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Imperatives for Bamboo Textiles Production in Nigeria

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Abstract
The Nigerian textile industry is currently undergoing serious decline in production as a result of its total dependence on cotton as its primary raw material. Cotton production has dwindled considerably in the country, thereby, placing serious stains on capacity utilization in the sector. One of the ways capacity utilization can be boosted is to introduce the utilization of bamboo as an alternative or complimentary raw material for textiles production locally. Bamboo fibre consists of 99.51% cellulose, 0.25% ash and 0.24% wax. The cellulose is the most important component required for textiles production. Bamboo currently grows in 23 states of the federation and its utilization in the textiles sector has been perfected in China, India, Europe and the United states. The production process is simple and consists mainly of cooking the bamboo leaves and the soft inner pith from hard bamboo trunk in a solution of 15 to 20% sodium hydroxide at a temperature between 20 to 25^{o}C for 1 to 3 hours to form alkali cellulose which is crashed by a grinder and left to dry for 24 hours After this, carbon disulphide is added to form a viscose solution which is forced through spinneret nozzles into a diluted sulphuric acid solution form a reconstructed and regenerated bamboo fabric. As bamboo is available in Nigeria, the utilisation of bamboo fabric will save Nigeria an excess of 500 billion naira in foreign exchange equivalent annually.
Keywords: bamboo, fibres, textile, enzymes, investment

1.0 Introduction

One of the major potential of bamboo in Nigeria is for textile production. The imperatives for the development of bamboo have become more critical since the early 1990's as cotton production is becoming a major issue nationally. Currently, textile fibres are mainly produced from cotton in Nigeria. In the 1960's to the 1970's, textiles production was one of the major industrial activities in Nigeria, contributing more than 25% of the Gross Domestic Product (GDP). During this period, the textiles sector employed more than 700,000 people and catered for more than 2 million family members (RMRDC, 2003). More recently however, most especially in the 1990's, the sector experienced serious downturn leading to the closure of textile mills in various parts of the country. This has led to considerably downturn in the sector. The ginning capacity of existing ginneries diminished from 78% to 33% from 1980 to 2012.(Awolehin *et al.*, 2016). Among the major problems that led to the demise of the sector include, the drop in the national production of cotton and general decrease in investment in processing activities in Nigeria (Ogunwusi, 2013). Most of the pioneer investors which consists mostly of the Lebanese and the Chinese citizens lost interest in the sector and instead of upgrading the equipment and facilities within the industry, allowed the old installed facilities to deteriorate (FMITI, 2015). Today, most of the mills are old and the technology of textiles production remains obsolete (RMRDC, 2015). The problem is further compounded by importation of inferior textile materials at low prices into the country (FMITI, 2015). As a result, the current domestic market size or cotton fabric which is 1,200 million meters is mostly dominated by imports.

In view of the above, to promote increased activity in the sector, it has become expedient to investigate the prospects and challenges of bamboo utilisation for textiles production in Nigeria. This paper examined the status of bamboo utilization for textiles production globally. The problems and the challenges of the initiative in Nigeria are also outlined. This is important as one of the major approaches being sought globally by textiles manufacturers who are seeking new approaches to producing environmentally friendly products, such as recyclable and biodegradable textile materials are critically focusing on bamboo utilization in the industry.

2.0. Properties of bamboo

The industrial utilization potentials of bamboo are hinged on its properties (Ogunwusi, 2012). Cellulose is the most important component of bamboo for textile production purposes. Whether regenerated (chemical bamboo/viscose) or mechanically or biologically extracted from the stem (mechanical bamboo), bamboo textiles are made from bast fibres of cellulose (Waite, 2009). The basic composition of the bamboo fibre include 99.51% cellulose; 0.25% ash and 0.24% wax. According to Mwaikambo (2006), bast fibre bundles are made of elongated thick walled cells joined together both end to end and side to side and arranged in bundles along the length of the stem. As lignification may continue with increased maturation, it is important that bamboo textiles be produced from young cells. This is imperative as the higher the lignin content of bamboo, the lower the cellulose content. The advantages of bamboo include its fast renewability, biodegradability, its efficient space consumption, low water use and its organic status (Waite, 2009).

Ogunwusi (2012) discussed other industrial properties of bamboo. The density of bamboo is reported to vary from 500 to 800kg/m^3 depending on anatomical structures such as quantity and distribution of fibres around

vascular bundles (Sattar, 2005). Density increases from the centre to the periphery of the culm (Sekhar and Bhartari, 1960; Sharma and Mehra, 1970). It also increases from the base to the top of the culm. The maximum density is from about 3 years old culms (Liese 1986; Sattar et al 1990; Kabir, et al 1993; Espisloy, 1994). The physico – mechanical properties are extremely unstable. In certain respects, it is more unstable than wood. The complexity is due to uneven distribution of vascular bundles, variation in moisture content, differences in the physico – mechanical properties of the node and internode parts, most especially with age. The physico - mechanical properties of bamboo material in all the three directions are also different. Bamboo possesses high moisture content which is influenced by age, season of felling and species. Although unlike wood, bamboo starts shrinking above the fibre saturation point. Nevertheless, bamboo possesses excellent strength properties, especially, tensile strength. Most of the properties depend on species and on the climate condition of where they grow (Sekhar and Gulati 1973). Strength varies along the along culm height. Compressive strength increases with height, while bending strength has inverse trend (Liese 1986; Espiloy, 1987; Kabir et al, 1991, 1993). An increase in strength is reported to occur at 3-4 years and thereafter decreases (Espiloy, 1994). Thus, the maturity period of bamboo may be considered at 3-4 years with respect to density and strength. Maturity of culm is a prerequisite for the optimum utilisation of bamboo in construction and other structural uses. Janssen (1981) reported that the ratio between the ultimate compression and the mass per unit volume for dry bamboo is higher than that of dry wood. The reason is attributed to the higher cellulose content of about 55% in bamboo compared with about 50% in wood (Sattar, 1990).

Some studies have been conducted on the relationship between anatomical structure, physical and mechanical properties on one hand, and the technological characteristics, behaviour in processing and product quality on the other (Janssen 1981; Liese, 1992). Density of bamboo is closely related to the relative proportion of vascular bundle and ground tissue, and plays an important role in influencing the mechanical properties. This explains the variation of strength along the culm height. Permeability which is affected by anatomical characteristics, influences moisture movement and thereby treatability (Sattar, 1990). In wood, the chemical by products such as polyphenol, resin and wax influence properties such as shrinkage, durability and gluability. Nothing in this regards is known for bamboo.

3.0 Textiles Production in Nigeria

The Nigeria textile industry was the third largest in Africa after Egypt and South Africa. The industry is mainly dominated by cotton production, production of cellulose and synthetic fibres. The Hausa weavers use homemade horizontal lathes for making coloured fabrics while in the West, the cities of Ibadan, Abeokuta and Iseyin used vertical and horizontal machines. By handcraft method, Nigerians annually produce about 35 million meters of fabric (Obasanho, 2017). The top periods for the textiles industry according to Obasanho (2017) include the 1960's which was the period of steady growth for the industry; the 1970's which coincides with economic boom period; the mid 1980's recession; the late 1980's industry recovery and the great improvements of the 1990's.

The growth of the textiles industry began in Africa in the mid 1950's. In the 1960's to 1980's, Nigerian market was known predominantly for cotton production. In 1954, cotton production reached 30,000MT and this rose to 60,000MT in 1979. In 1988, production however declined to 30,000MT. The industry is mostly based on private mainly foreign capital (Obasanho, 2017), and attracted local raw materials producers.

In the golden era of the industry between 1985-1991, the sector had an annual growth rate of 67% and as at 1991, employed 700,000 people who made up 25% of the workers in the manufacturing sector. The number of mills as at then was about 180. The story of the industry changed in the 1980's. The discovery of oil turned farming into a lacklustre activity and reduced significantly the production of cotton to less than 40%. This was compounded by economic regression which made it impossible to upgrade equipment and facilities in the sector. Further militating factors include the Structural Adjustment Programme (SAP) which provided avenue for importation of cheap imported fabrics and finished goods, thereby lowering further utilization capacity. Further problem of the industry include the high cost of power as most of them were forced to provide their own electricity as a result of unreliable output from the national grid. These factors made most of the industries that could not cope to close down and by 1988, the industry was operating at about 28% capacity utilisation.

As the textile sector is considered globally as a driver of growth and employment, all hands have to be on deck to promote the re-invigoration of this sector. This is imperative as more than 75% of Nigeria youths despite having modicum education are either unemployed or under employed. For example, in China, more than 10 million people are employed by more than 100,000 textiles manufacturers in the country. The industry is estimated to contribute over 47% to the country's GDP with its value on garment export believed to be about 153.219 billion dollars in China in 2013 (Ademiluyi, 2017).

As a result of its proclivity for employment generation and its role in boosting economic growth, it is imperative for Nigeria to identify other options for inclusive growth of this sector. One of the major areas that should be identified and pursued vigorously by both the private sector and the government is the use of bamboo for textiles production locally in view of availability of the resource in about 23 states of the federation. The

next section examines the potentials of bamboo in the textiles sector of Nigerian economy.

4.0 Prospects for bamboo utilisation in the textile industry in Nigeria

The textile industry in Nigeria was one of the most important manufacturing industries that contributed to the development of the nation's economy in the 70's – 80's (RMRDC, 1990). The industry is the second largest employer of labour in the country (RMRDC. 2006). In the 1990's, Nigeria has a share of 24% installed short staple spinning capacity (Aribisala, 1993). In 2002, Nigeria produced about 500 million linear meters of all types of fabrics, representing 72% of the West African production. The existing industries produce primarily African prints of real wax and imitation wax with little products differentiation which affects their competitiveness (Aribisala, 1993). The major determinant of competitiveness in the textile industry is cotton. The index of manufacturing production for cotton declined to 94.5 in 1998 compared to 106.1 recorded in 1997. However, it picked slightly in 2001 to 93.7 as against 93.3 in 2000 (RMRDC, 2009).

The sector has high propensity for growth and competitiveness if there is adequate and sustainable supply of raw materials (Aribisala, 1993). Cotton fibre contributes more than 70% of the fibre raw material requirements and manmade fibre account for 30%. The textile industries in Nigeria produce fibre**,** yarn and fabric materials. Cotton lint is the most important single apparel fibre. It is the first basic raw material in the textile industry. The domestic availability of this raw material is an essential factor for the establishment of a virile textile industry. The Nigerian cotton board (now abolished) did not have enough productive capacity to sustain and ensure a continuous flow of cotton to the textile mills.

The most commonly used fibre, cotton and polyester cause serious environmental problems. Cotton production accounts for 11% of all pesticides and 25% of all insecticides used each year worldwide World Wildlife Fund (2005). The growing of cotton consumes large amount of water from 7 to 29 tons per kg of raw cotton fibres (Kalliala and Nousianien, 1999). Polyester is manufactured from oil, a non-renewable resource. The manufacturing process use high energy input and generates large amounts of harmful emission (Anson and Brocklehurst, 2007). Organic textiles which revolves around cultivation of raw material under organic condition is based on a system of farming that maintains and replenishes soil fertility without usage of and persistent pesticides, fertilizers and genetically modified seeds (Green Biz, 2006). Organic cotton is more costly to grow since there are additional costs at each stage of processing (Coster, 2007). In view of the above, textiles from bamboo has been observed to be able to address the aim of sustainable development by utilising a renewable resource to make cloths and other textile applications. Bamboo fabric is widely available in China, India and Japan. A Philadelphia based footprint provide socks made from 95% bamboo to offer anti-bacteria and moisture wicking properties (Textile World, 2008). London based bamboo clothing supply a range of bamboo clothes for men and women that stay naturally cool in the summer and hot in the winter (Bamboo clothing, 2008). In 2006, roughly 10 million USD worth of bamboo textiles were sold in the US and 50 million USD worth worldwide (Durst, 2006). There are over 200 retail stores offering bamboo textile products in the US alone.

The advantages of using bamboo in the textile industry derives from its renewability, its biodegradability, efficient space consumption, low water use, organic status and its carbon sequestration abilities. Another important advantage is predicated on some of the properties of bamboo textile. Since bamboo is naturally hollow in the horizontal cross section, the fibers show abundant gaps. These gaps can absorb and evaporate human skin moisture just as bamboo plant absorbs moisture in the ecosystem (INBAR, 2004). Also, bamboo does not require pesticide as a result of its natural antifungal and antibacterial agent known as Kun (or Kunh). The same natural substance that protects bamboo growing in the field, functions in spun bamboo fibre (FAO, 2007). The Kun stops odour producing bacteria from growing and spreading in the textile. A quantitative antibacterial test was performed in China by the China Industrial Testing Centre in 2003 in which 100% bamboo fabric was tested in bacteria strain type *Staphylococcus aureus.* After 24 hours incubation period, the bamboo fabric showed a 99.8% antibacterial destroy rate (FAO, 2007). To expand activities in Nigeria textile industry, it may be possible to utilize bamboo as a source of raw material for textile production.

5.0 Production of bamboo textiles

Bamboo textiles are easy to produce and the investment cost is relatively low. The production process is simple and it requires simple equipment. In the mechanical process, the woody parts of the bamboo plant are crushed and natural enzymes used to break the bamboo walls so that the fibres can be mechanically combed out and spun into yarn. Bamboo fibre products made by this process are called bamboo linen.

Chemically manufactured bamboo textile is a regenerated cellulose fibre called bamboo rayon. The chemical process consists of cooking the bamboo leaves and woody shoots in strong chemical solvents such as sodium hydroxide and carbon disulphide in a process known as hydrolysis alkalization combined with multi phase bleaching (Waite, 2009). According to Waite (2009), the general process for producing regenerated bamboo fibre using hydrolysis alkalization and multi-phase bleaching technology involves the following:

1. Leaves and inner fiber are removed from bamboo
2. Leaves (in some cases) and inner fibers are crushed together to make bamboo cellulose
3. Bamboo cellulose is soaked in a solution of 18% sodium hydroxide, NaOH, at 20-25°C for 1-3 hours.
4. Bamboo cellulose and NaOH mixture is pressed to remove excess NaOH, crushed by a grinder and left to dry for 24 hours.
5. Carbon disulfide, CS_2, is added to the mixture.
6. Bamboo cellulose, NaOH and CS_2 mixture is decompressed to remove excess CS_2, resulting in cellulose sodium xanthogenate.
7. A diluted solution of NaOH is added to the cellulose sodium xanthogenate, which dissolves it into a viscose solution.
8. The viscose is forced through spinneret nozzles into a large container of a dilute sulfuric acid solution, H_2SO_4 (that hardens the viscose and reconverts it to cellulose bamboo fiber).
9. The bamboo fibers are spun into yarns (to be woven or knitted).

6.0 Properties of bamboo textiles:

A number of bamboo textile producers used only one species of bamboo while others used as many as 13 species without distinguishing between species and textiles. As a result, any of the five species available in Nigeria can be used to produce bamboo textile. Bamboo makes a wonderful clothing material. The fibre is filled with micro gaps and holes which promotes moisture absorption and ventilation. In addition, the property of bamboo textile is different from those of cotton fibres. Bamboo textiles has antibacterial properties, it is very comfortable to wear in view of its antistatic properties. It is thermal regulating and has superior wicking capability.Bamboo viscose yarn is hypoallergenic, wrinkle resistant, colourfast and energy efficient. The use of bamboo fibre for clothing is a 20th century development pioneered by several bamboo corporations. Bamboo fibre resembles cotton in its unspun form. Many companies bleached the fibres to turn bamboo to white fibre while some of the companies producing organic bamboo fabric leave the bamboo fibre unbleached (Dylewski. 2008).

7.0 Challenge of Bamboo Textiles Development in Nigeria

A number of problems are constraining industrial development of bamboo thereby impeding potentials of bamboo to be sustainable for industrial use in textile industries in Nigeria, generate income and alleviate poverty in developing countries, including Nigeria. According to Leonard (2000), there is general lack of understanding of the industrial potentials of bamboo among policy makers. The national forest policy under which bamboo is subsumed gives litle or no attention to its development. Consequently, the bamboo sector in Nigeria is still part of the informal and backward rural economy. There has been no concerted effort to grab the large potential which has been successfully demonstrated by the Chinese bamboo industry. Consequently, although bamboo is found in abundance, it is underutilized.

As a result, it has been impossible to develop bamboo to the level where it can contribute in any reasonable measure to raw materials supply or as a foreign exchange earner in the sector. A new National Forest Policy was approved in June 2006 and ratified in October 2008 to be domesticated by all the States in Nigeria (FME, 2012). The new policy, just as the one before it did not give specific consideration to bamboo development as it is treated as one of the numerous non timber forest products. This classification indicated that bamboo does not have official backing despite its multiple industrial potentials. This creates a disjunction between modern international forest policy and needs of many people in developing countries (Buckingham, *et al,* 2011). According to Buckingham *et al,* (2011), recent international forest policy has focused on the implications of tropical deforestation for climate change, biodiversity loss and livelihoods, while key emerging issues for many developing countries continued to be the supply of timber in the face of increasing demand. While bamboo presents a promising alternative to products from trees, the international forestry policy focus on tree lands (Hunter, 2002). Thus, the potential to develop bamboo in developing countries is constrained by continual institutionalization of bamboo as a non timber forest product, while attention is given to development of trees. The situation in Nigeria is more difficult as tropical forests have a significant characteristic which makes monocultures difficult to develop as trees usually respond to minor localized climatic differences that have led to diversification of species (Gorte and Sheik, 2010). This makes sustainable management of tropical forests a difficult objective to pursue (Gorte and Sheik, 2010). According to Buckingham (2011) and Ogunwusi *et al.* (2013), the problem has four dimensions. One of the most important is that bamboo is neither treated as a crop nor as a tree. Thus, it has no apparent sivicultural or cultivation relevance in tropical forestry. Second, historic policy frameworks equate forest with trees which seek to accommodate bamboo in silvicultural management logistics, despite its being a fundamentally different plant. Third, the power and influence of western silvicultural science and practice in international development, continues to expand and as bamboo is not found in most western countries, it is not given primacy in forest policy development. Likewise the growing influence of market based forest policy instrument, notably the Forest Stewardship Council (FSC) are designed for trees and

not for bamboo. Four; bamboo receives minimum attention by development agencies, leading to underfinanced research and development (Buckingham, 2011, Ogunwusi 2013).

Nevertheless, in view of the need to accommodate bamboo development UNFCCC (2008) has considered bamboo as being on the same level with trees in the context of afforestation and reforestation. According to (Buckingham, *et. al.* 2011), the importance and utilization potentials of bamboo in various industries are compelling arguments for a more assertive approach category for bamboo to be placed on the same level as trees.

8.0. Recommendations for bamboo industry development in Nigeria

According to Ogunwusi (2013), Nigeria's bamboo sector are wrought with problems among which are unplanned harvesting, lack of large organized bamboo industries, prevalence of low cost, low added bamboo products and lack of research and inventory data for bamboo lands. Industrialization of a bamboo based sector is very important for generating livelihood without any damage to the environment. The vast and yet untapped potential needs cultivation, primary processing, integrated processes and transfer of technology and a coordinated sustained national level effort .According to Ogunwusi (2013), for a virile bamboo industry to be established in Nigeria, the following recommendation have to be attended to:

- Promotion of bamboo textiles investment in Nigeria.
- Establishment of a bamboo development institute or organization to coordinate and midwife activities relating to bamboo development in Nigeria.
- There is need for a national bamboo policy. The policy should spell out the objectives of bamboo development and provide detail guidelines for implementation.
- Nigeria needs a bamboo inventory. It is necessary to determine the quantity and quality of bamboo that currently exists, their distribution and types of species and quality of stocks available.
- There is need for the establishment of an association of Nigerian bamboo producers which could help set up quality standards and implement effective quality control, provide a forum for the exchange of information and ideas, collaborate with government agencies to formulate favorable bamboo manufacturing policies with regards to export and import regulations and also organize business promotion activities and build marketing networks.
- Government must promote bamboo tenure reforms. This could be done by giving farmers or groups who are committed to manage bamboo resources proper incentives.

9.0. Conclusion.

Bamboo is fast becoming a very important industrial raw material globally as a result of its multiplicity of uses. The development of bamboo for use in the textiles industry in Nigeria reduce dependence on imported raw materials and free foreign exchange for other uses. t is envisaged that the development of bamboo for textiles production will lead to savings of more than 500 billion naira annually. Incorporation of bamboo into the vision 202020 action plan will present more opportunities for a successful outcome.

Reference

ABS American. Bamboo Society, ABS, (2002a). General bamboo information. ww.bamboo.org/GeneralInfo.htmI

Ademiluyi Ronke (2017). How Nigeria can benefit from textile manufacturing revival. The Cable news and Vicious unlimited. theCable.ng.

Akinbile, C.O, O.A. Fakayode and K.O. Sanusi (2011). Using Bamboo (*Bambusa vulgaris*) as a field drainage material in Nigeria. African Journal of Environmental Science and Technology 5(12): 1124-1127.

Ami, S.R. (1987). Drainage pipe testing manual. CIDA Hull, Quebec, Canada.

Anson, R. and G. Brocklehurst (2007). Trends in World Textile and Clothing Trade. Textile Outlook International November – December 2007 (132)

Aribisala, A. O. (1993): Raw Materials Revolution and Impact on Industrialisation in Nigeria. Mednet Publications Ltd. (1993). ISBN 978 – 024 – 000 – 4

Arowosege O.G.E (2010) Lesser used wood species and their relevance to sustainability of tropical forests. In

Asadu, C.L.A, P.I Ezeaku and G.U Nnaji (2004). Land use and soil management situations in Nigeria: An analytical review of changes. J. Outlook Agric USA., 33:27-37

Awolehin, G. G., Ibrahim, H. D. and Hasan, U. A. (2016). Cotton and Textile Development in Nigeria. Raw Materials Research and Development Council Publication. 337pp.

BambooClothing. (2008). Bam Bamboo Clothing Frequently Asked Questions. http://www.bambooclothing.co.uk/faqs.html. May 12,2008.

Biopact (2006). Bamboo power. Indian State of Mizoram to produce electricity from Bamboo. Biopact towards a green energy pact between Europe and Africa. Mongabay.com/bioenergy/2006/08/bamboo-power-indian-state of mizoram.html.

Blackett, H and Gardette, E. (2008). Cross border timber and wood products flow West Afica. European Commission Final Report. Contract Reference 2007/146818.

Bourgione, J. (1991): Demand and Supply of Forestry Products in Nigeria. World Bank. Washington D.C.

Buckingham, K. ,Jepson, P, Wu, L., Rao, I.V.R. , Jiang, S., Liese, W., Lou, Y and FU, M. (2011). The potential of Bamboo is constrained by outmoded frames. Ambio 40(5):544-548.

Casey, James P. (1980) : Pulp and Paper chemistry and chemical technology. Third edition, Vol 1. Wiley Interscience publication.

Coster,J.D. (2007). "Green Textiles and Apparel: Environmental Impact and Strategies for Improvement" Textile Outlook International November-December 2007 (132)

Dayawansa, H. (2012). Sri Lanka kicks off first ever bamboo processing initiative. *Celon Development* 9(2): 136-146.

Deshmukh, S. And Sanjeev. Karpe (2007). Bamboo based enterprenureship: Consideration and Challenges. Draft paper.

Dylewski, A.(2008). Aboost for Bamboo-based Blouses and Blankets. http://www.newswise.com/articles/view/539088/. May 12,2008.

Edward, K. and Doing, H. (1995). The importance of bamboo in house construction: a case study of Flores. Proceedings of the International Bamboo Workshop and the IVth International Bamboo Congress, Ubud, Bali, Indonesia, 19-22 June, 1995.

Espiloy, Z. B. (1987). Physico-mechanical properties and anatomical relationships of some Philipine bamboos. In Rao,A. N. ; Dhanarajan, G.; Sastry, C.B. ed., Recent Research on Bamboo. Proceedings of the International Bamboo Workshop, Hangzhou, China, 6-14 October 1985. Chinese Academy of Forestry, Beijing, China; International Development Research Centre, Ottawa, Canada. Pp. 257-264.

Espiloy, Z.B. (1994). Effect of age on the physio-mechanical properties of some Phi-ippine bamboo. In bamboo in Asia and the pacific. Proceedings of the 4th International Bamboo Workshop, Chiangmai, Thailand, 27-30 November 1991. International Develop-ment Research centre, Ottawa,Canada; Forestry Research Support Programme for Asia and the Pacific, Bangkok, Thailand. Pp. 180-182.

FAO (2006). Global forest resource assessment. FAO publication. FAO Rome

FAO(2007). The Versatile Bamboo. Non-wood News 14. Rome, Food and Agriculture Organization

FAO. (2007). Extent and Characteristics of Bamboo Resources. ftp://ftp.fao.org/docrep/fao/010/a1243e/a1243e03.pdf. April 20,2008.

FAO. 1997. Provissional Outlook for global forest products consumption, production and trade. Forestry Department, Policy and Planning Division, FAO, Rome.

FME (2012). New Forest Policy in Nigeria. Federal Ministry of Enviroment, Abuja Nigeria. Unpublished.

FMITI (2015). Report of the Special Committee on the Resucitation of the Cotton, Textile and Garment Subsector in Nigeria. Unpublished. 75pp.

G. W. V. Consultants (1994). Review of Wood Based Sector to Nigeria Final Report. Presented to Forest Management, Evaluation and Coordination Unit, Federal Ministry of Agriculture and Natural Resources, Federal Department of Forestry, Abuja, Nigeria.

Gorte, R.W. and Sheikh, PA. (2010). Deforestation Prepared for Members and Committees of Congress.

INBAR (2009). The Climate Change Challenge and Bamboo INBAR publication. www.inbar.int.

INBAR (2011). New Bamboo Charcoal Technologies promise to jump start African Bioenegy Sector, slow deforestation and fight climatec change. INBAR Newsletter e-Newsletter www.inbar.int./2011/2012/new-bamboo-charcoal-technologies-to jumpstart-africas-bioenergy.

Janssen, J. J. A. 1995. Building with bamboo (2nd ed.). Intermiadiate Technology Publication Limited, London. Pp. 65.

Janssen, J.J.A. (2000). Designing and Building with Bamboo. International Network for Bamboo and Rattan Technical Report No. 29. pp 207.

Janssen, J.J.A. 1981. The relationship between mechanical properties and the biological and chemical composition of bamboo. In Higuchi, T. ed., Bamboo production and utilisation. Proceedings of XVII IUFRO World Congress, Kyoto, 1981. Kyoto University, Kyoto, Japan. Pp. 27-32.

Jiang Z. (2007). Bamboo and Rattan World. China Forestry Publishing Houter, Beijing.

Jimoh, H.I., O.D. Ajewole, S.I. Onotu and R.O. Ibrahim (2012). Implications of land degradation, reclamation and utilizations in the oil producing areas of Nigeria; perspectives on environmental sustainability and development. Environmental Research Journal 6(2): 100-105.

Kabir, M.F.; Bhattacharjee, D.K.; Sattar, M.A. 1991. Physical and mechanical properties of four bamboo species. Bangladesh Journal of Forest Science, 20(1&2), 31-36.

Kabir, M.F.; Bhattacharjee, D.K.; Sattar, M.A. 1993. Effect of age and height on strength properties of *Dendrocalamus longispaths.* Bamboo Information Centre India Bulletin 3(1), 11-15

Khan,A.U. and Hazarai A.(2012); Industrialization of The Bamboo Sectors: Challenges and Opportunities.

Larinde S.L (2010) Secondary processing and the Nigerian saw mill industry: Issues, challenges and opportunities. In S.Kolade Adeyoju and S.O Bada (eds) Readings in sustainanble tropical forest Management. Pp 277-291

Liese, W. 1986. Characterization and utilization of bamboo. *In* Higuchi, T. ed., 1986. Bamboo production and utilization. Proceedings of the Congress Group 5.04, production and utilization of bamboo and related species, XVIII IUFRO World Congress Ljubljana, Yugoslavia, 7-21 September 1986. Kyoto University, Kyoto, Japan.

Liese, W. 1992. The structure of bamboo in relation to its properties and utilization. *In* Zhu, S.; Li, W.; Zhang, X.; Wang, Z. ed., Bamboo and its uses. Proceedings of the International Symposium on Industrial Use of Bamboo, Beijing, China, 7-11 December 1992. International Tropical Timber Organization; Chinese Academy of Forestry, Beijing, China, pp.95-100.

Lipange, T.N. (1991). Manufacture and Construction of Bamboo water supply syatems. J.Am. Bamboo. Soc. 8(1-2):191-198.

Makinde, M.A. (2004): Keynote Address at the National Symposium of Technical Association of Pulp and Paper Industry in Nigeria. In Proceedings of the One Day National Symposium on Rehabilitation of the Forestry, Pulp, Paper and Board Industries for the Revival of National Economy. Conference Hall, Federal Institute of Industrial Research, Osodi (FIIRO) .pp 7-15

Mohd Edeerozey, A.M., Akil., H.M., Azhar, A.B., AND Zainal Ariffinn, M.I. (2007). Chemical Modification Of Kenaf Fibres. Materials Letters, 61., 2023-2025.

Naxium, Ma (2001) Biodiversity and resources exploitation of Bamboo in China. In Zhu Zhaohua Ed. Sustainable Development of Bamboo and Rattan Sectors in Tropical China. Sector Proceedings No. 6. INBAR and China Forestry Publishing House.

Obasanho, S. (2017). Interacting! History of textiles industry in Nigeria. www.google.com.ng.

Ogunsanwo, O.Y (2010) . Challenges of wood utilization in Nigeria. In S.Kolade Adeyoju and S.O Bada (eds) Readings in sustainable tropical forest Management. Pp 293-303

Ogunsile, B.O and C.F. Uwajeh (2009). Evaluation of pulp and paper potentials of a Nigerian grown *Bambusa vulgar*is. World Applied Science Journal 6(4) 536-541

Ogunwusi A.A. and M.A Jolaoso. (2012). Bamboo, Conservation of environment and sustainable development in Nigeria. *Advances in Arts, Social Sciences and Education 2*(9):346-358.

Ogunwusi A.A. and M.A Jolaoso. (2012). Bamboo, Conservation of environment and sustainable development in Nigeria. *Advances in Arts, Social Sciences and Education 2*(9):346-358.

Ogunwusi, A.A (2013c). Optimizing pulp and paper capacities in Nigeria. *Advances in Affrev Stech.* 2(1): 27-44

Ogunwusi, A.A. (2011). Potentials of bamboo in Nigeria's Industrial Sector. *Journal of Research in Industrial Development* 9(2): 136-146.

Ogunwusi, A.A. (2012a). Forest Products Industry in Nigeria. A*frican Research Review.* 6(4): 191-205.

Ogunwusi, A.A. (2012b). Promoting green growth of forest products industry in Nigeria through bamboo development. *Journal of Developing Country Studies* 2(11): 61-74.

Ogunwusi, A.A. (2012c). Imperatives and Guidelines for Bamboo Development Policy in Nigeria. *Journal of Research in Industrial Development* 10(2b): 348-357

Ogunwusi, A.A. (2013a) Green Investments Required in the Forest Products Industry in Nigeria. *Developing Country Studies* 3(3):51-63.

Ogunwusi, A.A. (2013b). Impact of forest policy and land tenure system on bamboo development in Nigeria. *Public Policy and Administration Research* 3(5):13-20

Ogunwusi, A.A. and Onwualu, A.P.(2011). Indicative inventory of Bamboo availability and Utilization in Nigeria *Journal of Research in Industrial Development* 9(2): 1-9

Onilude, M. A. (2006). Potentials of Bamboo as a raw materials for the wood Industry in Nigeria. Paper presented at the seminar organised by Raw Materials Research and Development Council in collaboration with the Manufacturers Association of Nigeria at MAN House, Ikeja. 14th June, 2006.

Paglione, J.P.F. (2003). Sustainable biomass production utilizing bamboo as alternative renewable non-wood resource. www.bamboocentral.org/whybamboo.html

Pandey, C.N and Shyamasundar K. (2008) : Post harvest Management and Storage of Bamboo Culms. Proceedings of the International Conference on Improvement of Bamboo productivity and marketing for sustainable livelihood. 15th-17th April, 2008, New Delhi, pp 47-58

Pandey, S.S. (2008). Proceedings of the international conference on improvement of bamboo productivity and marketing for sustainable livelihood. 15th -17th April, 2008, New Delhi.pp 76-91

Picornelli, P.M. (1984). Protecting new pulp and paper industries: an opinion from developing countries. Unasylva 144: 54-62

Qisheng, Z., Shenxue, J. and T. Yougyu (2002). Industrial Utilisation of Bamboo. INBAR. Technical Report No. 26

RMRDC (1990). Raw Materials Sourcing for Manufacturing . Macmillian Nigerla Publishers Limited ISBN 978-2043-00-1.

RMRDC (1991). Report of the Multi-Disciplinary Task Force on Pulp, Paper Paper Producta, Printing and Publishing Sector RMRDC Publication. 1991

RMRDC (2003). Report of the Multi-Disciplinary Task Force on Pulp and Paper Sector in Nigeria. A Publication of the Raw Materials Research and Development Council, Abuja. 85pp.

RMRDC (2004). Bamboo Production and Utilisation in Nigeria. RMRDC Publications August, 2004.

RMRDC (2009) Multi-Disciplinary Task Force Report of the Pulp, Paper, Paper Products, Printing and Publishing Sector. Raw Materials Research and Development Council Publications, 2009.

RMRDC(2006) . Taxonomy of bamboos in Nigeria. Report of experts committee submitted to the Raw Materials Research and Development Council, Abuja.

Salam, K. (2008). Bamboo for economic prosperity and ecological security with special reference to north-east India, CBTC, Guwahati.

Sastry, C.B.(2008). A vision 2020 for bamboo in India: Opportunities challenges. Proceedings of the International Conference on Improvement in Productivity and Marketing for Sustainable Livelihood. 15-17th April, 2008. New Delhi. Cane and Rattan Technical Papers

Sattar, M.A,(1995).Traditional Bamboo Housing in Asia: Present status and future prospects in Proceedings of the Vth International Bamboo workshop and the IV international Bamboo Congress, Ubud, Indonesia. 19-22, June, 1995.

Sattar, M.A. and Kabir, M.F. (1990). Effects of age and height position of muli (*Melocanna bmcifea)* and borak (*Bumbusa bulcooa)* on the physical and mechanical properities. Bangladesh Journal Forest Science, 19(1&2), 29-38.

Schellnhuber J. (2209) Unpublished Paper Delivered in Copenhagen. April, 2009.

Sekhar, A.C.; Bhartari, R.K. 1960. Studies of bamboo. A note on its mechanical behaviour. Indian Forester, 86(5), 296-301.

Sekhar, A.C.; Gulati, A.S. 1973. note on the physical and mechanical properties *Dendrocalamus strictus* from different localities. Van Vigyan,-11(314), 17-22.

Sharma, S.N.; Mehra, M.I. 1970. Variation of specific gravity and tangential shrinkage in the wall thickness of bamboo and its possible influence on trend of the shrinkage-moisture content characteristics. Indian Forest Bulletin 259,7

Singh, M. (2008). Message. Proceedings of the International conference on improvement of bamboo productivity and marketing for sustainable livelihood. 1th-17th April, 2008, New Delhi.

Singh, S.R. Anjaneyulu, B., Vashi, A.K., Shakya, S.K. (2009). The design of low cost ground well. Ground water 47(2): 310-313.

UNFCCC. (2008). Report of the 19th Meeting of the Afforestation and Reforestation Working Group. UNFCC Headquarters, Bonn, Germany, 14–16 April 2008. United Nations Framework Convention on Climate Change, Bonn.

UNIDO (2009). Bamboo: An untapped and Amazing Resource Retrieved. November 30, 2009.

Waite, M. (2009). Sustainable Textiles: the role of bamboo and the comparison of bamboo textile properties. Journal of Textile and Apparel Technology and Management 6(2):1-21

Wooldridge, M. (2012). Booming Bamboo: The next super-material? BBC News Magazine. 3rd April, 2012.

WWF. (2005). Agriculture and Environment: cotton, environmental impacts of production: use of agrochemicals. http://www.panda.org/about_wwf/what_we_do/policy/agriculture_environment/commoditied/cotton/environmental_impacts/agrochemicals_use/index.cfm. April 2008