

**FACTORS INFLUENCING THE DEVELOPMENT OF BAMBOO VALUE
CHAIN IN KENYA: A CASE STUDY OF NAIROBI COUNTY**

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DECLARATION

Declaration by the student

I declare that this project paper has not been previously presented for examination in this university or award of a degree in any other University. The work reported herein has been carried out by me and all sources of information have been acknowledged by means of references.

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The persons mentioned above shall however not be held responsible for any shortcomings and omissions in this report. It is solely the researcher's responsibility.

DEDICATION

I dedicate my work to my husband Mr. Charles Wanjala and mother Mrs. Leah Ogega; you have been there for me like no one else has. I adore you and thank God for having you in my life.

ABSTRACT

Kenya, like many other developing countries has experienced its fair share of challenges of balancing between environmental sustainability and development. Key among these challenges is the deteriorating environment as a result of lack of sustainable livelihood support systems. A large population of Kenya still relies directly on the natural resources for energy and other forms of livelihood support. This leads to rapid land use changes and consequent land degradation which in turn affects the overall wealth of the nation.

Bamboo is a fast growing, renewable, widespread, low cost, plant in the family of grasses with great potential in environmental conservation and poverty alleviation. Bamboo has over 1500 documented uses and with the ever growing population it can be a good alternative for conventional resources in Kenya. In Kenya however, the use of bamboo is still minimal and its full potential is yet to be realized. Bamboo enterprises have slowly been established over the recent past and Nairobi County has the most developed enterprises of all other counties in Kenya. The objectives of this study therefore were to: examine the sourcing, processing of raw bamboo as well as the selling and marketing of bamboo products; explore the development of the bamboo value chain in Kenya and; evaluate the challenges to development of the bamboo value chain in Kenya.

Snowball sampling was used in primary data collection using questionnaires and interview schedules. A total of 7 key informants were interviewed and 37 questionnaires were administered to bamboo dealers and customers. In addition, observation checklists and photography were also used in data collection. Secondary data were collected from scientific journals, books, periodicals, research reports, published and unpublished theses, International Network for Bamboo and Rattan (INBAR) data bank and the Internet. Quantitative data were analyzed using measures of central tendencies such as means and percentages. Qualitative data were organized and categorized into thematic areas of the study objectives. The results were presented in form of text, table, charts and photographs.

The study established that bamboo was mostly sourced outside Nairobi County as raw poles especially from Kiambu and Kajiado Counties. Processing was done using simple technology and selling of bamboo products was mostly done in Nairobi. Bamboo was also used in several

environmental rehabilitation initiatives in the capital. Bamboo nurseries provide bamboo seedlings for aesthetic uses in the residential areas and city centre; they also provide seedlings for the city afforestation programmes. The bamboo cottage industry provides items from a sustainable renewable resource with minimal and bio-degradable wastes. The study also revealed that bamboo has the potential to replace wood in many aspects but bamboo remained a fairly untapped resource and compared to most similar products it had no formal marketing structure. It also showed that the bamboo value chain was affected by ecological, social-cultural, legal, technological and economic factors.

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CHAPTER ONE: BACKGROUND OF THE STUDY

1.0: Introduction

The growing human population on our planet in combination with an increase of consumption per capita puts immense pressure on global natural resources. These cause three main interrelated environmental problems: depletion of resources, deterioration of ecosystems and deterioration of human health, and their effects. It has therefore become the preoccupation of many to focus towards sustainable development.

Starting in the 1970s through the alarming warning from the Club of Rome, public awareness about the environment has increased drastically over the last decades. In 1987 the World Commission on Environment and Development headed by Brundtland presented the report *Our Common Future* (Brundtland *et al.* 1987) including the - now widely adopted - concept of sustainable development: “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” Although the report also emphasized the importance of decreasing the differences in wealth between developed countries in the “North” and developing countries in the “South”, through a better balance in economy and ecology, the term “sustainability” was first mostly interpreted in its environmental meaning (Van der Lugt *et al* 2009).

1.1: Study Background

The increasing global attention towards the potentially devastating effects of climate change has led to increasing focus on the role of deforestation and land use change. Fuelled by an ever growing demand for wood products, deforestation continues to increase at an alarming rate. Deforestation leads to land degradation and eventual lose of the natural resource base on which most people in Africa depend. For instance, wood has many uses in Africa and supports almost all human activities including energy production, construction, trade and manufacturing.

KFS 2013 estimates that Kenya forests cover an area of 4,986,676 ha of which natural forests cover an area of 4,754,378ha while plantations cover an area of 232,298 ha. Public or gazetted natural forests cover an area of 905,357ha. Natural forests in community lands cover 3,849,021ha of which 596,099ha were found to be national parks, hence 3,252,922ha being the

forest area under community management. Public plantations cover an area of 138,152 ha and community/private plantations cover an area of 94,146ha. In Kenya the wood is mostly used as a raw material in wood product industries and as a source of fuel. Generally more than 75% of the country's domestic energy comes from fuel wood and charcoal. (EPZA 2005)

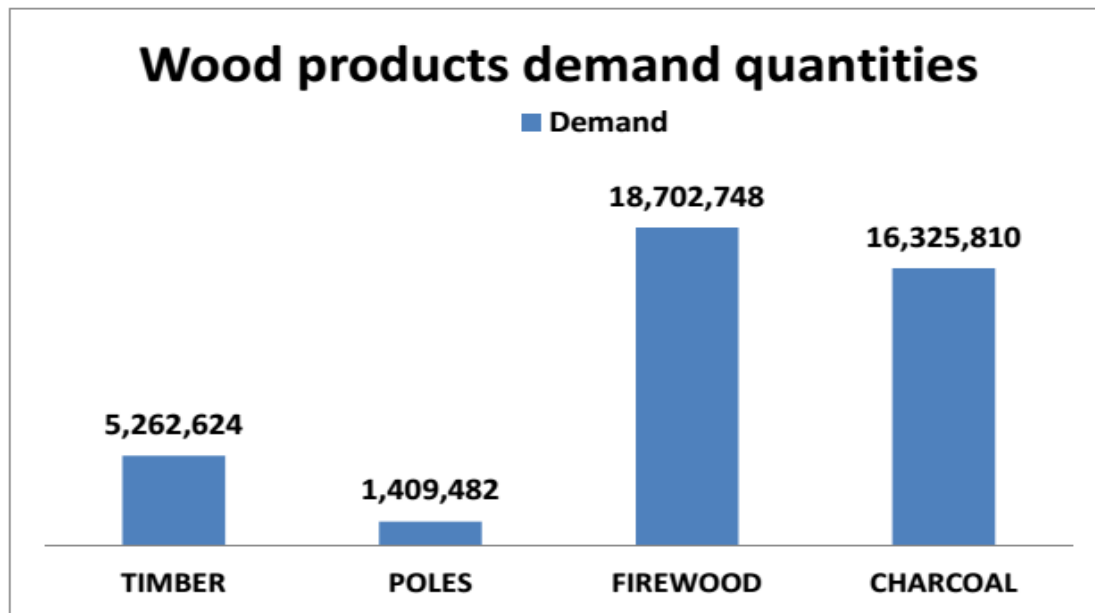


Figure 1: Wood demand in Kenya

Source: KFS 2013

Based on the national population for the year 2012, demand quantities for timber, poles, firewood and charcoal are calculated to be 5,262,624m³, 1,409,482m³, 18,702,748m³ and 16,325,810m³ respectively. Demand at county level is based on each county's population and national per capita demand to arrive at the consumed quantities. Nairobi County has the highest demand at 3,389,582m³ (KFS 2013).

In an attempt to successfully reverse the current trends of deforestation and forest degradation, it is imperative that market demands for wood and timber products that cause such land use change, are addressed. Bamboo is a fast growing, renewable, widespread, low cost, environment enhancing resource with great potential to improve poverty alleviation and environment conservation. The development of a sustainable supply of timber bamboo such as *G. angustifolia*, provides one such solution.

Bamboo can be utilized at all levels of industrial activity from small craft based industries to modern highly integrated plants. Bamboo industry is making important contribution in providing food, housing and income generation for 2.2 billion people in the world. Half of the world's population is involved in the use and trade of bamboo products. As the market for environment friendly green bamboo is growing, it is estimated that the world bamboo market will grow from its present size of USD10 billion to over 20 billion by 2015 (Xuhe, 2003).

Mature in a fraction of the time of tropical hard woods (4yrs compared to over 20yrs for species such as teak, mahogany, rosewood etc) and with new technology now available in countries like Japan that enables the processing of bamboo for high end products such as flooring, decking, construction and furniture, bamboo represents a sustainable alternative. Bamboo can be processed using simple technology especially for small crafts which means that it can be easily utilized in small and medium enterprises as no huge amounts of capital are required.

If grown under the correct conditions, with a particular focus on the utilization of degraded land for reforestation initiatives, bamboo's green credentials are impressive. It not only prevents further soil degradation and erosion, but it utilizes very low levels of water from the soil, and its extensive root system acts as a watershed protector. Furthermore bamboo sequesters significant volumes of carbon dioxide from the atmosphere within a relatively short time period. If used for high end wood products, such carbon remains stored for long time periods, contributing to the fight against climate change.

Bamboo is widely used as a raw material in Asia, South America and Africa, where abundant different species of bamboo grow. Nowadays, over 2.5 billion people worldwide use or trade in bamboo worth 4.5 billion US Dollar every year (INBAR 1999). Every type of bamboo product that is manufactured with a view towards quality and durability makes use of raw materials with distinct physical and mechanical properties. For Europeans, bamboo is an exotic plant, as a material it was even stranger before the sixteenth century when it was first introduced in Europe. But in other continents like Asia, Africa and South America people have used bamboo in their daily life for more than thousand years, from bamboo buildings to bamboo furniture, from bamboo bridges to bamboo foods. In Kenya bamboo has been used in fencing, as fuel wood, food, handicrafts and for aesthetics.

Due to the expected higher annual yields, and the ability of bamboo plantations to be established on areas of land where trees may not survive (e.g. degraded hill slopes), bamboo could be a promising alternative to help meet the increasing demand in raw materials and timber in particular. Bamboo therefore covers most aspects of sustainable development due to its ability to reduce poverty by providing employment, income, environmental sustainability and provide a better opportunity for distributional equity.

There are some constraints to the development of the bamboo sector in Kenya. According to the Forestry Department, bamboo is classified as a minor forest product (Ongugo *et al*, 2000). This has slowed the recognition and development of this resource. There has been a slow but steady progress in the cultivation of exotic bamboo in Kenya. So far some 48 local uses of bamboo have been recorded in Kenya (Ongugo *et al*, 2000) such as providing raw materials for many activities such as production of incense sticks, toothpicks, food and forage, water harvesting, medicine, supports for commercial flower growing, tea picking baskets and making handicrafts. There has been little research done on bamboo and its benefits to the environment. Little is known on the diversity of bamboo species and their benefits to the ecosystem both at local and national level in Kenya.

This paper sought to reveal the factors influencing the development of the bamboo value chain in Kenya and formulate recommendations towards the improvement of bamboo sector in the country bearing in mind its potential value to the economy and the environment.

1.2 Statement of the problem

Deforestation presents one of the major challenges to environmental sustainability in Kenya. Kenya is internationally considered to be a low forest cover country as it has less than 10% of its total land area classified as forest. Kenya is a low forest cover country, with a present cover of only 6.9%. In spite of this low cover, the country relies heavily on its forest resources to steer economic growth through the provision of the much needed forest goods and services. Since this is attributed to deforestation and poverty it is imperative that various actors increase the area under wood to solve the problem of environmental sustainability.

Majority of Kenya's population relies heavily on forest products for livelihood support. Wood has always been the preferred raw material for production in Kenya. Dependence on fuel wood

in rural Kenya is almost 100% and also about 80% of urban population relies on charcoal for domestic energy requirements (MENR, 1994). It is not fully recognized that poverty causes people to rely directly on the natural resources because of limited options they have access to. If the poor are adequately uplifted then poverty will not have to be a major cause and consequence of the environmental degradation and resource depletion where major environmental challenges include deforestation, soil degradation and desertification, declining biodiversity and marine resources (Okwi *et al.*, 2005).

One of the main strategies toward environmental improvement with respect to material use is the deployment of renewable materials during production. Bamboo, as a fast growing renewable material with a simple production process, is expected to be a sustainable alternative for more traditional materials like concrete, steel and timber. The use of bamboo as a raw material provides a reasonable alternative to the use of hardwood for production of various goods but there is a shortage of qualified actors to implement this.

The market for bamboo in Kenya is also still immature and hence bamboo remains relatively less unexplored than other wood products. Bamboo products still lose against imported industrial products in the country. In regards to bamboo there seems to be a disconnection between the end users, the government institutions, researchers and the commercial bamboo entities with respect to knowledge of bamboo resources.

Despite being a country with vast resources and great potential for developing its raw material base, Kenya still lags behind in its utilization of bamboo as raw material and therefore bamboo remains relatively unpopular. Development of bamboo as a resource is minimal and consequently bamboo enterprises are very few and scattered within Nairobi County. KEFRI is the only government institution that trains artisans on the use of bamboo using low cost technology.

The purpose of this study was to examine the factors that influence the development of bamboo value chain in Kenya.

1.3: Research Questions

This study was guided by the following research questions:

1. What are the sources of bamboo for various productions streams?
2. What is the status of bamboo value chain development in Kenya?
3. What are the challenges in the development of bamboo value chain in Kenya?

1.4: Research Objectives

1.4.1: General objective

The general objective of this research was to investigate the factors influencing the development of bamboo value chain in Kenya. It sought to examine the challenges and opportunities of development of the bamboo value chain tracing from the source to end while also highlighting the potential of existing bamboo enterprises in environmental conservation and livelihood support.

1.4.2: Specific objectives

- i. To examine the major sources of raw bamboo in Kenya
- ii. The status bamboo value chain development in Kenya
- iii. To evaluate the challenges in bamboo value chain development in Nairobi County

1.5: Hypotheses

- a) There is no significant difference in bamboo enterprise incomes in the various sampled areas
- b) There is a significant relationship between the level of education and the preference for bamboo products

1.6: Justification of the study

Kenya has experienced its fair share of environmental problems; deforestation being among the leading, in the face of economic development which has led to the integration of environmental protection strategies including environmental acts, establishment of environmental authorities, research and development and international treaties *inter alia*.

Kenya is a low forest cover country, with a present cover of only 6.9%. In spite of this low cover, the country relies heavily on its forest resources to steer economic growth through the provision of the much needed forest goods and services. Over 80% of Kenyans depend on forests for provision of domestic energy needs in terms of either charcoal or firewood (Githiomi J.K and Oduor N. 2012).

This study seeks to strengthen the push for use of bamboo to substitute the use of wood for both commercial and domestic purposes. The physical and environmental properties of bamboo make it an exceptional economic resource for a wide range of uses. It grows quickly and can be harvested annually without depletion of the parent plant and without causing harvesting damage or deterioration of the soil. Bamboo can grow on marginal land, not suitable for traditional agriculture or forestry, or as an agroforestry crop. It is relatively light weight, because the culms are hollow, and unlike wood can be easily harvested and transported without specialized equipment or vehicles. Processing normally does not require highly skilled labor or special qualifications and can be started at a minimal cost (FAO, 2005).

The bamboo sector is a fairly new but emerging sector. KEFRI has been on the forefront of research and sensitization on bamboo farming, processing, production and marketing. While bamboo provides a viable alternative for industrial production as a raw material and has high environmental credentials, it has not caught on well in Kenya and hence its full potential has not been realized in this context.

Kibwage *et al.* (2007) examined the structure and performance of formal retail market of bamboo products in Kenya with specific reference to market segments in Nairobi, Mombasa and Kisumu cities. The study revealed that most of the bamboo products (toothpicks, baskets, bowls, table mats, trays, skewers, flower vases and edible shoots) sold in the formal retail market is

imported from China, India and Thailand a scenario that results in high market prices and low demand for the products, thus the need to encourage domestic production of the products especially in urban areas.

There is need for more research in this area because information helps to empower people for decision making. This will in turn facilitate the adoption of renewable energy sources as well raw materials for production. It will therefore enhance the move towards sustainable production and development.

This study will seek to encourage more interest in bamboo as a resource and especially inform policy on the need to lift the ban on harvesting of bamboo in Kenya. It will also encourage further research into this subject and open new opportunities for use of other renewable resources.

1.7: Scope and limitations of the study

This study focused on factors influencing the development and use of bamboo as a resource within the bamboo value chain. It further sought to trace the bamboo raw material from the source to the end use with respect to Nairobi County. It also highlighted the major uses of bamboo in Kenya. Further, it was limited to small and medium furniture enterprises within the boundaries of Nairobi County with the main focus being at KEFRI bamboo sections as this is the most established enterprise in Kenya currently.

The lack of knowledge of both producers and consumers of bamboo products was expected to be a major challenge when carrying out this study. It was also expected that there will be few dealers of bamboo and its products which limits the amount of data available for the study.

This was also an expensive venture as dealers were scattered across Nairobi County and most raw bamboo was produced in the neighboring Counties.

1.8: Assumptions

The study made the following assumptions:

1. The sample studied was representative of the total population of bamboo dealers and activities in Kenya.
2. Responses received from respondents and experts reflected accurate information with regards to their experience

1.9: Operational Definitions

Bamboo Dealers – persons involved in a range of bamboo selling and processing activities.

Canopy interception – The rainfall that is intercepted by the canopy of a bamboo tree and successively evaporates from the leaves.

Culms- Bamboo stems

Gregarious- The property of bamboo to grow in groups/clusters.

Rattan - The thin bendable stems of a palm, used to make furniture.

Sequester - The process of withdrawing carbon dioxide from the atmosphere

Value chain - The full range of activities that are required to bring bamboo products from conception, through the different phases of production, to delivery to final consumers and disposal after use

1.10: List of Abbreviations

CBOs – Community Based Organizations

EPZA – Export Processing Zones Authority

FAO – Food and Agriculture Organization

IFAR – International Foundation for Art Research

IGAD - Intergovernmental Authority on Development.

INBAR – International Network for Bamboo and Rattan

KEFRI – Kenya Forest Research Institute

KFS – Kenya Forestry Services

MENR – Ministry of Environment and Natural Resources

NGOs – Non Governmental Organisations

PCS – Production- to-Consumption Systems

RELMA – Regional Land Management Unit

WWF International – World Wide Fund for Nature International

CHAPTER TWO: LITERATURE REVIEW

2.0: Introduction

Man is extracting more resources than the earth can regenerate. A useful indicator, which makes this deficit quantifiable in numbers, is the Ecological Footprint, which is defined as “a measure of how much biologically productive land and water an individual, population or activity requires to produce all the resources it consumes and to absorb the waste it generates using prevailing technology and resource management practices” (WWF International 2006).

Due to the increasing depletion of finite abiotic raw materials, renewable resources are gaining an increasing amount of attention, since they enable the demand for materials in a potentially sustainable manner (Van der Lugt *et al.*, 2009) because they can be regenerated.

2.1: Wood demand and supply in Kenya

KFS 2013, reports that the national wood consumption per capita is 1m³ per year. However, wood is consumed in form of processed end products whose consumption varies from one region to the other depending on socio economic conditions of the region. Urban centers consume relatively more charcoal than rural settings. Timber is demanded in high proportions in industrial and upcoming urban centers than rural areas. Poles consumption is relatively high in rural areas where transmission works are being undertaken as well as where fencing and building of wooden houses is taking place. Firewood is mostly consumed in rural areas.

Population control to curb rising demand require policy interventions which are long term in nature leaving checking of wood consumption rates as viable option to limit high and rising demand. This can be done through adoption of strategy options targeting:-

- Change or improvement of wasteful utilization techniques and practices through capacity building and tax adjustments for wood working equipment's
- Promotion of alternatives products to wood.
- Review and adoption of policy and legal guidelines that regulate timber harvesting methods and charcoal regulations (GoK 2013).

Focusing on wood alternatives would be more long term and self regulating. The industrialization of the material bamboo is supposed to solve the problem of utilizing wood in the industrial context, which has been considered an important strategy for local economic development in many developing countries where bamboo sources are abundant. Through industrialization bamboo is processed and fabricated into different standard industrial products which are mainly used as a cheap substitute for hardwood because bamboo grows much faster than timber and is a renewable source after 4-5 years.

2.2: Opportunities for bamboo value chain development

Bamboo is the common term for members of a particular taxonomic group of large woody grasses (subfamily *Bambusoideae*, family *Andropogoneae/Poaceae*). Bamboos encompass 1250 species within 75 genera, most of which are relatively fast-growing, attaining stand maturity within five years, but flowering infrequently. Dwarf bamboos may be as little as 10 cm in height, but stands of tall species may attain 15-20 m, and the largest known (e.g. *Dendrocalamus giganteus*) grow up to 40 m in height and 30 cm in culm (stem) diameter. Bamboos are distributed mostly in the tropics, but occur naturally in subtropical and temperate zones of all continents except Europe, at latitudes from 46° N to 47° S and from sea level to 4000 m elevation (IFAR/INBAR, 1991; Tewari, 1992).

Asia accounts for about 1000 species, covering an area of over 180,000 km² (the size of Missouri, half the size of Germany, or about 2% of U.S. total land area). Most of this comprises natural stands of native species rather than plantations or introductions. China alone has about 300 species in 44 genera, occupying 33,000 km² or 3% of the country's total forest area (Qiu *et al.*, 1992). Another major bamboo-producing country is India, with 130 species covering 96,000 km² or about 13% of the total forested area (Shanmughavel and Francis, 1996). Other nations with significant bamboo production and utilization include Bangladesh, Indonesia and Thailand.

Although the information gathered from Africa is partial, a total of over 2.7 million hectares of bamboo forest was reported by six countries (Ethiopia, Kenya, Nigeria, Uganda, Tanzania and Zimbabwe).

Bamboo has been identified as the second largest sustainable forest resource (Brias, 2006), which has begun to show its significance in people's daily production and life. Resource

management and technical improvements can convert this fast-growing grass into a durable raw material for construction purposes and a wide range of semi-industrialized products. New industrial applications and modern construction design have both demonstrated bamboo's huge potential. A study published by ICRAF (2004) revealed that bamboo absorbs water faster than most plants and in some parts of the world is used to clean sewage. Even more importantly, it soaks up heavy metals. It is a potential answer to polluted waters in Kenya, including those of Lake Victoria whose shores are dotted with large urban centers that discharge domestic and industrial waste into its waters.

Its culms are the strongest and lightest natural material known to man. ICRAF (2004) reputed bamboo's versatility in environmental conservation and commerce and recommended it to be a viable replacement for both hardwoods and softwoods. With a growth rate three times that of eucalyptus it matures in just three years. Moreover, the study further revealed that bamboo is very effective in controlling soil erosion as its rhizomes can anchor topsoil along steep slopes and riverbanks. Bamboo leaves, sheaves and old culms that die and fall to the ground decompose and create a thick humus layer that enriches the soil.

Bamboo is also a vital component of the environment because bamboo areas indicate zones of high biodiversity as it provides suitable habitat for a number of wildlife species and microorganisms. Due to high adaptability, versatility and ability to improve soil conditions facilitating fast and diverse growth of bamboo even on degraded areas, it is a superior species for restoration of degraded wildlife habitats. The bamboo shoots and other parts of culms provide a rich, nutritious and unlimited source of food to many animal species. Similarly, dense growth of bamboo culms and their canopy contiguity in association with high forests impart protection, breeding cover and connectivity for uninterrupted ranging to the animals. Extensive root system and vast underground rhizome network almost covering ca 100 m² area around bamboo clumps strongly hold and bind the soil and make the bamboo growth capable of tolerating the onslaughts of landslides, floods, hurricanes and quacks (Varshney, 2004).

The role of bamboo in conserving soil and protecting watersheds is also substantial in Africa. For example, in Kenya, *Yushania alpinas* (formerly *Arundinaria*) receiving attention from the government especially for catchment rehabilitation, regulation of water-flow and erosion control (Ongugo *et al.* 2000). Considering the special properties of bamboo, especially its fast growth,

easy to cultivate and excellent mechanical properties, researchers have begun trying to get the natural material bamboo industrialized so that it can be used in the industry.

The many characteristics of bamboo make it an enduring, versatile and highly renewable resource. Bamboo has more than 1,500 documented uses, ranging from fuelwood to light bulbs, medicine, poison and toys to aircraft manufacturing. Over 1,000 million people live in houses made of bamboo or with bamboo as the key structural or roofing element. Its biological characteristics make it a perfect tool for reducing carbon dioxide levels in the atmosphere. It generates more oxygen than equivalent strands of trees, lowers light intensity, protects against ultraviolet rays and is an atmospheric and soil purifier. Bamboo is an enduring and versatile natural resource. The great diversity of species makes bamboo adaptable to many environments.

Bamboo grows very fast and has a short growth cycle. Bamboo not only grows much faster than wood, it also needs relatively little water. It is the fastest growing canopy, growing three times faster than most eucalyptus species. Commercially important species usually mature in four to five years (versus 10 to 25 years for most soft woods). Annual harvests are subsequently possible. Bamboo also prevents soil erosion. Its anti-erosion properties create an effective watershed, stitching the soil together along fragile river banks, deforested areas, and in places prone to earthquakes and mudslides. The sum of stem flow rate and canopy intercept of bamboo is 25% which means that bamboo greatly reduces rain run-off, preventing massive soil erosion. Thus, bamboos help control landslides, keep flooded rivers along their natural course and slow the speed of the water flow.

Bamboo is foremost in biomass production, with up to 40 tonnes per hectare per year in terms of culms only in managed stands. An estimated one-quarter of the biomass in tropical regions and one-fifth in subtropical regions comes from bamboo (Scurlock *et al*, 2000). Bamboo is a renewable resource for agro-forestry products. Bamboo is a high-yield renewable natural resource. Ply bamboo is now being used for wall panelling, floor tiles, for paper making, briquettes for fuel, raw material for housing construction, and rebar for reinforced concrete beams. It can be used to produce many items of daily use that are currently made out of plastic or other less eco-friendly materials.

Bamboo is one of the world's best natural engineering materials. Due to its high tensile strength, it is an essential structural material in earthquake architecture and is one of the strongest building materials. Its strength-to-weight ratio is better than that of teak wood and mild steel. Bamboo's tensile strength is 28,000 lb per square inch versus 23,000 for mild steel. This makes bamboo wood a potential alternative, at least in some applications, to steel which requires more energy for manufacturing/production. Its strength and flexibility make it a viable material for building shelters that offer protection against hurricanes and earthquakes. In Bangladesh, 73% of the population lives in bamboo houses. Bamboo based pre-fabricated houses also can be constructed quickly with new and emerging techniques and is thus an important post-disaster relief material. It is extensively being used in Tsunami rehabilitation in India. Bamboo reinforcement in concrete piles is used by the Indian Railways (Hazra, 2008)

As a food source, bamboo shoots have provided nutrition for millions of people worldwide. In Japan, the antioxidant properties of pulverized bamboo bark prevents bacterial growth and it is used a natural food preservative. Taiwan alone consumes 80,000 tons of bamboo shoots annually constituting a \$50million industry. In parts of Western Kenya edible bamboo shoots are used as food in some communities.

Bamboo is a viable replacement for wood. Its qualities of strength, light weight and flexibility make it a viable alternative to tropical timber that is used in the furniture and building materials industries. It is a critical element of the economy. Bamboo and its related industries provide income, food and housing to over 2.2 billion people worldwide. There is a 3-5 year return on investment for a new bamboo plantation. Bamboo is being used as an input or raw material in certain industries. It has been primarily been used in the paper industry in bulk quantities as a raw material for paper pulp. Bamboo is also used in manufacturing wood substitutes, composites and utility products.

Bamboo is also a source of energy. Gasifiers can produce electricity using bamboo as fuel. These can also be used for thermal applications replacing furnace and diesel oil. Charcoal and its processed form in powder and briquettes can also be manufactured. It is superior to other sources of charcoal in terms of calorific value. Bamboo charcoal can also be used as a raw material for activated carbon manufacturing which is used as adsorbent in different industries like vegetable oil, beverage, pharmaceuticals etc. Goldsmiths prefer bamboo charcoal in making jewels.

In sum, bamboo's excellent growth, environmental, mechanical and engineering properties make it a fine alternative to tropical timber. Its potential for different value added products and application make it an extremely important material for dispersed employment generation and economic activities. Perhaps these properties and potential usage coupled with increased urgency of environmental issues ought have been sufficient to change the attitude towards bamboo, and solved the problems of tropical deforestation.

Millions of people depend on this plant for their livelihood. It has become so much a part of the culture and memory of societies that the existence of a Bamboo Age has not been ruled out. Its use in food and cooking goes far back in history" representing a social stigma (Hazar 2008).

2.2.1: Bamboo based Products

Literature regarding the multiple uses of bamboo highlights the utility of bamboo for house construction, bamboo ply, agricultural implements, handicraft, irrigation, brooms, medicine, food, fuel, fodder, paper & pulp etc, especially bamboo as a perfect substitute for some wood based products.

Worldwide, various bamboo products provide high income levels. For example, the global market for bamboo products is approximately USD 7 billion which is expected to triple by the year 2017 (Smith and Marsh, 2005). In China, bamboo has been used in many projects in rural areas to alleviate poverty and conserve the environment (Zhu, 2006). From the small organized microenterprises, China gets to package and market its bamboo products for export. China's annual export value from bamboo products is estimated to be more than USD 600 million, with the total value of bamboo industries estimated to be 12 billion (Smith and Marsh, 2005). Several counties have shown strong growth related from bamboo cultivation and processing and bamboo projects are being encouraged for rural poverty alleviation in several provinces (Zhu, 2006). Asia has recorded 1500 uses of Bamboo, (RELMA, 2003; Madhab, 2003), whereas in Africa, possibly due to lack of awareness, bamboo's great potential is rarely exploited. About 14 million hectares of bamboo cover exist in the world, out of which 80% is distributed mainly in Asian Tropical Region (Sharma, 1980). India has about 8 million hectares that provide 60% of its massive population requirements and meet much of its commercial timber needs (ICRAF, 2004).

The environmental impact of a product depends on all the life cycle stages of the product. Intuitively one expects that the environmental impact of a material has the most influence on the production phase of a product caused by raw material provision and factory production. However, the choice for a specific material in a product also has a strong and direct impact on other aspects of the product in other stages of the life cycle, such as the processing stage (e.g. impact on energy impact and efficiency of production technology), use phase (e.g. durability during life span) and the end-of-life phase (e.g. possibility of recycling, biodegradation, or generation of electricity at the end of the life span). This shows that materials are intrinsically linked to every stage of the life cycle of a product.

The physical and environmental properties of bamboo make it an exceptional economic resource for a wide range of uses. It grows quickly and can be harvested annually without depletion of the parent plant and without causing harvesting damage or deterioration of the soil. Bamboo can grow on marginal land, not suitable for traditional agriculture or forestry, or as an agroforestry crop. It is relatively light weight, because the culms are hollow, and unlike wood can be easily harvested and transported without specialized equipment or vehicles. Processing normally does not require highly skilled labor or special qualifications and can be started at a minimal cost (FAO, 2005).

The products that can be made from bamboo can be broadly be categorized into wood substitutes and composites like flooring boards; industrial use and products, food products and construction and structural applications. Apart from this broad classification various handicraft and cottage industrial products are also made from bamboo.

2.3: State of bamboo resources in Kenya

The utilization of bamboo has a very long history in the world, particularly in Asian countries but also in Africa and Latin America. Especially where it was available as the main plant and was used as a substitute for wood in many cases (Blowfield *et al.*, 1995). Traditional bamboo products include paper, construction and housing materials, household tools, handicrafts, furniture, weavings, carvings, and boats. Bamboo housing and construction materials from the large Latin American species, *Guadua angustifolia*, were also an important part of culture in countries like Colombia and Ecuador. Widenoja (2007) noted that industrial processing of bamboo began first in India and China with pulp production for paper

making. The first bamboo paper was made around 100 AD in China and the first paper mill was established in the 6th century. These early bamboo processing plants utilized bamboo as it was the dominating plant in their regions.

The bamboo sector in Kenya is not well established compared to the situation in most of the Asian countries. In a study on the production-to-consumption system (PCS) of the bamboo sector in Kenya, Ongugo *et al.* (2000) identified potential development interventions for the improvement of the livelihoods of the local people. Bamboo was also identified to be an environment enhancing grass with potential of rejuvenating degraded land. The study was done in the rural and peri-urban areas, the conclusions of the study were however drawn from the rural perspective i.e. How bamboo in Kenya enhances rural livelihoods. So far there has been little or no research done on the development of bamboo value chain with specific attention to its benefits in the urban areas.

There are about 150,000 hectares of bamboo forests in Kenya, partly pure and partly in mixture with trees and shrubs. Most of the bamboo resources in Kenya comprise one indigenous species, *Yushania alpina* which was formerly known as *Arundinaria alpina* or (K.Schum). It grows to 20m tall in ideal conditions, but at high altitudes, the culms are relatively slender and short.

Culms are thick-walled and branches emerge at the upper nodes. Shoots are produced during the rainy season and culms live for between seven and fourteen years. Flowering is thought to occur at forty-year intervals in the Aberdare ranges and at fifteen-year intervals in the Mt. Elgon range. Gregarious flowering is not known in *Arundinaria alpina* occurs between 2290 and 3360 m above sea level (a.s.l.) and covers about 150 000 ha either as pure or mixed stands. Estimated coverage in the Timboroa plateau is about 31, 000 ha, 65,000 ha in the Aberdare ranges and 51,000 ha in the Mount Kenya, Mt. Elgon and Mau ranges. The species is found mainly in areas of high agricultural potential where competition for land is intense. *A. alpina* is receiving attention from the government especially for catchment rehabilitation, regulation of water-flow and erosion control where it is a vitally important species (Ongugo *et al.*, 2000)

With the exception of a few clumps of the species left on farms by farmers living around forest areas in the highlands, very little cultivation of this species on farm has been done (KEFRI 2008).

Bamboo in Kenya play a very important role in fencing, house construction, water harvesting, cottage industries dealing with matchsticks, furniture, baskets, tooth-picks, various other handicrafts and, in agricultural farming especially for supporting horticultural crops (Kigomo 2007).

Over-time bamboo resource cover has undergone changes largely through clearing to provide clear areas for plantations, cultivation and settlement developments. The area under bamboo is therefore presently much smaller and, may be one-third of what was there by the third decade of this century. Much of the remaining bamboo is found on mountains, covering large areas in Mau, the Aberdares and Elgon mountains. (Kigomo 2007).

By 1980 overharvesting of indigenous timber and bamboo forests was having a devastating effect on the environmental and therefore in 1986 there was a presidential directive banning all cutting of indigenous bamboo. However there was no setting up of clear and definite guidelines for the follow up of the directive.

Research on bamboo since 1980s by KEFRI has led to introduction of over twenty Asian bamboo species whereby half of them have thrived in various ecological zones. The introduced species are more versatile and can be cultivated where local bamboo does not thrive. The introduced species include *Bambusa bambos*, *B. lako*, *B. nutans*, *B. tulda*, *B. vulgaris*, *B. vulgaris var Vitatta*, *Cephalostachyum pergracile*, *Denrocalamus asper*, *D. brandisii*, *D.giganteus*, *D. Hamiltonii*, *D. membranaceus*, *D. strictus*, *Oxytenanthera abyssinica*, *Phyllostachy nigra var. Henonis*, *P. pubescens*, *Shibataea kumasaka*, *Thyrsostachys siamensis* (KEFRI 2008).

There are no established, formalized market outlets for bamboo products in Kenya currently. As such modern marketing strategies for bamboo are absent. These means that bamboo usage is relatively unknown or poorly understood due to lack of awareness among masses. Private companies also grow and sell bamboo either as culms or processed products but general bamboo trading activities are usually limited. As a non-timber forest product, bamboo is not routinely included in forest inventories. According to the FAO (2001) statistical data on bamboo are available for the period 1954 to 1971 only. The description of bamboos is an ongoing process; not only do new species remain to be discovered and described, but many earlier descriptions and classifications of species are being revised.

A number of institutions are involved in various ways in the conservation and development of bamboo and rattan resources. Most of these do not however have well planned initiatives geared to the development of bamboo per se. The list below indicates the institutes' interventions in this sector.

- Forestry department, Ministry of Natural Resources is involved in the management and regulation of resource exploitation in the natural gazetted forests.
- Kenya Wildlife Service, Ministry of Natural Resources has the mandate of protecting forest resources and biodiversity in the National Parks and Reserves.
- Kenya Forestry Research Institute, Ministry of Research and Technology is a national forest research organization that undertake research in management and utilization of forest and tree resources, including bamboo and rattan resources.
- A number of small scale enterprises are involved in the utilization of bamboo and rattan resources for general handicraft and basketry production.
- Moi and Jomo Kenyatta Universities have undertaken research on bamboo in collaboration with KEFRI jointly and through students' attachments.
- Winrock International (WI) and KEFRI have been jointly involved in projects and training activities geared towards enhancing the utilization and management of bamboo resources both in Kenya and IGAD region.
- International Union for Conservation of Nature (IUCN) - involved in research in collaboration with national institutions on utilization, management and conservation of natural resources where bamboo is major forest component (Kigomo 2007).

In Kenya, the bamboo industry is fairly new, and its development is held back mainly by a ban on bamboo harvesting and utilization, making bamboo items rather unknown to many people. Kibwage *et al.*, (2007) examined the structure and performance of formal retail market of bamboo products in Kenya with specific reference to market segments in Nairobi, Mombasa and Kisumu cities. The study revealed that most of the bamboo products (toothpicks, baskets, bowls, table mats, trays, skewers, flower vases and edible shoots) sold in the formal

retail market is imported from China, India and Thailand a scenario that results in high market prices and low demand for the products, thus the need to encourage domestic production of the products especially in urban areas.

The direct actors in the bamboo value chain in Kenya are farmers, processor/craftpersons who are also traders (largely individuals or micro and small enterprises), with many mainly one-off customers with whom there are limited information flows.

2.4 Challenges of developing bamboo in Kenya

The biggest impediment towards a bamboo based sector from developing is the irregular and scant supply of bamboo for entrepreneurial use. An efficient regulatory institution is essential for markets to grow in a sustainable manner usually where environment concerns are coupled with commercial development. Unfortunately, the regulatory structure as regards the bamboo industry has remained caught in the cycle of archaic forest laws. If all of this impediments can be considered then bamboo sector linkages can be able to livelihood benefits better than any wood products.

In Kenya, the development of the bamboo industry is constrained by a wide range of factors. Blowfield *et al.*, (1995) observed that the socio-economic status of someone prior engaging himself in a bamboo based village enterprise will determine the sustainability of the business. Middle class farmers who owned land and could plant bamboo would benefit more and were likely to sustain their businesses poor farmers who had to go seek waged employment to complement what they earned from their farms.

Uravu (2009) also observed that the human potential (such as availability of prior skills, real need for employment and income, cohesiveness of bamboo enterprises) and environmental potential (such as access to raw materials in the proximity of the units, assistance from the government for infrastructure and additional working capital etc.) could be a crucial yardsticks for the sustainability of the bamboo enterprises.

One of the major challenges in Kenya as a whole is the lack of skilled human resources and technical knowhow on bamboo processes. As technical courses like building and construction in the higher learning institutions don't include bamboo as a raw material in their curriculum,

students lack exposure to bamboo as a building material. This creates a knowledge gap of alternative materials for production among the various actors.

Kigomo (1988) had earlier noted that according to the KFS in Kenya, bamboo is classified as a minor forest product which slowed the recognition and development of this resource. Other factors affecting the development of the bamboo resource in Kenya include; the ban on harvesting, lack of awareness on its potential, production of unprocessed or semi-processed products, poorly developed marketing structures, lack of information on availability of planting materials, lack of information on the methods of propagation, establishment, crop management and harvesting (Ongugo *et al.*, 2000). It is, therefore, clear from the above studies why as much as bamboo is versatile; its potential is largely hampered by many external factors.

2.5: Conclusion to literature review

Though there have been few studies done on the bamboo situation in Kenya, there is no quantification regarding bamboo availability from non-forest land. Most of the economic activities related to bamboo are not recorded officially. Accurate statistical information on trade in raw bamboo and its products is also difficult to find, and even internationally and this can be attributed to the existing ban on harvesting of indigenous bamboo.

Statz (2007) analysed the current value-added chains of bamboo for Eastern Africa Bamboo Project (Kenya) and identified options for their development. Each value chain comprised of four elements design/product development, production, marketing, and consumption. Statz (2007) gave a profile, sourcing, sales and market of various bamboo enterprises in Kenya as part of a bigger project to assess the environment for bamboo trading in Eastern Africa. The main focus here was on indigenous bamboo found and managed by the government.

Statz (2007) made the biggest contribution in outlining the marketing of bamboo in Kenya whilst giving a comparison to the bamboo market in Ethiopia. There have been few studies on the viability of bamboo to support livelihood within village based localities and the industrial use of bamboo. There have also been various research papers done by KEFRI and INBAR on bamboo in Kenya but mostly focused on the status of bamboo indigenous forests in Kenya. With the introduction of new species of bamboo in Kenya, the performance of bamboo as a resource in

Kenya has not been fully understood and/or explored. This paper gave specific attention to Nairobi County as a hub of commercial activity, technology transfer and dispersion of information.

Despite all these studies and efforts by various researchers, the ban still exists and there is still no specific policy governing the use of bamboo. Bamboo is still classified as a minor forest product. In addition to that, the last study was done 7 years ago. This study sought to examine any changes to the status of bamboo development as a resource especially with introduction of exotic species in Kenya and to encourage more interest in bamboo by policy makers, researchers and investors.

2.6: Theoretical Framework

2.6.1: The value chain concept

The value chain concept is a systems approach that evolved over time drawing from different disciplines (da Silva and de Souza Filho 2007). The scientific discussion about the vertical integration of production and distribution processes started in the 1960s. The ‘*filière*’ concept was developed at the French Institut National de la Recherche Agronomique (INRA) and the Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD) as an analytical tool to study the ways in which agricultural production systems were organized in the context of developing countries (Nang’ole *et al* 2011).

Value chain analysis recognizes that different arrangements of actors may affect outcomes along the chain by influencing capabilities and levels of bargaining of the actors. Hence, the analysis focuses on institutional arrangements that link producers, processors, marketers, and distributors, recognizing that power differentials among them may influence outcomes along the chain. Its methodology specifically involves: 1) Identifying the outline of the chain and the position of the various economic agents within it—all who contribute to production, transformation and marketing of a specific product; 2) Identifying the roles and functions of these agents, including those who perform multiple roles; 3) Grouping agents into categories which are homogeneous from the point of view of economic, technical and/or socio-economic analysis; 4) Showing interactions among agents; 5) Quantifying the flows corresponding to the activities of the actors both in physical and monetary terms; 6) Mapping key policies and institutions along the value

chain that influence the functioning of the chain; and 7) Establishing key drivers, trends, and issues affecting the value chain and its actors

Development of bamboo exists within the context of the society in which it is carried out and is therefore subject to constraints from many factors within that society. These factors may at times be directly related to the growing, processing and selling of bamboo and its products.

Because of the variety of raw material management systems and processing techniques to which bamboo is subjected, and diverse products into which bamboo is made, it is important to use a standardized model for analyzing all processes involved and all factors that influence them. Thus the value chain concept would be more useful in this case. The analysis involves the entire chain of activities from production of bamboo raw material through the intermediate stages of sales and processing to the consumer final product. The system includes the technologies used to process raw bamboo as well as the socio-economic and political environments in which these activities exist. Subsequently the analysis will allow for identification of limiting factors and also highlight opportunities for the bamboo sector.

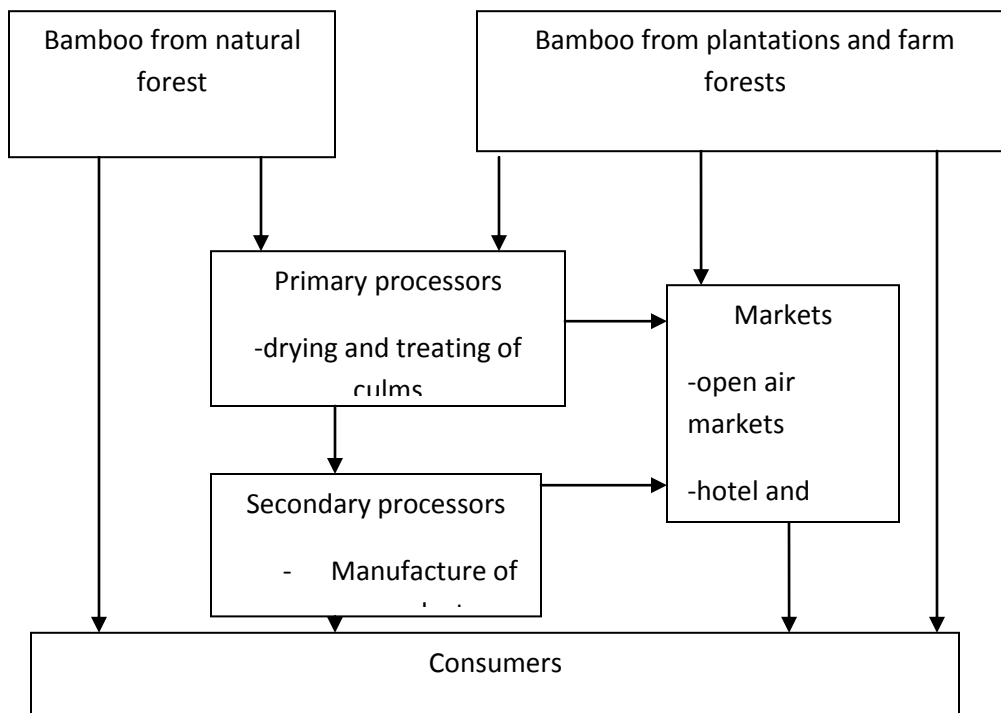


Figure 2: The Bamboo value chain in Kenya

Source: Ongugo *et al.*, 2000

Bamboo for use in the enterprises is obtained mainly from the natural forest and partly from on-farm forestry. The bamboo from natural forests is either illegally, or legally harvested from the forests and sold to timber yards or other kinds of Bamboo enterprises. Bamboo from farms is also sold to the enterprises. The primary processors are mainly bamboo/timber yards whose main activity is to treat, preserve and sell bamboo and bamboo nurseries that propagate bamboo seedlings. Secondary processors include artifact makers, toothpick makers and bamboo furniture. Bamboo enterprises are mainly located in Nairobi urban areas as they provide informal employment to the urban dwellers, most of whom would have been unemployed.

2.7: Conceptual framework

The development of the bamboo value chain in Kenya is influenced by various factors. The most outstanding factors revealed by this study were the general lack of awareness on bamboo as a resource and lack of advanced technology to effectively explore bamboo as a resource. Resources are not, they become, and they contract or expand in response to human wants and actions. Zimmerman (1951) affirms that resources are subjective, relative and functional depending on technological, cultural, political, economic and natural endowment or potential.

Figure 3 identifies the dependent variable here as the development of the bamboo value chain and the independent variables as socio-economic, political and environmental factors. This chart demonstrates how the development of the bamboo value chain is influenced by issues such lack of awareness or lack of institutional coordination.

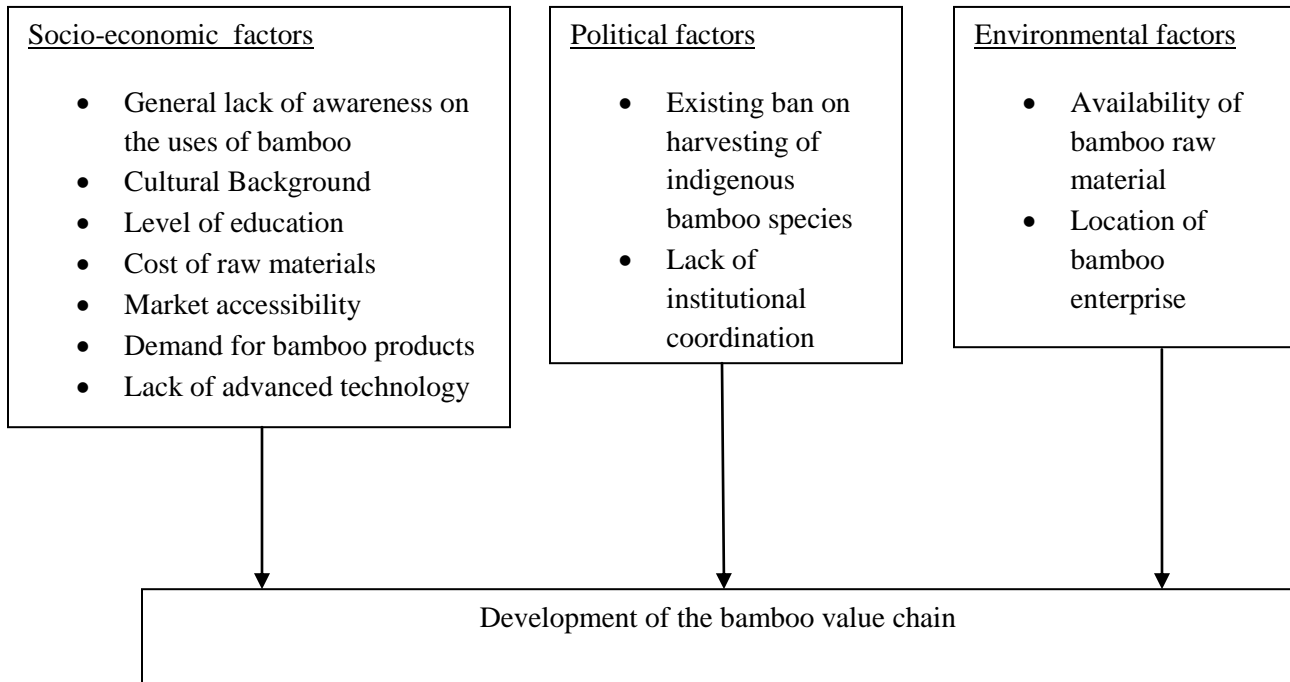


Figure 3: The conceptual framework

Source: Researcher

Factors featured in the diagram above work in combination to influence the value chain at various levels and neither one can be ignored as these factors exist within the society in which they operate.

CHAPTER THREE: RESEARCH METHODOLOGY

3.0: Introduction

This study used a case study to give a picture about the complex situation surrounding the use of bamboo as a resource in many aspects of life in Kenya. A description of the research methodology is given below.

3.1: Study area

The study was carried out in Nairobi County. The main focus will be in Nairobi County where most processing of bamboo raw material occurs. Nairobi County is the major market segment for bamboo products in Kenya for both low and high end consumers.

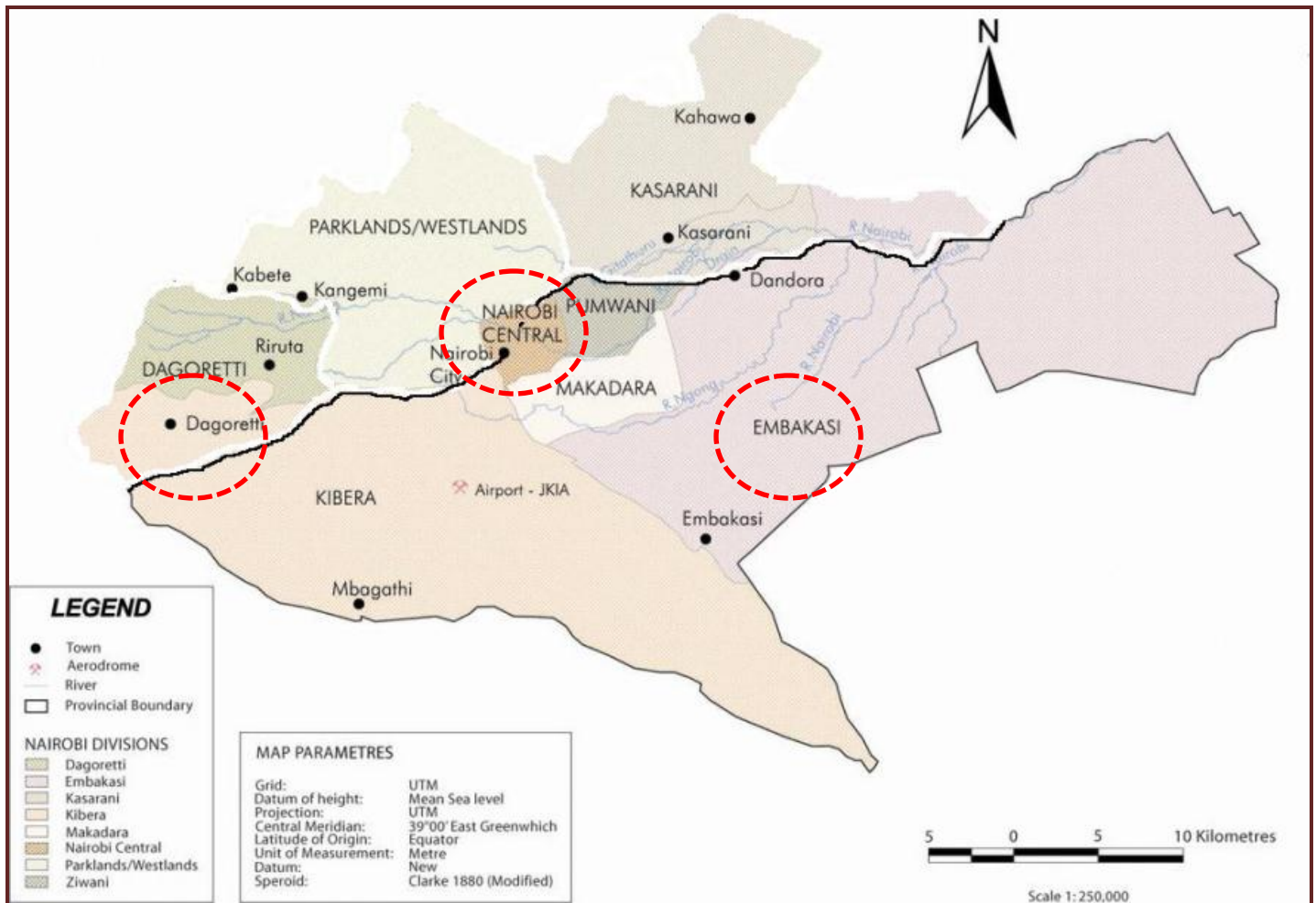
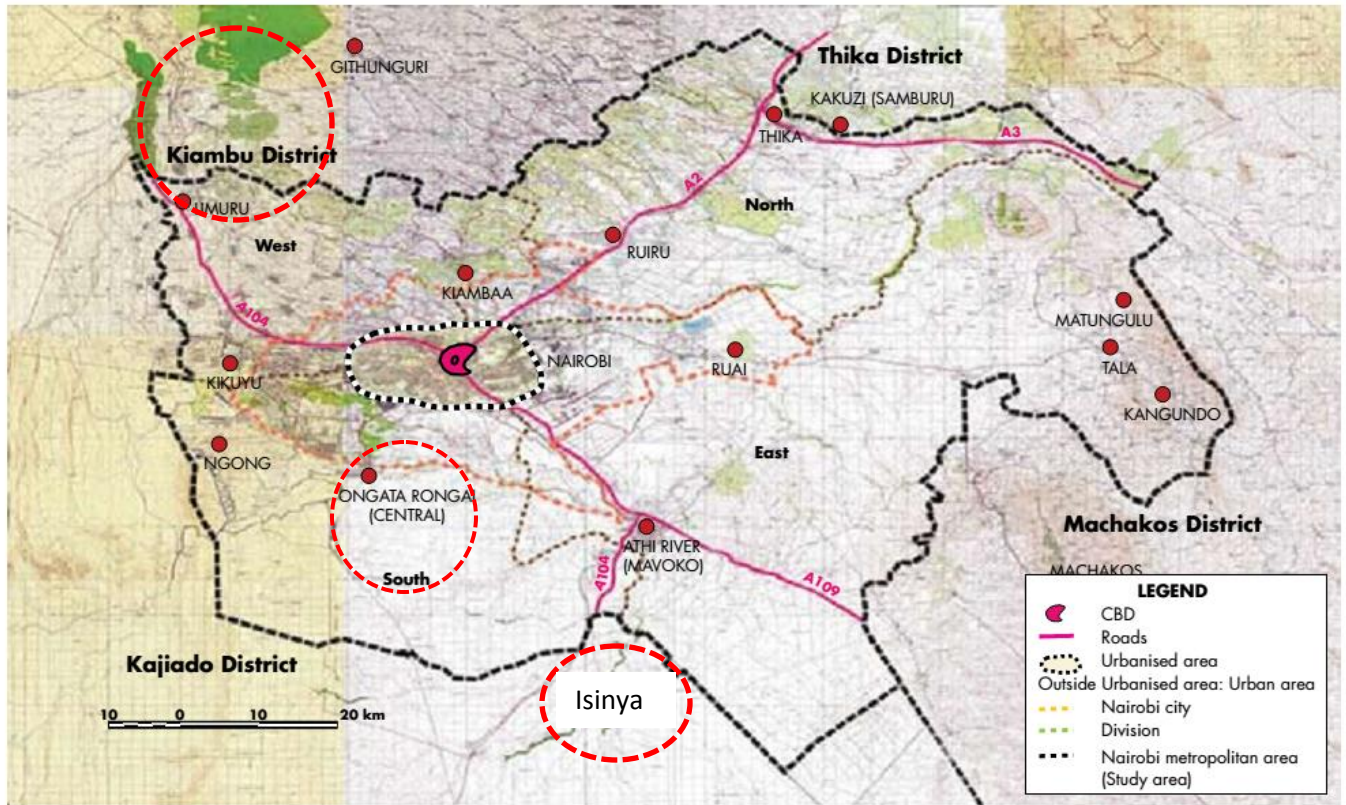


Figure 4: The study area



Source: JICA 2004

Figure 5: Nairobi and its Environs

Nairobi city has been identified by Ongugo *et al.* (2000) to be the leading town in the country in bamboo processing and selling. The area has a concentration of various bamboo related activities more than any other County in Kenya. Being the capital of Kenya, it is also the center for dissemination of information and technology.

Areas that were sampled included:

3.1.1: Doonholm area

This is situated in Embakasi Division of Nairobi County. This area predominantly consists of a mixed economy with a large group of its dwellers being middle income to low income earners. The main bamboo activities include secondary processing and sell of handicrafts.

3.1.2: Dagoretti area.

This area covered Dagoretti corner, Karen areas and Kawangware. It consists of a wide range of furniture enterprises from bamboo yards to bamboo furniture workshops with diverse

populations of both high and low end consumers. This area has most bamboo processing enterprises in Nairobi and most products are available in this area. A few bamboo entrepreneurs have also recently began to plant their own bamboo culms

3.1.3: KEFRI Forest Products Research Centre/Kenya Forest Service, Kiambu road.

KEFRI's Karura Forest products research centre is located in the Northern part of Nairobi County. The bamboo related activities in the centre include the development of sample bamboo products in view of an expected boom in bamboo utilization once the ban on the cutting of indigenous bamboo is lifted. Producing and selling bamboo furniture is also to become a commercial activity in line with the revenue generating policy of the centre.



Plate 1: New KEFRI building at Muguga.

While the KEFRI headquarters in Muguga wants to improve cultivation and management practices, the centre in Karura (Kiambu road) sees its mission in developing bamboo

products for the Kenyan context. It is a centre for training and sensitization on research of bamboo. Bamboo experts and policy makers in the centre were also sampled.

KEFRI has been at the forefront in research of new and better exotic bamboo species for Kenya's economy.

3.1.4: Masai market

It is situated within Nairobi city. It is a mobile market i.e. it is found in different areas of Nairobi on specific days of the week. It is stationed in shopping malls in the outskirts of town on Fridays at the Village Market, on Sundays at Yaya Centre, on Tuesday in Capital centre on Mombasa road and Saturdays in the city center by the law courts. The market sells artifacts with an African but mainly Kenyan touch. The products are normally made from natural material like wood, horn, bones, cloth and even bamboo.

3.1.5: City Market

City market is located along the Muindi Mbingu Street in Nairobi City centre. The market sells a variety of goods including groceries; it, however, has a section dedicated to artifacts. Most of the traders are retailers buying their products from middlemen who obtain them from various parts of the country.

3.1.6: Nairobi metropolitan areas

This included areas like Kajiado, Ongata Rongai and Kiambu. These areas mostly consisted of individual farmers who produced bamboo culms and sold them as raw material. Others also cultivated seedlings only with the biggest farm as Kitil farm in Kajiado forming the larger part of the sample.

3.2: Research design

The study undertook an exploratory cross sectional survey. This method was used as the research topic is relatively new and has previously scarcely been studied in Kenya. People involved in various aspects of small and medium furniture enterprises were carefully selected using snowball sampling as respondents to ensure a representation of their different types of experience. Relationships between various stakeholders in the enterprises were linked and factors affecting their activities were established.

3.3: Sampling procedures

3.3.1: Sample population and size

The study population was all the persons involved in bamboo related activities within Nairobi and its neighbors. Primary data was collected from bamboo micro enterprises scattered across Nairobi city and its environs. Individual respondents were purposively selected to fit study objectives and interviewed. The sampling frame relied on the central limit theorem states that the sampling distribution of any statistic will be normal or nearly normal, if the sample size is large enough (i.e $n > 30$) Many researchers agree that 30 is a large enough sample.

3.3.2: Sampling frame

Total of 42 respondents

Area/category	Producer/supplier	Processor/traders	Consumers	Experts
KEFRI/KFS	1	2	0	2
Doonholm	0	2	3	0
Dagoretti	1	2	2	0
Masai market	0	2	2	0
City market	0	2	3	0
Kajiado	1	2	1	1
Rongai	0	2	2	0
Kiambu	1	2	2	1
Total	4	16	18	4

Table 1: Sampling frame

3.3.3: Sampling method and design

Using snowball sampling, responded were identified and data was obtained from the various categories of respondents in the bamboo industry i.e. Bamboo enterprise proprietors, employees, retailers, bamboo experts and bamboo customers. According to Cooper and Schindler (2003) snowball sampling, also known as chain is sampling, chain-referral sampling or referral sampling is a non-probability sampling technique where existing study

subjects recruit future subjects from among their acquaintances. A respondent was asked to give two other names from which the researcher selected one randomly.

Thus the sample group appears to grow like a rolling snowball. As the sample builds up, enough data is gathered to be useful for research. This sampling technique is often used in hidden populations which are difficult for researchers to access.

3.4: Data collection

The study used both primary and secondary data sources. Secondary data was collected from text books, scientific journals, periodicals, reports, published and unpublished theses, International Network for bamboo and Rattan (INBAR) data bank and Internet. Primary data was collected using a key informant guide, a questionnaire for bamboo dealers, an observation checklist and photographs. Observation of behaviors, actions, activities and interaction as argued by Orodho (2003) is a powerful tool for understanding people and complex situations.

This study used various data collection tools to collect both qualitative and quantitative data. To collect quantitative data the study used questionnaires while observations, interview guides and key informant interview guide were used to give qualitative data.

3.5: Data analysis and presentation

Both qualitative and quantitative techniques were used in data analyses. This is because some objectives require in depth information (qualitative) while other objectives need quantitative data for drawing analysis and conclusions.

After data collection, the questionnaires were checked for completeness, cleaned and coded to represent specific responses to specific questions. Quantitative data was analysed using descriptive statistics such as means and percentages. For qualitative data the researcher created notes of the outstanding points; field notes were edited and cleaned up as the researcher is organizing the work, it was then categorised to themes in line with study objectives and the data were analysed. The results were presented in form of text, table, charts and photographs.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.0: Introduction

The results and discussions of this study have been divided into four major sections. The first section provided the results on the sourcing of the bamboo raw material for various users. The second section provides an insight into the status of the bamboo value chain in Kenya. The third section gives results on the challenges facing the development of the bamboo value chain in Kenya.

4.1: The sourcing of raw bamboo in Kenya

The major source of bamboo raw material is Kenya Forest service where buyers are required to have a permit to harvest indigenous bamboo and the quantity to be harvested is also controlled. Buyers of bamboo can also get from farmers of bamboo at a cost ranging from KES 100 per culm to KES 150 per ft depending on the species and size of the culm. The farmers are scattered in areas like Kajiado, Rongai, Kiambu District and even as far as Nyanza province. Suppliers do not easily disclose their sources of bamboo as they fear penalties especially if it has been illegally acquired.

Despite the bottle-neck in supply resulting from the bamboo use ban, sourcing is not yet a major problem for informal /cottage industries who manage to get what they require. Sourcing and production of bamboo culms is done in a spontaneous manner depending on the arising demand. However, the quantities that can be sourced this way are very limited and could not sustain a major industry. This scenario also causes lack of uniform prices because every seller sets their own prices depending on their operational costs.



Plate 2:: Bamboo culms stacked for drying at the KEFRI workshop, Karura.

Most of the bamboo produced in farms is used locally for fencing, for sheds and ornamental purposes. Seeds for planting can either be imported from countries like Taiwan, Japan or Indonesia while others are cultured locally in research centers.

There are no farmers among those interviewed that relied entirely on bamboo farming as a source of income. Most owed this to the fact that bamboo farming is a relatively new venture and there are a number of uncertainties facing this trade hence they would like to take time to assess its market performance.

KEFRI has permission to use up to 400 culms (*Yushania alpina*) from Kinale, Kamae and Kamakia at a price of 80-150 each. Furthermore, culms of *Dendrocalamus giganteus* have been bought at a rate of 150 KES/ft from the Bamboo Trading Company. Much of the stocks of unused bamboo are piling up in the centre and have been infested by unidentified borers.



Plate 3: Infested bamboo culms

Kianda Mbao Enterprises at Kawangware is also another major supplier of dry bamboo culms which are acquired from private farms. The enterprise sells to other smaller processors who use it to make camp torches, furniture and weaving.

4.1.1: Kitil farm

Kitil Farm is a licensed open quarantine in Isinya which operates in Kajiado County in Kenya. They grow and sell bamboo seedlings to individuals, investment groups, NGOs, CBOs, Government ministries and departments, and County governments. The organization has established bamboo nurseries, and is trying to rehabilitate degraded land, to fully functional ecosystem using bamboo. They also conduct training to individual investors and/or groups on all aspects of bamboo care, bamboo management, harvesting and associated technologies. The following species of bamboo can be found here: *O. Abyssinica* (giant and solid stemmed bamboo), *Bambusa textilis* or longinternode, *Phyllostachys pubescens*(moso), *Dendrocalamus*

membranaceus cv grandis (a giant clumping bamboo), *Dendrocalamus maximuslamina* (a giant clumping bamboo and giant leaf), *Dendrocalamus giganteus* (a giant clumping bamboo), *Dendrocalamus asper* (a giant clumping bamboo), *Dendrocalamus barbartus* (a giant clumping bamboo), *Dendrocalamus giganteus* (a giant clumping bamboo). Other tree seedlings are: *Pinus Kesiya*, *Juniperus sabina chinensis*, *Leucaena leucocephala*. The seedlings are sold at KES 200 each. The farm is owned by a community of farmers. The farm also collaborates with INBAR and KFS to train and create awareness on the propagation. Products here are made on an experimental basis and have not yet been rolled out to the market. Their products include charcoal briquettes, utensils, bamboo tea bags, floor boards.



Plate 4: Bamboo seedlings at Kitil farm.

4.1.2: Bamboo Trading Company

This is a bamboo company hosted by the Kenya Forest Service at Kieni Station on a 26ha land. It has been in operation for 15years. This farm is a major supplier of raw bamboo and even engages in primary processing of bamboo. Depending on the clients demand they can treat and cut bamboo to the required sizes at a price. The farm has a permit to harvest a controlled amount of *Yushania alpina* from the forest as well. The bamboo plantations of *Dendrocalamus giganteus* and *Bambusa vulgaris* are done on tracts of the farm's land that are not suitable for

coffee production, generally water logged depressions and slopes that are prone to erosion. Much of the plantations are done applying innovative techniques like planting the bamboos on micro hills to lift their root system above the water table or horse-shoe patterns when planting clumping bamboos like *Dendrocalamus giganteus*.

The farm supplies bamboo to many clients within the Kieni area, Nairobi and as far as the Far East for various purposes ranging from fuel to poles. Recently they have sold bamboo poles to Ecopole in Nairobi, a company that makes poles for electricity. The seedlings sold here are also used for ornamental purposes.



Plate 5: Bamboo pegs used for demarcation; packed for shipment at Bamboo Trading Company

4.2: Status of the bamboo value chain in Kenya

The typical bamboo value chain in Nairobi consists of producers, primary processors, secondary processors and consumers. There are very few large scale producers of culms and even fewer seedlings in Kenya. Bamboo in Nairobi is scattered in various places most notably at Chiromo along the river banks, at Uhuru park, the Arboretum, in homes as fences in Kabete, Spring

Valley estates, as potted plants outside Sarova Stanley on Kenyatta avenue etc. notably, some people have planted bamboo but are not aware of its value while others cannot identify it.



Plate 6: Potted bamboo seedlings used for ornamental purposes

Bamboo activities are largely undertaken by self-employed persons in informal market setups. Owing to the ban imposed on the utilization of bamboo in Kenya, sourcing is generally only possible through spontaneous utilization. There is a shortage of supply for high end users of bamboo due to the scarcity of bamboo in larger quantities. Harvesting of raw bamboo culms is done with a backsaw. Harvesters are usually trained on how to harvest bamboo and to identify mature bamboo.

For cottage industries the supply issue is not really a major issue as they usually get what they require from timber yards and individual farmers once or twice a year. An artisan can use one culm to make almost 10 different handicrafts and since the demand for such products is relatively low, only fewer culms are required.

There are no standardized prices for goods or services or any formal marketing strategies. The prices of the bamboo products are determined by the depending on the price of raw bamboo, design of item and size of ordered item.

4.2.1: Processing and Marketing

There are two levels of processing bamboo that include initial treatment and drying of bamboo culms and manufacture of products. The sampled enterprises obtained raw bamboo from farmers in Kiambu and KFS while others got them from timber yards in Nairobi. Most enterprises were not registered but obtained trading licences from the Nairobi County Council. There were no outstanding marketing strategies observed as was previously documented by Statz (2007) and selling was done on small scale.

The technological standard of the bamboo processing sector is modest. The rudimentary, low level technologies include hack-saws, kitchen knives, drills and hammers, wood varnish and paint. No special skills are required to make the products and labor is mostly required on demand basis. Few entrepreneurs needed permanent employees and in most cases 1-2 employees were employed on permanent basis. Majority of the processing activities is done by men usually. Women are involved in finer duties like weaving and decoration of finished products.

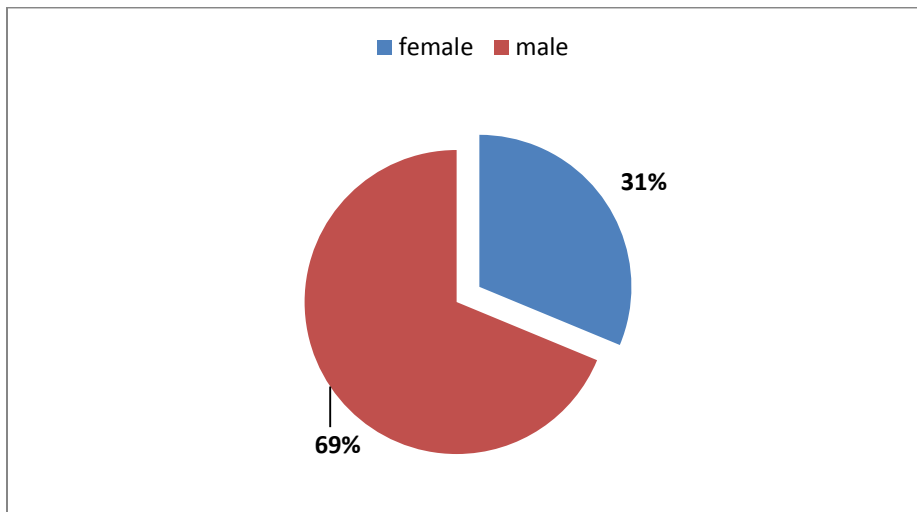


Figure 6: Classification of bamboo processors by gender

The scenario above could be attributed to the fact that most bamboo processing activities were carried out in rudimentary sheds as workshops with little or no sanitary services that could allow

women to carry their other duties alongside those of the workshop. This perhaps was the reason for the low level of involvement for women.

Products were mostly sold at the point of manufacture and few traders would buy and sell in curios in Karen Shopping Center, City Market, Masai Market and Kariokor Markets but in small scale. Unlike furniture outlets there are no big shops that specialize in bamboo furniture or artifacts in Kenya. Hotels and restaurants also form a significant section of clients as they buy furniture for outdoor decoration and functions and potted seedlings for aesthetics.



Plate 7: Bamboo flutes at City Market

Recently Kitil farm has began sale of bamboo mini clumps (more developed rhizome mostly used for landscaping) and plantlets for establishing bamboo nurseries. Bamboo has also been sold for horticulture farms in Naivasha for supporting climbing plants like beans and flowers.

The price of the culm varied with respective market places and species of bamboo. It was found by Brias (2006) and Cindano and Omenda (2007) that bamboo is mostly sold in December the festival season. During this time, there is a lot of bamboo furniture and other household items being made and sold. Sales are much lower in January to April and very high in October to December. The main season for the sales of bamboo culms are October to December (the

festive season) and the hot season (for production of ice cream sticks); it is also the season when many homes and hotels are refurbishing their quarters.

Table 2 summarizes processing stakeholders and the status of activities in bamboo enterprises.

Area	Sex	Level Of Education	Av. Monthly Income	Primary Source Of Income	Designation	Form Of Employment	Any Other Source Of Income
City Mkt	Male	Secondary	12000	Yes	Owner/ Designer	Full Time	No
City Mkt	Male	Secondary	20000	Yes	Trader	Full Time	No
Dagoretti	Female	Primary	10000	Yes	Sales	Full Time	No
Dagoretti	Male	Tertiary	30000	Yes	Owner/ Designer	Part Time	Yes
Doonholm	Male	Tertiary	15000	Yes	Owner/ Designer	Full Time	No
Doonholm	Female	Primary	5000	Yes	Weaver	Part Time	Yes
Kajiado	Male	Primary	10000	Yes	Workshop Assistant	Full Time	No
Kajiado	Female	None	4000	Yes	Weaver	Full Time	No
KEFRI	Male	Secondary	14000	Yes	Workshop Assistant	Full Time	No
KEFRI	Male	Secondary	14000	Yes	Workshop Assistant	Full Time	No
Kiambu	Male	Primary	4500	Yes	Workshop Assistant	Part Time	Yes
Kiambu	Female	Primary	5000	Yes	Workshop Assistant	Part Time	Yes
Masai Mkt	Male	Tertiary	15000	Yes	Trader	Part Time	Yes
Masai Mkt	Female	Secondary	10000	Yes	Trader	Full Time	No
Rongai	Male	Tertiary	20000	Yes	Owner/ Designer	Full Time	No
Rongai	Male	Primary	5000	Yes	Workshop Assistant	Part Time	Yes

Table 2: Summary of bamboo processors/traders socioeconomic status

Table 2 also shows that men involved in bamboo activities earned more than their female counterparts. The females with only 18% of the total income of the sampled entrepreneurs have a minor share.

4.3: Hypothesis testing

H₀: There is no significant difference in bamboo enterprise incomes in various areas.

Test of difference using ANOVA

AREA	CTM	DAG	DON	KJD	KFR	KMB	MSM	RON	GRAND
	12000	10000	5000	10000	14000	4500	15000	15000	
	20000	30000	15000	5000	14000	5000	10000	5000	
TOTAL	32000	40000	20000	15000	28000	9500	25000	20000	188500
MEANS	16000	20000	10000	7500	14000	4750	12500	10000	11781.25

Table 3: Incomes for the sampled enterprises

CTM = City Market, DAG =Dagoretti, DON = Doonholm, KJD = Kajiado, KFR = KEFRI, KMB =Kiambu, MSM =Masai Market, RON = Rongai

Table 4: Analysis of Variance (ANOVA)

Source of Variation	Sum of Squares	Degrees of Freedom (df)	Mean Squares	Computed F
Column Means	SSB= 144359375	k-1 = 7	SSB/k-1 =20622767	S_1^2/S_2^2
Error	SSW = 557125000	N-k /k(n-1) = 0.125	SSW/k(n-1) =69640625	= 0.296
Total	SST =701484375	7		

$$F_{\text{calc}} = 0.296 \quad \alpha = 0.05$$

Critical value = 3.50

Therefore: $F_{\text{cal}} < F_{\text{crit}}$. Hence we cannot reject the H₀

The study concludes that there is no significant difference in incomes from Bamboo within various areas sampled in Nairobi County.

For many bamboo enterprises demand is low for bamboo products and in turn there is insufficient capital to expand the businesses as most traders make products when an order is placed. Consumers of bamboo products remained relatively low as compared to consumers of timber due to the reliance on timber products especially in cottage industries. The study concluded that the main motivation for buyers of bamboo product was for aesthetics and closely followed by the affordability of bamboo products compared to other similar products. Figure 5 illustrates all the reasons for purchase and weights them into percentages

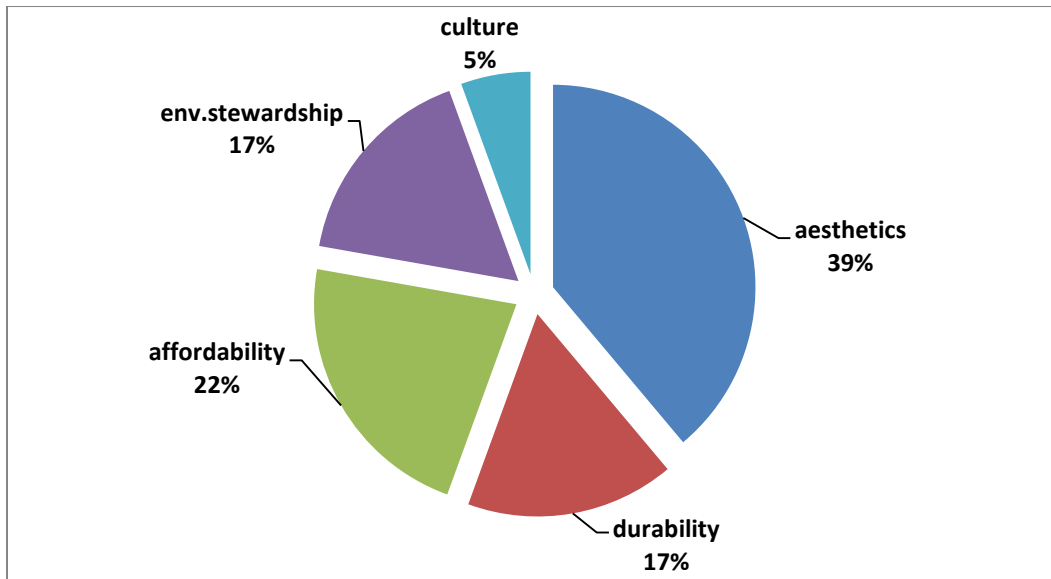


Figure 7: Reasons given by consumers for purchasing bamboo products

Also very few consumers purchased bamboo products for their cultural significance. This implies that culture had very little influence on the preference for bamboo products on consumers.

H₁: There is a relationship between level of education of consumers and the frequency of purchase of bamboo products.

From the data collected there is evidence that there was a relation between education levels of consumers and their awareness of bamboo products. The sampled areas from which various consumers were interviewed and their levels of education were cross tabulated and the results are as shown in Tables 5 and 6.

Area	Frequency	Percentage	Gender		Level of Education	
			Male	Female	Secondary	Tertiary
City Market	3	16.7	2	1	2	1
Dagoretti	3	16.7	2	1	1	2
Doonholm	3	16.7	2	1	0	3
Kajiado	1	5.6	0	1	0	1
Kiambu	2	11.1	1	1	1	1
Masai Market	3	16.7	2	1	1	2
Rongai	3	16.7	3	0	0	3
Total	18	100	12	6	5	13

Table 5: Summary data for consumers

From Table 5 it shows that 78% of the sampled population had tertiary education and 22% of the consumers had a secondary school level education.

Table 6: Crosstabulation of the Level of Education and Frequency of Purchase

		FREQUENCY_OF _PURCHASE		Total
		Often	Rarely	
LEVEL_OF_EDUCATION	Secondary	4	1	5
	Tertiary	10	3	13
Totals		14	4	18

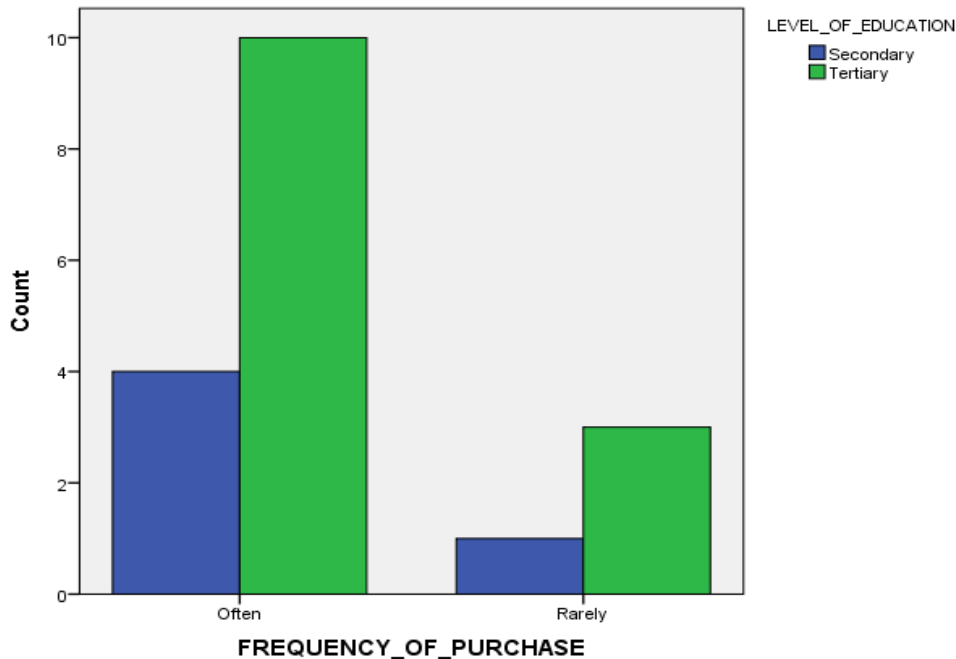


Figure 8: The influence of level of education on purchase of bamboo products.

From the collected data, the consumers of bamboo products had a level of education of secondary and above. It is also evident that those that purchased these products more often were had tertiary level of education. The study therefore concluded that the level of education therefore had an influence in consumers’ preference for bamboo products maybe because they had knowledge on bamboo products and their uses.

4.4: Challenges to development of bamboo value chain

Manufacturers, retailers and consumers alike are not yet sufficiently aware of the variety of potential uses and applications that bamboo has. But this is not the most important weakness. Statz (2007) concluded that the major factor preventing bamboo from being used more widely is obviously “the ban”; Only in exceptional cases are permits issued for harvest of bamboo from government or private lands. It therefore doesn’t come as a surprise that cottage industries like the *juakali* furniture traders had neglected the potential of bamboo furniture. However, the situation now is slightly different. This study found out that the ban only applies to the harvesting of indigenous bamboo (*Yushania alpina*) from forests. Now harvesters can obtain permits more easily from Kenya Forestry Services and even better obtain exotic species from farmers of which harvesting does not require special permits.

For many bamboo enterprises demand is low for bamboo products and in turn there is insufficient capital to expand the businesses as most traders make products when an order is placed.

There are technical limitations too. It is evident from the literature review that the number of innovative uses of bamboo is growing. The technology accessible to most entrepreneurs in Kenya is still basic and therefore limiting the products that can be made from bamboo. This only hinders bamboo's competitiveness in the conventional markets. Currently only KEFRI workshop has obtained the machines for processing bamboo to the best levels. This means that for one to access the machines you would have to transport the raw bamboo to Karura for processing and back to their respective shops which is an additional cost and cumbersome.



Plate 8: Tools used in Bamboo enterprises

While bamboo is remarkably strong, it also is highly susceptible to decay when brought into permanent contact with water. Manufacturers and traders have understandable reservations to invest in the sector looking at the susceptibility of bamboos to fungi and borers with concern.

There is also lack of incentives to encourage cultivation of bamboo by entrepreneurs as the benefits are not well understood and the market is limited.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.0: Summary of findings, conclusion and recommendations

This section summarizes the major findings, conclusions and recommendations derived from the study. It will also recommend areas that need further enquiry as gathered by the study.

5.1: Summary of findings

The bamboo enterprises consist of a few workers mostly less than five, some specialize in specific activities and most of whom multitask. Most of the enterprises did not have a secure source of bamboo culms. They source their raw material from bamboo depots, farms in neighboring towns and even residential compounds that have bamboo within the city.

For most enterprises the bamboo products were made and sold from the same venue, some however sold their products in market centers. There is a market for the bamboo products in the city; this was indicated by the rate at which the few bamboo products produced were sold.

The enterprises in Nairobi have created employment to bamboo seedlings producers, bamboo hardware and bamboo artisans. The sector is broad and accommodates people with varying skills and education backgrounds. For example, the youth with artistic skills were mainly in bamboo utilization, i.e., handicraft work and designing; women were seen to be part timers in bamboo retailing and bamboo nursery maintenance/ gardening; and people with a post-secondary school education were seen to juggle different activities in the enterprises such as designing, marketing and overall administration of the enterprises.

The level of education of the workers mostly influenced the duties they had in enterprise and, as a result, influenced their income i.e. their income rose with increase in education. The study established that enterprises have a lot of potential for environmental conservation.

Technology is a major hindrance in the development of bamboo enterprises as they have less competitive products due to their quality and appearance.

5.2: Conclusions

Bamboo is a versatile crop with many uses. It has important direct and indirect economic and ecological benefits such as providing housing, furniture, artisan products and soil and water conservation. The bamboo sector is broad; at least 1,500 uses of bamboo have been identified globally. However, In Nairobi and Kenya in general little is known on bamboo and there are very few people engaged in the bamboo sector.

In Nairobi, the development of bamboo as a resource is influenced by many factors. Environmentally, bamboo's ability to be harvested sustainably for up to 100 years after planting can ensure continuous and sustainable gains. Socially, bamboo has been previously known by many communities in Kenya, it will therefore be easy to readapt. Economically, enterprises create employment but have poor access to credits, they are therefore prevented from up-scaling their businesses. Sales of bamboo raw materials are also highly personalized. Technologically, the bamboo enterprises use hand tools (mainly different types of knives) which increases the time to process items and leads to lower quality of bamboo items. Politically, the continuing ban on bamboo harvesting is a disincentive to its local innovative use and processing into products that are capable of generating income.

Bamboo still has the stigma of being a poor man's timber; even researchers and decision makers who are aware of the virtues and beauties of bamboo admit that they do not have bamboo furniture themselves, but would rather go for the conventional products with "modern" designs.

There is need to change peoples' attitudes towards the use and production of bamboo. At the same time institutional coordination and support should be key to these strategies.

5.3: Recommendations

1. Coordination among the bamboo enterprises which will improve marketing and as stakeholders can lobby for lifting of the bamboo ban and any issue which might come up in future.
2. There is need for bamboo dealers to be assisted in polishing their bamboo propagation, preservation and utilization skills; this can fall under KEFRI's awareness creation on bamboo. The people who are already working in the BME's can be trained further

on improving the quality of their work or the BME's could be assisted with appropriate machines that will enhance increase the quality of bamboo items made. The youth in the urban areas could be trained on bamboo utilization and the youth in the rural areas on bamboo propagation.

3. There is need for consumer education to encourage use of bamboo
4. The Government needs to be proactive in tapping opportunities in the bamboo sector; it is a new addition to the SME sector in the country. It is unique in that it is a very eco-friendly SME. This can be done by partnering with the private financial institutions to evolve special packages for development assistance especially in areas of machine procurement.

5.4: Areas of further research

1. An assessment into potential and viability of bamboo in sustainable development.
2. An enquiry into potential of bamboo in building and construction.
3. Integration of the study of bamboo as an alternative renewable resource into school curriculum.

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APPENDIX: TOOLS FOR DATA COLLECTION

APPENDIX 1A: QUESTIONNAIRE FOR BAMBOO PRODUCERS

Introduction

The University of Nairobi is carrying out a survey on the collection and use of bamboo in cottage industries in Nairobi County. This questionnaire is directed towards getting an insight of bamboo micro enterprises from the stakeholders' perspective. Your open and genuine responses will be highly appreciated and treated with confidentiality. The information obtained will be used only for academic purposes.

Instructions; please tick or fill gap where appropriate

All money is written in KES.

Date of Interview: _____

GENERAL:

1. Name of Respondent _____
2. Location _____
3. Age _____
4. Gender _____
5. Marital Status _____
6. Level of Education (Completed)
 - Primary
 - Secondary
 - Tertiary
7. Occupation
 - Formal
 - Informal
 - Self Employed
8. What products do you produce?
9. Estimate the monthly income from bamboo related activities _____
10. Is this the primary source of income? _____
11. Any other sources of income _____
12. How many employees do you have _____

13. At what level are they involved in this farm? _____
14. Do you involve women at any level _____
 - a) If Yes, at what level are they involved _____
 - b) How do they perform against their male counterparts _____
15. Do you own the land on which you plant bamboo? _____
16. How many years have you been involved in bamboo business? _____
17. What motivated you to venture into bamboo business _____
18. How do you identify mature bamboo? _____
19. What determines the quantity of bamboo to be harvested? _____
20. Where do your clients come from? _____
21. What are the challenges to the production of bamboo culms _____
22. Any other comments _____

APPENDIX 1B: QUESTIONNAIRE FOR PROCESSORS/TRADERS

1. Name of Respondent_____
2. Location_____
3. Age _____
4. Gender_____
5. Marital Status_____
6. Level of Education (Completed)
 - Primary
 - Secondary
 - Tertiary
7. Occupation
 - Formal
 - Informal
 - Self Employed
8. Size of household_____
9. Estimate the monthly income from bamboo related activities_____
10. Is this the primary source of income?_____
11. Any other sources of income_____
12. What was your motivation for venturing into bamboo business_____
13. What are some of the products that you manufacture with bamboo_____
14. Labor Employed

	Number of employees	Wage paid
Full-time		
Part- time		
Sub –Contract		
Piece-wise		

15. At what level are they involved in the enterprise?_____

16. Are women involved at any level in activities here _____
 - a) If yes, at what level are they involved _____
 - b) How would you rate their performance compared to their counterparts _____
17. What skills are expected of employees here? _____
18. What species do you use in this enterprise? _____
 - a) Reason _____
 - b) What species is most preferred _____
19. Where do you get bamboo culms from _____
20. What determines the price of products sold here _____
21. What determines the quantity of bamboo culms bought? _____
22. What are the challenges of using bamboo for production _____
23. What other products that could be made from bamboo _____
24. Where do your clients come from _____
25. What is the demand for bamboo products in Nairobi _____
26. Any additional comments

APPENDIX 1C: QUESTIONNAIRE FOR CONSUMERS

1. Name of Respondent_____
2. Location_____
3. Area of residence_____
4. Age _____
5. Gender_____
6. Marital Status_____
7. Level of Education (Completed)
 - Primary
 - Secondary
 - Tertiary
8. Occupation
 - Formal
 - Informal
 - Self Employed
9. What bamboo products do you buy mostly?
10. How often do you purchase bamboo products?
 - often
 - Rarely
11. What is your most important motivation for buying bamboo products?
 - Availability
 - Affordability
 - Aesthetics
 - Environment stewardship
 - Durability
 - Social Acceptability
 - Culture
 - Other (explain)
12. Do you think Bamboo is capable of replacing the current/conventional product sources?

- Not at all
- Maybe
- Yes
- Yes, Absolutely

13. What price are you willing to pay for bamboo products?

- Half the price at which I buy current products
- About the same price as I pay for the current products
- Up to twice as much as
- Not at all

14. What is your opinion on the quality of bamboo products in comparison with other products?

15. Any other comments

Thank you.

APPENDIX 1D: INTERVIEW GUIDE FOR BAMBOO EXPERTS

Introduction

The University of Nairobi is carrying out a survey on the collection and use of bamboo in cottage industries in Nairobi County. This questionnaire is directed towards getting an insight of bamboo micro enterprises from the stakeholders' perspective. Your open and genuine responses will be highly appreciated and treated with confidentiality. The information obtained will be used only for academic purposes.

Date of interview_____

Name of respondent_____

Organization_____

Designation_____

1. Give an overview of the bamboo industry in the Kenya?

2. Who are the major suppliers of bamboo in Kenya?

3. What influences the development of bamboo sector in Kenya?

4. What are the factors that affect the sustainability of bamboo sector Nairobi?

5. What are the reasons that make you advocate for bamboo planting or using?

6. A) What is the demand for bamboo products in the Kenyan Market?

B) What are the reasons for the above scenario?

7. What are the common problems encountered in the use of bamboo in Kenya?

8. Any other information you would like to share with the researcher regarding the bamboo value chain in Nairobi County?

Thank you so much