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Techno-Economic Analyses of Bamboo Furniture Production in Nigeria

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Abstract: **The paper assesses the Techno-economical values of bamboo with a view of assessing its potential for furniture production and employment generation. Rate of returns and Cost Benefit ratio of bamboo furniture such as beds and tables were examined to establish the economics value of the production and the Impact bending which determines its strength to resist sudden load was also evaluated along the height to establish the fitness and appropriateness of the laminated bamboo for production of furniture. Samples were taken along the length at the base, 25%, 50% and top of the total length of the culms. The Rate of Returns (RORI) of bamboo furniture is above 60% and Cost Benefit Ratio is higher than 1. The mean Impact Bending for laminated bamboo is 0.76±0.17m; it ranges from 0.79±0.18m, 0.77±0.19m, 0.75±0.13m and 0.74±0.16m for the base, 25%, 50% and Top of the total height of the bamboo culms respectively.**

Keywords: **Bamboo, cost benefit ratio, employment, Furniture, Mechanical property, impact bending.**

1. INTRODUCTION

Bamboo is one of the lesser known/lesser used non-wood renewable natural resources that have long been identified for multi-purpose uses (Sattar, *et al*., 1996, Sekar, *et al*., 1998) having long history of utilization in many parts of the world, with relics from bamboo mats and baskets dated at younger stone age between 3,300 and 2800 BC already obtained (Erakhrumen and Ogunsanwo, 2009; Ding, 1996). The importance of these plant species for multi-purpose uses might have stimulated and encouraged their use for many applications in many countries (Gielis 2002; Chand, *et al*, 2006; Nordin, *et al*, 2007) ranging from food, handicraft, furniture, house hold utilities, fish traps to various industrial uses.

In Nigeria, the current patterns of development in the forest industry which rely solely on diminishing forest resources have been observed to be unsustainable (Ogunwusi and Jolaoso, 2012). A number of studies (Larinde, 2010) have reported the timber resources in the country to be dwindling in availability. There is therefore need to search for more sustainable, climate friendly alternatives that have potentials for alleviating the social and environmental problems the world is currently facing.

The mechanical properties of wood are the expression of its behaviour under applied forces (Panshin and de Zeeuw, 1980). The strength of wood referred to its ability to resist external forces or load that can change its size and its shape. The change in size or shape of wood is generally known as deformation or strain. The force of deformation when expressed on the basis of unit is known as stress.

The term strength properties or mechanical properties as applied to a material such as wood refers to the ability of the wood to carry applied load or forces (Haygreen and Bowyer, 1996). Tsoumis (1991) defined strength properties as the measure of its resistance to exterior forces, which tend to deform its mass. The resistance involves a number of specific mechanical properties and it is these that determine the suitability of different species of timbers for the various purposes for which they are used (Illston *et al*,1987). Desch and Dinwoodie (1996) also defined the strength of a wood as the ability of the wood to resist applied forces that could lead to its failure. Haygreen and Bowyer (1996) indicated that mechanical properties are usually the most important characteristics of wood products to be used in structural applications. They further explained that the term strength is often used in general sense to refer to all mechanical properties. Nonetheless, there are many different types of strength and elastic properties and as such it is important to be very specific about the type of mechanical property being discussed. A comprehensive knowledge of the structure of wood, its chemical and physical behaviour, and the causes of variability, as they affect its utilization form the basis of present and potential utilization of wood (Panshin and de Zeeuw, 1980). According to Farmer (1972), timber, like all other materials of construction, has the ability to resist applied or external forces. In practice, timber is frequently subjected to a combination of stresses (compressive, bending tensile and shearing), although one usually predominates.

Cost-benefit analysis (CBA) is a method for organizing information to aid decisions about the allocation of resources. Its power as an analytical tool rests in two main features: costs and benefits are expressed as far as possible in money terms and hence are directly comparable with one another; and costs and benefits are valued in terms of the claims they make on and the gains they provide to the community as a whole, so the perspective is a 'global' one rather than that of any particular individual or interest group.

CBA is a tool used to determine the worth of a project, programme or policy. It is used to assist in making judgments and appraising available options. CBA principles and practice are well established – as evidenced by the vast amounts of literature available from academics, CBA practitioners, and government agencies (both domestically and abroad). CBA is a quantitative analytical tool to aid decision-makers in the efficient allocation of resources. It identifies and attempts to quantify the costs and benefits of a programme or activity and converts available data into manageable information. The strength of the method is that it provides a framework for analyzing data in a logical and consistent way. From the above, the paper therefore assesses the Impact Bending which is known as the maximum hammer drop. It shows the ability of wood samples to resist suddenly applied load. Impact bending is just one of the three criteria used in the laboratory for measuring toughness (Desch, 1988) and Cost benefit analysis of bamboo glue-lam in the production of furniture in Nigeria

2. METHODOLOGY

Impact bending:

The bamboo culms (*Bambusa vulgaris*) that were converted and experimented upon in this study were obtained from the Asanmagbe stream of Forestry Research Institute of Nigeria, Ibadan. Forestry Research Institute of Nigeria is located on Latitude 7°22''N and Longitude 3°53''E

The bamboo culms were converted to strips and glued together using top bond, test samples of 2x2x30cm according to BS 373 were produced from the laminate formed at different level of the bamboo culms along the height.

The impact bending test was carried out using the Hatt-Turner Impact Testing Machine at the Department of Forest Products Development and Utilization, Forestry Research Institute of Nigeria, Ibadan; following British Standard BS 373. In this method, standard test specimen 20 x 20 x 300mm was supported over a span of 240mm on a support radiused 15mm, spring restricted yokes are fitted in order to arrest rebounce.

This was then subjected to a repeated blow from a weight 1.5 kg at increasing height initially from 50.8mm, and then every 25.4mm, until complete failure occurred at which point the height was recorded in meter as the height of maximum hammer drop.

The experimental design for the experiment was a Completely Randomised Design (CRD) with fifteen replicate, after which different furniture products such as Bed, Table and Stool were produced from the laminate.

Production and costing of furniture items

Profitability analysis: the profitability of the production of the bamboo laminate furniture was calculated using Rate of returns on Investment (RORI)

$$RORI = \frac{TR - TC}{TC} x100 \qquad (1)$$

Where: TR=total revenue (Selling price)

TC=Total cost (Production cost)

The viability of the production was also determined using the cost benefit analysis. For any production or business to be economically viable, the benefit cost ratio must be greater than one (1)

The formula is given as:

$$BC = \frac{\sum \frac{R_t}{(1+r)^t}}{\sum \frac{C_t}{(1+r)^t}} \quad \text{...(2)}$$

Where: R_t= Revenue over time t

C_t= Cost over time t

r= Discount rate (10%)

1= constant

t= one (1) year

3. RESULT AND DISCUSSION

Impact Bending:

The mean Impact Bending for laminated bamboo is 0.76±0.17m; it ranges from 0.79±0.18m, 0.77±0.19m, 0.75±0.13m and 0.74±0.16m for the base, 25%, 50% and top of the total height of the bamboo culms respectively (Table 1), IMB decreases from base to the middle and further decreased to the top.

TABLE.1: Mean of Impact Bending (m) for Bamboo glue-lam

Sampling Height	Mean (m)
Top	0.74±0.16
25%	0.79±0.19
50%	0.74±0.13
Base	0.77±0.19
Total mean	0.76±0.17

This is contrary to Ajala, (2005). Who discovered inconsistence variation in the IMB of *Anningeria robusta* that is a dicotyledon. Adejoba, (2008), obtained 0.3m for the IMB of *Ficus mucuso*. In his findings, he opined that the IMB was the same at any point of the wood of *Ficus mucuso*. While Ojo, *et al*., (2012) observed the same pattern of decrease from the base to the top on the wood of *Borassus aethiopum* given the impact bending as 0.92±0.07m at the base, 0.83±0.08m at the middle and 0.48±0.04m at the top in *Borassus aethiopum* which is a monocot, and the Impact bending of *Borassus athiopum* is 0.74±0.02m.

This variation pattern in IMB may be attributed to the fact that wood is a natural material and the tree is subject to many constantly changing influences, hence wood properties vary considerably. (Green, *et al*., 999) Statistically there is no significant difference among the treatment.

It shows the ability of wood samples to resist suddenly applied load. Impact bending is just one of the three criteria used in the laboratory for measuring toughness (Desch, 1988). It is important to note that scientists have not agreed as to which one shows shock resisting ability of wood material which can be widely used as an indicator of toughness of wood materials. The amount of shock resistance of a solid body depends on the ability to absorb energy and dissipate it before deformation, (Kollman and Cote, 1968). The maximum hammer drop is read directly from impact bending machine and recorded in metres. The result obtain compare favourably with conventional timber species. Statistically, there was no significant difference among the sampling height of the bamboo culms glue-lam (Table 11)

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TABLE.2: Analysis of variance for Impact Bending of Bamboo glue-lam

SV	df	Sum of square	Mean of square	Fcal	Ftab
Trt	3	0.024	0.008	0.28^{ns}	3.15
Error	56	1.60	0.029		
Total	59	1.63			

ns= Not significant (P>0.05)

Cost Benefit Ratio Analysis:

Each bamboo culm cost #200 (Two hundred naira only) and 20 culms of bamboo will be needed for the production for the production of a 6x6 bed. Therefore, 20 culms will cost #200x20=#4000

Transportation= #1000

Preservation of the culm=#2000

Finishing= #2500

Labour cost= #5000

Adhesive (glue) for lamination = #2000

Total cost = #16500

A 6x6 bamboo bed is sold for #27,000

Therefore, Rate of Returns on Investment (RORI) $= \frac{\#27000 - \#16500}{\#16500} \times 100$

=63.64%

$$BC = \frac{\sum \frac{N27{,}000}{(1+10\%)}}{\sum \frac{N16500}{(1+10\%)}}$$

BC=1.64

The valuation of forest resources has been a concern in forestry for a quite long time (Agbeja, 2007), however, most valuation efforts until the 1950s were limited almost entirely to timber compartment of the forest (Champman and Meyer, 1947; Hiley, 1956). The purpose of valuation is to make the value on each forest use explicit, and not necessarily to put total value on nature (Micheal, 1995). Various techniques have been developed over the years to derive the various measures of value that are appropriate for a particular forest product valuation situations, there are several comprehensive reviews and appraisals of these techniques that outline how they can be applied as well as their advantages (IIED, 1994; Winpenny, 1991). FAO (1995) suggests that forest valuation should be always attributed only to the commodity studied and to the actual context and situation studied.

Value is the worth of a product or service to an individual or like-minded group in a given context, often involving a complex set of relationships (Brown, 1984). All economic values are anthropocentric by nature; that is, they are human-assigned. A value according to Barbour (1980) is a general characteristic of a thing or a circumstance that a person views with favour, believes is beneficial, and is disposed to promote. Values are not held in isolation but as component of a value system, or ordered set of values.

4. CONCLUSION

The relationship between man and forests has always changed with socio-economic development and will certainly continue to change, the reason being that Man/Land ratio will continue to be high and more wood products will be demanded, therefore, there must be a substitute for this demand as a result of increasing population.Base on this research work, the impact bending of bamboo glue-lam compares favourably with tropical timber species such as *Milicia excelsia*,

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Nauclea diderichi and so on. It was also discovered that every part of bamboo can be used in production of whatever furniture. The rate of return on bamboo furniture is highly encouraging, this is even slightly above 60% and the Cost Benefit Ratio is above 1, therefore, bamboo furniture production is a laudable and a viable project and a veritable means of employment for youth in the country.

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APPENDIX - A

BAMBOO BED PRODUCED FROM LAMINATED *Bambusa vulgaris* IN FORESTRY RESEARCH INSTITUTE OF NIGERIA (FRIN), IBADAN, OYO STATE, NIGERIA

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APPENDIX - B

BAMBOO TABLES PRODUCED FROM LAMINATED *Bambusa vulgaris* IN FORESTRY RESEARCH INSTITUTE OF NIGERIA (FRIN), IBADAN, OYO STATE, NIGERIA