre	NEMA	National Environmental Management Authority
FGD	Focus Group Discussion	NGO	Non-Governmental Organisation
ERC	Energy Regulation Commission	PPA	Power Purchase Agreement
EU	European Union	R&D	Research and Development
G	Gram	SFA	State Forestry Administration
GBM	Green Belt Movement	SWOT	Strengths, Weaknesses, Opportunities and Threats
GIS	Geographical Information System	TC	Technical Committee
GO	Governmental Organisation	TRIPS	Trade-Related Aspects of Intellectual Property Rights
GPE	Green Pot Enterprises	UN	United Nations
GSP	Generalised System of Preferences	UNCTAD	United Nations Conference on Trade and Development
Ha	Hectares	UNIDO	United Nations Industrial Development Organisation
HS	Hormonised System	UK	United Kingdom
ICT	Information Communication Technology	USA	United States of America
INBAR	International Bamboo and Rattan Organisation	USD	United States Dollar
INGO	International Non-Governmental Organisation	VIED	Victoria Institute of Research in Environment and Development
IPR	Intellectual Property Rights	WIPO	World Intellectual Property Organisation
ISO	International Organisation for Standardisation		

Foreword

Bamboo is a fast-growing, renewable and versatile resource, which is found across the Global South and is interlinked with the lives and livelihoods of numerous communities. It is well accepted that bamboo development could contribute directly to at least seven of the UN Sustainable Development Goals, including poverty alleviation, affordable and clean energy, affordable and resilient housing, sustainable consumption, climate change mitigation, and terrestrial ecosystem protection.

Kenya has an estimated 140,000 hectares of bamboo, belonging to one indigenous species, *Yushania alpina*. Despite this natural abundance, however, existing bamboo resources in Kenya are underutilised and often poorly managed. Currently bamboo is limited to subsistence-related uses, namely bamboo poles, traditional utility products and crafts. As such, the large potential of bamboo for job creation, income generation and environmental development is still untapped in Kenya, and the country contributes only 0.02% to the global export of bamboo products.

Bamboo could be a home-grown substitute for a lot of Kenyan imports, including furniture, timber products, pulp and paper, panels and boards. The development of the bamboo sector would also help Kenya to access high-end export markets such as the European Union and USA, where the demand for bamboo-based products is increasing. More locally, bamboo can promote the use of micro- and small-scale enterprises, creating everything from utility products and furniture to souvenir items and packaging materials.

This market study was conducted as part of INBAR's Dutch-Sino East Africa Bamboo Development Programme, supported by: the Ministry of Foreign Affairs, the Netherlands; China's State Forestry Administration; Wageningen University; Moso Bamboo BV; the Netherlands and local partners. It assesses existing bamboo value chains in Kenya and explores the market potential for bamboo products in Kenya and beyond. Through a comprehensive analysis of existing value chains, opportunities for growth, and policy aspects, the report provides a robust set of recommendations and action points for Kenya to scale up its bamboo industry development.

This study is a valuable addition to the existing knowledge of the bamboo sector in Kenya, and we hope it will be of use to policy makers, development practitioners and the private sector.

Dr. Hans Friederich

Director General, International Bamboo and
Rattan Organisation (INBAR)

Executive Summary

The bamboo forest covers 140,000ha of land area in Kenya (Zhao et al., 2017). The Aberdare Range has the highest bamboo cover (50,038ha), followed by Mount Kenya (25,966ha). The bamboo forest in Kenya is mostly found at an altitude between 2200m and 3300m above mean sea level (AMSLL) and the predominant species is *Oldeania alpina* or *Yushania alpina*, commonly known as highland bamboo. In addition, bamboo has been cultivated on private land for more than a decade. Despite a lot of potential for its subsistent and commercial use, the use of bamboo is very limited in Kenya, and the bamboo resource is largely untapped.

The overall objective of the assignment was to assess the bamboo value chain and explore the market potential of selected bamboo products in Kenya and beyond. Terms of reference are attached as Annex 8.

Data were collected both from primary and secondary sources. The primary data was collected from farmers, entrepreneurs, owners and staff of private companies, input suppliers and enablers, including governmental organisations, national and international non-governmental organisations, researchers, and regulatory institutions. The secondary sources of data consisted of published and unpublished reports related to bamboo in Kenya and beyond.

A stakeholder workshop was conducted at KEFRI to prioritise bamboo products and to select bamboo products which have the most immediate and long-term market potential. The prioritised products were grouped into three categories based on the intensity of value addition: i) construction materials with no or minimum-value addition, ii) small-scale enterprise products with moderate-value addition and iii) industrial products with high-value addition. The study found that, despite a lot of economic potential and a larger scope for value addition (employment, income generation and poverty reduction), the bamboo sector, as well as value chains in Kenya, faces a number of constraints. The bamboo business is limited to seedling production and sale between nursery owners and development projects for conservation and land rehabilitation purposes. The major constraint in the bamboo value chain is its inability to tap the domestic market. As a result, commercialisation of bamboo is confined to limited areas where development agencies are implementing projects. Nonetheless, lead farmers are coming up for commercial cultivation, particularly in new areas, where the private sector has an assured market and offers a buyback guarantee.

The bamboo value-addition enterprises are in a very primitive stage in Kenya. There are a few poorly-functioning bamboo enterprises in urban and rural areas of Kenya. The underlying reason for the poor functioning is their weak backward and forward linkages. For the enterprises which are located near cities, accessing raw materials is a herculean task. Similarly, for the enterprises located in rural areas, it is not easy to access the market. However, limited or no capacity for the former types of enterprises to access the market cannot be ignored. Lack of investment capacity of entrepreneurs in small and medium enterprises hinders the growth.

Nevertheless, in recent years, the private sector has been coming aggressively into the bamboo sector and investing in cultivation and establishing a facility for industrial scale processing to produce biomass for energy, timber for furniture and flooring, and fibre for textile. The latter two types of bamboo products have the potential for exporting.

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Based on the findings, the following approaches are recommended for overall development of the bamboo sector: promotion of the local use of bamboo, promotion of small-scale enterprises and support to the private sector for industrial production. Promotion of local use of bamboo is important, as it helps to increase the resource base and makes bamboo a part of the farm landscape. Promoting the use of bamboo in scaffolding, construction of rural dwellings, houses and eco-tourism resorts can increase the local use of bamboo. The advantages of small-scale enterprises are that they can operate with a small volume of raw materials. They do not need high capital, and returns on investment are high. Handicrafts and furniture can be product lines of small-scale enterprises. Likewise, private sector involvement in the value chain is important for harnessing the economic potential of the bamboo sector and significantly contributing to the national economy. The private sector can be involved in the production of bamboo stick-based products, bioenergy products, timber substitute products and textiles. However, the project needs to support the private sector in the transfer of the technology, market assessment at national and international levels and increase production of bamboo through cultivation on private land and connecting the companies to the farmers' group networks.

1. Introduction

According to the inventory undertaken by the Kenya Forest Service (KFS) in 2010 (KFS, 2013), forests in Kenya occupy 6.99 per cent of its land area. These forests are categorised as montane, western rainforest, bamboo, Afromontane undifferentiated forest, coastal and dryland forests. Among these forests, the Afromontane forest type is associated with highland forests in Africa that spread from Guinea and Liberia in the west to Ethiopia in the east and the Drakensberg Mountains in the south. In Kenya, Afromontane forest covers Mount Kenya, the Aberdares, Karura, Mau Forest Complex, the Cherang'any Hills, Mount Elgon, Mount Nyiro, Mount Kulal, the Mathews Range and Mount Marsabit forest ecosystems. These forests form the catchments of the main rivers of the “water towers” in Kenya. The Afromontane forest types are categorised as two major subtypes – mixed indigenous natural forest and bamboo-dominated forest. According to the recent GIS-based bamboo inventory conducted by INBAR and Tsinghua University (China), bamboo forest covers 140,000ha land area in Kenya (Zhao et al., 2017). According to the study, the Aberdare Range has the highest bamboo cover (50,000ha), followed by Mount Kenya (25,966ha). The bamboo forest in Kenya is mostly found at an altitude between 2200m and 3300m AMSL. The dominant species of bamboo is *Oldeania alpina* (K. Schum) (Stapleton, 2013) and it is found mainly in Mount Elgon, Mount Kenya, Cherang'any Hills, the Mau Forest and the Aberdare Range.

Among the most important minor forest products, bamboo has continued to gain recognition in Kenya. Previously, bamboo was regarded as a weed; today, it is considered as a multi-purpose plant and a valuable timber substitute (Personal Communication, 2017). Bamboo raw materials are, however, scarce due to the current ban on bamboo extraction from public forests. Even if the ban were to be lifted, the cover of bamboo resource is presently low due to excisions of indigenous forests where bamboo was dominant (KEFRI, 2007). This calls for production of raw materials from farms not only to ensure expanded supply, but also to get the materials nearer to the market yards where handicraft industries are flourishing. Increased availability of materials would be a source of bioenergy, and would also provide input materials, mainly props for the fast-expanding industrial horticultural flower farming in Kenya.

Bamboo is a fast-growing plant, reaching its full size and height in three to five months of shoot emergence. It is a versatile plant/raw material with diverse applications, which include construction, furniture, handicrafts, baskets, human food, animal fodder, paper, bioremediation, briefcases, clothes, boats, bows and arrows, biomass fuel, ladders, mats, musical instruments, fencing, fibre, fans, spears, spoons, toys, toothpicks, recycling and filtration of domestic and industrial wastewater (Latif and Liese 1995; Kigomo, 2000; INBAR, 2006 and Kibwage et al., 2008). Bamboo leaves are used as animal fodder, while its shoots are a good source of human food. Kenya has so far recorded up to 48 local bamboo uses (Ongugo et al., 2000).

However, the development of the bamboo sector in Kenya is characterised by a number of constraints. The constraints include the ban on harvesting of the indigenous bamboo; lack of awareness of its potential; lack of technology required for processing and value addition; poorly developed marketing structures; lack of information on availability of planting materials and lack of information on propagation, establishment, crop management and harvesting methods (Nyambati et al., 2016).

2. Objective

The overall objective of the assignment was to conduct a national market assessment for bamboo products in Kenya, primarily aimed at identifying bamboo value chains with big potential for up-scaling (Annex 8). The specific objectives of the assignment were:

- Assess the bamboo value chain and identify the key opportunities and bottlenecks
- Map the existing bamboo products and explore products that have potential in the domestic market
- Identify bamboo products (existing, as well as potential) that have potential for exporting regionally, as well as to Europe, and
- Provide concrete recommendations for upscaling the existing, as well as potential, bamboo products.

3. Methodology

3.1 Study sites

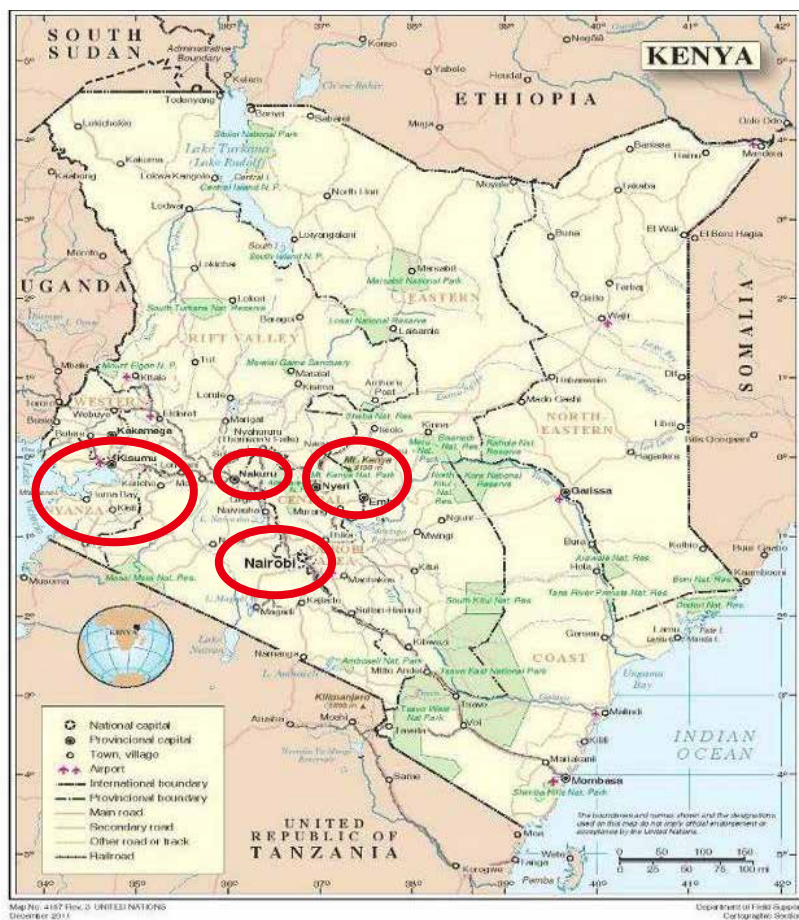


Fig. 1: Map of Kenya showing field sites in red circles

Data collection was done in Nairobi, Western Kenya, the Rift Valley and Central Kenya – specifically, Kakamega, Kisumu, Kisii, Homa Bay, Nakuru and the Mount Kenya region. The red-circled areas in Fig. 1 are the sites visited during the study. In Nairobi, the study particularly focused on policy issues, processing potential and market assessment, whereas in locations other than Nairobi, the focus was on production and processing status, availability of value-chain actors and transportation practices.

3.2 Data sources

Data were collected both from primary and secondary sources. The primary data was collected through individual interviews with entrepreneurs, owners and staff of private companies, input suppliers, enablers, including governmental organisations (GOs) and national and international non-governmental organisations (I/NGOs), researchers and regulatory institutions. In addition, focus group discussions were conducted with farmers/farmer groups.

The secondary sources of data consisted of published and unpublished reports of GOs and I/NGOs working in the bamboo sector. Data of the global trade of bamboo products was extracted from UN Comtrade database (<https://comtrade.un.org/data/>) and compiled. For the purpose of analysis, global bamboo trade data of 2014, 2015 and 2016 was downloaded and compiled for the following 12 bamboo commodities:

1. Bamboo poles (HS code: 140110);
2. Preserved bamboo shoot (HS code: 200591);
3. Bamboo mats/screens (HS code: 460121);
4. Bamboo plaits and plaiting material (HS code: 460192);
5. Bamboo basketwork (HS code: 460211);
6. Bamboo charcoal (HS code: 440210);
7. Bamboo flooring (HS code: 440921);
8. Bamboo plywood (HS code: 441210);
9. Bamboo pulp (HS code: 470630);
10. Bamboo paper-based articles (HS code: 482361);
11. Bamboo and rattan seats (HS code: 940151); and
12. Bamboo and rattan furniture (HS code: 940381).

Since the data of the same period was not available for Kenya, data from 2009, 2010 and 2013 under the same HS codes were downloaded and compiled and used for analysis. In addition, data of other commodities that could be alternated with bamboo such as furniture and parts (HS code 9403); wood and articles of wood and charcoal (HS code 44); Agarbatti and other odoriferous preparations which operate by burning (HS Code 330741); matches, other than pyrotechnic articles (HS Code 3605); shutters, blinds (including Venetian blinds) and similar articles and parts thereof, of plastics (HS Code 392530) was compiled from the UN Comtrade database for analysis.

3.3 Data collection process

The study was guided by a conceptual framework, which is presented in Figure 4, and data collection was conducted in two steps, which are as follows:

Step I – Prioritisation of most potential bamboo products: Prioritisation of the existing bamboo products, as well as potential bamboo products having domestic and export market potential, was done at a stakeholder meeting organised by KEFRI. The meeting's

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participants included bamboo entrepreneurs, farmers, NGO representatives, nursery owners and KEFRI staff (Annex 1). At the workshop, potential bamboo products were shortlisted and prioritised through a scoring and ranking exercise based on the criteria and indicators presented in Table 1. The criteria and indicators covered potential bamboo products having both domestic and export markets.

The five-point Likert scale was used to measure each indicator, where 5 was the highest score and 1 was the lowest. A discussion was held prior to giving a score to each criterion and scores were assigned with consensus. The score against each indicator was weighed based on the weight given to each criterion and indicator. The weighted score was added and the total score was calculated. Finally, a ranking of each bamboo product was done based on its total weighted score. The products with the highest scores were considered potential products for assessment.

In addition, the participants were asked to share their views about the opportunities and constraints facing the bamboo sector in Kenya, especially focusing on trade, policy, governance and resource production status. This exercise also helped to identify the potential actors or market players in the value chain. However, finalisation of products was done after field visits and consultations with farmers, nursery owners, potential investors, N/GO staff and researchers.

Table 1: Criteria and indicators for prioritisation of bamboo products

Criteria	Weight (%)	Indicators	Weight (%)
Growth potential	30	Technology available/possibility of transfer	30
		Value addition	30
		Investment capacity	20
		Minimum wastage	20
Poverty reduction potential and social benefit	20	Employment generation	35
		% of poor household engagement	35
		% women engagement	30
Prospect of success	20	Policy environment for production, marketing and export	30
		% coverage by public sector service providers	20
		% coverage by private sector service providers	30
		Urgency of intervention	20
Market and trade potential	30	Market demand in domestic market	60
		Demand in international market	40

Step II – Assessment of supply conditions: Along with the market assessment of the selected bamboo products, the study assessed the value chain of bamboo and concomitant opportunities and bottlenecks. A few bamboo production sites were visited and the study team interacted with bamboo producers, traders, entrepreneurs and enablers (Annex 2). Information was collected using individual checklists for producers, traders and enablers (Annex 5). The methods used for data collection were focus group discussions (FGDs) with farmers, individual interviews with nursery owners, NGO/GO staffs, representatives of private companies, potential

investors and training institutions (Annex 3).



Fig. 2: Interview with the farmers



Fig. 3: Focus group discussion with the farmers

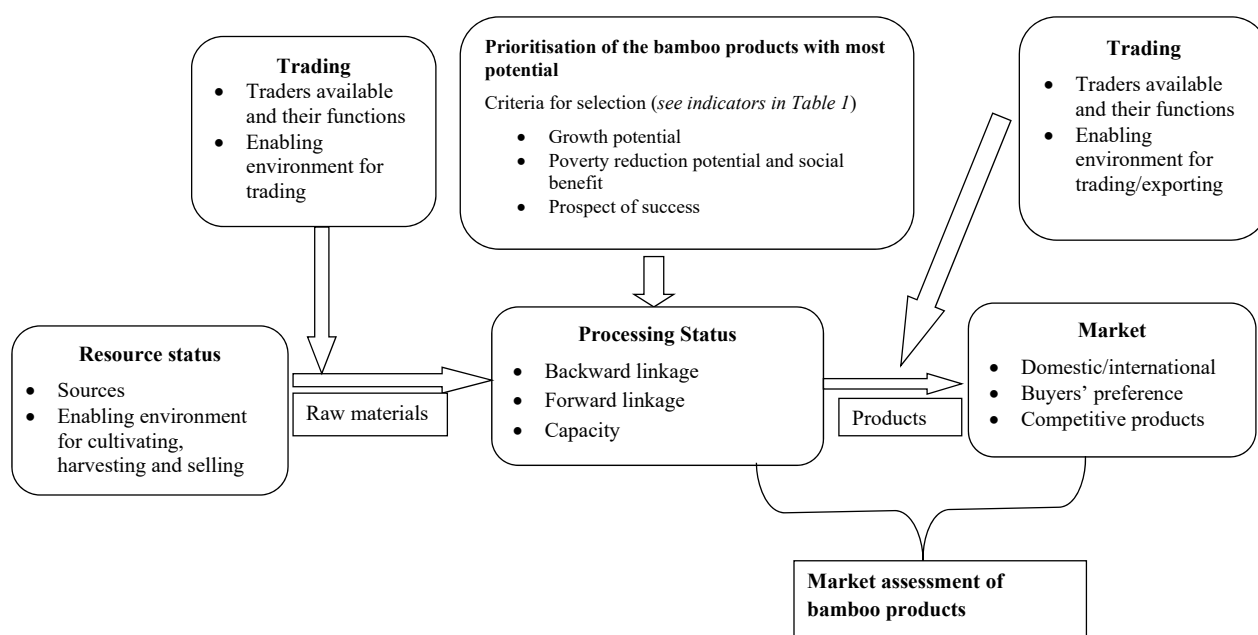


Fig. 4: Conceptual framework of the study

4. Trading Scenario of Bamboo Products

4.1 Global scenario of bamboo and its products trading

Bamboo and its products are one of the important traded natural commodities in the world. Data compiled from the UN's Comtrade database (<https://comtrade.un.org/data/>) show that average trade value (both import and export) of 2014, 2015 and 2016 is about USD 3 billion (Table 2). Table 2 indicates that China is the major exporter of bamboo and its products, accounting for 72.6 per cent of total exports in the world, whereas its imports are less than one percent. Among the importing countries, the EU is the largest importer (27.8 per cent) followed by the USA (20.4 per cent). There are 12 commonly traded bamboo products; among them, preserved bamboo shoots are the most exported item (20.4 per cent), followed by bamboo flooring (19.4 per cent), bamboo basketry (14.2 per cent) and bamboo and rattan furniture (10.3 per cent). In all the cases, the EU and the USA are the major importers, accounting for 28 per cent and 21 per cent of imports, respectively. Kenya's import and export of bamboo products is negligible and shares less than one per cent of global trade of bamboo and its products. The whole of Africa accounts for just over one per cent of global imports and exports.

Table 3 shows that only two items – bamboo charcoal and bamboo pulp – are exported in a significant quantity from Africa, whereas none of the items are exported in a significant quantity from either from Kenya or COMESA. The table shows that all of the 12 items have a good market in the EU, followed by the USA. Despite Africa in general, and Kenya in particular, having a comparative advantage in terms of proximity to the world's biggest bamboo market, the region is not able to capitalise on this opportunity.

Table 2: Import and export scenario of bamboo trading in global market in USD

Product Code	Product	Trade Value (USD)																% Product Import	% Product Export
		Kenya		COMESA		Total Africa		Total EU		USA		China		Global					
		Import	Export	Import	Export	Import	Export	Import	Export	Import	Export	Import	Export	Import	Export				
140110	Bamboo	5,137	0	274,196	295,724	503,559	309,374	52,982,330	12,311,210	20,117,378	427,327	1,663,015	67,611,593	134,075,491	95,074,389	10.16	6.31		
	Preserved Bamboo																		
200591	Shoot	5,825	14	163,796	58	261,908	89,441	36,276,330	18,601,725	29,621,677	221,648	131,979	274,725,989	230,630,792	308,001,800	17.48	20.43		
	Bamboo Mats / Screens																		
460121		23,288	127,156	119,370	549,399	348,834	593,133	22,740,742	5,880,534	4,237,098	454,586	52,937	81,525,800	61,308,259	91,153,174	4.65	6.05		
	Bamboo Plaits and																		
460192	Plaiting material	27	0	48,707	6,609	297,887	23,610	7,714,951	1,929,503	4,199,688	309,650	105,516	54,100,125	32,341,004	58,161,394	2.45	3.86		
460211	Bamboo Basket Work	15,438	257	221,668	15,136	1,126,872	197,967	46,347,637	13,691,972	53,920,248	1,815,118	576,919	149,036,258	171,990,202	214,618,781	13.04	14.23		
440210	Bamboo charcoal	1,145	1,475	115,237	1,171,608	872,286	11,741,910	9,585,305	5,056,054	2,975,879	349,901	314,134	31,974,073	38,762,065	58,416,320	2.94	3.87		
440921	Bamboo Flooring	209,104	0	476,257	42,221	2,369,534	2,245,681	24,237,144	7,475,305	3,164,373	6,389,588	60,894	271,484,623	88,491,293	292,741,064	6.71	19.41		
441210	Bamboo plywood	355,314	250	2,886,041	35,232	5,485,052	555,286	37,005,125	10,527,382	46,079,657	6,503,300	223,281	75,739,897	161,450,208	99,733,636	12.24	6.61		
470630	Bamboo pulp	49	555	12,727	164	24,813	1,783,986	1,573,715	1,318,873	861,692	61,248	396,999	2,760,426	5,388,638	6,562,809	0.41	0.44		
	Bamboo Paper based																		
482361	articles	1,145	0	1,149,320	69,992	1,466,245	259,896	14,195,668	6,218,069	4,627,576	1,264,255	20,530	9,430,144	37,321,707	31,072,976	2.83	2.06		
	Bamboo and Rattan																		
940151	seats	71,172	7,951	247,928	10,372	2,876,853	215,676	51,230,523	16,311,612	52,184,363	2,371,787	1,954,507	10,928,384	170,351,824	96,967,163	12.91	6.43		
	Bamboo and rattan																		
940381	furniture	92,174	138,165	3,547,650	18,112	5,594,062	290,191	62,772,934	43,092,511	47,411,598	4,036,911	687,185	66,010,375	187,254,968	155,347,652	14.19	10.30		
	Total (USD)	779,818	275,823	9,262,898	2,214,628	21,227,906	18,306,151	366,662,405	142,414,751	269,401,226	24,205,318	6,187,895	1,095,327,687	1,319,366,451	1,507,851,158	100	100		
	Per cent per block (%)	0.06	0.02	0.70	0.15	1.61	1.21	27.79	9.44	20.42	1.61	0.47	72.64						

Note: Kenya: Average derived from trade data of 2009, 2010 and 2013; Others: Average derived from trade data of 2014–2016

Source: UN Comtrade Database, 2017

Table 3: Import and export scenario of bamboo trading in global market

HS Code	Product	Averaged Percentage of Trade Value (%)											
		Kenya		COMESA		Total Africa		Total EU		USA		China	
		Import	Export	Import	Export	Import	Export	Import	Export	Import	Export	Import	Export
140110	Bamboo	0.00	0.00	0.20	0.31	0.38	0.33	39.52	12.95	15.00	0.45	1.24	21.95
200591	Preserved bamboo shoot	0.00	0.00	0.12	0.00	0.11	0.03	15.73	6.04	12.84	0.07	0.06	89.20
460121	Bamboo mats/screens	0.04	0.14	0.09	0.58	0.57	0.65	37.09	6.45	6.91	0.50	0.09	89.44
460192	Bamboo plaits and plaiting material	0.00	0.00	0.04	0.01	0.92	0.04	23.86	3.32	12.99	0.53	0.33	93.02
460211	Bamboo basketwork	0.01	0.00	0.17	0.02	0.66	0.09	26.95	6.38	31.35	0.85	0.34	69.44
440210	Bamboo charcoal	0.00	0.00	0.09	1.23	2.25	20.10	24.73	8.66	7.68	0.60	0.81	54.73
440921	Bamboo flooring	0.24	0.00	0.36	0.04	2.68	0.77	27.39	2.55	3.58	2.18	0.07	92.74
441210	Bamboo plywood	0.22	0.00	2.15	0.04	3.40	0.56	22.92	10.56	28.54	6.52	0.14	75.94
470630	Bamboo pulp	0.00	0.01	0.01	0.00	0.46	27.18	29.20	20.10	15.99	0.93	7.37	42.06
482361	Bamboo paper-based articles	0.00	0.00	0.86	0.07	3.93	0.84	38.04	20.01	12.40	4.07	0.06	30.35
940151	Bamboo and rattan seats	0.04	0.01	0.18	0.01	1.69	0.22	30.07	16.82	30.63	2.45	1.15	11.27
940381	Bamboo and rattan furniture	0.05	0.09	2.65	0.02	2.99	0.19	33.52	27.74	25.32	2.60	0.37	42.49

Note: Kenya: Average derived from trade data of 2009, 2010 and 2013; Others: Average derived from trade data of 2014–2016

Source: UN Comtrade Database, 2017

4.2 Import and export scenario of bamboo products in Kenya

Figure 5 shows that import of bamboo products in Kenya is an increasing trend. The most imported bamboo product is bamboo plywood, followed by bamboo flooring. On an average, Kenya's annual total import value of bamboo and its products is about USD800,000. From the graphs below (Fig. 5 and Fig. 6), the import of bamboo flooring, plywood and bamboo and rattan seats, as well as furniture, is increasing. The data shows that the market for the bamboo products is growing in Kenya. The most exported/re-exported bamboo products from Kenya were bamboo and rattan furniture and bamboo mats/screens (Fig. 6). The average annual export value of these two products was less than USD300,000. This shows that Kenya is not able to harness the market opportunity in the world market, particularly the EU.

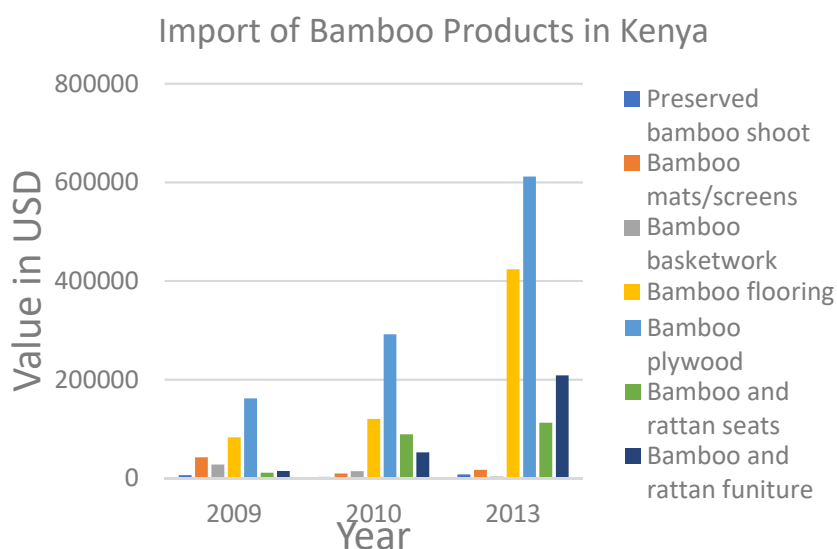


Fig. 5: Import value of bamboo products in Kenya

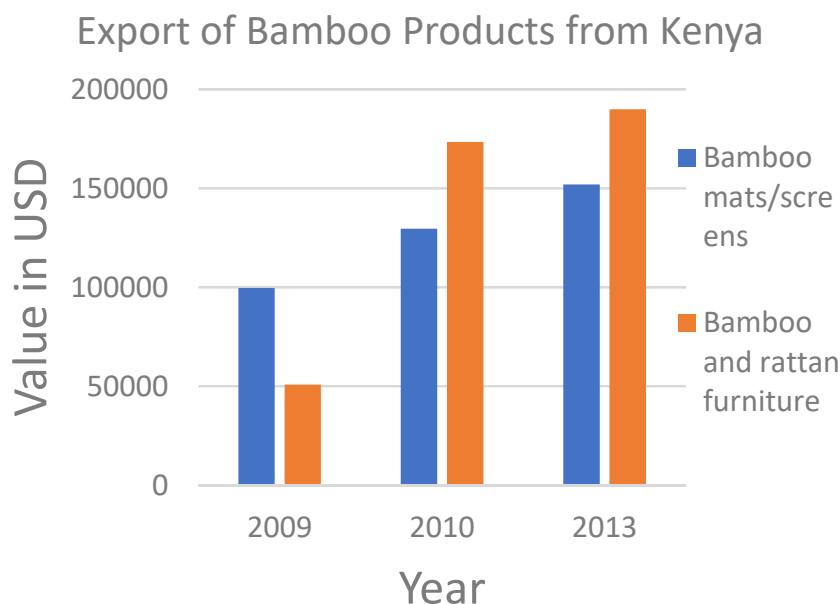


Fig. 6: Export value of bamboo products from Kenya

4.3 Import and Export Scenario of Furniture in Kenya

The Kenyan furniture market in 2013 was estimated to be USD496 million in sales, with a compound annual growth rate (CAGR) of 10 per cent between 1999 and 2013 (Creapo Oy, 2015). This growth was driven by urbanization, economic growth, housing and office construction. The Kenyan furniture market is serviced by the formal furniture sector, *jua kali* enterprises (the informal sector) and imports.

The trade statistics of the years 2009, 2010 and 2013 (Table 4) show that both the import and export value of furniture (wood, steel, plastic, bamboo and rattan, others) in Kenya is gradually increasing and the total average annual import is more than USD60 million for furniture, whereas its export is one third of that sum. Wooden furniture for general purposes is the most imported item, most importantly office furniture, bedroom and kitchen furniture. In total, about USD21 million worth of wooden furniture is imported annually. In addition, Kenya's annual imports of metal furniture, plastic furniture and bamboo/rattan furniture are valued at USD5 million, 1.2 million and 0.1 million, respectively. Like in exporting, Kenya exports/re-exports USD8.7 million worth of wooden furniture, USD1.8 million worth of metal furniture, USD4.6 million worth of plastic furniture and USD0.14 million worth of bamboo/rattan furniture. There is a great opportunity for alternating the wooden, steel and/or plastic furniture with bamboo, thus reducing the dependence on imported furniture. This is further supported by the furniture market, which is expected to grow at an 8 per cent CAGR between 2013 and 2018 (Creapo Oy, 2015).

Table 4: Import and export value of furniture in Kenya

HS Code	Product	2009		2010		2013		Average	
		Import (USD)	Export (USD)	Import (USD)	Export (USD)	Import (USD)	Export (USD)	Import (USD)	Export & Re-export (USD)
9403	Furniture and parts	19,248,892	9,522,713	28,945,563	10,658,144	44,529,638	13,329,750	30,908,031	11,170,202
940310	Metal furniture for office use	512,445	293,765	1,167,327	382,914	2,453,920	819,116	1,377,897	498,598
940320	Other metal furniture	1,792,556	2,042,448	3,549,864	881,759	5,604,260	1,169,094	3,648,893	1,364,434
940330	Wooden furniture for office	4,510,408	1,216,655	3,435,952	1,118,507	7,699,716	1,273,786	5,215,359	1,202,983
940340	Wooden furniture for kitchen	1,820,354	50,812	1,577,952	221,336	2,710,953	65,143	2,036,420	112,430
940350	Wooden furniture for bedroom	2,099,066	349,234	2,469,836	523,529	4,045,608	348,710	2,871,503	407,158
940360	Other wooden furniture	5,717,992	2,257,030	10,413,512	2,788,640	16,744,850	1,951,211	10,958,785	2,332,294
940370	Plastic furniture	382,601	2,739,176	2,060,073	4,208,784	1,272,571	7,084,632	1,238,415	4,677,531
940381	Bamboo or rattan furniture	14,834	50,942	52,551	173,494	209,137	190,058	92,174	138,165
940389	Other	2,022,409	475,299	3,692,983	297,303	1,981,066	353,539	2,565,486	375,380

Source: UN Comtrade Database, 2017

4.4 Import and export scenario of wood, wood articles and charcoal in Kenya

Kenya imports and exports a considerable amount of wood and articles of wood that account for more than USD26 million in imports and more than USD18 million in exports and re-exports (Table 5). Furthermore, a bamboo charcoal trade has started, though it is very negligible. Bamboo, a woody biomass, can be processed with available technologies into lumber, wood and bioenergy products.

Table 5: Import and export value of wood, wood articles and charcoal in Kenya

HS Code	Product	2009		2010		2013		Average	
		Import (USD)	Export & re-export (USD)	Import (USD)	Export & re-export (USD)	Import (USD)	Export & re-export (USD)	Import (USD)	Export & re-export (USD)
44	Wood and articles of wood and charcoal	19,963,362	12,970,322	28,107,793	10,851,297	45,910,191	30,672,712	26,247,956	18,164,777
4402	Charcoal: wood, nut charcoal and bamboo	64,538	8,059	2,364	3,693	12,846	21,568	29,490	11,107
440290	Wood charcoal, including nut charcoal	64,498	8,059	2,364	2,662	9,450	21,568	29,477	10,763
440210	Bamboo charcoal	40	-	-	1,031	-	3,396	40	2,214

Source: UN Comtrade Database, 2017

4.5 Import and export scenario of possible stick-based products

Kenya, on an average, imports incense sticks valued USD0.20 million annually (Table 6), which are primarily made from bamboo. There is a good market for incense sticks in the East Africa region (USD4 million) and the global exports of incense sticks are valued at USD250 million per annum (Refer to Annex 10). Currently, Kenya imports plastic-based Venetian blinds, valued at USD0.15 million per annum, and matches, valued at USD2.15 million, which can be easily alternated with bamboo stick-based products (Table 6). In addition, the global export market for bamboo mats and screens is valued at USD91 million.

Table 6: Import and export value of bamboo/other stick-based products

HS Code	Product	Value in USD							
		2009		2010		2013		Average	
		Import	Export	Import	Export	Import	Export	Import	Export
330741	Agarbatti and other odoriferous preparations which operate by burning	198,621	7,409	154,268	486	255,955	0	202,948	3,948
3605	Matches, other than pyrotechnic articles	3,188,994	465,009	2,236,175	316,359	996,846	1,078,909	2,140,672	620,092
392530	Shutters, blinds (incl. Venetian blinds) and similar articles and parts thereof, of plastics	107,702	58	132,974	6,946	192,928	6,379	144,535	4,461

Source: UN Comtrade Database, 2017

5. Resource Status and Policy Environment

5.1 Resource Status

The dominant species of bamboo in Kenya is the indigenous *Oldeania alpina*, formally known as *Arundinaria alpina* (K.Schum) or, most recently, *Yushania alpina*, locally known as *Mirangi* (Kikuyu), *Techani* (Pokot), *Tegek* (Kipsigis), *Tekek* (Sebei), *Modi* (Luo) and *Mianzi* (Kiswahili). In discussion with the government officials, it was revealed that most of the bamboo resources in Kenya are found within government forests (95 per cent). Private farmland has less than 5 per cent of bamboo. However, the resources in government forest cannot be harvested without a licence or permit from KFS.

Oldeania alpina, commonly grows in high altitude zones between 2,200 to 3,400m AMSL, and it prefers relatively cool annual average temperatures of 14–17°C (KEFRI, 2008; UNIDO 2009). Bamboo resources of this species are predominantly found in the Aberdares range, Mount Elgon, Mount Kenya, Mau and Cherang'any ranges. This species is estimated to cover an area of over 140, 000 hectares (KEFRI, 2008; Zhao et. al 2017). In Kenya, *O. alpina* is found mainly in areas of high agricultural potential where competition for land is intense. It is receiving attention from the government especially for catchment rehabilitation, regulation of water-flow and erosion control where it is a vitally important species. *O. alpina* is a tufted, sympodial bamboo with erect green culms ranging from 2 to 19.5m in height; 5–12.5cm in diameter; intermodal length ranging from 30–70cm; and wall thickness ranging from 2cm in bottom to 0.3cm in the top of the culm (UNIDO, 2009). The technical specification (Total height, diameter, wall thickness and inter-nodal length at different positions) of *Oldeania alpina* collected from Mount Kenya and the Aberdare Range are shown as Annexes 9A and 9B, respectively.

Bamboo clumps are sustained by a rhizome system, which annually produces new bamboo shoots. Due to their fast-growing nature, new bamboo shoots grow to their full height and become bamboo culms within a period of three months; and with the annual harvesting of 20–25 per cent of standing culms, it can yield 10tons/ha/year (Endalamaw, 2015). Culms of *O. alpina* are fully mature three years after they emerge, and thereafter, old culms start deteriorating, eventually dying and rotting (UNIDO, 2009). A study by Seyoum et al. (2014) shows that *O. alpina* culms need about three years for maturation and are suitable for industrial application. Thus, it provides an opportunity for annual rotational harvesting, providing annual income for farmers or collectors, sustained raw material for enterprises and industries and live intact bamboo culms and rhizome system that protect the soil and perform ecosystem functions.





Fig. 7: Bamboo habitat in Kenya

O. alpina, being the most important indigenous bamboo resource of southern and eastern Africa, is traditionally being used for producing a variety of handicrafts, furniture items, housing and fencing, props for agriculture and horticulture application. Numerous bamboo-working communities in the form of household, micro- and cottage industries produce traditional bamboo products such as basketry, mats, furniture and handicrafts items to cater to local market demand. In recent years, *O. alpina* bamboo has been used for manufacturing industrial products such as flooring tiles, blinds and curtains, stick-based products and as a bioenergy (UNIDO, 2009).

Studies on *O alpina's* wood properties, based on the bamboo samples collected from Ethiopia, have validated that this bamboo fulfils the ISO standards for industrial products such as bamboo plyboards, oriental standard boards, medium density fibre-boards, bamboo lumber, pulp and paper, charcoal, furniture and bamboo shoots (Endalamaw, 2015; Starke, 2014). Annexes 9A and 9B show the technical specification (total height, diameter, wall thickness and internodal length at different positions) of *Oldeania alpina* Bamboo slat-based product lines (floorboards, panels, matboards), stick-based product lines (curtains, incense sticks, toothpicks, matchsticks and other stick-based products), and bioenergy products are suitable to make. Since 1988, KEFRI has introduced over twenty Asian bamboo species into Kenya, namely: *Bambusa bamboos*; *B. laka*; *B. nutans*; *B. tulda*; *B. vulgaris*; *Cephalostachyum pergracile*; *Dendrocalamus asper* (Giant bamboo); *D. brandisii* (giant bamboo); *D. giganteus* (giant bamboo); *D. hamiltonii*; *D. membranaceus*; *D. strictus* (semi-solid/drought resistant bamboo); *Oxytenanthera abyssinica* (semi-solid/drought resistant bamboo); *Phyllostachys nigra* var. Henonis, *P. pubescens*, *Shlbataea kumasaka* and *Thyrsostachys siamensis*. Some of these are successfully growing in the field and on farms in western, central and coastal Kenya. Table 7 presents the bamboo species introduced by KEFRI in different locations in Kenya. The location details of the on-farm bamboo resources/bamboo cultivated on farmers' land are shown as Annex 7.

Table 7: Bamboo species introduced by KEFRI in different locations in Kenya

Location	Species
Kakamega	<i>Bambusa brandisii</i>
Nyabeda	<i>Dendrocalamus brandisii</i> , <i>B. vulgaris</i> , <i>B. bamboos</i> , <i>B. tulda</i> , <i>Dendrocalamus membranaceus</i> , <i>D. strictus</i> , <i>Gigantochloa aspera</i> , <i>Oxytenanthera abyssinica</i> , <i>Phyllostachys pubescens</i> , <i>Thyrsostachys siamensis</i>
Jilore	
Malindi	
Muguga	
Kaptagat	

Source: Field study, 2017

Among the introduced species, *Dendrocalamus brandisii*, in Kakamega and Nyabeda, is performing well (Table 8). *Bambusa vulgaris* is growing very well in varied eco-regions in the country. It is one of the easiest to propagate through vegetative propagation methods. *Oxytenanthera abyssinica* is performing well in the drier parts of the country, such as Kibwezi, Maragua and Migori.

Table 8: List of bamboo species that are performing well in different locations in Kenya

Location	Species with better performance
Kakamega	<i>Dendrocalamus brandisii</i> , <i>B. vulgaris</i> , <i>Dendrocalamus hamiltonii</i> , <i>D. strictus</i> , <i>B. tulda</i> , <i>D. asper</i>
Muguga	<i>Thyrsostachys siamensis</i> , <i>D. hamiltonii</i> , <i>B. vulgaris</i> , <i>D. brandisii</i> , <i>D. strictus</i>
Gede	<i>Bambusa vulgaris</i> , <i>Thyrsostachys siamensis</i> , <i>D. brandisii</i>
Jilore	<i>Bambusa bambos</i> , <i>Dendrocalamus membranaceus</i>

Source: Field study, 2017

5.2 Policy environment for cultivation and harvesting and tenure issues

Private Land: Although bamboo is not widely cultivated in Kenya, a few cooperatives, such as in Homa Bay and Migori, and a private company (Green Pot Enterprises) are currently involved in bamboo cultivation. The predominant species of bamboo on Homa Bay and Migori farmlands are *Bambusa vulgaris* and *Dendrocalamus giganteus*. Consultation with value-chain actors and enablers did not bring to light any significant policy issues on bamboo cultivation. The government considers bamboo as a key resource for land rehabilitation and poverty reduction. However, there are some policy issues in bamboo harvesting and transportation. The farmers/traders have to obtain harvesting and transportation permission from the concerned KFS office for transporting bamboo culms harvested from private land. The provision may have been introduced to prevent resource degradation of indigenous bamboo in natural forests, but application of the provision to the harvesting and transporting of bamboo from private lands entails additional administrative work for private bamboo-growers.

Government-Owned Forests: The government of Kenya has imposed a ban on bamboo harvesting from natural forests, through a verbal proclamation of the president in 1982, which had a huge impact on the bamboo sector as the natural forests hold more than 95 per cent of the bamboo stock in Kenya. Although the ban was aimed at protecting indigenous species from overharvesting, it has affected the overall development of the bamboo sector. It is important to note, the ban was not followed by the setting of clear and definite or specific guidelines for implementation of the ban (KEFRI, 2008). Only controlled harvesting is allowed, upon obtaining a special user-rights licence from the KFS. Since the execution of the ban in 1982, only two companies (Bamboo Trading Company and Green Pot Enterprises) have acquired a licence for the sustainable extraction of bamboo from the natural forests.

5.3 Transportation

Bamboo cultivation on private lands generally is in the accessible area; however, many roads are earthen. The transportation can be done in lorry. However, the government-management forests are in remote and mountainous areas with relatively less access. In such areas, transportation can be done by tractor from the forests to the road head. Then, transportation can be done in a lorry.

6. Existing and Potential Bamboo Products

In Kenya, bamboo is used as firewood, food and forage, a prop for commercial flower growing, production of tea-picking baskets and handicrafts. Furthermore, bamboo is used for fencing and rural construction. It is also used as a raw material for enterprises producing incense sticks and toothpicks. These activities provide job opportunities and additional income for the rural poor. The stakeholder workshop organised at KEFRI identified seven different products for market assessment (Table 9). After field visits and consultations with other stakeholders, two more products (timber and fibre) were added to the list. The identified products were grouped into three categories based on the intensity of value addition: i) construction materials with no or minimum-value addition, ii) small-scale enterprise products with moderate-value addition, and iii) industrial products with high-value addition. Culms for house construction and scaffolding fall into the first category. Likewise, handicrafts and furniture items fall into the second category. Finally, bio-briquettes, bamboo stick-based products, timber and fibre fall in the third category. Bamboo stick-based product production technology exists in Kenya, and the products (such as curtains/blinds, toothpicks, incense, barbeque sticks, etc.) have good domestic market potential. This product line basically uses the middle and upper part of bamboo. Hence, it can be associated with other industrial products, such as scaffolding, timber and board to maximise the resource use and minimise wastage. Finally, the study came up with the final products for detailed study (Table 10).

Table 9: Weighted score of potential products

Bamboo Products	Score
Culms for construction material (houses)	2.84
Culms for scaffolding, props for floriculture and horticulture industry	2.81
Handicraft	4.27
Furniture	3.45
Bio-briquettes and charcoal	3.66
Pellets	3.04
Bamboo stick-based products	2.75

Source: Field study, 2017

Table 10: Categories of products for detailed study

Existing and potential use of bamboo	Selected bamboo products
Local-use products	Culms for construction material (houses)/scaffolding, props for floriculture and horticulture industry
Small-scale enterprise products	Handicrafts, furniture items
Industrial products	Pellets, bio-briquettes and charcoal, bamboo stick based-products, timber, fibre

Source: Field study, 2017

7. Value-Chain actors and their Functions

Actors involved in the bamboo value chain can be categorised into different types according to their functions along the chain. They are farmers, traders and their agents, processors, wholesalers, retailers and consumers. A short description of each actor and their respective functions is illustrated in Fig. 11 and described in the following section.

7.1 Input suppliers

In Kenya, nursery owners are the major input suppliers in the bamboo sector. There are a few large-scale nurseries that produce large quantities of seedlings. All nurseries are either producing bamboo plants from seeds or through vegetative propagation. Kitil Farm produces bamboo plants from seeds and also plantlets¹ grown in the laboratory (Figure 9). The farm has a capacity for producing two million seedlings and three million plantlets per year (Figure 8). The price of seedlings varies from Kenyan shilling (KSh) 200 to 500, depending on the size and age of the plants. Plantlets, on the other hand, are being sold, mostly exported to international markets, at the rate of KSh50 per plantlet. The plantlets can be produced in 30 days, but they need to be kept in polybags in green houses for 9-14 months when the seedlings will be ready for transplanting.



Fig. 8: Nursery at Kitil Farm



Fig. 9: Laboratory at Kitil Farm

Likewise, TIRIKI Tropical Gardens and Farm at Kaimosi, in western Kenya, has a production capacity of about 100,000 seedlings per year. The selling cost of a seedling is KSh200–300. It is the only nursery of this scale in the area of Kaimosi. The nursery is selling seedlings mostly to donor-funded projects and to GOs/NGOs, such as the National Environmental Management Authority (NEMA) and KFS, particularly for conservation and landscape rehabilitation purposes. For instance, the nursery sold 14,000 seedlings to a World Bank-funded project in 2014 and it plans to supply to KEFRI this year.

Value Chain Analysis and Market Assessment of Bamboo Products in Kenya

Similarly, Green Pot Enterprises (GPE) has two nurseries at Mau Narok, in the Rift Valley (Fig. 10), and Nyeri, in Central Kenya, for their own plantations, contract farming and selling to third parties. The production capacity of nurseries is about 600,000 plants/annum. GPE has planted more than 200,000 bamboo seedlings in Mau Narok and Transmara – both areas located in the Rift Valley. It also has satellite farmers in Central Kenya, the Rift Valley and Upper Eastern Kenya. In addition, Global Bamboo is another leading bamboo nursery. KEFRI has nurseries at different places in Kenya, which produce and sell bamboo seedlings, mostly from cutting, along with other species, such as eucalyptus and pine. Likewise, farmers associated with cooperatives in Homa Bay and Migori also have small-scale nurseries. Seedlings are sold mostly through development organisations directly, or through middlemen.



Fig 10: GPE bamboo nursery in Eor Ekule, Narok County (Rift Valley)

Based on the observations and meetings with nursery operators, it is important to note that the sale of the bamboo seedlings is comparatively low. The main reasons could be the high cost of seedlings, KSh200–500 per bamboo plant, which is rather high compared to tree seedlings raised from seed, ranging from KSh10–50 (grafted tree seedlings cost from KSh100); lack of awareness of the potential of bamboo and the ready market for sale of bamboo poles. Nursery operators observed that the cost of bamboo plants could be largely reduced if the scale of sales increases. In addition, production of seedlings from bamboo seeds, instead of from bamboo cuttings, reduces input materials and transportation costs, as the seedlings from cuttings need extensive management during initial phases (till rooting) and require bigger polybags, which are costly

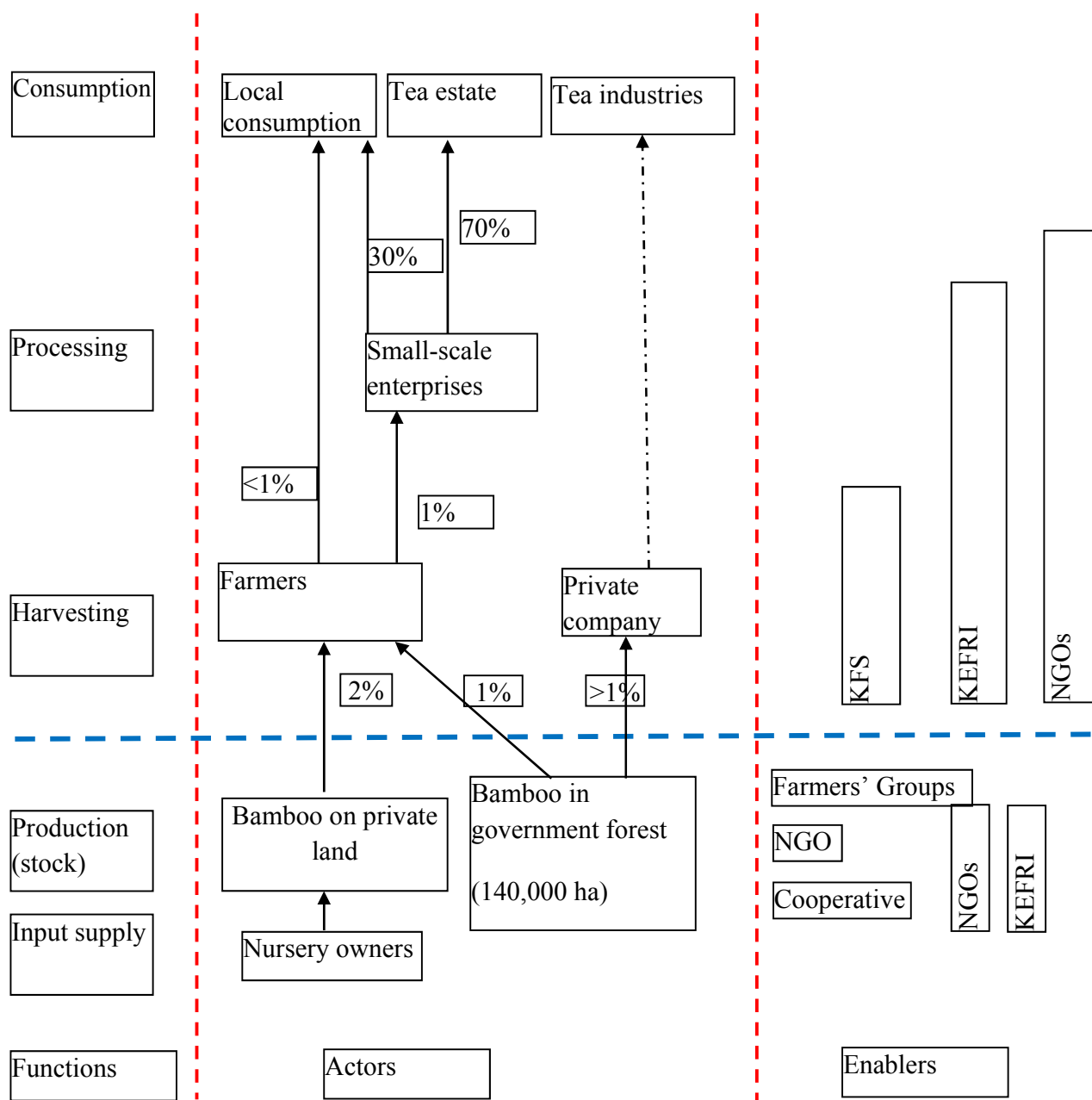


Fig. 11: Bamboo value chain map in Kenya

7.2 Producers

Bamboo producers in Kenya can be categorised into two groups: small-scale farmers and private companies. The farmers cultivating bamboo are mostly small-scale, with an area of 0.5 to 3 acres. Four farmers' groups were formed during the year 2006 (Homa Bay Bamboo Farmers' Group, Migori Bamboo Farmers' Group, Kuria Bamboo (Imiere) Farmers' Group and Suba Bamboo Farmers' Group). In fact, bamboo cultivation was introduced in Kenya, mostly in South Nyanza, by research project "Tobacco to Bamboo" a decade ago (Kibwage et al., 2008). Each group had 30 tobacco and non-tobacco farmers (Kibwage et al., 2009). These groups are mainly engaged

Value Chain Analysis and Market Assessment of Bamboo Products in Kenya

in bamboo farming/production as an alternative crop to tobacco and as a long-term strategy of livelihood diversification, poverty alleviation and environmental conservation in the region. These farmers cultivate mostly exotic bamboo species, such as *Bambusa vulgaris*, *Dendrocalamus giganteus* and other species introduced from India or China. The plantations established through the Tobacco to Bamboo project intervention are already mature for harvesting. However, none of the farmers are able to sell bamboo culms to organised enterprises, except for local use for making TV antennae, fencing, use as fuelwood, rudimentary furniture and propagation to produce seedlings. The farmers are desperately waiting for the market and some level of frustration among them can be seen.

In recent years, GPE has been promoting bamboo plantations in different locations in Kenya. The company has basically adopted three approaches to promoting bamboo production: cultivation on one's own land, cultivation on leased land from farmers, contract farming with local farmers and also large-scale land restoration. In leasing, the land is leased for thirty years and in contract farming, contracts are signed with farmers for fifteen years. Farmers are free to sell their bamboo produce to anybody after the contract period ends. The company provides bamboo seedlings to farmers on a 50 per cent down payment, and the farmers can pay back the rest of the money in the first harvest.

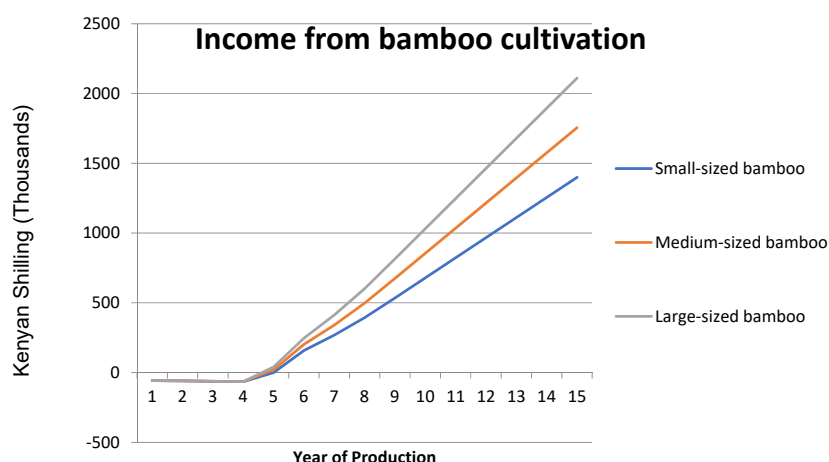


Fig. 12: Income from bamboo cultivation in an acre (Source: Field Study, 2017)

Based on a focus group discussion with Homa Bay County farmers and expert consultation, a conservative estimation of cost and income of bamboo cultivation was carried out to illustrate the potential of bamboo cultivation (Figure 12). The estimation was done considering 200 clumps in an acre, using the fifth year of cultivation as the first harvesting year. In the fifth year, five culms can be harvested from a clump, followed by six culms in the sixth year, seven culms in the seventh year, eight culms in the eighth year and nine culms in the ninth year onward (Agrifarming, 2017). The estimation shows that the farmers realise annual income starting from the fifth year of planting/cultivation. Income from large-sized or large-diameter bamboo species is the highest, followed by medium- and small-diameter bamboo varieties/species. The difference in income is mainly because of the price difference according to the size of bamboo poles. However, the estimation does not consider the possibility of intercropping. The detailed cost and income analysis is presented in Annex 6.

7.3 Traders and their agents

Traders and their agents are largely missing in the bamboo value chain in Kenya because the market for bamboo is poorly developed. Those who need bamboo for local use or processing go to farmers directly and transport the bamboo on their own. However, Kapi Industries, located at Nakuru, used to purchase bamboo from middlemen at KSh100 per culm, mostly *O. alpina* species. The industry

had been producing incense sticks since 1964 till it stopped production in 2014, when it also stopped buying bamboo anymore. The production was stopped when the company started importing bamboo sticks from Vietnam at a cheaper price.

7.4 Processors

Processing of bamboo is very limited in Kenya. There are about a dozen enterprises, mostly small-scale, that are producing furniture items, such as chairs, tables, shelves, handicrafts, such as penholders and baskets, decorative items and kitchen utensils. However, they are limited to the local level and most of them lack formal market linkages. For instance, Madoya Tumaini Youth Group, with 32 members, at Huruma, Nairobi County, is a bamboo enterprise established in 2010 with support from Collective Community Action (Figure 13). The enterprise is heavily subsidised by development agencies, including KEFRI, but the enterprise is not fully functional. It is surprising to know that the enterprise is not sourcing any piece of bamboo but managing with the stock provided by the Collective Community Action during establishment and some provided by KEFRI. This indicates the scale of production.



Fig. 13: A bamboo enterprise at Huruma



Fig. 14: Tea-picking baskets at Githunguri, Central Kenya

The enterprise used to produce handicrafts and kitchen utensils, such as cooking sticks, on a small scale and sell them to the locals who came to the enterprise to buy. In a discussion, the leader of the group confessed that the group, in fact, never tried to market its products. Similar is the situation with the enterprises located in South Nyanza. Despite several trainings provided by various development agencies in making bamboo products, the skills learned at the training were seldom applied in practice. Whatever limited items they produced, finding a market was difficult. The products were being sold locally in negligible quantities. Nevertheless, an entrepreneur from Kaimosi used social media, such as WhatsApp and Facebook, to advertise their products and sell them to consumers in urban areas, mostly political leaders and businessmen, for their personal use.

One product with a regular market is bamboo baskets for tea picking (Figure 14). Bamboo baskets are being produced by the communities around Mau Forest, the Aberdare Range and Mount Kenya forests, where there is a good stock of bamboo in government-managed natural forest. The baskets are sold directly to tea estates around the area. Similarly, individuals in Oleng'uruone (close to Mau Ranges), Kericho, Kakamega, Kiambu and Nyeri Counties are also producing bamboo baskets.

7.5 Wholesalers and retailers

Wholesaling activities of bamboo culms are largely missing as there is no commercial use for bamboo. Until a few years ago, Kapi Industries used to buy bamboo culms in bulk from middlemen for incense stick production. However, as pointed out above, the industry stopped buying bamboo culms as it stopped production of incense. According to an official from Kapi, the reason for stopping the production was the high cost of production of sticks. The company is now importing bamboo sticks from Vietnam.

There are handicraft shops in Nairobi where bamboo products can be sold and shopkeepers are also interested in selling. Unfortunately, not a single piece of bamboo product could be found. Bamboo culms or poles are also not traded in Nairobi. During the whole study period, only a shop at a street market in Nairobi was found to have a few pieces of bamboo culms, which is sold to consumers for use as electrical lamp posts or as television antennas (Figure 15). According to retailers, no entrepreneur ever came to them with bamboo products to sell. During discussions, the retailers of handicrafts said that the buyers believed that bamboo handicrafts were of inferior quality, as bamboo is a non-durable material.



Fig. 15: Handicraft products similar to bamboo products on the street markets of Nairobi

7.6 Consumers

Bamboo culms and bamboo products have not reached consumers. Locals have no or little knowledge on the use of bamboo. Some of the local communities in bamboo-growing regions use bamboo, although in very limited fashion, for making fences, house construction (semi-permanent houses), fuelwood, charcoal, TV antennae, etc. Only a few people living around bamboo enterprises buy low quality/cheaper bamboo products. A few high-end consumers buy bamboo furniture from the enterprises directly, on a very small scale. For instance, TIRIKI Tropical Gardens and Farm at Kaimosi is selling bamboo furniture to few consumers in cities, mostly political leaders.

8. Enablers and their Functions

A few GOs and NGOs are working to promote the bamboo value chain. KEFRI is one of the key GOs promoting the bamboo sector in Kenya. It has developed a guideline on bamboo cultivation (Kigomo, 2007). Likewise, it operates well-equipped training centres in KEFRI Karura, Nairobi and the Rift Valley Eco-Region Research Programme, Londian, where it provides training in bamboo product-making to potential entrepreneurs (Fig. 16 – Fig. 19). The training centres are well-equipped with different machines and tools such as splitting knives, drilling machines, hole saws, general carpentry tools, preservation troughs, working benches, pressing machines, four-sided moulding machines and two-sided knot removing machines. The training centres provide training in three product lines – furniture, handicraft and weaved products (curtains and tablemats). Each centre provides training to two to three groups of 20 persons annually.



Fig. 16: A bamboo-processing machine at KEFRI – Londiani, Rift Valley



Fig. 17: The bamboo-splitting machine at KEFRI – Karura



Fig. 18: An aerial view of some of the bamboo-processing machines at KEFRI – Karura



Fig. 19: A bamboo-weaving machine at KEFRI – Karura

KFS is another key enabler that has a mandate to regulate harvesting and ground level conservation of bamboo in government-managed forests, as well as to develop policy and strategy for bamboo sector development. As bamboo pole extraction from government forests is prohibited for commercial purposes, KFS is doing very limited bamboo sustainable management work.

Currently, bamboo forests are mainly intended for conservation purposes (to protect the “water towers”). Key activities of KFS related to bamboo development are planting bamboo for slope stabilization, gully plugging, riverbank protection and soil erosion control. On the regulatory and/or governance part, KFS issues licences to private companies for controlled harvesting and to sustainably manage the bamboo forests to perform ecological and economic functions. It is important to note that KFS have given out special user rights or concessions to a private company, located at Kamae, to manage the indigenous bamboo (along with adjacent Community Forest Associations) to harvest and/or utilise the dead/dried bamboo into fuel wood for tea factories. It is important to note, bamboo forests in government forests are largely unmanaged, posing fire hazards due to a huge fuel load of dead/dried bamboo and old bamboo, leading to congestion and a lack of space for new bamboo shoots to emerge and flourish.

The other enablers in the bamboo sector are NGOs and development projects. A few NGOs, namely VIRED (Victoria Institute of Research in Environment and Development) at Kisumu and Green Belt Movement (GBM) at Muranga, are promoting bamboo in their project target locations, mainly aimed at land rehabilitation. In addition, GBM trained a few groups for making bamboo products. But, due to the shortage of raw materials and lack of a market, the trained groups are not producing products and/or are producing products in very limited numbers. The land rehabilitation or plantation is being mostly done in the governmental lands; hence, the community has no access or it is difficult to harvest bamboo. These NGOs mostly buy seedlings from private nurseries and distribute them to farmer groups for conservation purposes; however, in some cases, they also produce seedlings in limited quantities.

In addition, Kenya VISION 2030 is a long-term development blueprint which aims to make Kenya “a globally competitive and prosperous country with a high quality of life by 2030”. The vision is based on three pillars, namely: The economic pillar (improving prosperity), the social pillar (social equity, clean and secure environment) and the political pillar (realise democratic political system, protect the rights and freedom of citizens). The realisation of the action plan of economic and social pillars directly provides an enabling environment for the promotion of the bamboo sector. For instance, Kenya Vision 2030’s flagship activities/targets are directly relevant to bamboo sector development: (a) creating at least five small and medium enterprise industrial parks to promote manufacturing; (b) rehabilitating and managing of five water towers to protect the environment and (c) ensuring equity and eliminating poverty.

8.1 Other business-enabling factors

Other business-enabling environments, such as (1) support from Kenya Investment Promotion Agency (KenInvest) for investment, registration, exit and transfer, ownership, access to land and banking; (2) exit and transfer of property; (3) ownership on investment and land; (4) electricity and its tariff; (5) potential human resources, labour rates and conditions; (6) taxation provisions; (7) intellectual property rights and (8) transport and shipping (railway transport and sea freight cost) are explained below:

8.1.1 Investment promotion agency: one-stop center

Kenya is actively engaged in the promotion of domestic and foreign investment in various sectors, including agricultural and natural resources. KenInvest a dedicated agency established in 2004 is aimed at promoting investment into Kenya is mandated to provide advisory services to government to improve investment environment; provide pre-investment and post-investment facilitation services to investors (<http://www.investmentkenya.com/>; invest.go.ke). Key information required for the investors was extracted from the *United Nations Conference on Trade and Development (UNCTAD): Investment Guide to Kenya – Opportunities and Conditions 2012* (UNCTAD, 2012) and from KenInvest (www.investmentkenya.com).

In Kenya, for any foreign investor, it is necessary to obtain an “investment certificate to operate business” from KenInvest. A foreign investor is required to invest a minimum of USD100,000 and also must show that the investment is beneficial to Kenya, such as employment benefits, skill upgradation, technology transfer, foreign exchange generation, tax revenue generation, etc. A local investor

who does not hold an investment certificate shall register the investment with the authority. The benefit of the investment licence is avoiding other extensive licensing requirements, initial insurance, work permits, etc. Nevertheless, there is no legal differentiation of treatment between local and foreign companies.

8.1.2 Exit and transfer of property

Exit and/or transfer of property and investment is flexible, depending on the agreement between investor and buyer. Investment certificates can be transferred with written approval of a competent authority. The banking sector in Kenya is well developed, with 44 registered banks, and repatriation of profits is allowed.

8.1.3 Ownership on investment and land

Kenya provides 100 per cent ownership for investments in many sectors except information communication technology, insurance, air services and the stock market. Likewise, the government can allocate government trusts and private lands to foreign investors on lease for a maximum of 99 years.

8.1.4 Electricity and its tariff

Electricity generation in Kenya is liberalised, with several licenced electric power producers, distributors and transmission utilities. The net electrical energy from the power generating plants is bought by the Kenya Power and Lighting Company (KPLC) through power purchase agreements (PPAs). The energy is then conveyed over transmission systems owned by KPLC or the Kenya Electricity Transmission Company (KETRACO), both of whom are licensed by the Energy Regulation Commission to provide transmission services. Then, finally, KPLC carries out distribution and retail supply of the electrical energy to customers in accordance with licences and permits issued to it by the commission. The commission also approves the retail tariffs charged for the supply.

Currently, the percentage of Kenyans connected to the electricity grid is 44.85 (Kenya power connectivity performance as of October 2017). The electricity tariff in Kenya is presented in Table 11.

Table 11: Energy tariff scheme in Kenya

Nature of consumption	Supply volt	Minimum units	Fixed rate (KSh)	Per unit rate (KSh)
Domestic consumers	240 or 415	15,000	150	- 2.5/unit for 0-50 units consumed - 12.5/unit for 51-1,500 units consumed - 20.5/unit for units consumed above 1500
Non-domestic small commercial consumers	240 or 415	15,000	150	- 13.5/unit for all units consumed
Commercial and industrial consumers	415	15,000	2,500	- 9.20/unit energy charge - 800/kVA demand charge
Commercial and industrial consumers	11,000	-	4,500	- 8/unit consumed - 520/kVA demand charge
Commercial and industrial consumers	33,000	-	5,500	- 7.5/unit consumed - 279/kVA demand charge
Commercial and industrial consumers	66,000	-	6,500	- 7.3/unit consumed - 220/kVA demand charge

Nature of consumption	Supply volt	Minimum units	Fixed rate (KSh)	Per unit rate (KSh)
Commercial and industrial consumers	132,000	-	17,000	- 7.1/unit consumed - 220/kVA demand charge
Interruptible off-peak supplies to ordinary consumers		15,000	17,000	- 13.5/unit consumed
Public and county government (street lights)	240 or 215		200	- 11/unit consumed

Source: ERC 2013

8.1.5 Potential human resources, labour rates and conditions

The unemployment rate in Kenya is an increasing trend. A recent survey by the World Bank shows that unemployment in Kenya has increased from 18.8 per cent in 1991 to 22.2 per cent in 2016 (World Bank, 2016). The bamboo sector in Kenya can provide employment opportunities in rural and urban areas. In discussion with the communities during field visits, it was revealed that labour wages are relatively cheap in rural Kenya. The daily wages are around KSh200–500, depending on the region. This is an excellent opportunity for the industry to come up. The wages in urban area are comparatively high; however, if differently-abled people are trained in handicraft making, that may bring a win-win situation for both entrepreneurs and job seekers.

Labour: Normal working hours consist of a maximum of 52 hours per week, with one day of rest. Employees are entitled to 21 days of annual leave, seven days of sick leave, with full pay, and seven additional days of sick leave, with half-pay. In addition, Kenya has about 10 days of public holidays per annum. Tables 12 and 13 show the minimum wage rates fixed under the Labour Institutions Act, published on 27 July 2017 (GoK, 2017).

Table 12: Labour wage rate in agriculture sector

Occupation	Per Month (KSh)	Per day (KSh)
Agriculture unskilled	6,415	269
Farm foreman	11,574	489
Farm clerk	11,574	489
Farm artisan	7,668	326
Tractor driver	8,131	345
Combine harvester driver	8,958	380
Lorry driver/car driver	9,401	399

Table 13: Labour wage rate in different areas of Kenya in general

Occupation	Nairobi, Mombasa and Kisumu		All former municipalities and towns of Mavoko, Ruiru and Limuru		All Other Areas	
	Monthly contract (KSh) cts	Daily Rate (KSh) cts	Monthly contract (KSh) cts	Daily Rate (KSh) cts	Monthly contract (KSh) cts	Daily Rate (KSh) cts
General labourer	12,927	622	11,926	571	6,896	350
Logger	13,961	671	12,386	593	7,968	394
Machine attendant	14,651	704	13,634	659	11,050	534
Plywood machine, saw mill operator	17,447	838	16,103	774	13,310	640
General clerk, receptionist	19,909	957	18,202	875	15,520	744
Ungraded artisan	17,447	839	16,103	774	13,310	640
Artisan grade III	21,942	1,056	20,167	971	17,948	878
Artisan grade II	23,699	1,162	22,602	1,177	20,399	979
Artisan grade I	29,169	1,404	27,449	1,321	25,737	1,237

8.1.6 Markets

Kenya has market access to the EU under the Generalised System of Preferences (GSP) agreement; unrestricted entry into the USA market under the African Growth and Opportunity Act (AGOA) for specified Kenyan products and unrestricted market access to COMESA, a market of 400 million people.

8.1.7 Taxation

Kenya has double taxation avoidance agreements with the United Arab Emirates, the UK, Germany, India, Canada, Norway, Sweden, Denmark, Zambia, France, South Africa, and is currently negotiating a number of others with various countries.

Personal income tax: There are five income tax slabs – 10 per cent, 15 per cent, 20 per cent, 25 per cent and 30 per cent, depending on the income from business, employment, rent, dividends, interest and pensions, among others.

Corporate tax: Investment in machinery and manufacturing enjoys 100 per cent tax deduction. Investors in export processing zones enjoy 10-year tax holidays, followed by a 25 per cent corporate tax rate for following 10 years.

Value-added tax: The normal rate of VAT is 16 per cent.

8.1.8 Intellectual property rights

Kenya is a member of World Intellectual Property Organisation (WIPO) and the African Regional Industrial Property Organisation as well as the Trade-Related Aspects of Intellectual Property Rights (TRIPS). The Kenya Industrial Property Act, 2001, provides protection for intellectual property rights generators under civil and criminal proceedings. Other institutions, such as Kenya Industrial Property Organisation (KIPI) are in place to grant industrial property rights; the Kenya Copyright Board and Anti-Counterfeit Agency are in place

to provide necessary protection. Foreign applicants are entitled to right of priority and international filing.

8.1.9 Transport and shipping

Mombasa is the main port in Kenya, which handled about 19 million tons of cargo in 2010. In addition to Kenya, it also serves as a port for Uganda, South Sudan, the Democratic Republic of Congo, Rwanda, Sudan, Somalia and some parts of Tanzania and Ethiopia.

Railway transport: Railway accounts for four to six per cent of cargo transported in and out of Port Mombasa (SCEA, 2015). Transportation of shipment from Mombasa Port to inland are expensive compared to transporting goods from inland to port due to lesser movement of goods into Mombasa Port.

Table 14: Cost of shipment from Mombasa to inland and vice versa

Size of container	From Mombasa (USD)		To Mombasa (USD)	
	Nairobi	Kampala	Nairobi	Kampala
20 feet	500	1250	200	600
40 feet	1000	2200	400	700

Source: SCEA, 2015

Sea freight cost analysis: Table 15 shows the cost involved in export of goods in 20 feet container from port to different destinations in the world. The cost of shipping a 20 feet container to North America, Europe, the Middle East and Asia-Pacific was about USD5500, USD 4500, USD3500 and USD4800, respectively, in 2016.

Table 15: Cost of shipment to different parts of world from Mombasa port in Kenya

Year	North America (USD)	Europe (USD)	Middle East (USD)	Asia-Pacific (USD)
2012	4900	3400	2600	4200
2014	5000	4000	3000	NA
2016	5500	4500	3500	4800

Source: SCEA, 2015

Based on the World Bank's business data for shipment of a 20 feet container, the cost of handling shipments in East African countries is much higher compared to China (~ 10 times), EU (~ 2 times), USA (~ 4 times) and approximately twice the cost of the global average (Refer to Table 16).

Please note: (1) The cost includes (a) fees levied, (b) procedural compliances to export or import the goods, (c) documents, (d) administrative fees for customs clearance and technical control, (e) customs broker fees, (f) terminal handling charges and (g) inland transport. And, (2), the cost measure does not include tariffs or trade taxes. Only official costs are recorded.

Table 16: Cost of shipment from Kenya to different countries in the world

Country Name	Country Code	Cost (USD)				
		2010	2011	2012	2013	2014
China	CHN	275	275	319	823	823
Ethiopia	ETH	2180	2180	2180	2180	2380
European Union	EUU	1034	1045	1039	1035	1042
Kenya	KEN	2055	2055	2255	2255	2255
North America	NAC	1145	1145	1157	1422	1452
Netherlands	NLD	925	925	925	925	915
Uganda	UGA	2780	2880	3050	2800	2800
United States	USA	630	630	654	1164	1224
World	WLD	1369	1389	1461	1530	1560

Source: World Bank, 2017

9. Existing Status and Future Potential of Bamboo

The status and future potential of bamboo products are discussed for three categories based on the intensity of value addition: i) construction materials and local-use products; ii) small-scale enterprise products and iii) industrial products.

9.1 Construction materials and local use products

Although, currently there is no tangible practice of using bamboo as a construction material, it has huge potential in the housing and construction sector, such as scaffolding, construction of rural dwellings, houses and eco-tourism resorts, as shown in Figure 20. The building that was done in the school was a prototype. During field visits to the South Nyanza area, it was observed that more than 70 per cent of the rural houses were made of mud, using eucalyptus poles and branches as reinforcement. Based on discussion with local communities, crude estimations on costs of constructing houses using eucalyptus poles vs. bamboo showed that the cost of houses made of bamboo would be less, or almost equal, to that of houses made of eucalyptus. Surprisingly, even bamboo farmers were not using bamboo from their own farms to make their own houses and were instead buying eucalyptus. When asked why, one bamboo farmer said, "I don't want to waste bamboo in making houses; it is valuable. One day a factory will come and buy all my bamboo and I will become a millionaire."



Fig. 20: Use of bamboo as roof trusses at Moi Siongiroi Girls School in Bomet County

9.1.1 Resource availability

Kuria, Homa Bay, Migori, Ngorika and Suba Counties are some of the areas where about 600 farmers are cultivating bamboo (*Bambusa vulgaris*, *Dendrocalamus giganteus* and *Bambusa tulda*). The number of clumps of bamboo with each household ranged from 20 to a few hundred. As the bamboo were planted in 2008, the bamboo are already mature for harvesting. Others are farmers in Maragua, Muranga County under the GBM who have planted *Oxytenanthera abyssinica*. GPE have also planted *Dendrocalamus asper* and *D. membranaceus* in Narok County and have contracted farmers in Narok and Nyandarua Counties. Resource is not a problem. Development efforts are needed to demonstrate and capacitate the local communities on use of bamboo in construction, making scaffolding and supplying to floriculture/horticulture industrial farms. Prevailing forest policies do not restrict harvesting and selling of bamboo culms produced on farmlands. However, a transportation permit is needed to transport them out of the counties.

9.1.2 Technology and skilled human resources available

Although eucalyptus can be replaced by bamboo in the construction of rural houses, as houses made of bamboo are relatively economical and durable (personal communication with experts, 2017), there is no local technology available. Local communities do not have any knowledge of usage of bamboo as a construction material. In addition, bamboo is a less durable material when immature and/or untreated poles are used. It is important to impart knowledge on harvesting the right bamboo culms as well as information on preservation against insect and fungal attack. Likewise, skilled human resources that could build houses or make scaffolding of bamboo are not available.

9.1.3 Investment required and capacity to invest

The major investment required will be technology transfer for construction of bamboo houses and in training human resources in selecting, harvesting, treating bamboo culms and constructing techniques. To bridge the gaps, project intervention is essential in technology transfer, capacity building and facilitation.

9.1.4 Environmental impacts/carbon footprint

As bamboo is a fast-growing, renewable resource, using it in construction does not involve extensive processing activities. With treatment, bamboo houses can have a longer shelf-life; this will help in both carbon sequestering and storage. However, long shelf-life and durability happens only when bamboo is treated chemically, which may have an environmental impact if the effluent is not handled properly.

9.2 Handicrafts and furniture

As stated earlier, bamboo handicrafts and furniture-making are being done by local communities and individuals in Nairobi and rural areas, such as Migori and Kaimosi. However, bamboo products, especially furniture, have not reached the desired market. There is a clear disconnection between the existing enterprises and market. The bamboo furniture, if produced to meet the quality and price requirements of the market, can generate a good demand for office and home furniture. Kenya, with its growing population, as well as economy, has a rapidly growing demand for furniture. According to the report of the Ministry of Industrialization and Enterprise Development (MoIED, undated) the wood furniture and timber sectors combined together employ over 160,000 people per year, and the furniture market value was estimated at USD 496 million in 2013, with an annual growth rate of about 10 percent annually. In addition, Kenya's total average import of furniture is valued at USD60 million/annum (refer Table 4).

On the handicraft and basketry front, a large number of communities currently produce tea collection baskets and sell locally. Kenya has about 260,000 small-scale tea farmers with about 63,000 tea pickers. They are the market for the tea baskets. The existing handicraft and basketry products are confined to the traditional market segment.

Despite the existence of a potential market for bamboo handicrafts and furniture items, the value chain is very weak. The forward and backward linkages of bamboo handicraft enterprises are weak, where projects need to intervene, particularly in demand creation, technological improvement, product diversification and capacity building of entrepreneurs in production and market linkages.

9.2.1 Access to raw materials

Although accessing raw materials, particularly bamboo, is relatively easy for the enterprises located in rural areas, it is difficult for the enterprises located in urban areas. There is not a single wholesale or retail depot of bamboo in any town and city in Kenya. The entrepreneurs have to directly source bamboo raw materials from farmers. As most of the enterprises are small in scale, their requirement for bamboo is low; it is impractical for them to go directly to farmers for purchase and transport of small quantities of bamboo. It is found that enterprises located in Nairobi are generally sourcing a few pieces of bamboo from KEFRI, or are still using the same stock which was supported by an NGO during the establishment of the enterprise a few years back. This clearly indicates the level of consumption of raw material. Rural enterprises which are located far from bamboo production areas are also facing similar raw material limitations.

9.2.2 Access to markets

Forward linkage is very weak in either of the cases. Although a number of people are trained in producing handicraft and furniture items, they are not aware of the markets. In other words, they do not have the capacity to reach the market. Enterprises located both in rural and urban areas are selling their products in surrounding areas in negligible quantities, except tea-picking baskets. They neither have their own sales outlets, nor have contacts with any shop in cities. The scale of production is another challenge for accessing the market. The existing enterprises are scattered, with small or negligible production; even if any middlemen want to take the products to the urban areas, the transaction cost is high. Furthermore, bamboo handicraft and furniture enterprise activities are considered as part-time activities to generate additional income.

9.2.3 Technology and skilled human resources available

Small-scale bamboo enterprises do not need advance technology; they need simple tools, such as hand splitters, handsaws, knives, hammers, chisels, drill machines and bench presses, in addition to skilled human resources. For instance, bamboo in the South Nyanza area can be used for making bamboo baskets for tea picking for the market – tea estates are not far from the area (such as Kisii and Nyamira) – but many locals lack skills in basketmaking. On the other hand, many development agencies are providing training to locals in making handicraft and furniture items, but such training is being given without assessing the potential market demand. There are a few places in Nairobi where furniture, baskets and handicrafts made of materials other than bamboo can be found. Although such products can also be made of bamboo, no efforts are made to produce such products that already exist on the market. A few years ago, a development agency sent a few potential entrepreneurs to China to learn different bamboo-product-making skills. According to one of the participants, the training was not very useful as the technology used in China was very sophisticated and, as a result, the participants got discouraged as such technologies were either not available in Kenya or were inaccessible to small-scale entrepreneurs.

9.2.4 Investment required and capacity to invest

Although small-scale furniture and handicraft enterprises do not need much investment, entrepreneurs were unable to invest even on a minimum level (USD200–300). A list of equipment required for a small-scale furniture and handicraft enterprise is given in Annex 4. With few exceptions, entrepreneurs have neither the capacity to invest on their own, nor have access to financial institutions. In Kenya, sources of finance for small-scale enterprises are moneylenders, *chamas*¹, banks and shareholding or equity investments (FSC Kenya, 2016). However, bamboo being a new sector, banks generally may be hesitant to finance the sector. This may limit the growth of their production scale, even if they get a good market for the products.

¹ *Chamas* is an informal cooperative society that is normally used to pool and invest savings by people in East Africa, and is particularly prevalent in Kenya.

9.3 Industrial products

Potential industrial products of bamboo are bamboo stick-based products, chopped bamboo chips and pellets for energy, boards, timber for flooring and furniture and fibre for textiles for domestic use and export. Global import and export data (Table 2 and Table 3) show that there is high demand of bamboo products in global markets, particularly in the EU and USA. A private company in Kenya, Bamboo Trading Company, has been issued a special user-right permit or licence from KFS to harvest bamboo sustainably from 3,000ha of government-managed natural forest to produce chopped pieces of bamboo. The company plans to sell biomass to tea processing companies for biofuel, but the deal has not materialised yet. The company has also undertaken trial production of bamboo mats and plans to produce bamboo matboards. There are indications that the company is extracting bamboo poles for sale in their raw form. Similarly, GPE has made significant investments in the bamboo sector. They, too, have been issued a special user-right licence by KFS. They plan to establish factories at five different places (possibly around Transmara, Narok and other strategic places close to the area of the special licence) for producing bamboo stick-based products, bamboo pellets, briquettes (carbonised and non-carbonised), charcoal, timber and fibre. However, it is important to note that none of the factories or production have commenced yet, and both the investors are in their planning and preparation stages.



Fig. 21: Bamboo poles in truck and Bamboo Trading Company (BTC) chipping machines

9.3.1 Access to raw materials

Industrial processing and production needs large quantities of bamboo of a specific species, age-class and dimensions (diameter wall thickness, internodal length, etc.). Unfortunately, harvesting bamboo is banned in government-managed forest (except for two licenced companies) and production on private land is negligible with regard to the consumption scale of industries. In addition, bamboo production on private land is scattered. Nevertheless, private companies can practice controlled sustainable harvesting from natural forests with the licence/permit from KFS. BTC and GPE are the companies which have special user-right licences from KFS to harvest bamboo in 3,000 and 5,000 hectares of natural forests, respectively. It is important to note that the bamboo forests allocated were not managed, and it will be required to invest firstly to transform the unmanaged bamboo forests into a sustainable bamboo forest regime to suit the quality standards of raw material required. This will entail large investment in clearing out debris and dead bamboo poles (which are unusable) and create space for new growth of bamboo culms, sustainable management, age marking and mature bamboo pole extraction of specified quantity and quality. For industrial application, bamboo raw material of specific quantities, as per specified quality, is necessary, which will only be possible in sustainably- managed natural forests, rather than in unmanaged forests. For maintaining the health of bamboo forests and to enhance the climate change mitigation potential of bamboo forests, regular harvesting and management practices are necessary.



Fig. 22: Unmanaged bamboo forest in Mount Kenya and Aberdare Range

The GPE has a long-term plan to create a resource base on private lands. The company has taken three approaches to creating a resource base: planting bamboo on the purchased land, planting bamboo on the leased land and contract farming with farmers. Currently, the GPE is aggressively engaged in promoting bamboo cultivation on private land. The company has done contract farming with more than 500 farmers and each farmer has planted 125–500 seedlings, mostly *Dendrocalamus asper* and *Dendrocalamus membranaceus*.

Likewise, GPE has planted more than 300,000 seedlings on more than 1200 acres of leased and purchased land. Moreover, the company has a long-term plan to upscale bamboo plantation areas on leased land as well as adopting a contract farming approach. The company is facing challenges in mobilising farmers in forming farmers' groups and their networks, and motivating farmers for commercial cultivation of bamboo, as social mobilisation is not its area of expertise.

The African Plantation Capital (APC) is also another private company venturing into planting bamboo and is also using the contract farming approach. They have planted 72ha in Kilifi County (at the Kenyan coast), mainly with *Bambusa vulgaris* species, and are looking at reaching the first 100ha soon.

9.3.2 Access to markets

Markets are different for different industrial products. In the case of bamboo stick-based products (incense sticks, toothpicks, skewers and barbeque sticks, curtains/blinds and matchsticks) a good domestic market exists, which is currently catered by imports. In addition, a large export market (regional markets) and global market exist (refer to Annex 10, Table 1 and Table 6). In the case of pellets, the consumers are industries, such as tea processing factories and other factories that consume biomass or fossil fuel in huge quantities to produce thermal energy for process heating and drying. Currently, tea factories are using eucalyptus timber to produce thermal energy. However, according to the BTC and experts in KEFRI, the calorific value of bamboo is higher or similar to eucalyptus. The caloric value of four-year old *Bambusa vulgaris* ranges from 3844 to 3984cal/g (Sadiku et al., 2016) which is almost equal to that of *Eucalyptus*

tereticornis (4050cal/g) (Chow and Lucas, 1988). Likewise, markets for bio-briquettes and charcoal can be hotels and restaurants that need such products for barbeque or making “Nyama Choma” – roasted meat. Charcoal is a key bioenergy resource in Kenya, providing domestic energy for 82 per cent of urban households and 34 per cent of rural households (Oimeke, 2012).

Kenya, particularly after federalisation or devolution of its powers in 2010, is urbanising rapidly. There are a number of new cities and towns growing in each of the 47 counties. With rapid urbanisation, the demand for scaffolding materials, furniture, partition boards and flooring material is increasing. There is no doubt that unless appropriate products are developed at reasonable prices, bamboo products cannot be sold. Currently, bamboo stick-based products (curtains, toothpicks, incense sticks, barbeque sticks) and flooring material, including bamboo flooring material, are being imported. In addition to catering to the domestic market, bamboo products can also be exported to neighbouring countries, the EU and the USA. Import and export data compiled from the UN Comtrade database, shows that, on average, Kenya imports USD779,818 worth of bamboo/rattan products and exports USD275,823 worth of bamboo products with a trade deficit of USD503,995 (refer to Table 2). The European Union (EU) is the largest importer of bamboo products, accounting for USD607 million in the year 2012 (INBAR, 2012). China is the major exporter. Considering the geographical vicinity, the EU, USA and COMESA, Kenya can be well placed to tap the export market in addition to domestic demand. Bamboo fibres/textiles are another product that have good potential in high-end markets. The product can be exported to Europe, Canada and the USA (INBAR, 2012). However, a detailed study needs to be done of production feasibility, competitiveness and market assessment before starting production. The GPE plans to produce textiles from bamboo and export them to the international market.

9.3.3 Technology and skilled human resources available

No technology, except chipping of bamboo/production of charcoal and briquettes and production of bamboo stick-based products, is available in Kenya. KEFRI has a few advanced machines (for stick/slat-based value chain) at their two facilities and skilled human resources. The facilities are currently used to conduct training for people interested in producing bamboo handicrafts, furniture and other products. These facilities can be used for building skilled human resources that can be absorbed by private companies like the GPE.

9.3.4 Investment required and capacity to invest

No doubt, industrial production of bamboo products needs a high level of investment. Unfortunately, as shared by senior staff of the GPE, the bamboo sector being a new venture, banks are not willing to invest in this sector. Nevertheless, the GPE has a plan to raise private equity investment of about USD4.2 million for producing industrial products. The company plans to start with energy products, such as pellets, bio-briquettes and charcoal, and gradually move on to timber at the second stage and fibre at the third stage.

9.3.4 Environmental impacts/carbon footprint

The use of bamboo as timber and an energy alternative helps to offset carbon, replacing the use of petroleum products, and reducing the usage of timber/wood. As bamboo is a renewable resource, the net carbon sequestration is positive. Likewise, use of bamboo as timber helps to increase carbon sink. However, in producing fibre, bamboo has to go through a series of chemical treatments that may result in negative environmental externalities when the effluent is not handled properly.

10. SWOT Analysis of Bamboo Value Chain

In order to gain an in-depth understanding of the bamboo sector, a SWOT analysis was separately conducted for each step of the value chain. The findings of the SWOT analysis are presented in Table 17. Although the bamboo sector is in its inception stages in Kenya, it has already introduced and validated different economically viable bamboo species, and these bamboo varieties are successfully growing in Homa Bay, Kisumu, Migori and Mount Kenya regions of the country. The lead farmers who planted the species in their farmlands consider bamboo as a potential crop for income generation. The agro-climatic conditions in Kenya are suitable for commercial cultivation of bamboo. Furthermore, tissue culture technology has already been introduced, which provides scope for production of large-scale planting material and scaling up the bamboo plantation activities in Kenya. Two private sector players are operating (BTC and GPE); a scope for large investment for producing industrial production are in place.

However, the bamboo sector suffers several challenges. On the plantation front, the challenges are (a) many farmers are not aware of the economic potential of bamboo, (b) landholdings of most farmers are small, where replacing agriculture crops by bamboo is difficult and (c) cost of planting material is high. On the processing front, the challenges are (a) existing farm plantations are scattered, therefore, consolidation, supply chain or logistics will be difficult and (b) lack of trained human resources for industrial production. Furthermore, the enabling-business environment is not favourable. There are (a) restrictions on harvesting bamboo in natural forests for processing and (b) an unwillingness of banks to provide loans for the bamboo sector.

Nevertheless, there are enormous opportunities for promoting the bamboo sector. Commercial cultivation can be increased by aggregating farmers together into producer groups, cooperatives and networks. It is important to note that Kenya has a vibrant cooperative sector in many sectors, and the same can be replicated for bamboo. Kenya's economy, as well as population, is growing fast, and the need for furniture, boards, flooring material, and construction materials, including scaffolding, is increasing. In addition, the large-scale floriculture and horticulture industry requires props for supporting plants. With the available technologies, the above-mentioned products can be alternated with bamboo. In addition, there is high demand for bioenergy products, such as pellets and chips for industrial application; charcoal, briquettes for household cooking and heating.

Bamboo, being a fast-growing species with annual harvesting possibilities, can be one of the best alternatives to bioenergy. There is a large scope for industrialization as well. Kenya, as well as the entire Eastern African region, is a net importer of bamboo panel products. Currently, China is the major exporter of bamboo products to the EU, Asia and the USA. Kenya has suitable bamboo species (*O. alpina*) which could be converted into industrial products, such as bamboo stick-based products, flooring boards, panels, etc. In addition, there is a large demand for wood pellets in the EU and the USA. Considering the geographic closeness to the EU and the USA, it has a tremendous scope. In addition, there is good demand for natural textiles in the international market. However, commercial production for industrial use exclusively depends on a single company; failure of the company for any reason will jeopardise the sector. In addition, cheap plastic products are threats to furniture and handicraft enterprises.

Table 17: SWOT analysis of bamboo sector in Kenya

Strengths	Weaknesses
Production	
• Kenya has indigenous bamboo resources. • Indigenous and exotic bamboo cultivation were trialled, demonstrated and validated. • Lead farmers perceive bamboo as a potential crop for income generation. • Agro-climatic conditions are suitable for commercial bamboo cultivation. • Tissue culture technology is available; nurseries have the capacity to scale up planting material production.	• Most of the farmers have small land size and they cannot replace their agricultural crops with bamboo. • Many farmers are not aware of the economic value of bamboo, considered it as a witch crop and habitat for snakes. • Existing bamboo plantation/production is scattered. • High cost of seedlings/planting material.
Trading	
• Private plantation sites are well-connected by road.	• High transaction costs in trading because of scattered production. • Absence of local traders. • Need transportation permit from the KFS.
Processing	
• Trained human resources are available for making handicrafts and furniture. • A few enterprises are already producing handicrafts and furniture. • The private sector is coming up with a high level of investment in industrial products. • A few industrial product lines, such as bamboo stick-based products, combined with bioenergy products, use all parts of bamboo, with no wastage.	• No access to bamboo in natural forest without licence; getting a licence is a cumbersome process. • Difficult to access raw material for small-scale handicraft and furniture enterprises situated in urban areas. • Producing handicrafts and furniture without understanding market need and demand. • Poor quality of furniture and handicraft products. • For industrial production, the resource base is weak. • Industrial production is new to Kenya; lack of trained human resources; market is uncertain. • Banks are not willing to invest in bamboo sector.
Wholesaling/retailing	
• Markets already exist where furniture made of raw materials similar to bamboo is being sold. • Shops targeting high-end consumers are interested to sell bamboo products.	• No bamboo depots in cities. • Potential retailers and wholesalers are not aware of the sources of bamboo products.
Consumption	
• Good market for products resembling bamboo products is a proxy indicator of market potential for bamboo products. • Environmentally-conscious consumers are interested in bamboo products.	• Most of the common users/consumers perceive bamboo products as non-durable. • Ignorance of local use of bamboo for making houses and scaffoldings.

Value Chain Analysis and Market Assessment of Bamboo Products in Kenya

Opportunities	Threats
Production	
• Formation of farmers' groups, cooperatives and networks for commercial bamboo production. • Landless households get jobs during harvesting, as it is labour-intensive work. • High scope of area expansion due to suitable agro-climatic condition.	• Commercial production for industrial use exclusively depends on a single company; failure of the company for any reason will jeopardise the sector.
Trading	
• Developing traders at different levels.	• Not specific.
Processing	
• High rate of urbanization after 2010 political change; demand for furniture/flooring material is high, and construction material as scaffolding. • Possibility of producing bamboo stick-based products – curtains, mats, incense sticks, tooth picks, etc. • Possibility of substituting for imported flooring material. • High demand for bioenergy in industries and households. • Products like fibre/textile can be exported to European markets.	• Import of cheap alternate products. • Ability to produce products of high quality and quantity. • Consumer/market acceptance.
Wholesaling/retailing	
• Introduce environmentally-friendly products targeting environmentally-conscious customers.	• Cheap plastic and metal products for household use.
Consumption	
• Number of environmentally-aware consumers is growing.	• Consumer acceptance and preference.

11. SWOT Analysis of Bamboo Products

11.1 Construction material and local use

The study shows that bamboo can be used locally as a construction material. The results of the SWOT analysis of the use of bamboo as a construction material are shown in Table 18.

Table 18: SWOT analysis of use of bamboo as a construction material and local-use material

Strengths	Weaknesses
• Resource available locally for using bamboo in rural house construction; scaffoldings and props • A few houses constructed of bamboo have already been demonstrated by some projects • Tourism industry offers large scope for construction of eco-tourism resorts • Large-scale floriculture and horticulture industry currently uses bamboo as props • Bamboo can be locally used as props by farmers; food, fodder and feed for human and livestock	• Bamboo resources in farms are location-specific • Local people perceive bamboo as a non-durable material for constructing houses and weak for using as scaffolding • Low awareness among local communities on use of bamboo as a suitable construction material • No skilled human resources available locally or regionally for bamboo house construction • No bamboo depot available; have to reach the farmers even for small quantity • Its susceptibility to borers – thus requiring treatment
Opportunities	Threats
• Almost 70% of houses in rural areas are made of mud and wood with a lifespan of 10–15 years; bamboo can be used to increase the lifespan of houses and make them stronger • Bamboo is a proven earthquake-resistant construction material • Kenya is rapidly urbanising; building construction is rapidly growing; bamboo can be used as scaffolding, as it is stronger and relatively more economical than eucalyptus • Generation of employment opportunities at the local level • Timber yards present in local towns can be used as depots for bamboo • Large-scale floriculture and horticulture farms require bamboo as props	• Use of iron scaffolding

11.2 Handicrafts and furniture

The study shows that bamboo can be used to make handicrafts and furniture products. The results of the SWOT analysis on the use of bamboo in producing handicrafts and furniture products are shown in Table 19.

Table 19: SWOT analysis of use of bamboo as handicraft and furniture

Strengths	Weaknesses
• Few handicraft and furniture-making enterprises exist • KEFRI have the capacity and experience in handicraft and furniture capacity building activities • Good market potential • Urban people are relatively aware of the value of bamboo products • Products made from natural materials similar to bamboo are already being sold in markets • Can operate with small volume of raw material • High return on investment	• General perception that bamboo products are not durable • Very weak forward and backward linkages of the enterprises (enterprises are standalone) • Low investment capacity • Low business literacy with the entrepreneurs and the groups • Mostly enterprise businesses operate as a part-time job • Poor quality of furniture (cracking is the main problem); susceptibility to borers and fungus – thus requiring capacity building on selective harvesting; preservation and treatment methods
Opportunities	Threats
• Employment generation at the local level and engaging poor and marginalised people (especially youth and women) in handicraft and furniture making • Possible to promote enterprises in road corridor adopting cluster approach • Possibility of market penetration in big cities such as Nairobi and Mombasa • Availability of chemicals and technologies to treat bamboo against insect attacks	• Cheap and fancy products made from plastic can take the market of bamboo handicraft and furniture

11.3 Industrial products

The scope of using bamboo for producing industrial products is increasing in Kenya. The results of the SWOT analysis are presented in Table 20.

Table 20: SWOT analysis of use of bamboo as an industrial product

Strengths	Weaknesses
• Private sector is coming up with significant investment • Good stock of resources available in government forests; license to sustainably harvest bamboo is already in place • Pellets, bio-briquettes and charcoal use 100% bamboo, no wastage • Bamboo can contribute on development and creation of at least five Small and Medium Enterprises (SME) industrial parks, the water catchment management initiative and equity and poverty elimination agenda of VISION 2030	• Completely a new area of intervention; high associated risks • Technology and service provider network is weak in Kenya • Skilled human resources are not available • Need high level of investment; banks are reluctant to invest in bamboo sector • Land acquisition and motivating farmers for commercial cultivation is difficult, as the crop is new for them • Commercial plantation is expensive because of high cost of seedling • More than 95 per cent of bamboo resources are under government control and getting a licence for harvesting is a cumbersome process • Benefit to locals is negligible when using bamboo exclusively from government forests
Opportunities	Threats
• A large number of farmers can be involved in commercial cultivation of bamboo, thereby providing a sustainable raw material supply, wider income and employment generation • Demand for pellets, bio-briquettes, bamboo stick-based products, flooring material, boards, and furniture is increasing as a result of urbanisation and increasing purchasing power • Bamboo products produced locally have an export market; can also substitute for imports	• Bamboo resources in government-owned forests are not managed; quality of bamboo poles is poor • Farmers solely depend on one or two companies • Import of comparatively cheaper products from abroad (especially Asia); those enterprises use advanced technologies and are located in resource-rich areas

12. Research and Development, and Innovation in the Bamboo Sector

KEFRI is the only institute in Kenya that has invested in forestry research and development (R&D), and innovation. However, lack of financial resources is a constraint for them. Of late, the Kenya Bureau of Standards (KEBS) joined a ISO/TC 296 committee as a participating member to standardise the specifications and quality requirements for bamboo and rattan products. Currently, the GPE is aggressively involved in the bamboo sector and has been investing significantly in R&D. Likewise, Kitil Farm has a laboratory and nursery with a capacity of producing 60,000 plantlets per week, and it is also engaged in R&D. Nevertheless, the efforts of farmers, small-scale nurseries and enterprise owners in R&D cannot be undermined.

13. Conclusion

Commercial cultivation of bamboo in Kenya started more than a decade ago; however, bamboo business is limited to seedling production and sale. Moreover, the markets for bamboo seedlings are basically NGOs and development projects that are promoting bamboo for conservation purposes, but not as a commercial crop. The initiative taken a decade ago has resulted in good bamboo stocks on private lands, which are at the harvesting stage. However, due to the lack of a market, farmers are not able to sell mature bamboo culms, thus the frustration is clearly seen among them. As a result, commercialisation of bamboo is confined to limited areas where development agencies are implementing projects. A lot needs to be done to make bamboo a part of the farm landscape. Nonetheless, lead farmers are coming up for commercial cultivation, particularly in new areas, where the private sector promises an assured market and offers a buyback guarantee.

The special user rights license issued by government to private companies for exploitation of bamboo from government-managed forests is less likely to deliver extensive benefits to local communities. The interface may consume a significant amount of bamboo and generate good revenue. Unfortunately, things are not moving as planned, and the only benefit to local communities can realise is income from manual labour. Although the government and other development agencies are promoting bamboo by providing various trainings to locals, such as in nursery management, handicrafts and furniture making, only a few farmers are applying in practice the skills gained in nursery raising. Other skills are seldom being applied. In fact, the bamboo enterprises are in a very primitive stage. The underlining reason for this are weak backward and forward linkages. For the enterprises which are located near urban areas, accessing raw materials is a herculean task. Similarly, for the enterprises located in rural areas, it is not easy to access the market. However, one cannot ignore urban-based enterprises' limited access markets, their inadequate skills and inappropriate tools.

Nevertheless, some ray of hope can be seen in the bamboo sector. A few companies like GPE, APC and the Kenya Tree Farms are coming up aggressively in the bamboo sector, expanding the area of cultivation, purchasing and leasing land and contract farming with farmers. These companies are producing large quantities of seedlings and selling them to the contracted farmers with a buyback guarantee. As these companies actively engage local farmers, potential benefits for farmers can be possibly realised. However, there

is a high level of potential risks, which should not be overlooked. These companies are new to the sector, with no prior experience in the business of natural products, and have plans for commercial production of bamboo. Should the companies decide to leave the bamboo sector because of any unavoidable circumstances, it will be a significant loss to the farmers.

14. Way Forward

The strength of any chain is measured by its weakest link and the same applies to the value chain. For overall development of any value chain, each step should be strengthened. This study shows that the bamboo value chain is primitive in Kenya. A lot needs to be done to build, and strengthen bamboo value chains. In addition, every bamboo species or variety as a raw material has different characteristics – physical, chemical and mechanical. So matching species to end use is critically important. Based on the findings, the following approaches are recommended for overall development of the bamboo sector: promotion of the local use of bamboo for day-to-day applications; promotion of small-scale enterprises and support to the private sector for industrial production. Each approach is described below in detail.

14.1 Promotion of bamboo as construction material and local usage

Promoting the local use of bamboo could be an entry point for commercialisation/industrialisation of the bamboo sector. Until, and unless, there is a strong resource base, its commercialisation/ industrialisation will not be possible. To develop a resource base, there should be a high level of participation of local communities, especially farmers, in growing. During initial phases, the required level of participation will need enhancing of the direct benefits to the farmers. The direct benefits can accrue at the subsistence level: usage of bamboo as construction material, fencing material, props for agriculture, bamboo biomass as household energy, enhanced food security from fodder and feed availability for farm animals and chickens as well as bamboo shoots. Income will be generated from the sale of bamboo poles or made into products on demand. Lead farmers, ready to harvest bamboo plantations on their farms, as well as local communities, are not aware of the subsistence and local uses of bamboo, and farmers are waiting for industries to come and buy their produce.

The farmers perceive that the standing culms in the farms are of large quantities, but this volume is insignificant for operating a factory and/or an industry. As a result, area expansion of bamboo cultivation has been halted. The project can target a few key product lines, such as promoting bamboo for scaffolding, house construction, props for floriculture and horticulture industry and fencing. In addition, demonstration and sensitisation activities towards usage of bamboo as food, biomass, feed and fodder can be undertaken. The following interventions are recommended for increasing the local use of bamboo at four levels: production, marketing, consumption and research.

14.1.1 Production

- Build capacity and promote community nursery enterprises at the local level to reduce the cost of planting material, avoid high transportation cost and mortality. Ensure production of quality planting material of required species in quantity. In addition to large-scale or block plantation, promote bamboo planting as farm boundaries, shelter beds, and stream/riverbank protection for creating additional income for farmers and growers without competing with food crops.

- Conduct trainings and building capacities of farmers on bamboo plantation establishment, intercropping, maintenance, sustainable harvesting and management of bamboo clumps as well as on post-harvest management.
- Establish bamboo preservation and treatment facilities, and building capacities of primary processors on selective harvesting, treatment and commoditisation of bamboo poles and supply chain.
- Develop linkages with ongoing and future development programs on climate change mitigation, land degradation and ecosystem development for scaling up bamboo plantation.

14.1.2 Marketing

- Develop market linkages with large-scale floriculture and horticulture farms for supply of bamboo props and support sticks.
- Conduct awareness and sensitisation trainings for builders and construction companies on suitability of bamboo as a construction material, interior decoration, scaffolding, etc.
- Facilitate depots in local towns to keep bamboo culms, along with eucalyptus poles, for sale.
- Capacitate and facilitate cooperatives/primary processors as traders in order to supply bamboo produce to depots.

14.1.3 Consumption

- Work with the government and development agencies to create demand for bamboo plants produced by community nurseries by leveraging the climate change mitigation; landscape restoration and ecosystem development actions.
- Conduct demonstration and sensitisation training to farmers and local communities on the suitability of bamboo as a durable construction material, scaffolding material, biomass, food, feed and fodder and other sustenance uses.
- Construct demonstration bamboo structures targeting low-cost rural housing, high-end eco-tourism industry, scaffolding, polytunnels, etc., in strategic locations. In the process, train engineers, masons and carpenters on bamboo construction techniques.
- Facilitate development of standards and guidelines on bamboo construction and scaffolding.

14.1.4 Research

- Involve local research teams and undertake field research on bamboo propagation techniques, sustainable management and harvesting, as well as post-harvest management.

14.2 Promotion of small-scale enterprises

The advantages of small-scale enterprises are that (a) they can operate with a small volume of raw materials, (b) minimal or no investment is necessary and (c) return on investment is high. However, the challenges for small-scale enterprises are a lack of business skills among entrepreneurs and poor market access, enterprise being considered as a part-time job. The household, micro- and small-scale enterprises are currently operating in a stand-alone mode. It is difficult for them to perform all the functions of an enterprise such as backward linkages (raw material and input supplies), production, design development, quality control, logistics and transportation,

taxation, market linkages, etc. To ensure forward linkages, quality control and input material support – a “Common Production and Training Centre” (CPTC) approach operated in the community –private partnership model will yield better results.

The project can basically focus on three product lines: (a) household and farm utility products, (b) bamboo furniture and (3) souvenir and decorative items targeting environmentally-conscious consumers. Household and farm utility products such as packaging baskets (fruits, vegetables), kitchen utensils, fruit baskets, dust bins, laundry baskets and winnowing trays are few utility products that could be promoted. Low-, mid- and high-end bamboo home and office furniture items such as stool, chairs and tables, rocking chairs, shoe racks, clothes hangers, tacks, coffee tables, cots, shelves, etc. can be targeted. Souvenir and decorative items catering to the tourism industry and domestic market such as pen holders, photo frames, lamp stands/covers, wind chimes, candle holders and false ceilings out of bamboo-weaved mat are a few of the items that can be promoted.

The following interventions are recommended to promote small-scale enterprises at five levels: access to resources, capacity building, research and development, market linkage and demand creation.

14.2.1 Access to the raw material:

Despite enormous opportunity to produce varieties of bamboo products, there remains a constraint in raw material supply. The project is recommended to:

- Capacity-build farmers and entrepreneurs on selective harvesting of mature bamboo poles and sustainable management of bamboo clumps.
- Facilitate establishing linkages with existing depots in local towns and cities to add bamboo into their portfolio of sales, along with eucalyptus poles and timber.
- Develop the supply chain and facilitate the establishment of community institutions as well as private enterprises for linking farmers/primary processors to the point of consumption.

14.2.2 Capacity building

Capacity building of craftsmen and entrepreneurs will be a primary task to ensure the success of any enterprise. The project is recommended to:

- Target existing bamboo-working communities and entrepreneurs working on traditional, as well as contemporary, bamboo products for capacity building and formation of enterprises.
- Conduct participatory micro-planning based on the local market demand; conduct intensive skill development training and diversification of existing product lines. In addition to skill development, conduct entrepreneurship training encompassing costing, quality control, record keeping, bargaining, logistics and transport management, etc.
- Provide a basic set of additional tools for improving the production efficiency and quality of products.
- To institutionalise household, micro and small enterprises and to address the backward (commoditised and primary processed intermediary products and input materials) and forward linkages (design development, quality control, logistics and marketing) adopt a cluster approach. Establish a CPTC managed by community-private partnership-based institutions, providing the necessary forward and backward linkages.

- The attraction of impact investment funds for developing CPTC processing units locally is desirable.
- Facilitate building a pool of handicrafts and furniture master trainers in Kenya by South-South Knowledge Transfer and cross-learning within Africa and between Asia.

14.2.3 Research and development:

- Work with local research agencies such as KEFRI for conducting research, and adopt/ develop local technologies on bamboo post-harvest management, preservation and treatment.
- Create awareness and link with local design institutes for development of new and innovative product designs on bamboo handicrafts and furniture.
- Build capacities and work with KEBS for development of standards and certification mechanisms for key bamboo furniture products.

14.2.4 Market linkage

- Organise B2B meetings between entrepreneurs/potential middlemen and wholesalers/retailers.

14.2.5 Demand creation

- Undertake awareness creation activities to the general public, wholesalers and retailers on the advantage of bamboo products.
- Facilitate and support the participation of enterprises in local and national level trade fairs and exhibitions.
- Develop market linkages with government-run sales outlets targeting domestic and tourism market.
- Similar to the preferential bamboo product purchase policies of the governments of Ghana and the Philippines, lobby the government for creating a preferential purchase of bamboo products by government agencies, schools and hospitals in Kenya. This will provide a guaranteed market and will provide a market pull during initial phases.

14.3 Support private sector for industrial production

Although the GPE is investing in the bamboo sector with a clear and long-term vision, the initiative faces a lot of challenges as it is new to Kenya. The first and foremost challenge is the availability of suitable raw materials. Another company, BTC, has already acquired special user rights from KFS and started production a few years back, but they are struggling to access suitable raw material as well as markets and their technical capacities on sustainable management and harvesting are limited. It is important to note that the benefits to the local communities from such endeavours are limited compared to small- and medium-scale community enterprises. Instead, contract farming with local farmers with buyback guarantees will deliver them more benefits.

To support industrial production, the product and/or production line should be developed in a phased manner in accordance with resource availability and quality, market demand and technological availability. Firstly, the focus should be given to producing bamboo stick-based products (curtains, mats, incense sticks, barbeque sticks, matchstick splints, etc.) combined with bioenergy products, such as bio-briquettes, charcoal and pellets due to the availability of a large and ready market. This also requires low technology and

quality standards compared to the high-end value chains such as bamboo timber substitutes and textiles. Producing timber, including flooring material, should be in the second step followed by textile.

14.3.1 Bamboo stick-based products and bioenergy products

Bamboo stick based product line combined with bioenergy product production could maximise the usage of biomass, as well as provide better returns to the entrepreneurs. Suitable bamboo poles (by grading) from unmanaged bamboo resources could be used for production of bamboo stick-based products and the waste generated from stick processing, in addition to the unusable bamboo, can be used for production of bamboo bioenergy products.

Bamboo stick-based products: Bamboo stick-based product line, including production of round bamboo sticks and further value addition into Venetian blinds, curtains, tablemats; incense sticks, skewers/barbeque sticks, toothpicks, matchstick splints, etc. There is a large demand for bamboo stick-based or alternative stick-based products domestically, regionally and globally (Table 1, Table 6 and Annex 10).

Bioenergy products, such as bio-briquettes and charcoal have a huge market, especially in urban areas in Kenya. Annually, Kenya consumes about 15 million tons of biomass as fuelwood and 16 million tons of charcoal, which requires clearing of about 550,000ha to cater to the demand (Mugo and Gathui, 2010). Cottage industries such as restaurants, the tea industry, brickmaking, tobacco, milk processing, fishing and fish smoking, jaggery and bakeries consume about 1.8 million tons of biomass annually (The Republic of Kenya, 2002). Considering the proven energy qualities of bamboo, its calorific value, annual harvesting possibility, suitability of its products' applications at household and industrial scale, ready market and the current state of bamboo resources, production of bamboo bioenergy could be the entry point.

In addition to private companies, farmer groups, micro- and small entrepreneurs generating bamboo waste from processing, and youth groups could be organised to establish micro-enterprises and produce charcoal and bio-briquettes at the local level. This could create local employment and income as well as opportunities for value-addition of bamboo waste. In addition, bio-briquettes are energy efficient and do not produce smoke or smell, which could improve the health indicators of women. As a result, farmers will realise the economic use of bamboo and be motivated to increase the area of cultivation. In case of insufficient bamboo resources, other woody biomass from agricultural waste can also be mixed with bamboo.

The following approaches could be undertaken to promote charcoal, bio-briquettes and pellets:

Decentralised charcoal and bio-briquette enterprises at the local level

- Organise farmers, micro- and small entrepreneurs and youth groups in a formal enterprise to establish and operate decentralised charcoal and bio-briquetting enterprises.
- Support establishment of charcoal kilns for production of charcoal and fabrication of necessary tools, equipment and moulds for briquette production.
- Conduct capacity building or skill training on charcoal kiln construction, maintenance, charcoal, bio-briquette production and burning. Facilitate availability of suitable energy efficient stoves to suit the bio-briquettes.
- Provide entrepreneurship training for identified members of the groups.
- Conduct awareness and demonstration activities for local communities, wholesalers and retailers and develop market linkages.

- Support in branding and packaging in case of sales in urban centres.

Centralised stick-based product and biomass briquetting and pelleting enterprises

• Considering the special harvesting/user rights for GPE and BTC and availability of bamboo, it is possible for these enterprises to venture into production of bamboo stick- based products, combined with bamboo bioenergy products, during initial phases until the unmanaged bamboo forests are transformed into sustainably managed forests, where suitable quality raw material of required specification and age is possible. Until then, sustainably extracted bamboo can be used for high volume low to medium value bamboo stick-based and bioenergy products. In the case of bioenergy products, the profit margins are low, and can only be achieved by large-scale production.

• To increase the profitability, it will be necessary for the enterprises to develop an intermediary value chain such as the production of bamboo stick and commoditised bamboo poles using generic machines. This will help in recovering some of the costs. The waste generated from the production of intermediary products and unsuitable bamboo for value addition can be converted into bioenergy products in the form of charcoal, bio-briquettes and pellets. In the long run, with the maturation of ongoing plantations and the maturation of the bamboo sector in Kenya as a whole, the bio-briquettes and pelleting enterprise should use bamboo waste generated from value-addition. The project is recommended to facilitate activities in the following areas:

Raw material and supply chain

- Conduct training on sustainable management and harvesting practices for forest managers, entrepreneurs and farmers.
- Conduct training on grading of bamboo poles as well as development of value chain and intermediary product production.
- Facilitate development of bamboo producer networks for a sustainable supply of raw material and sale of intermediary products.

Marketing

- Conduct a market survey to study the market demand, cost and technical requirements of bamboo stick-based products, bio-briquettes and pellets.
- Design and conduct awareness and demonstration activities for the broader public, large consumers, wholesaler and retailers.
- Support and demonstrate usage and suitability of bamboo stick-based products to urban consumers and bamboo bio-briquettes and pellets for large consumers such as tea factories, restaurants, etc.
- Facilitate participation in domestic and international trade fairs and exhibition.

Research

- Conduct research to identify appropriate introduced species of bamboo for stick-based products and bioenergy and promote cultivation
- Facilitate South-South Knowledge Transfer and involve local research agencies in the development of suitable technologies and low-cost machine and equipment, including suitable stoves.

- Facilitate and support Kenya Bureau of Standards for developing standards and certification mechanisms for bamboo stick-based and bioenergy products.

Enabling environment

- Develop business models along with investors for attracting impact investment funds for scaling up businesses.
- Organise B2B meetings between factories and potential investors.
- Advocate for subsidies in import and export duties and taxes for machines and products.

14.3.2 Timber, including flooring material and bamboo Fiber

As Kenya is rapidly urbanising, there is a growing demand for flooring material as well as panel- based products. Currently, large quantities of bamboo and timber flooring material and panel-based furniture are being imported from abroad, especially China. Production of bamboo material within Kenya curtails the import and creates local employment. However, there should be a strong resource base with a well-established supply chain to initiate establishment of high-end industrial production.

Bamboo fibre has many excellent properties that make it ideal for processing into textiles. Bamboo is also very sustainable to grow, as it does not require the use of pesticides and grows very quickly in favourable conditions. Bamboo fabric may have an antibacterial property that is maintained in fabric, meaning that bamboo fabric does not require the use of chemical antibacterial agents (www.bamboofabricstore.com). The yarn and cloth made by bamboo fibre are labelled first-class quality in all aspects of quality standards. It is also an environmentally-friendly raw material that enjoys a splendid prospect for application as did its predecessor, wood pulp fibre. Meanwhile, cloth made with mixed material, combining bamboo fibre with cotton or other raw materials, also boasts the same superior property. Towels and bathrobes made of bamboo fibre have a soft and comfortable feel and a special lustre.

Unlike a tree, which can take decades to grow to maturity, bamboo is ready to harvest within four to five years, and thereafter is annually harvestable. The potential market for bamboo fibre textiles can be Europe, Canada and the USA. As Kenya is geographically located at a strategic area, there is a high opportunity to export the product in European markets. However, producing bamboo fibre textiles should be a long-term strategy, as it needs a significantly high resource base, advance technologies and highly skilled human resources. This needs a separate study to explore the potential of producing and exporting bamboo fibre textiles.

Considering that most of the interventions proposed are for both timber and fibre production, the interventions proposed are clubbed together.

Raw material and supply chain

- Develop a value-chain involving all actors – nurseries, plantations, primary and secondary processors. Develop linkages with entrepreneurs working on other product lines/entrepreneurs (to minimise wastage and maximise value).
- Promote appropriate bamboo species cultivation on private lands and capacitate farmers in sustainable farming system.
- Capacitate farmers, primary processors and intermediaries on sustainable management and harvesting practices, primary processing, preservation and treatment, commoditisation and quality control.

Market

- Conduct a detailed market assessment of timber and flooring materials both at domestic and international levels.
- Conduct a detailed market assessment of bamboo fibre textiles both at domestic and international levels.
- Support promotional activities through different media to attract medium and high-end consumers to bamboo timber, flooring and panel-based furniture products.
- Support the private sector to participate in different international trade fair and B2B meetings.

Research and development

- Undertake research on physical, chemical and mechanical property testing of bamboo species; shortlist suitable species and development standards and guidelines for production.
- Facilitate South-South Knowledge and Technology Transfer for building the capacities of entrepreneurs and workers.
- Capacitate and work with KEBS on the development of standards and certification mechanisms for bamboo timber and panel products.

Enabling environment

- Facilitate leasing out/special user rights for sustainably managing government-controlled bamboo forests to private sector.
- Advocate for subsidies in import/export duties and taxes.
- Develop business models along with investors for attracting impact investment funds and green economy funds for setting up local businesses.
- A further attraction of bamboo impact investment funds for locally developing processing units is desirable.
- Support the private sector in technology transfer and in market development.

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Annexes

Annex 1: Participant list of bamboo stakeholder workshop

Date: 07 March 2017

Location: Kenya Forestry Research Institute (KEFRI)

Duration: 9:00–13:00 hrs

S No	Name	Organisation	Email	Phone
1	Collins Mulavi Asuza	BURUBURU	colinsasuza@gmail.com	0707493339
2	Paul Thiongo	Green Belt Movement	pthiongo@greenbeltmovement.org	0720996673
3	Masabe E Ogongo	Global Bamboo	nipponsukidesu@gmail.com	0729721368
4	Teddy Barry Odhiambo	Barryands	teddybarryodhiambo@gmail.com	0702211769
5	Grace Wambui Maina	Assurri Triap	allanvrace1@gmail.com	0721792229
6	Liam O'Meara	Bamboo Trading Company	liam@thebambootradingcompany.com	0722264051
7	Peter Odhiambo	Korogocho Bamboo	korogochobamboo02@gmail.com	0720635053
8	Nicholas Okech	Korogocho Bamboo	korogochobamboo02@gmail.com	0716406499
9	Boniface	Elegance Bamboo Ventures	elegancebambooventure@gmail.com	716416499
10	Elijah M Kinyanjui	Kianwe Products	ejmkinyanjinab@gmail.com	720211667
11	I.M. Njuguna	Kitil Farm	jjuguna@kitilfarm.com	721535396
12	Ezi Nchurigu	Bigtive Capital	rocksin705@gmail.com	722729650
13	Felix Oisiero	Madoya Tumanini	felixobieroaluoach@yahoo.com	728091004

Annex 2: List of the individuals consulted/interviewed

S. No	Name	Organisation	Address
1	Ms Kuki Njeru	Green Pot Enterprises	The Greenhouse, Adams Arcade, Ngong Road
2	Prof Jacob K. Kibwage	Africa Waste and Environment Management Centre	Top Plaza 4th Floor Office Suite 8, Kilimani, along Kindaruma Road, off Ngong Road
3	Mr Shiribwa Mwanga (Victor)	Tiriki Tropical Gardens and Farm	Kaimosi, Kenya
4	Ms Rose Akombo	Kenya Forest Service	Kaurura. Off Kiambu Road, Nairobi, Kenya
5	Mr J.M. Njuguna	Kitil Farm	Kitil Farm HQ, Isinya, Kajiado District, Kenya
6	Mr Andrew Mbuthia	KFS	Kamiru, Kericho
7	Mr Cristofor	KFS	Kibiri Forest Station
8	Prof J.B. Okeyo-Owuor	Vired International	Kisumu
9	Mr Boniface Maina	Bamboo enterprise	Nairobi, Kenya
10	Mr Peter Odhiambo	Madoya Tumaini Youth Group	Huruma, Nairobi County
11	Mr Samwel Chacha	Kuria Bamboo Farmers' Cooperative Society	Ekerege, Kuria Sub-county, Migori County
12	Mr Peter Osuka	Homa-Bay Bamboo Farmers' Cooperative Society Limited	Rangwe Market, Rangwe Sub- County, Homabay County
13	Mr Tobias Bongu Okeyo	Migori Bamboo Farmers' Cooperative Society Limited	Ngege Market, Migori County
14	Mr Liam O'Meara	The Bamboo Trading Company – Kieni Forest	Kieni and Ragia Forest Nyandarua and Kiambu Counties
15	Mr Masabe E Ogongo	Global Bamboo Solutions	Kisii County
16	Ms Inga	Spinners Web	Nairobi, Kenya
17	Ms Nellie Mugure Oduor	KEFRI	Mobil Plaza, Nairobi, Kenya

Annex 3: Overview of study methodology

Areas of enquiry	Indicators	Methods of data collection
Resource Status	Location (geography and area)	National statistics
	Volume	National statistics
	Cost of production/harvesting	Interview with farmers/companies
	Resource tenure	FGD with farmers and interview with government officials
	Access – physical, legal	Interview with traders, company
	Cultivation and harvesting practices	FGD with farmers
	Policy environment	Key informant interview
Trading	Traders available/capacity	Interview with traders and government personnel; records in forest offices
	Mode of transportation and issues	Interview with traders
	Cost of transporting/ trading	Interview with traders, wholesalers, retailers
	Access to finance	Interview with traders; stakeholders
	Number of wholesalers and retailers	Soft Kenya Directory of 2016
	Fiscal policy environment	Interview with government officials and stakeholders
	Export policy environment	Interview with exporters; enablers/stakeholders
Processing Status	Exporting companies	The government authority; enablers/stakeholders
	Raw material source and sufficiency	Interview with entrepreneurs/company owners/R&D persons (for new products), project staff; enablers/stakeholders
	Inputs required and affordability	Interview with entrepreneurs/company owners
	Technology available/required/ transfer	Interview with entrepreneurs/company owners; enablers/stakeholders
	Skill – existing and required	Interview with entrepreneurs/company owners; enablers/stakeholders
	Possibility of utilisation of max bamboo clumps	Interview with entrepreneurs/company owners/ R&D persons; enablers/stakeholders
	Cost of production	Interview with entrepreneurs/company owners/ R&D persons;
	Investment required	Interview with entrepreneurs/company owners, enablers/stakeholders
	Policy environment – government support	Interview with entrepreneurs/company owners, project staff
	Energy require and supply status	Interview with entrepreneurs/company owners, enablers/stakeholders
	R&D interest and budget allocated	Interview with entrepreneurs/company owners/ R&D persons
	Sustainability – carbon foot print	Interview with entrepreneurs/company owners/ R&D persons
	Safeguarding intellectual property	Interview with entrepreneurs/company owners, enablers/stakeholders

Areas of enquiry	Indicators	Methods of data collection
Marketing	Domestic/ international markets	Interview with wholesalers/retailers, exporters
	Buyers' preference	Interview with retailers
	Number of outlets	Interview with company owners, wholesalers
	Volume sold	Interview with retailers
	Competitive products	Interview with company owners, wholesalers, retailers
	Cost associated with exporting	Interview with exporters

Annex 4: Equipment required for operating small-scale enterprise

Item	Unit cost (KSh)
1. Pointed knives	500
2. Panel pin hammer	250
3. Splitting knife	650
4. Scraping knives	500
5. Sharpening stone	150
6. Ear picks	250
7. Chisels	150
8. Ape measures (5m)	200
9. Scissors/garden shears	200
10. Auger bits	2,000
11. Hand drill	1,500
12. Drilling bits sets	8,000
13. Hacksaw blades	80
14. Hacksaw frames	450
15. Toolbox	3,000
16. Knot planers	400
17. Kerosene burners	4,500

Annex 5: Checklist for data collection

Primary data collection checklist

At field level

1. Interview/focus group discussion with farmers/farmers groups

- Where is the major production area of bamboo – private land, government forest, community forests?
- What is the landholding size of private bamboo cultivation land?
- What are the ownership issues on bamboo resources?
- What are the challenges in bamboo cultivation – land availability, inputs, finance, etc?
- What are the constraints in bamboo harvesting?
- Where farmers sell their bamboo? What are the challenges in selling?
- What is the average quantity of bamboo a farmer sells? And what is the average price of bamboo? How you know the price of bamboo in different markets?
- What is the cost of bamboo production? Per unit cost?

2. Interview with licence-holding company

- What is the licensed area to be harvested or quantity to be harvested? (species-wise, if possible)
- What are the challenges in getting licensed?
- What are the challenges in harvesting and transporting?
- Where is the bamboo sold?
- How is harvesting and transportation done?
- What are the administrative hurdles in transporting?
- What are the harvesting and transporting costs?
- What are the other costs associated?

3. Interview with enablers at local level

- What are the production areas of bamboo – private, wild?
- How many farmers or companies are involved in cultivation and harvesting?
- What is the production quantity? (species-wise, if possible)
- Who are the key farmers and traders of bamboo?
- What are the opportunities and challenges in the bamboo sector?
- How many input suppliers are there in the area, and what is their capacity?
- What types of processors are available in the area, and where are they?

4. Interview with input suppliers

- What is the process of seedling production?
- Technology available
- What is the demand and supply of the seedlings?
- Any quality issues? If yes, what you are doing or what do you need to do?
- What are the challenges and opportunity in seedling production?

5. Interview with traders and their middlemen

- How do you purchase bamboo from farmers/groups – directly, middlemen, auction?
- Do you purchase bamboo from wild/government-managed forest?
- What is the most traded species?
- How you manage the finances?
- How many traders are there in the area?
- What is the quantity of bamboo exported from the area?
- How is harvesting and transportation done?
- Where the bamboo is sold?
- What are the administrative hurdles in transporting?
- What are the harvesting and transporting costs?
- What are the other costs associated?
- What are the challenges in bamboo transporting and trading?

6. Interview with local processors

- What are the products you produce?
- What parts of bamboo do you use? And what you do with the rest of the parts? Any wastage?
- What technology is available? Do you know of any advance technology available elsewhere?
- Are you ready for investment in technological improvement?
- What is your total investment? Do you have any plan to increase your investment? If yes, how and why?
- Where and how do you sell your products?
- What are the challenges of product marketing?
- What is your unit cost of production and unit sell price?

At Regional/National level

1. Interview with processors – company owners of the selected bamboo products

- From where and how do you source the required raw material?
- Which species do you use the most?
- Is there any issue in accessing bamboo?
- What is your annual consumption of bamboo?
- What part of bamboo do you use? And what do you do rest of the parts? Any wastage?
- What is the availability of inputs for processing? (glue, lacquers, stains and its affordability)
- What technology is available? Do you know of any advance technology available elsewhere?
- Are you ready for investment in technological improvement?
- What is the status of skilled human resources?
- What is the source of energy and its reliability?
- Do you invest in R&D?
- What is your total investment? Do you have any plan to increase your investment? If yes, how and why?
- Where and how do you sell your products? Are you exporting?
- What are the challenges of product marketing/exporting?
- What is your unit cost of production and unit sell price? (carry out the detailed cost estimation)

2. Interview with wholesalers/retailers

- Which bamboo products do you sell most?
- Which bamboo product's market is rising?
- From where do you purchase the products?
- Where and how do you sell your products?
- What is the buying and selling price of the products?
- What is your cost of operation?
- How you manage finances? (personal, credit from bank, or other sources)
- What are the opportunities and challenges of bamboo product trading/retailing?

3. Interview exporters

- What are the products you export and where?
- What is the gap in demand and supply? Quality and quantity?
- What are the policy hurdles in exporting?
- What is your purchasing price and exporting price?
- What is the associated unit price cost?
- What are the opportunities and challenges of bamboo product trading/retailing?

4. Interview with personnel of R & D institutions

- How can the value be added to full bamboo resources, from top to bottom, from inside to outside? (e.g. outer skin, core tissue, fibre inner skin)
- What are the technological gaps in manufacturing bamboo products? What is your institution doing to fill the gap? How do you disseminate the innovation?
- Is any advance technology available elsewhere in the world? What can be done in importing the technology?
- Application fitting to species? (pulp, textile, charcoal, lumber etc)
- What are the challenges on R&D in Bamboo?
- Any policy issues in R&D?
- How much of a budget is available for the R&D?

5. Interview with enablers/stakeholders

- How do you see the future of bamboo in Kenya?
- What can be done to tap the economic potential of bamboo of Kenya? – (product development, diversification, export, import substitution)
- What is the employment potential of the bamboo sector in Kenya? How it can be more inclusive?
- What technological advantage is needed to manufacture competitive products – quality and price?
- What are the policy issues from cultivation, harvesting, transporting, processing, marketing and exporting?
- What can be done to strengthen the value chain of bamboo in Kenya?

Secondary data collection checklist

- Total area of bamboo under different level of management (cultivation, plantation, wild forest, etc.)
- Quantity of bamboo that can be harvested per hectare annually from each management level management (cultivated, plantation, wild forest, etc.)?
- Amount of total production, and marketing of various bamboo products at district or regional level?
- Bamboo processing companies and their capacities?
- Bamboo products sold in both domestic markets and exported (last five-year figure, if possible?)

Annex 6: Cost benefit analysis of bamboo cultivation

Year	Particular	Unit	Quantity	Rate (kSh)	Total (kSh)	Cost of production (kSh)	Production per acre			Market Price (kSh)			Income (kSh)			Cumulative Income (kSh)			Net Income (kSh)		
							Year	Survived Clump	Number of harvestable culms	S	M	L	S	M	L	S	M	L	Small-sized bamboo	Medium-sized bamboo	Large-sized bamboo
1st year	Land preparation	Person Days	20	200	4000																
	Seedlings	Number	250	210	52500																
	Plantation	Person Days	5	250	1250																
	Cost of production in the first year					57750	1st	200	0	80	100	120	0	0	0	0	0	0	-57750	-57750	-57750
2nd year	Cleaning (2 times in a year)	Person Days	8	250	2000	2000	2nd	200	0	80	100	120	0	0	0	0	0	0	-59750	-59750	-59750
3rd year	Cleaning and pruning (2 times in a year)	Person Days	10	250	2500	2500	3rd	200	0	80	100	120	0	0	0	0	0	0	-62250	-62250	-62250
4th year	Harvesting and cleaning	Person Days	10	250	2500	2500	4th	200	0	80	100	120	0	0	0	0	0	0	-64750	-64750	-64750
5th year	Harvesting and cleaning	Person Days	60	250	15000	15000	5th	200	1000	80	100	120	80000	100000	120000	80000	100000	120000	250	20250	40250
6th year	Harvesting and cleaning	Person Days	70	250	17500	17500	6th	200	1200	80	100	120	96000	120000	144000	176000	220000	264000	158500	202500	246500
7th year	Harvesting and cleaning	Person Days	80	250	20000	20000	7th	200	1400	80	100	120	112000	140000	168000	288000	360000	432000	268000	340000	412000
8th year	Harvesting and cleaning	Person Days	90	250	22500	22500	8th	200	1600	80	100	120	128000	160000	192000	416000	520000	624000	393500	497500	601500
9th year	Harvesting and cleaning	Person Days	100	250	25000	25000	9th	200	1800	80	100	120	144000	180000	216000	560000	700000	840000	535000	675000	815000
10th year	Harvesting and cleaning	Person Days	100	250	25000	25000	10th	200	1800	80	100	120	144000	180000	216000	704000	880000	1056000	679000	855000	1031000
11th year	Harvesting and cleaning	Person Days	100	250	25000	25000	11th	200	1800	80	100	120	144000	180000	216000	848000	1060000	1272000	823000	1035000	1247000
12th year	Harvesting and cleaning	Person Days	100	250	25000	25000	12th	200	1800	80	100	120	144000	180000	216000	992000	1240000	1488000	967000	1215000	1463000
13th year	Harvesting and cleaning	Person Days	100	250	25000	25000	13th	200	1800	80	100	120	144000	180000	216000	1136000	1420000	1704000	1111000	1395000	1679000
14th year	Harvesting and cleaning	Person Days	100	250	25000	25000	14th	200	1800	80	100	120	144000	180000	216000	1280000	1600000	1920000	1255000	1575000	1895000
15th year	Harvesting and cleaning	Person Days	100	250	25000	25000	15th	200	1800	80	100	120	144000	180000	216000	1424000	1780000	2136000	1399000	1755000	2111000
	Total (kSh)				314750																

Note: S = Small-sized bamboo; M = Medium-sized bamboo; L = Large-sized bamboo

Annex 7: Location of on-farm bamboo resources

County	Sub-County/ Constituency	Ward	Village
HomaBay	Rangwe	Kochia	Oderi
		East Gem	Sare
		West Gem	Bondo
	Suba	Gwasi North	Sindo
		Gwasi South	Makende
		Kaksingiri	Lukango
Migori	Kuria	Kuria East	Nyamonsense
		Kuria West	Nyabasi
			Bukira
	Suna East	Suna Central	Wasweta
			Wiga
			Kakrao
Kiambu	Lari	Kinale	Kinale
Kakamega	Sinyalu	Sibuye	Isukha West
			Isukha East
			Isukha Central
			Isukha North
Kisii	Bonchari	Bogiakumu	Bogiakumu
Bungoma	Kanduyi	Khalama	Musikoma
Muranga	Kandara	Kariara	Ndakaini
Machakos	Machakos Central	Mua	Mua
Nyeri	Mathira	Karatina Town	Ihigwagi
Nairobi	Langata	Karen	Karen
Siaya	Gem	Gem Central	Nyabeda
Kilifi	Malindi	Lango Baya	Baolala
Narok	Narok North	Olorropil	Orbaoi
	Kilgoris	Lolgorian	Nkararo
	Kilgoris	Kimintet	Pusanki
Kisumu	Muhoroni	Miwani	Jamna
	Muhoroni	Ombeyi	Ombeyi
	Nyando	Ahero	Ahero

Annex 8: Term of reference of the study

Pursuant to this contract, the consultant shall conduct national market assessments for bamboo products in Kenya, primarily aimed at identifying bamboo value chains with big potential for upscaling. The study will focus mainly on domestic markets, with a long-term view to supporting East African bamboo producers in exporting their products regionally as well as to the EU. For the study, Chinese expert teams, consisting of a bamboo expert and a bamboo value chain and livelihood specialist, will work with the project team in the country.

The specific objectives of the assignment will be as follows:

- Assess the bamboo value chain in Kenya and identify key opportunities and bottlenecks
- Map the existing bamboo products and explore potential products with potential in the domestic markets
- Identify bamboo products (existing, as well as potential) that have potential for exporting regionally as well as to Europe
- Provide concrete recommendations for upscaling the existing, as well as potential, bamboo products

1. Scope of the Work

The consultant needs to work closely with various project partners who will also be involved in market study. The partners that will be involved are MOSO Bamboo, The Netherlands, Wageningen University, The Netherlands, ICBR, OR China and local partner agencies in Ethiopia and Kenya. INBAR will provide the list of the local partners in Kenya and potential sites/locations for the study.

The consultant with the above-mentioned team will review existing project document, including various publication as well as research reports. The consultant will explore and assess the following items:

(a) Resource

- Amount of resources available (hectares)
- Condition/management of the bamboo resource (managed, wild forest, plantations, etc.)
- Accessibility of the resource (truck transport, seaport, etc.)

(b) Processing

- Existing capacity (technical as well as financial) capacity for investment in good machinery and operation and maintenance
- Technological know-how – access to knowledge (technology transfer, e.g. China)
- Competitive wage and working culture
- Reliable energy supply
- Inputs for processing, i.e. glues, lacquers, stains available and affordability
- Governmental support – no hampering legislation (e.g. export band)

(c) Plan

- Application fitting to species (pulp, textile, charcoal, lumber, etc.)
- Current and potential uses and application of bamboo
- Add value to full bamboo resource, from top to bottom, from inside to outside (e.g. outer skin, core tissue, fibre, inner skin)
- Identify (domestic) markets including feasibility for export (competitive?) First focus on 'cash cows' (e.g. pulp, charcoal) for

consistent, high volume return, then focus on 'stars' (e.g. engineered bamboo products > value-added, lower volume, > tech know how – more difficult!)

(d) Product development possibilities

- Attitude for product development/R&D/innovation in company:
- R&D budget
- Testing facilities/laboratory
- Sustainability focus (improving environmental footprint)
- Partnership – trust in safeguarding intellectual property (e.g. bio-based glue)

2. Final deliveries

- Inception report: Following the review of the relevant documents and interaction with the project officials and key stakeholders, the consultant shall produce a brief report explaining how he/she will carry on the assignment including a detailed plan of activities with a timeline, methodology/tools and feedbacks mechanism to be followed to carry out the assignment.
- Draft reports: Summarizing the outcome of the information collected (draft report will cover above-mentioned aspects provided in point IV of "Scope of Work") including conclusion and recommendations.
- Final report: Feedback provided by the key stakeholders will be incorporated in the final report

3. Timeline, duration of assignment, duty station and expected places of travel

- Contract duration: From 1 March 2017 to 30 April 2017.
- Duty Station: Home-based, with field visits to project sites in Kenya. The Consultant will need to complete field study in 10 days with the help of local assistants that will be directly hired by the project.
- Number of estimated working days: 20 days, including 10 days for inception and reports writing and 10 days for field study.

Annex 9 A: Technical specifications of bamboo sampled (*Oldeania alpina*): Chogoria Forest, Mount Kenya Ecosystem

Size	Portion	Diameter	Thickness	Internodal length
Large (total height 15m) No branching up to 6m	Bottom	8.0cm	2cm	40cm
	+1.5m	7.5cm	1cm	57cm
	+3.0m	7.8cm	0.8cm	67cm
	+4.5m	7.2cm	0.7cm	68cm
	+6.0m	6.5cm	0.7cm	65cm
	+7.5m	5.5cm	0.5cm	60cm
	+9.0m	4.2cm	0.5cm	58cm
	+10.5m	3.5cm	0.5cm	58cm
	+12.0m	2.5cm	0.4cm	43cm
	+13.5m	1.5cm	0.3cm	30cm
Medium (total height 14m) No branching up to 6m	Bottom	6.1cm	1.5cm	25cm
	+1.5m	6.0cm	0.8cm	60cm
	+3.0m	5.8cm	0.6cm	68cm
	+4.5m	5.3cm	0.6cm	70cm
	+6.0m	5.0cm	0.5cm	72cm
	+7.5m	4.0cm	0.5cm	70cm
	+9.0m	3.7cm	0.4cm	64cm
	+10.5m	3.0cm	0.4cm	53cm
	+12.0m	2.0cm	0.4cm	44cm
Small (total height 8.5m) No branching up to 4.5m	Bottom	3.7cm	1.0cm	26cm
	+1.5m	3.8cm	0.5cm	62cm
	+3.0m	3.6cm	0.5cm	67cm
	+4.5m	3.5cm	0.5cm	63cm
	+6.0m	2.5cm	0.4cm	56cm
	+7.5m	1.8cm	0.3cm	43cm

Availability of Bamboo as per diameter

Large	30%
Medium	40%
Small size	30%

Annex 9 B: Technical specifications of bamboo sampled (*Oldeania alpina*): Ragia Forest, Aberdare Ecosystem

Size	Portion	Diameter (cm)	Thickness (cm)	Inter-nodal length (cm)
Large (total height 11.5m) No branching up to 6m	Bottom	6.0cm	2.0cm	28cm
	+1.5m	6.0cm	0.8cm	59cm
	+3.0m	5.5cm	0.8cm	68cm
	+4.5m	5.5cm	0.5cm	70cm
	+6.0m	5.0cm	0.5cm	63cm
	+7.5m	4.0cm	0.4cm	53cm
	+9.0m	3.0cm	0.3cm	41cm
	+10.5m	2.0cm	0.3cm	30cm
Medium (Total height 10.5m) No branching up to 6m	Bottom	5.0cm	1.6cm	33cm
	+1.5m	4.8cm	0.9cm	64cm
	+3.0m	4.5cm	0.6cm	73cm
	+4.5m	4.2cm	0.5cm	74cm
	+6.0m	3.5cm	0.5cm	68cm
	+7.5m	3.0cm	0.4cm	54cm
	+9.0m	2.3cm	0.3cm	34cm

Size	Portion	Diameter (cm)	Thickness (cm)	Inter-nodal length (cm)
Small (Total height 9m) No branching up to 4.5m	Bottom	4.0cm	1.3cm	28cm
	+1.5m	3.7cm	0.7cm	49cm
	+3.0m	3.5cm	0.5cm	54cm
	+4.5m	3.0cm	0.4cm	49cm
	+6.0m	2.0cm	0.3cm	40cm
	+7.5m	1.5cm	0.2cm	30cm
Extra small (Total height 7m) No branching up to 2.5m	Bottom	3.5cm	1.2cm	26cm
	+1.5m	3.2cm	0.5cm	45cm
	+3.0m	2.8cm	0.4cm	46cm
	+4.5m	2.0cm	0.3cm	39cm
	+6.0m	1.0cm	0.2cm	26cm

Availability of Bamboo as per diameter

Large	20%
Medium	20%
Small size	30%
Extra small size	30%

Annex 10: Imports and exports of Agarbatti/incense sticks

HS Code	Description	Countries	2009	2010	2011	Average (USD)
330741	Agarbatti and other odoriferous preparations which operate by burning	Export (USD)				
		Total World	259,134,245	248,662,252	255,802,272	254,532,923
		Key Exporters				
		India	72,440,589	82,869,223	89,002,848	81,437,553
		China	59,552,538	65,155,440	87,108,277	70,605,418
		Import (USD)				
		Total World	189,590,642	229,430,501	164,639,484	194,553,542
		East Africa				
		Ethiopia	3,082,860	3,991,695	2,624,715	3,233,090
		Kenya	198,621	154,268		176,445.5
		Tanzania	168,953	238,325	265,730	224,336
		Uganda	83,945	84,320		84,133.5

Source: Indexmundi (2017); Indexmundi (2017a)

