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Bamboo as the Future for an Underdeveloped Economy: A Study on its Uses and Implications

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Abstract:

In the recent period, bamboo based technology has been highly recognized as a good replacement for forest wood and wood based products as these products are analogous to various environmental issues. The growing concern about the environmental effects of using forest wood has attracted the attention of the researchers and academicians to search for a good alternative of wood and various products of wood. Bamboo and bamboo based products gradually found to be the most favourable substitute for forest wood. The present study intends to explore and examine the uses and applications of bamboo as a way to reduce environmental degradation and also as a way to earn livelihood for the forthcoming generations. This study is an attempt to attract attention of the young minds towards "Timber as the Future instead of Timber as the Poor Man's Timber".

Keywords: *Bamboo, Bamboo technology, Green buildings, Economic Development*

Introduction:

Bamboo belongs to a special category of grass which is a member of Poaceae family. Bamboos are mostly found in the equatorial, semi–tropical and clement zones betwixt 46° north and 47° south latitude and beyond 90 genera of bamboo sub–divided into almost 1,200 different breeds (Ling, Kawamura, & Nakane, 2011). This special category of grass is mostly found in Asia, Africa, South and Mid America and in some segments of Europe as well as North America also. India is endowed with abundance of Bamboo resources with total bamboo bearing area of the country estimated as 1, 60,037 Sq. Km. and there are almost 125 indigenous and 11 exotic species of bamboo belonging to 23 genera are found in different regions of India (Forests, 2017). Bamboos are extensively scattered in different parts of India, particularly in semi arid and arid zones along with plains and hilly tracts, generally up to the verticality of 1000 meters. The extensive spread of bamboo across different regions of India manifests the potentiality of the soil of the nation to promote bamboo based technology and bamboo industries. The main species of bamboo found in India are, Arundinaria, Bambusa, Chimonobambusa, Dendrocalamus, Dinochola, Gigantochloa, etc. Almost all the states of the North – East India are in abundance of bamboo production, comprising of about 50% of the total bamboo production of the nation (Forests, 2017).

Review of Literature:

Borah, U. K. (2015), explained about the accessibility of the different variant of bamboo found in the North-Eastern region of India which can be used for various industrial purposes considering the present scenario of the bamboo Industry in North East India. The study found that 89 species of bamboo are available in North East India which is recognized as an industrial material for the manufacture of handicrafts, incense sticks, furniture and paper. The study also reveals that this region of the nation can also attain the standards of the developed states of the nation if the indigenous people of the region utilize the benefit of the abundance of this natural resource efficiently and optimally (Borah, 2015). Further, Singha, K. N. and Timung, L. (2015) studied the cultural significance of bamboo to the Karbi tribe of Assam. It found that bamboo is associated with the livelihood of the rural people of Assam. It is the backbone of the rural economy of Northeast India. Karbi tribes make products like agricultural implements, utensils, and food (bamboo shoots) using bamboo which is a daily diet of the Karbi tribe in addition to construction of fences, bridges, houses and artwork of culture (Singha & Timing, 2015). Anokye, R. Bakar, E. S. Ratnansingam, J, J, and Awang, K.B (2016) studied about the importance of bamboo in replacing the wood (timber) product and presented bamboo wood as an excellent engineering material of high strength. It stressed on the feasibility of using bamboo for blocks, boards etc. through advanced processing technologies and found that the strength to weight ratio of bamboo exceeds aluminium, iron, and timber. Another study by Gaggar, K. and Goswami, S. (2018) focused on the challenges faced by the industries in conducting business of bamboo wood. It found that there is a lack of skilled workers and availability of proper technology. The machinery also has to be imported from China and Taiwan. The cost involved is very high and people are hesitant to bear such a high cost.

Objectives:

The study intends to investigate and appraise the uses and applications of bamboo as a way to improve the quality of nature by reducing the environmental degradation and also as a way to earn livelihood for the forthcoming generations. An attempt has been made to highlight the implications of using bamboo technology in the North-Eastern States of India and especially in Assam.

Methodology:

The study is entirely based on secondary sources of data. The secondary data are mostly collected from both published as well as unpublished sources, including books, journals, and news papers. Besides these sources, some important information is also collected from relevant websites. The present study is descriptive in nature.

Conventional Usage of Bamboo:

In the nations of the continent of Asia, cane and bamboo has been utilized for domestic utilities like vessels, sticks, twisted and hand woven mats, fish pole, cricket boxes, handiworks, furniture, etc. Conventionally, bamboo has been widely used as an important tool for construction of buildings**.** Bamboos are also used as a tool for construction of aqueduct, water transportation facilities (Hoang, Kinney, & Corsi, 2009). Bamboo is one of the powerful materials for construction of buildings and other household items in comparison to steel used in building industry since ancient times. The endurance of bamboo (28,000 pounds per square inch), is much higher than that of steel (23,000 pounds per square inch). From various research works, it has been found that bamboo as a building substance requires comparatively less energy than steel. Therefore, bamboo can be considered as one of the good substitute for steel and steel appliances (Ghavami, 2009; Liese, 1985)**.** The hollow designs are fundamentally superior to wooden stem of firewood. Density of various bamboo species is 700-800 kg/m3 and it is a significant component for the construction buildings. Bending stress at failure is 0.14 times mass per unit volume. High value of mass per unit volume for bamboo provides it greater strength of bending failure.

Table 1: Specific Properties of Bamboo

Property	Value
Specific gravity	0.575-0.655
Bond stress	5.6 kg/cm2
Safe working stress in shear	115-180 kg/cm2
Safe working stress in compression	105 kg/cm2
Ultimate compressive stress	794-864 kg/cm2
Modulus of Elasticity	1.5-1.0 x 105 kg/cm2

Utilization of bamboo ranges from various traditional and conventional household products to numerous commercial as well as industrial practices. Furnishings, artefacts, ladder, vessels, receptacle, hedge, fencing etc. are the conventional usage of bamboo. Along with this traditional uses of bamboo, it is increasingly recognised as a good mean of stabilising the environmental values in the contemporary society and realising this fact bamboo is considered as the finest alternative for housing, handicraft, and pulp and paper industry. Hollow internal structure makes it light weight, easy to work with and transport and being easy to split it is used in woven industry including agricultural instruments, fishing tools, musical instruments.

Future Potential of Bamboo Utilization:

The revolutionary stage of bamboo started with the application of bamboo as a mean of earning livelihood, especially in the industrial sector. Since early 1990s, bamboo has been adopted as a raw material for making productive activities in both India as well as China (Ling, Kawamura, & Nakane, 2011). International trade in Bamboo is expected to be between $5 and $10 billion. Local trade at village level is often not recorded officially. India plays an important role in global bamboo market. Worlds 80% bamboo forests are in India, China and Myanmar (~ 198 lakh ha). Although India contributes 45% to the world bamboo production, its share in global market is only 4.5 % (Ting, Wu, Hsu, Chuang, & Yang, 2008). With the implement of proper management and preservation techniques utilization potential of bamboo can be achieved properly.

Table 2: Market demand of bamboo in various applications (India)

Bamboo items	Market Size, 2003 (Rs. in Crore)	Market Size, 2015 (Rupees in Crore)
Shoots	5	300
Timber substitution	10,000	30,000
Plyboard	200	500
Plyboard for truck, railways	1000	3,400
Bamboo Matboards	--	3,908
Bamboo Flooring	200	1950

Pulp	100	2088
Furniture	380	3265
Scaffolding	--	861
Housing	--	1163
Road	--	274
Miscellaneous (pencil, matches etc.)	394	600

Source: (Hammett, Youngs, Sun, & Chandra, 2001)

Utilization of bamboo as an alternative to wooden materials can be includes processing of raw bamboo which does not require any specialized skill and expensive equipments. Therefore, implementation of bamboo technology can be initiated with a low initial investment cost which is affordable for all the small entrepreneurs also. Bamboo plant is found to be an effective carbon sink and effective in mitigation of greenhouse effect (Choi & Ahn, 20014).

Multi-storey constructions with green roof top are the ways by which the consumption of energy can be reduced in comparison to the traditional construction materials (Lobovikov, Ball, Guadia, & Russo, 2007). Provision of bamboo as material of construction will not only provide comfortable temperature zone inside the house but also helps to reduce indoor air pollution. Zhang and Niu (2003), found in their study that the material of construction is responsible for 60% of total volatile organic compounds (TVOCs) in residential buildings and highlighted the fact that buildings based on bamboo have better indoor air quality and less ozone level in inside air (Zhang & Niu, 2003).

Bamboo is known to have superior energy conservation properties as compared to conventional building materials. Insulation properties of bamboo in construction industry makes the building more eco-friendly.Charcoal obtained from pyrolysis of bamboo biomass is known to possess high surface area and better absorption properties than wood charcoal (Bardhan, Fathima, Mohan, & Pant, 2014). This makes it beneficial for various biomedical applications. Bamboo charcoal coated with nano-particles spinel ferrite ($Ni_{0.5}Zn_{0.5}Fe_2O_4$) spinel ferrite, forming a core- shell structure, and introduced into epoxy resin was found to be a microwave and Infrared energy absorber. Bamboo charcoal's amalgamation with long with silver nano-particle resulted in microwave absorption properties in 2-18 GHz. Bamboo is recognized as one of the most popular bio-resources, capable of adsorbing toxin in blood as well, and hence is useful in blood purification process. It has been reported that the effectiveness of bamboo charcoal for removal of Ciprofloxacin, which is largely available in pharmaceutical industrial waste. The adsorption capacity of this charcoal was found to be 613 mg/g which is much higher than the charcoal obtained from other sources (Chou, Chen, Lin, Lu, & Wu, 2015). Growth of S. mutans reduced by 58% on bamboo charcoal medium (Concentration: 2% and 5%). Studies found that the there lies high antibacterial efficiency of bamboo silver composites. With 18 hours of inoculation, bacterial colonies of Gram-positive Staphylococcus aureus were found to be completely killed and a complete reduction of bacterial growth can be initiated. In addition, above mixture showed strong antibacterial properties against CRPA, E. coli and E. coli JM109, and B. subtilis bacteria.

The roof tops spread with bamboo based charcoal can be maintained with lower temperature compared to non-green roof tops. Comparison of heat fluxes of conventional roof tops and bamboo charcoal roof tops showed that 10 % reduction in temperature during summer months. Contrary to conventional buildings, heat balance for the greening area during the day and night were found to be negative and positive. To improve the conversational efficiency of Dye-sensitized solar cell (DSSC) using bamboo charcoal and titanium dioxide and bamboo charcoal composite are mixed using dry mixing method and are applied to the working electrode of DSSC. Appropriate choice of mass ratio of this mixture, can provide electrode the maximum conversational efficiency than conventional methods (Chou, Chen, Lin, Lu, & Wu, 2015).

Bamboo Industry and its Economic Prospects:

Bamboo is very eco-friendly to the environment which does not harm our environment like timber products and plastic products. Assam has the highest number of bamboo as a local resource. Amongst various variants of bamboo, the most commonly found bamboo is Jati bamboo which is a local name of a bamboo species and is utilized for production of bamboo wood products. As a result it gives an economic benefit to local farmers in cultivation and harvesting of bamboo for generating more income and provides an opportunity to the local human recourses in getting employed in the manufacturing unit of bamboo wood industry. Bamboo wood products are the alternative the timber and plastic products which are harmful to our environment. To produce timber products it is required to cut down the trees and these activities results into the degradation of our eco-system and on the other hand plastic products are non-degradable products for which bamboo becomes the best alternative products for building materials and day to day used products. New business unit can enter into this industry of manufacturing bamboo wood products which has a high market potential. The demand for bamboo wood products are increasing in the market of Assam as a result of a single manufacturing unit the demand is unfulfilled. The qualities of the products are very high and standard in comparison to timber and plastic products and the durability of the products is for a long period of time. The utilization of bamboo as a way to earn livelihood can also lead to the generation of employment opportunities if the young and aspiring minds get attracted towards the entrepreneurship activities in the North-East Region of India. Encouraging entrepreneurial activities in the bamboo industry leads to the substitution of the age old pollution generating wood industries which can not only protect the environment but can also improve the economic status of the people of the region. Promotion of cane and bamboo technology and its effective implementation can gradually encourage its uses

and will be able to capture both the national as well as international markets. The products of the cane and bamboo industries can also be used as a good source of earning for a nation by increasing exports to others nations of the world.

Conclusion:

Though, timber was recognized as the root of human civilization and settlement with abundant forest reserves all across the glove. But over the period of time with increasing amount deforestation, there is a world-wide movement towards reduction of the use of timber and prevention from the process of deforestation. Assam has also lost a significant amount of forest cover over the years and as an alternative to timber, plastic has come to the forefront lately but it has also drastic impact upon the environment which is a direct threat to our sustainability. Under such circumstances, bamboo wood serves as a perfect alternative with similar durability and comfortability. Promotional measures and dedicated investments in this sector will not bring rich dividends but also direct us towards sustainable economic development. Prospects of bamboo utilization as material of future are bright. Traditional uses of bamboo include building and construction as well as paper industry. Handicraft and furniture industry also rely on bamboo as major raw material. In modern houses, green housing, roof top based on bamboo can be developed to reduce the load of electricity. Recent studies show the potential of bamboo based charcoal composites are associated with high surface area and absorption properties. Their utilization in water purification and treatment of pharmaceutical wastes are under the stage of development.

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