

Techno-Economic Feasibility of Indian Bamboo as Wood Substitute



Sangeet Baksi
Scientist-F



Technology Information, Forecasting & Assessment Council (TIFAC)
Department of Science & Technology
New Delhi

www.tifac.org.in

ACTIVITY profile

Technology Information

- **Technology Market Survey Reports**
- **Technology databases**
- **TIFAC Expert Network database**
- **Patent information**

Technology Foresight

- **Technology Vision 2020**
- **Technology Vision 2035**
- **Technology Roadmaps**
- **Technology Gap Analysis Reports (MSME)**
- **Demand driven specialised reports (Food processing, Biomass, Solar PV, Electric Mobility, Security)**

Technology Assessment and piloting

- **Technology Demonstration Projects in mission mode**
- **Technology Needs Assessment Study (Climate change)**
- **Global Technology Watch**
- **Technology Assessment of proposals for funding**
- **Technology Readiness Level assessment**

Innovation Support

- **TePP**
- **TREMAP**
- **HGT**
- **SRIJAN**
- **Patent Facilitation**

TIFAC Activities: National Imprint



- **Technology Vision 2020 (1996)** released by Hon'ble PM Dr H D Devegowda (Technology trajectory for 17 sectors)
- **Technology Vision 2035 (2016)** by Hon'ble PM, Shri. Narendra Modi
- Report on **Biofuel** facilitated led to **National Biofuel Policy**
- **Seaweed report** catalysed **Pradhan Mantri Matsya Sampada Yojana (PMMSY)**
- **Techno Market Survey Reports (>300)** led to **several Missions**
- **Bamboo project** under ACM led to **NMBA, NECTAR**
- **PURA concept** in 1990s catalyzed the **Smart City** Project concept.
- **MATURE project** of TIFAC led to **JNNURM** programme
- Collaborative Automotive R&D (CAR) led to **NMEM**
- MSME Model was adopted by **PM Task Force on MSME**
- **DPR on NMQM** led to **Rs.8000 Crore ICPS Mission** implemented by DST
- TIFAC report on **Methanol** facilitated establishment of first pilot plant to convert high ash coal to Methanol by **BHEL**, Hyderabad
- **Technology and Policy papers** for containment of COVID 19 surge and also to attain Atma Nirbharta

Why bamboo?

- **Bamboos** grow more rapidly than trees and start to yield within three or four years of planting.
- **Plantation** establishment requires minimal capital investment and builds upon the inherent plant-cultivation skills of local farmers and foresters.
- It has a great capacity for shock absorption, which makes it particularly useful in earthquake-prone areas
- Bamboo is extremely lightweight as compared with hardwoods.
- Bamboo is considered to be a sustainable and renewable alternative to hardwoods, foremost because it regenerates at exceptionally fast rates.
- Bamboo can be smoked in its own resin making its surface impenetrable to insects thereby protecting it from insect infestation.
- The culm and all other parts of the bamboo plant can be used in rural livelihoods - shoots for food, leaves for fodder, and branches for items such as brooms and for firewood.
- Bamboo consumes high quantities of nitrogen and this can help reduce water pollution where it converts waste water into nutrients for its own growth. Bamboo is also desalinate sea water



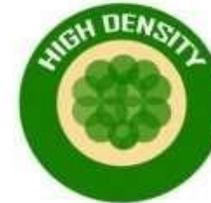
Why bamboo?

- ▶ Bamboo can substitute not only wood, but also plastics, steel, cement & other materials in structural applications through improvements in processing technologies, product innovation
- ▶ The sector has vast potential for generating income and employment, especially in remote areas, and amongst communities, which have tended to be economically and socially disadvantaged.
- ▶ Bamboo and bamboo products are emerging as replacements for building, housing and domestic/agricultural requirements for wood and wood-based products.



Why Bamboo Wood ?

- Eco-Friendly & Green Product
- High Density
- Bend & Wrap Resistant
- Termite & Borer Proof
- Water Resistant
- Fire Retardant
- Acoustic Properties – Wall Cladding



Bamboo as Wood Substitutes

Comparison of Strength Parameters Among Different Materials

Property (kN/cm ²)	Wood	Bamboo	Steel
Elastic modulus	1100-1500	1800-2200	21000
Bending strength	7-12	8 - 28	14
Compressive strength	4-6	6- 9	14
Tensile strength	9-12	15-38	16
Shearing strength	1-2	2-3	9



Bamboo as Wood Substitutes and Composites

1. **Bamboo Mat Based Products** – bamboo products includes the following:

- Bamboo Mat Board [BMB]
- Bamboo Mat Veneer Composites [BMVC]
- Bamboo Mat Corrugated Sheet [BMCS]
- Bamboo Mat High Density Panel
- Bamboo Mat Moulded Skin Board (BMMSB)
- Bamboo Mat Ridge Cap (BMRCS)

2. **Bamboo Strip Based Products** – the list includes the following:

- Bamboo Wood [Laminates]
- Bamboo Flooring Tiles
- High Density Transport Flooring

3. **Bamboo in Round/Split/Composite Form** – the product list includes

- Bamboo Based Housing System
- Bamboo Match Splint





Bamboo Composites & Laminates



Features

- ✓ Excellent value-addition
- ✓ Wood/Timber substitute
- ✓ Innovative resin system
- ✓ Domestic & international market potential
- ✓ In terms of specific strength,
Steel > Bamboo > Timber > Concrete
- ✓ In terms of specific stiffness
Bamboo > Steel > Concrete > Timber.



Bamboo as Wood Substitutes and Composites

Sector-Wise Applications of Bamboo Boards/Laminates:

- ◆ Building & Construction, Interior design: sheds, scaffolding, ladders, roofing, poles and composite bamboo laminates for flooring tiles, panels & partitions, doors & windows, reconstituted wood, etc.
- ◆ Marine & Industrial Applications: vessels, pads for printing, thermal & acoustic insulation
- ◆ Transportation: Bridges, rafts, walk-ways, truck body, partitions
- ◆ Consumer applications: Kitchen tools & dinnerware, furniture, decorative artifacts etc.
- ◆ Agriculture, Horticulture & Sericulture - Shoots, beer, props & supports for horticulture drip irrigation, cocoon trays
- ◆ Industrial Applications - Truck bodies, railway, coach interiors, activated carbon, charcoal, acoustic & thermal insulation



Bamboo as Wood Substitutes and Composites

Advantages of Bamboo Based Boards/Laminates :

- ◆ Bamboo board strength, hardness and intensity are better than common wood board.
- ◆ Can withstand high vapor pressure processes
- ◆ Longer-lasting, long life and strong recyclability can withstand heavy duty use,
- ◆ Waterproof
- ◆ Unable to rust and with a strong lustre.
- ◆ Twice as stable, 25 percent more difficult than red oak and 23 % more difficult than rock maple.
- ◆ Bamboo has no "rays" like those that are found in wood. Rays are locations where food is transported and processed but they weaken the material. This makes bamboo stronger than wood in shear strength.
- ◆ In structural efficiency, bamboo is better than wood



Bamboo as Wood Substitutes and Composites

Bamboo Processing

- ❖ **Harvesting**
- ❖ **De-limbing**-cutting branches from the main culm using knief
- ❖ **Primary preparation**-Cross cutting of the Culm to the lengths required
- ❖ **Secondary Preparation**-extraction of starch from the culm, the reduction of fungal and insect assaults
- ❖ **Primary Processing**-splitting of the Culm to form strips, splits and slivers, as well as the Culm's straightening and bending
- ❖ **Secondary Processing-Bleaching, Dying**
- ❖ **Manufacturing**
- ❖ **Finishing**-. Smoking, to achieve a uniform dark brown texture b, by putting the finished product in an oven



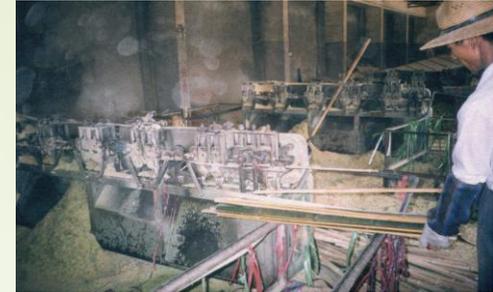
How are bamboo floorboards produced?



1. Bamboos are split into thick section (or sheets)



2. Sheets are coated with adhesive resin



3. Sheets are assembled into units



4. Units are pressed together in a hot press to form floorboards



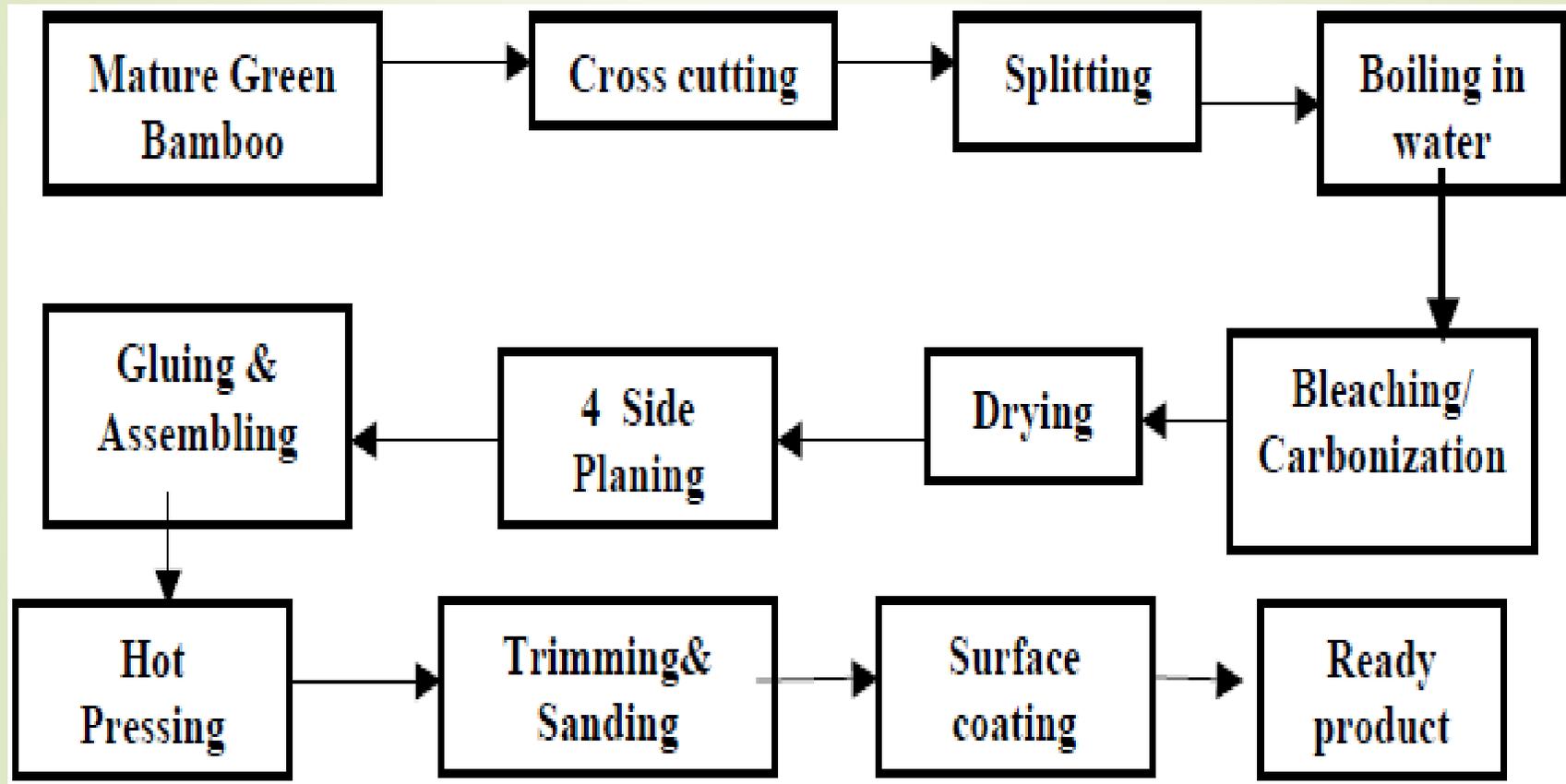
5. Floorboards are sanded and tongues and grooves cut to facilitate board jointing



6. Boards are painted or varnished

Bamboo as Wood Substitutes

Flow Chart for the Manufacture of Bamboo Wood



Bamboo as Wood Substitutes and Composites

Bamboo Housing - There are three major styles of bamboo housing:

- (a) **traditional houses** using bamboo culms as the primary building material;
- (b) **traditional bamboo bahareque houses** with a cement or clay bamboo frame;
- (c) **modern prefabricated houses** constructed of laminated bamboo boards, veneers and panels.

Generally, these buildings are cheaper than wooden houses, light, solid and earthquake resistant, unlike brick or cement constructions. New types of prefabricated houses made of engineered bamboo have distinct advantages.

Traditional Bamboo Roof



Modern Bamboo Roof



Traditional Bamboo Window



Modern Bamboo Window



Traditional Wall



Modern Bamboo Wall





Composites - An Innovative Material for Building & Construction

Composites in Rehabilitation

- **392** shelters (20'x12') made of **jute-coir composite & bamboo mat veneered rice husk boards** supported on steel structure
- **128 FRP toilet units for community use**
- **25 school blocks (24'x20')**
- **15 shops (12'x8') & One Post Office**



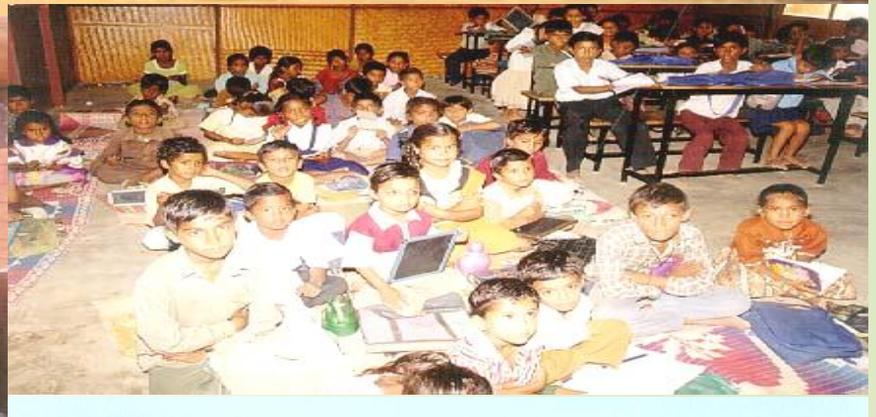


Composites in Rehabilitation

School blocks



Inside view of the shelter



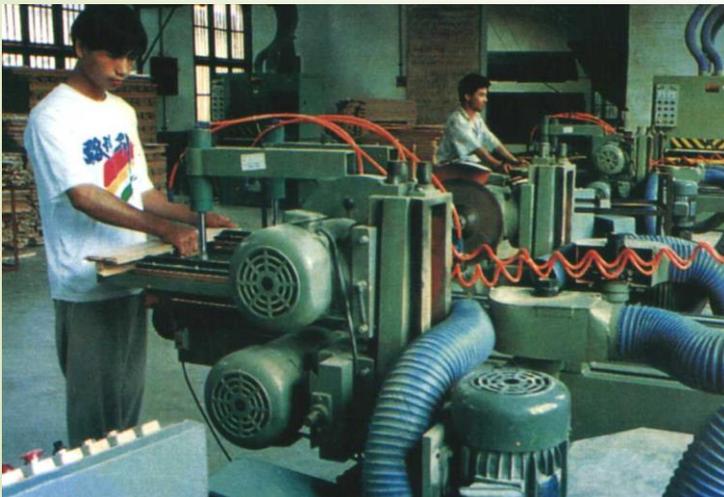
Shops



Modular Toilets

Main development attributes of Bamboo Composites unit

- Reduces dependence on timber resources as wood substitution.
- Permits rehabilitation of degraded lands through increased areas of bamboo plantations.
- Creates employment opportunities for unskilled, semi-skilled and technically-trained staff at the factory and for bamboo growers who will supply the unit.
- Increases community welfare and improves local rural economies if established as a community enterprise.



Cutting the grooves

Bamboo as Wood Substitutes and Composites

Economical Aspects

➤ Cost of Material

Bamboo can be transformed into modern products (engineered bamboo) that can compete in price and performance effectively with wood products

➤ Economic Benefits of Bamboo

- Bamboo cultivation provides an opportunity for rural people to generate income and helps create jobs for small and medium-sized enterprises.
- Bamboo grown communities benefit from services such as homes, roads, electricity, schools, hospitals, and good pipe-borne water. Their livelihoods have improved significantly through these community development projects from these industries.

➤ Policy Changes for Enhancing Use of Bamboo Wood

Bamboo, has immense potential to transform the country's rural / Tribal economy and contribute to the sustainable development efforts of the country. There are severe restrictions on its production, processing and transportation since it is regulated by a complex web of forestry laws and policies.

Regulatory Constraints on Bamboo Sector

Bamboo thus was subjected to a plethora of laws and rules, varying across states. Some states also have separate legislation regulating bamboo grown in private plantations.

There are three central acts regulating the development of trees and forests. The Indian Forest Act 1927, the Forest Protection Act 1980 and the Act on the Recognition of Forest Rights of Scheduled Tribes and Other Traditional Forest Dwellers, 2006

Ecological Benefits of Bamboo

Role of Bamboo in Soil Conservation and Nutrient Flux

- ❖ Improves water retention capacity, and plays important role in improving barren and semi-arid lands and rehabilitation of degraded land by increasing organic matter, nitrogen, phosphorus and potassium in the soil nutrient pool through litter fall
- ❖ Active nutrient cycling and litter production improves soil fertility of habitats.

Role of Bamboo in Carbon Sequestration

- ❖ Bamboo is a significant carbon source and carbon sink,
- ❖ Bamboo converts CO₂ into organic carbon through the photosynthesis process and stores it in its shoot, leaves and in soil
- ❖ Due to its rapid biomass accumulation and effective fixation of CO₂, bamboo can sequester carbon within a very short period of time
- ❖ On a global scale, bamboo keeps its negative carbon footprint only so long as the market for bamboo products continues to grow, placing more bamboo in long-lasting products such as building materials, flooring and panels, etc.

Bamboo Composites

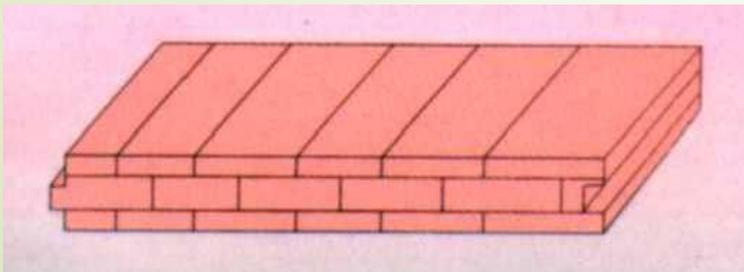
Few Key Issues Which Need Your Immediate Intervention

- Obtaining Forest Permit and Transit Pass for Bamboos
- Need for Effective Regional and State Policies on Bamboo
- Need for Integrated Policy Framework for Promoting Bamboo as Commodity
- Policy on Import Duty on Capital Goods
- Bamboo a Potential Environmental Friendly Material For Housing And Construction
- Skill and Capacity Building and Entrepreneurship

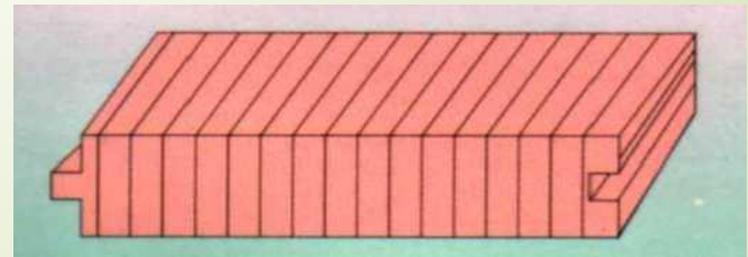


Requirements for success

- Sustained availability of bamboos.
- Inexpensive labour for the factory itself.
- Regular supply of electricity for the factory.
- Start up capital.
- Suitable marketing mechanisms for sale of boards.
- Finally, an innovative approach for improving export market potential of bamboo products.



Horizontal bamboo
floorboards



Vertical bamboo
floorboards

Thank You!

sangeetab@tifac.org.in



www.tifac.org.in