

DESIGN INNOVATION AND INDUSTRIAL UTILIZATION OF BAMBOO: A PROSPECTIVE BASE OF INCOME FOR RURAL LIVELIHOODS

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Abstract- Bamboo is an evergreen and multipurpose plant with a long history of human interaction. It's incredibly ubiquitous, has a global reach, and is used for anything from toothpicks to garments and home construction. The bamboo industry is critical to local economic development and, as a result, to farmers' livelihoods. Development of the bamboo sector, particularly in a few economically challenged places, could be a useful approach to alleviate poverty. Bamboo is a significant forest product that is incredibly important as a source of income for the country's forest-dependent rural population. Bamboo plantation on private land and exploitation of the product has been a common activity since ancient times and is recognized as a vital source of revenue for marginalized and landless people. Bamboo, because of its growth habits and biological qualities, is not only a great financial investment that can be used in a variety of ways, but it also has a huge potential for addressing a variety of environmental challenges that the world is currently dealing with. Weaving various varieties of bamboo items specialized in ancient as well as modern market need, commerce, and use of earned

money to uplift the family's maintain was found to economically empower skilled impoverished people. Because of the changing environment, traditional bamboo handicraft knowledge and abilities are not being passed down to the next generation. The current review examines the importance of bamboo in terms of food security, economic success, and environmental security, as well as future prospects.

Key words: Bamboo, biodiversity, forests, livelihood, poverty, rural communities, rural livelihood.

INTRODUCTION

Bamboo especially, has become a favoured non-lumber forest item since it is utilized by country networks inside the creating scene for food, building materials, cash monetary profit, furniture, and artworks (Souvanpheng et al., 2008). Bamboos are encountering expanding pressure due to the developing total populace and rising expectations for everyday comforts. Bamboo is that the most imperative non-wood woodland item and in India it's alluded to as the 'helpless man's lumber' though in China, it's the valuable crude material for the flourishing bamboo business (FAO, 2005).

Poverty is characterised by a scarcity of financial means and the ability to maintain a stable living situation. Hunger and deficient disease are examples of its expressions, as are limited access to education and other essential services, social prejudice and exclusion, and a lack of participation in decision-making. To provide property jobs and promote equality, the economic process should be inclusive (World Bank, 2015). Developing methods to improve economic conditions and plans for long-term development, particularly in rural areas, could be a huge issue for many governments around the world (UNDP, 2015a; UNDP, 2015b). The viable management of forest resources and non-timber forest products is embodied in a number of these (NTFPs). As rural populations continue to grow, so does the demand for forest products and the need for forest-dependent people to generate income. Non-timber forest products are being considered by a number of countries as a potential source of revenue to help support rural livelihoods (Xiaoali, 2006)

Dring the last 15–20 years, bamboo has created as an outstandingly important and inconsistently predominant substitute for wood. Bamboo-based boards and sheets are arduous and durable and ought to with progress substitute for hardwood items (MCI, 2013). It's almost replacement wood in a few mechanical applications and in this manner saving and re-establishing the world's backwoods. It's conjointly a genuine development material in a few nations, altogether in rustic zones since it is utilized for practically all components of homes, just as posts, rooftops, dividers, floors, pillars, supports and fences. Individuals conjointly use bamboo to supply mats, bins, devices, handles, caps, old toys, instruments and article of furniture likewise as inside the food area, any place bamboo shoots are a delicacy.

Bamboo includes a colossal potential for monetary and natural turn of events and worldwide exchange. Its capability to lift expectations for everyday comforts is being perceived, with numerous nations working to look out ways that to use bamboo assets for property advancement. This may most likely add enormously to the farming economy by and large and go about as monetary condition alleviator for the rural poor especially through the interaction and offer of bamboo items (Souvanpheng et al., 2008). Bamboo has a few little anyway fundamental uses like casting poles, woodwinds, fishing traps, handiworks, strolling sticks, pressing cases for tea and natural products, confines for poultry, pipes for establishment and water system, supports, truck burdens, bullock trucks, stepping stools, winnows and sieving for cleaning grains (Das, 2002).

In India, the horticultural populace is with respect to 68% of the nation's complete populace and a major a piece of its stricken by the timberlands for meeting the prerequisites of fuelwood, grain, little wood, bamboo and NTFPs. The domesticated animals populace inside the nation is one in all the greatest inside the world. According to the Census 2011, there are in regards to 6,50,000 towns inside the country, out of that almost 1,70,000 towns are set inside the closeness of woods regions, they're typically named Forest Fringe Villages (FFVs). Backwoods assume a vital part inside the financial and social existences of individuals occupying these towns. They have been contingent on the woodlands for fuel wood, feed, lumber and bamboo since ages anyway with the complex increment inside their populace in the last sixty to seventy years, tension on timberlands has conjointly increased inside the moreover way. In this way, likely a genuine driver of hindrance of backwoods usefulness remains un-assessed and doesn't stand out enough to be noticed of strategy producers and woods directors in light of absence of data (ISFR, 2019).

Madhya Pradesh has the most total removal of bamboo from forests by persons living in FFVs, followed by Chhattisgarh and Gujarat. Andaman and Nicobar Islands have the most bamboo removal per capita per year, followed by Chhattisgarh and Dadra & Nagar Haveli.

Bamboos are one among the speediest developing perpetual plants inside the world. They have a place with the Poaceae (Graminae) and are found inside the inside the tropical, sub-tropical and sensitive mild districts of the world. Bamboos are conveyed normally in plenitude in East and South-East Asia and Islands of Pacific and Indian seas. According to Food and Agriculture Organization report (2007), there are concerning 1,200 species in 90 genera around the world. Dissemination of bamboo is lopsided and generally relies upon ecological condition factors like precipitation, temperature, elevation and soil conditions. Monstrous plots of regular bamboo timberland are found in tropical Asian nations somewhere in the range of 15° and 25° North scopes. In India, bamboo develops normally for all intents and purposes all through the nation besides around there.SSSSS

India is purportedly home to concerning 125 endemic and 11 outlandish types of bamboo from 23 genera. Bamboos happen in plenitude inside the deciduous and semi-evergreen woods of the North-eastern area of the country and in this way the tropical moist deciduous woodlands of Northern and Southern Bharat. The key bamboo genera found in India are *Arundinaria*, *Bambusa*, *Chimonobambusa*, *Dendrocalamus*, *Dinochola*, *Gigantochloa* and so forth. The North Eastern States and West Bengal represent over half you care for the bamboo assets of the country. Other bamboo prosperous zones are the Andaman and Nicobar Islands, Chhattisgarh, Madhya Pradesh and the Western Ghats. Bamboo contributes significantly to the social, financial and biological improvement of any locale. It is a generally utilized plant and adds to resource wants of every 2.5 billion individuals. Bamboos are an imperative piece of the resource economy in giving keep to the tribals, woods inhabitants and elective networks. It is estimated that over two million traditional artists in India rely almost solely on the harvesting, processing, value addition, and sale of bamboo products such as baskets, mats, and handicrafts. The adaptability of bamboo allows small entrepreneurs to create a variety of products with little to no initial investment (ISFR, 2019).

In spite of the fact that bamboo happens in practically each State of the country, its dispersion and focus fluctuates principally due to the climatic and edaphic conditions. *Bambusa* and *Dendrocalamus* are the species found in tropical conditions, while *Arundinaria* and its partners happen inside the mild locale and are normal on high heights inside the Western and Eastern Himalayas. *Dendrocalamus strictus* is that the prevalent types of the dry deciduous timberlands, while *Bambusa bambos* flourishes inside the clammy deciduous backwoods. *Giganto chloarostrata* is that the most indispensable bamboo species inside the semi evergreen woodlands of Andaman Islands. The financially significant bamboo types of the Eastern and the north-eastern India are *Bambusa tulda*, *Dendrocalamus hamiltonii* and *Melocann abacciferra*. Bamboo is fit for flourishing in partner outrageous fluctuates of climatic and edaphic conditions. With its wide dissemination, Bamboo conjointly assumes a fundamental part in carbon sequestration, bio-variety and soil wetness preservation. Their biodiversity as far as size, being light-weight anyway solid, hard, straight and anyway adaptable, fast development and plenitude, makes them manageable to flexibility of employments (Saigal et al., 2002). The actual related natural properties of bamboo make it an uncommon financial asset for a decent scope of employments and for monetary easing. It's an imperative non-wood woodland item utilized in making customary and fine quality paper, furniture, flooring, painstaking work, strolling sticks, casting rods and so on. Youthful bamboo shoots are utilized as vegetables in a few cooking styles. Bamboo stems might be go various approaches to be utilized as lines in diverting water (Kelchner, 2013). Crude leaves of the numerous bamboo species are an inventory of grub for cow-like. The main stems of bamboo are utilized as boards for homes and pontoons, though each gigantic and little stems are lashed along to make the

frameworks at building destinations. Bamboo is in this way, alluded to as Green Gold, helpless man's lumber, support to final resting place wood and so on the Govt. of India, in an incredibly milestone drive, has distributed the Indian Forest (Amendment) Ordinance, 2017 to exclude bamboo full-filled in non-timberland zones from the meaning of tree, by revising the Section two (7) of the Indian Forest Act 1927 and in this way shedding the need of felling/travel take into account its vehicle and monetary use. Prior to this change, the felling and travel of bamboo full-developed on woods yet non-backwoods land pulled in the arrangements of the Indian Forest Act, 1927. This was a critical hindrance for bamboo development by ranchers on non-backwoods land. Significant target of the change is to advertise development of bamboo in non-timberland territories to acknowledge twin destinations of speeding up the pay of ranchers and conjointly expanding green front of the country.

Table 1. Market demand of bamboo in various applications (India)

| Bamboo item | Market size, 2003 (Rupee Crore) | Market potential 2015 (Rupees Crore) |
|--------------------------------------|----------------------------------|--------------------------------------|
| Shoots | 5 | 300 |
| Timber substitution | 10,000 | 30,000 |
| Ply board | 200 | 500 |
| Ply board for truck, railways | 1000 | 3400 |
| Bamboo Mat boards | - | 3908 |
| Bamboo Flooring | 100 for export, 100 for Domestic | 1950 |
| | | |
| Pulp | 100 | 2088 |
| Furniture | 380 | 3265 |
| Scaffolding | - | 861 |
| Housing | - | 1163 |
| Road | - | 274 |
| Miscellaneous (pencil, matches etc.) | 394 | 600 |

At the national level, the total number of culms is predicted to be 39,454 million, with green sound, dry sound, and decayed culms accounting for 74.41 percent, 17.14 percent, and 8.45 percent, respectively. The size class 2-5 cm supplied the most culms (38.67 percent). In comparison to ISFR's 2017 predictions, the overall number of culms has increased by 11,351 million.

1. Bamboo resource utilisation: a biophysical and ecological description

Bamboo is a member of the grass family, which includes about 90 genera and over 1200 species with a unique rhizome-dependent structure (FAO, 2005; Soreng et al., 2015). These can be found in a variety of climate zones in Africa, Asia, Australia, India, and the Americas (Newel, 2004). Bamboo forests occupy almost 4% of the world's total forest covering, with an estimated size of 37 million hectares (ha) (FAO, 2014; FAO, 2015). Some species are also known to thrive in Europe and North America's fragile temperate zones (FAO, 2005; INBAR, 2015a).

Natural bamboo forests in India are estimated to cover 10.03 million hectares, with northeast India accounting for almost two-thirds of the total bamboo area (INBAR, 2015a; INBAR, 2015b). Bamboo pulp accounts for 35 percent of the total bamboo extracted, while housing and rural usage each account for 20%. (Basky, 2013). In the Philippines, bamboo is assessed to differ between 39200-52700 ha with 20500-34000 ha put in backwoods lands, 2236 ha on government manors, 3037 ha private estates and 13434 ha framing common stands in private terrains (regular bamboo stands developing occasionally or in patches in patios and riverbanks among private grounds) (PCARRD, 2011). Bamboo inside the Philippines, is utilized essentially by country families for fencing, direct straightforward furnishings, horticulture and basic family devices (PCARRD, 2011).

Africa has around 43 types of bamboo covering about 1.5 million hectares (MCI, 2013; Xioali, 2006). Forty of those species are principally dispersed in Madagascar though the leftover 3 species are found in territory Africa. Ethiopia has more than 1,000,000 hectares of good country and marsh bamboo assets. The inclusion of swamp bamboo is assessed to be 1,000,000 ha, while high country bamboo inclusion is assessed to be 300000 ha (Kelbessa et al., 2000; Tinsley, 2014). This proposes with respect to 86 of the African bamboo asset is found in Ethiopia any place it is a resource material for provincial networks. Rustic people are generally stricken by crude bamboo for development, fencing, family household item, family utensils like cups, local lines, and vessels for conveying and putting away, and as a stockpile of homegrown energy (MCI, 2013; Xioali, 2006). predictable with a study directed by Kelbessa et al., (2000), an expanding scope of families are understanding the monetary capability of bamboo development and these families have started to develop bamboo around their estates. Cultivation is mostly for the operator's personal use and as a source of additional revenue, as there is only a very small local market for bamboo handicrafts that is neither developed nor organised (Kelbessa et al., 2000; Tinsley, 2014).

2. Bamboo for ecological security

Bamboo with its huge ecological benefits alone is quickly changing into over simply a poor man's timber. In recent time, bamboo is additionally seen because the 'wonder plant' of the twenty first century (Kalaiarasiet *al.*, 2014). It remains as an ideal animal varieties fit for accomplishing eco-reclamation of corrupted grounds, protection of soil, wet and giving monetary security besides (Swamy, 2011). It will alleviate the tension on regular woods besides as contribute preservation of biodiversity. India has gone through a progression of good and bad times because of the environmental conditions participating in tumult in long periods of irregularity. A few dry seasons in eighteenth and nineteenth hundreds of years are moon-looked by individuals (Gupta and Acharya, 2014). Bamboo has not exclusively being a standard financial yield for North-east district anyway is likewise very much attempted to claim colossal bio-genomic versatility in battling the power of worldwide environmental change. In abused scenes, it will aggregate natural matter, neutralize soil and thusly have turned around soil debasement (Zeng et al., 2006).

3. Economic Potentials of Bamboo

The value of bamboo as a non-timber forest product (NTFP) with significant economic and development potential is widely acknowledged (FAO, 2005; Sounthone, 2009). It is vital to the development of many nations, with more than 2.5 billion people relying on it for survival and livelihood (INBAR, 2014). In 2012, the home-grown commercial centre for bamboo and rattan items in significant assembling nations was assessed at US\$ 34.2 billion, with and extra US\$ 2.5 billion of worldwide exchange bamboo and rattan items (INBAR, 2015b).

In 2008, global exports of bamboo and rattan goods hit a new high of US\$ 2,557 million, but the financial crisis triggered a steep drop of about 25% in 2009. In 2012, global exports of bamboo and rattan goods were US\$ 1,881 million, with industrialised bamboo goods accounting for 29% and bamboo woven products accounting for 25%. (INBAR, 2015b).

The majority of bamboo and rattan products are exported to the world from Asia, which accounted for 84 percent of global trade in 2012, and Europe, Asia, and North America combined accounted for 93 percent of global imports. China accounted for approximately 66 percent of the global demand for bamboo and rattan in 2012, followed by the EU with 11 percent and Indonesia with 9%. The EU, the United States, and Japan are the top three shippers of bamboo and rattan products in the world, accounting for 72 percent of total imports in 2012. Different critical vendors of bamboo and rattan things were Canada, Singapore, Australia, Russia and Korean Peninsula (MCI, 2013). In 2012, the toll worth of bamboo and rattan things from INBAR people to

the planet showed up at US\$ 1,562 million, addressing 85% of the world total, however the import regarded at US\$ a 145 million, that addressed 9% of world imports. In 2012, the charge worth of bamboo and rattan things from Asia showed up at US\$ 1, 597 million, addressing 85% of overall admission cost. It was fully overtaken by Europe, which had a fare cost of US\$ 216 million, or about 14% of Asia's total, or 12% of global fares (Thammanu and Zhang, 2014).

With a rebuilding of the bamboo cycle exchange a few nations round the world, its significance as a NTFP with monetary and improvement possibilities, is acquiring worldwide consideration (Singh, 2012; Soreng et al., 2015). As an illustration in African country, bamboo has improved the existences of numerous thousand individuals and is furthermore getting utilized by these networks to turn around land corruption (IFAD, 2013a; INBAR, 2015a). More than 100 bamboo nurseries are made all through that disturbing 1,000 individuals have gotten preparing during an uncommonly made Bamboo Training Centre that furthermore saw miniature undertakings being found out about. These exercises have made new revenue streams in numerous country regions; any place networks turn out artworks and work areas for neighbourhood schools. Charcoal briquette creation and advertising that produce pay and moderate deforestation utilizes more than 5000 women, a few of them single parents, World Health Organization at present have stable earnings (INBAR, 2015a). In Ecuador, bamboo awards have started assortment of public-private organizations that form article of furniture, ground surface, artworks and development items (IFAD, 2013b; INBAR, 2015a). Over 2000 people now use these models, which have been shared with neighbouring regions in the Northern South American area. These value chains and companies manufacture low-cost, earthquake- and flood-resistant housing, reducing global climate change threats and providing higher-quality housing for low-income communities in coastal and peri-urban areas (IFAD, 2013b).

With over 1,500 documented uses in total (Goyal et al., 2012), it's a permanent and versatile resource that has become notable for its economic and cultural significance in SouthEast Asia, South Asia and East Asia chiefly. The archaeological proof suggests that some 5,300 years past, bamboo had already been accustomed weave baskets, mats and different helpful articles in China throughout period. As compared to 23,000 for steel (mild) (Swamy, 2011) that supports its application as a resilient material against forces created by earthquakes and high rate winds. Further, this sort of construction has been discovered in seismically active regions of India (Vengala and Lindt, 2013).

In totality, bamboo's spectacular growth, environmental, mechanical, and engineering features, as well as its potential for a wide range of valuable supplemental products and applications, make it a critical source for developing a greener economy and manpower, followed by property development.

4. Utilization of Bamboo Resources

Bamboo is a multi-use alternative to timber because of its vast range of applications and high adaptability (Campbell, 2009). This would most likely have a significant impact on the rural agricultural sector in general, as well as provide economic relief to the agricultural poor in particular (IMF, 2008; UN, 2015; Wu et al., 2011). Bamboos will strengthen the country's economy and ease the property development of many rural communities by putting various different economic uses into the bamboo product and product process (Souvanpheng et al., 2008).

Bamboo is changed and versatile with a decent fluctuate of anatomical, underlying and compound properties. It will substitute mechanically and economically not exclusively wood, anyway conjointly plastics, steel and concrete and composite materials in primary and items applications. This is regularly through upgrades in measure advances, item development and thusly the utilization of logical and designing abilities. The assumption is that, bamboo might be an indispensable vehicle for property and far reaching advancement, enlarging monetary possibility, monetary benefit and business, especially in relatively immature spaces of the world. Bamboo is also partner degree eco-accommodating different that might be a material that loans itself just to simple cycle advances (Ravallion et al., 2013). For instance, if extra expanded through the applying of contemporary designing procedures, it very well might be handled into trendy items (designed bamboo). These items may with progress battle with wood items in worth and execution. Utilization of bamboo in composite boards and sheets conquers varieties in quality related with the culms and licenses the get together of homogenized items. Planned bamboo may maybe supplant wood, steel and cement in a few uses (FAO, 2005).

In spite of the fact that the horticultural area actually stays the main customer of bamboo items, from planting to loading of grains, bamboo articles actually have wide use. Bamboo is utilized as an essential structure material in lodging development for 3 fundamental styles of bamboo lodging: customary homes that utilization bamboo culms as an essential structure material, conventional bajareque bamboo homes, inside which a bamboo outline is put with concrete or earth and popular prefab homes made from bamboo covered sheets, facade and boards (FAO, 2005). It's assessed that around the world, more than one billion people live in customary bamboo homes especially in South East Asia (FAO, 2005). These structures are ordinarily less expensive than picket homes, light, durable and seismic tremor safe, as opposed to block or concrete developments. Recent trends of pre-assembled homes fabricated from planned bamboo enjoy certain benefits. For instance, they will be stuffed level and moved significant distances at a moderate cost. They are better planned and harmless to the ecosystem and bamboo materials are wide out there and may be developed for minimal price (INBAR, 2014).

Bamboo has the ability to be used as a renewable energy source (bio-fuel), which could be realised if bamboo is harvested and sold in an environmentally friendly manner. Bamboo charcoal processing could make handling and transportation cheap enough to make it an economically viable small-scale industrial operation. It will also replace fossil fuels as a CO₂ gas neutral source of energy. The forest price can be maintained in each financial term and with relevant diversity by proper management or harvesting of fast-growing bamboo and subsequent replacement with higher-priced plants (Pathammavong, 2007). Bamboo charcoal will supplant the typical charcoal comprised of trees, in this manner diminishing deforestation. In 2009, African nation sent out bamboo charcoal esteemed at concerning US\$7 million making it the most noteworthy common around the world (MCI, 2013). For sure, through pyrolysis, bamboo might be renewed into bamboo oil and gas. Changing the pyrolysis boundaries will alteration the items shares figuring on the point and economic situations. The concentrates contain important parts used in drug items like creams, refreshments and bamboo gas might be utilized as a substitute for non-renewable energy source. Enacted charcoal is utilized as an antiperspirant, purifier, sanitizer, medication, horticultural substance and spongy of contamination and unnecessary dampness (FAO, 2014).

Gradually anyway consistent, bamboo is acquiring significance for being one in every one of the preeminent fundamental inexhaustible normal assets of India as of now. The business sectors for bamboo are blasting with gauges putting the value of industry 25 billion dollars. Once viewed as 'helpless man's wood' is presently being named as Green Gold for its immense natural advantages, for example, reducing tension on tropical woodland along these lines relieving environmental change and controlling deforestation (Goyal et al., 2010). Hence, it is totally worth referencing that the utilization of bamboo is unending and accordingly, it is an essential asset for the provincial individuals of North-East India.

5. Role of bamboo in food security

For food security, production, acquisition, and distribution are the 3 pillars. In the world, particularly in developing countries, it's estimated that regarding 1.2 billion people don't have enough food to fulfill their daily requirements and 2 billion people are deficient in one or a lot of micronutrients (Goyal et al., 2010). Consistent with the report of the year 2005 of World Bank, situation in India is worst. The prevalence of scraggy youngsters in India is amongst the best in the world and is sort of double than that of sub-Saharan Africa. North-Eastern region is well endowed in nourishing crops like vegetables, local rice, buckwheat, flax and lots of a lot of wild pulses. Customarily, underutilized crops are getting utilized by the nearby families to satisfy their necessities. Typically, the food and nutritionary frailty and monetary condition to each country and substantial local area are a direct result of rancher's reliance on barely any incredibly specific harvest and loss of

agro-biodiversity prompting slim food crates (Sahoo et al., 2019). Thusly, bamboo shoot, the ignored products asset, whenever used appropriately, will work with to satisfy the expanding interest for food and sustenance, energy, prescription and mechanical necessities (MCI, 2013). In spite of the fact that it's prominently better-known for its modern use, the work of adolescent bamboo shoots as food which might be devoured canned, new, soured or protected is similarly a lesser better-known truth. Shoots alludes to the youthful, eatable bamboo plant that have newly risen up out of the base. They normally 20-30 cm long with tightening at one completion and weigh around a pound with a sheath covering the shoots. Altogether their weight depends upon area, precipitation, watering and channel conditions, soil ripeness, profundity and sustenance of the dirt, temperature and pH (Choudhury et al., 2011). They are plentiful in starch, proteins, minerals and dampness. Moderately, the substance of cholesterol and fat is found less. Ongoing shoots of species like *D. giganteus* are far more healthfully made and better with higher organoleptic characteristics (Choudhury et al., 2011). The unmatched style and flavour makes the palatable vegetable an uncommon of its sort simply if there should arise an occurrence of foods (Pande and Pandey, 2008). aside from Asian country, there are a few nations any place bamboo gives frames a traditional delicacy among that couple of are Japan, US, Thailand, Nepal, Australia, Bhutan, New Zealand, Korea, Malaysia and Indonesia. Ethnic individuals from Nepal and Bhutan devour it as a pickle or fixing, while in Indonesia, the shoot is else with thick coconut milk and flavour to frame guleirebung and so on and Sikkimese esteem all the more profoundly to burn-through it as non-aged curry known as tama (Choudhury et al., 2011). Along these lines, for taking care of truly expanding human populace, bamboo shoots will totally be used. Conjointly in view of the remedial and nutritional qualities, it'll demonstrate valuable to frame up the dietary inadequacies of micronutrients inside the eating regimen prompting the world food security, wellbeing and hunger.

Due to their pervasiveness, bamboo-packed areas see an increase in plant and animal diversity, as well as an extensive subsurface web of rhizomes and roots. The rhizomes of *Phyllostachys bambusoides*, for example, are said to grow around 3.6 metres per year, but different species can produce a stalk network as large as 1000 m². This network normally binds a 6 m³ supply of dirt against soil erosion, especially on riverbanks and steep slopes. Bamboo's spreading leaves helps to lessen the damaging effects of tropical rainfall on top soil. Its leaf litter, which grows to a thickness of around ten centimetres per year, absorbs the impact of rain on the ground and facilitates absorption and soil moisture retention (FAO, 2005). The difficulties we tend to confront these days are to extra improve and present the employments of bamboo. Since bamboo is that the fastest developing plant on earth and a supportable building material, it might essentially substitute generally good known wood applications while not chopping down whole bamboo forests or ranches. Even better, bamboo ceaselessly

develops once gather while not having to re-plant it. Bamboo conjointly changes over about 35% additional CO₂ into oxygen than a standard tree.

Bamboo protects exposed areas and provides microclimates for growth and recovery of variety. The Atlantic Forest of eastern Brazil is home to the majority of bamboo-subordinate birds and warm-blooded animals. Within the Atlantic Forest, at least 27 species of birds are thought to be associated with bamboo, with some species living almost entirely in large bamboo stands. A few could relocate to various biological systems; anyway rely on bamboo for taking care of and reproducing. *Bambusico lathoracicus*, *Claravis godefrida*, and *Sporophila frontalis* are among the bird species that target bamboo hubs, internodes, and bugs on foliage. A few animal varieties feed broadly on bamboo seeds and don't dwell in bamboo woodlands all through non-cultivating periods (Haemig, 2012). The realized creatures fixated on bamboo are the enormous panda (*Ailuropoda melanoleuca*) and lesser panda (*Ailurus fulgens*) with an eating routine that almost totally comprises of bamboo shoots and leaves. A wide range of vertebrates and birds rest in subordinate associations with bamboo woodlands for example the southern bamboo rodent (*Kannabateo mysamblyonyx*) that lives in forests of *Guaduaan gustifolia* and a couple of presented bamboo species (Soreng et al., 2015). Bamboo even as rattan, will rapidly reestablish corrupted grounds, bring back life to the dirt and reestablish the scene, it's so a pioneer animal varieties for since a long time ago run re-afforestation. By reestablishing debased grounds and woods, engrossing carbon and arrangement energy to tremendous provincial networks, bamboo adds to significant decreases in fossil fuel byproducts. In China alone, the plant is projected to store a serious million tons of carbon by 2050 (INBAR, 2014). Bamboo is so valuable to biodiversity, soil and protection further as environmental change moderation (Sounthone, 2009). The bamboo items we tend to see available now-a-days, are basically a hint of something larger, we tend to foresee that a ton of and a great deal of inventive uses of bamboo can enter the purchaser advertises quickly. Consequently it is an energizing time to live in on the off chance that you are additionally a firm adherent of how bamboo can add to a greener and cleaner climate. We can't change our utilization based economy, however we can absolutely change the assets we use and the manner in which we fabricate our items.

6. Bamboo is both precious and practical

Bamboo, one of the "Four Gentlemen" (bamboo, orchid, plum blossom, and chrysanthemum), is so important in traditional Chinese culture that it's even considered a gentleman's behaviour model. People endow bamboo with dignity, beauty, and plainness because it has qualities such as uprightness, tenacity, and hollow core, despite the fact that it is not physically powerful. Traditional Chinese poets wrote countless poems on complimentary bamboo that is literally metaphorical for those who displayed these characteristics. As per laws, an antiquated essayist, BaicJuyi (772–

846), believed that to be a courteous fellow, an individual doesn't had the opportunity to be actually solid, and anyway he ought to be intellectually durable, upstanding, and perseverant. Indeed, even as a bamboo is empty hearted, he should hold nothing back from simply acknowledge something of benefit and ne'er have vanity or bias. Bamboo isn't exclusively a logo of a courteous fellow, anyway conjointly assumes a urgent part in Buddhism, that was brought into China inside the underlying century. Flesh and eggs were not included in the diet because Buddhist canons forbade cruelty to animals. As a result, the tender bamboo shoot became a healthy alternative. Thousands of years of preparation strategies have returned to be integrated into Asian cuisines, especially for monks.

7. Wonder Bamboo Products

•**Bamboo pulp, paper and cloth:** Bamboo is used in mash, paper, and other products in many bamboo-producing countries, such as India and China. Bamboo paper is very similar to wood paper in terms of consistency. Its radiance and optical properties remain stable, while those of wood-based paper can disintegrate over time. Bamboo filaments have morphological properties that produce paper with a high tear file, similar to hardwood paper. While the tractable solidity is lower than that of softwood paper, the strain strength is comparable to that of both hardwood and softwood papers. Preparing the mash may also increase the standard of bamboo paper (FAO, 2003).

•**Bamboo flooring:** Bamboo flooring is an excellent item with a wide scope of uses and a huge worldwide shopper market. On account of its perfection, brilliance, solidness, high obstruction, protecting capacities, and versatility, it has a few advantages over lumber floors. Bamboo flooring has a smooth common sparkle that saves the regular gleam and class of bamboo fibre. This ground surface bids to the most insightful purchasers in Europe, Japan, and North America (Customs General Administration of China, 2004).

•**Bamboo homes:** From super-deluxe homes to reasonable bamboo homes swollen affected areas, bamboo primarily based architectures are making wonders worldwide. Bamboo living, for example, is developing styles for building bamboo-created homes that are environmentally friendly to the environment, reducing CO₂ emissions, conserving natural resources, improving air and water quality, minimising waste, and conserving electricity. It also encourages safe and healthy living by stimulating subject area style and novice building. Over one billion people are thought to sleep in ancient bamboo homes around the world, especially in Southeast Asia (FAO, 2005). Prefabricated homes built from constructed bamboo have a number of advantages. They will, for example, be packed flat and transported over long distances at a low cost. They are more attractive and environmentally friendly, and bamboo materials are widely available and can be grown at a low cost (INBAR, 2014).

•**Bamboo charcoal:** Bamboo charcoal is made from bamboo via a pyrolysis process. Bamboo charcoal is divided into two types: raw bamboo charcoal and bamboo block charcoal, according to the content categories. Bamboo plant parts such as culms, leaves, and roots are used to make raw bamboo charcoal. Bamboo block charcoal is shaped of bamboo build-up, for example, bamboo soil, saw powder and so forth. Bamboo charcoal has been used as a substitute for wood charcoal and mineral coal previously. It will go about as a fuel, spongy, and conductor. Bamboo charcoal is a superb fuel for exchanging states and grilling. Initiated charcoal is utilized as an antiperspirant, a purifier, a sanitizer, a drug, a horticultural synthetic, and a contamination and dampness retentive (FAO, 2005).

•**Bamboo crafts and furniture:** The bamboo weaving products are renowned for its sturdiness and quality from the past. Several traditional bamboo weavers' happiness to completely different ethnic teams of Asian nation is concerned in creating lovely bamboo handicrafts. There are nearly twenty classes of plain-woven bamboo product in Asia, together with fruit baskets, trays, bottles, jars, boxes, cases, bowls, fans, screens, curtains, cushions, lampshades and lanterns. New techniques of creating bamboo furnishings by laminating the bamboo product have increased the sturdiness and potency of the products.

•**Bamboo shoots:** Bamboo shoots have long been considered a delicacy. Bamboo shoots from over 200 different species will be available for consumption. Bamboo shoots are tasty and nutritious, with a high fibre material. Baked bamboo shoots can be stored in containers and transported all over the world. It is also used as an ethno medicine by many Indian ethnic groups to treat a variety of ailments. The demand for bamboo shoots in India is regarding 4.8 crore and is predicted to grow at the rate of 25% every year annually (Mehra and Mehra, 2007). Though men play a big role in material assortment and promoting of the product, ladies play a key role in producing of product. Ladies even have the contribution in material assortment and promoting of the product. After household work they collect, splits and dried bamboo and store them for time of year once material is in short supply.

Common Bamboo Species with Local Names

Occurs in natural forest

Dendro calamus strictus- Saliabaunsa

Bambusa bamboos - Kantabaunsa, Dababaunsa

Cultivated by villagers

Bambusa vulgaris - Sundarkani

Bambusa nutans- Badiabaunsa

Occurs in natural forest & village lands

Giganto chloarostrata-Bolangi / Pani Baunsa

Thyrosta chusoliveri- NalaBaunsa

Bambusa tulda- Taledabaunsa

Schizosta chyumpergracile- Dangi

Occurs as very few individuals

Dendracalamus giganteous- Dababaunsa

Bambusa striata

Bambusa wamin

Thyrostachy sregia

Engineered bamboo blends the benefits of a natural fibre composite with the advantages of a laminated material, meeting an increasing need for sustainable materials. Large diameter bamboo, which is highly renewable and used for structural applications, is collected every 3-5 years. The raw material can be processed into strips and then laminated onto a board once it has been harvested.

8. Bamboo utilization in Industry

Bamboo chipboard is made from dried bamboo blended in with a specific measure of paste and a waterproofing fixing, framed, and hot-squeezed at a specific temperature and pressing factor. Bamboo shavings are produced using little bamboo culms and bamboo waste. Since the adverse consequences of green and yellow matter on attachment are decreased subsequent to shaving, the following nature of bamboo chipboard is remarkable. Bamboo chipboard is made from plentiful crude materials, and its creation is a savvy approach to support bamboo asset use. Bamboo chipboard is made utilizing a water-dissolvable phenol tar, which has a superior water resistance, a more noteworthy modulus of crack and versatility, and a lower dampness development in thickness (contrasted and wood chipboard). Bamboo chipboard is a sort of material that might be used in designing structure. It is these days generally used to make commonplace substantial shapes. Bamboo chipboard is produced using little measurement and lesser-realized bamboo stems, stem tips, and all bamboo handling extras to improve the utilization proportion of bamboo assets. The creation cycle, which depends on wood particleboard innovation, incorporates moving, cutting, chipping, re-

drying, sticking, spreading, and hot-squeezing. Bamboo chipboard is created utilizing an abundant store of unrefined material. Little bamboo begins from lesser-alluded to species, similarly as the additional items from bamboo cutting on groove land, can be utilized for manufacture. The rough material usage extent for chipboard make is high, with 1 m³ of chipboard being made from 1.3 ton of unrefined material (Shi *et al.* 2006). Bamboo chipboard creation techniques and equipment are equivalent to that of wood particleboard. It is prescribed that bamboo chipboard be made to improve the rough material usage extent and the undertaking's monetary show. Bamboo chipboard made with phenol formaldehyde sap has a high strength and MOE, similarly as a low water degree of consistency. The things can be animated if essential by adding a bamboo window adornment or bamboo mat to the surface. Such things have a huge load of potential.

Compressed wood has been used in various applications since 1865, when the compressed wood producing business started to essentially develop, zeroing in on building and creating the dividers of the main plane utilizing compressed wood (Sen *et al.* 2011). Plybamboo is quickly being utilized as a substitute for compressed wood for divider framing, floor tiles, bamboo mash for papermaking, and fuel briquettes (Makinejad *et al.* 2009). Among the several bamboo-based panels available, Plybamboo is a distinct category. Plybamboo is constructed from laminated bamboo veneers of varied thicknesses. Because thick strips are stiffer, they can only be stretched to cover the blank area between strips under extreme pressure, resulting in a lower MOR and sticking strength. Plybamboo has a promising future in the vehicle, building, and engineering construction industries because its strength, wear resistance, and stiffness are all higher than regular plywood (Mahadevi *et al.* 2012).

Medium Density Fiberboard (MDF) is a dry-shaped board produced using lignocellulosic strands and manufactured tars, for example, urea formaldehyde gum (UF), phenol formaldehyde tar (PF), or isocyanate cover. MDF was at first used financially in 1970, because of progressions in innovation and materials at that point. MDF, then again, is a sort of wood that isn't especially durable and is utilized for products like tables, racks, and capacity that don't need a lot of opposition. MDF can change shape over the long haul, especially on the off chance that it is presented to water and the weight is unreasonable. Most of MDF makers in Malaysia as of now use RW as their key crude material. Because of the development of unlawful logging, bamboo strands are used to make agro-based MDF to investigate elective woods. Every bamboo fiber used to make MDF is required to be remarkable because of the way that there are more than 1250 assortments of bamboo.

Furthermore, novel mixture biocomposites items were created utilizing bamboo strips and wood facade bound with PF tar. The mix of bamboo strips, bamboo molecule, and wood facade creates an even construction with a level and smooth surface, which is

valuable as a novel material for concrete formwork and truck side sheets. Hybridization of bamboo and other normal strands, then again, has become another technique in bamboo advancement. For instance, to fabricate elite composites, bamboo pole was stacked with OPF strands, coconut facade, and bamboo, individually, as shown to produce variety in plan and employments (Suhaily *et al.* 2013; Tripathy *et al.* 2020; Dongre *et al.* 2020).

9. Bamboo product design innovation Aid of Computer Simulation Software

Customary bamboo merchandise is made with obsolete hand-made innovation, have low creation proficiency, and depend on manual handling, so the bamboo structure can't improve fundamentally. Bamboo can be immediately cut and handled when present day creation gear is used in the assembling of bamboo things, and quick prototyping of the item can adequately help the item's creation effectiveness and empower large scale manufacturing. Also, squeezing and joining strategies created by current handling innovation can be utilized to make the shape and state of items that are hard to make utilizing conventional manual cycles, laying the specialized preparation for the improvement of new bamboo item styles, for example, the utilization of squeezing innovation appeared in FIG. This bamboo thing is a design wherein a tremendous bamboo piece is crushed, and the surface inside the bamboo material is kept, and it is an outstandingly appealing hand custom-made enhancement, as can be found in the image. If the item is composed of a single material, its visual appeal will be greatly diminished, resulting in visual fatigue. If the varied materials can be linked together to create a visual distinction, the visual satisfaction in the item may be successfully increased. Bamboo materials may now be gotten together with current metal, plastic, earthenware, glass, and different materials to feature the surface of assorted materials, because of China's grafting innovation. The illustration shows how the expert connecting of the bamboo and glass materials, as well as the bamboo material's surface treatment and the bamboo material's regular surface, may effectively enhance the bamboo material's natural splendor (Lu, 2020) .

10. Prospective base of income in bamboo by rural empowerment with IoT

The Internet of Things (IoT) is a disruptive and real-time technology that has inspired numerous sectors to bring smart and intelligence to the physical world (Kim *et al.* 2020). IoT in the forest offers real-time monitoring of the forest environment in terms of tracking fire incidents, crop health monitoring, continuous vegetation evaluation, and real-time forest logging tracking. The deployment of IoT has become a cost-effective and innovative option for tackling the issues in the forest, thanks to advancements in wireless communication technology and sensor technology. The wireless connection protocol enables the forest's sensory data to be sent to a cloud server for real-time monitoring and analysis of forest operations (Singh *et al.* 2021). The cloud server has the capacity to store sensory data in storage and show it using a Graphical User

Interface (GUI). Sensory data may be used to estimate the source and consequences of change in the forest environment using artificial intelligence and big analytics. We are categorizing the many areas in this study in order to discuss the deployment of digital technology in the forest. The study's categorisation includes the Internet of Trees, the Internet of Wildlife Monitoring, and minor forest products. Because of its capacity to combine various linking technologies into a better living experience for people, the world is heading toward Internet of Things. With its macro-level capabilities, the Internet of Things may lower costs by mass-producing elements such as sensors, making it more operationally sustainable and socially transformable. IoT transforms how we live and provides answers to important issues such as the lack of doctors in rural regions and increased crop losses for farmers. In rural India, the Internet of Things is almost non-existent since firms do not see a market here as they do in metropolitan regions. The Internet of Things (IoT) has the potential to revolutionize rural India by empowering millions of individuals and linking them to the rest of the country. While agricultural technological advancements are not new, the Internet of Things (IoT) revolution in India offers a bright future for agriculture and rural development (Patil *et al.* 2020).

We must collect field data to determine the impact of farmers' actions in the field before suggesting a manual or automated plan for water bamboo agriculture. We also need to look at the link between field data and product quality. This method may take a long time to uncover a consistent trend or pattern. Finally, conversations with agricultural specialists are required to produce many guidelines or rules for the development of an expert system. It is feasible to improve water bamboo farming with the use of IoT technology and an expert system. Despite the fact that the literature suggests a variety of IoT agriculture processes, an IoT system is inherently extremely configurable. However, more integration effort is required to develop the system, particularly when creating outside units (Hamid *et al.* 2019).

CONCLUSION

Rural communities benefit financially from their involvement in bamboo processing, administration, and promotion. Bamboo processing as a source of income or a business venture is largely undeveloped, focusing entirely on handicraft and other household processing, especially in rural areas. As a consequence, various countries should continue to implement administrative initiatives in order to maintain a favourable business environment that capitalises on local and global bamboo market demand. Aside from relying on natural bamboo resources, widespread household planting for local consumption and promotion will help improve rural livelihoods significantly. It'll give sufficient degree towards commitment of unwaged straightforwardly or in a roundabout way through advancing furthermore as creation of crude bamboo and its worth added items along these lines improving the food, monetary and environmental security of the previously mentioned locale. The public authority ought to convince and support to the

ranchers for the enormous scope creation of bamboo in days to come. There is colossal probability of bamboo workmanship ventures in India as there is immense number of immaculate bamboo clusters around there. Hence, it is important to support house businesses and bamboo business people and reveal market association for bamboo products to assist the general public and the country.

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