



FONDATION FOR
MSME CLUSTERS



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GRANTS PROGRAMME



An Overview of Bamboo, its different eco-friendly products & business opportunity

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India has been surpassed by many countries in value addition of bamboo products despite its rich resource base. The Government has taken mission-based initiatives in the past, leading to mixed results. A lot of work has been done by various institutions and entrepreneurs who have both succeeded and failed at scale. This book has been written as one document covering all the processes involved starting from cultivation, tissue culture, harvesting, usages, business opportunities, preservation, etc. related to bamboo India under the EU Switch Asia project: “To promote bamboo MSME clusters for sustainable development”.

We are grateful to all the authors and their discussants for their contributions and thoughtful insights, which helped us in structuring and developing this book. We would like to acknowledge the extraordinary debt that we owe to Dr. Tamal Sarkar, Mr. Mukesh Gulati and Mr. Sanjeev Karpe (Bamboo Expert) for sharing their insights about bamboo clusters in India, and also various stakeholders involved, issues pertaining to bamboo, etc. This book would not have been possible without their expertise, insightful thoughts, contribution and support.

We would also like to thank the experts like Mr. Ram Narain Pandey (Bamboo Expert), Mr. Navin Arora (Bamboo Expert), Mr. Selim Reza (Director, TRIBAC), Mr. Gaurav Sharma (Bamboo Expert, World University of Design), Mr. Pratap Goswami (Bamboo Expert) and Mr. Ajith Sen (Regional Director, ESAF) for their colossal support. Without their support, this book would have been an abeyant dream.

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Lastly, we are extremely grateful to the EU Switch Asia for giving us an opportunity for preparing this document under an ongoing project. This opportunity will help in bridging the gap of availability of such compact and complete information about the bamboo sector of India in one compilation.



(Iqbal Ahmed)
General Manager
Foundation for MSME Clusters







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List of Abbreviations

ADEO	Additional District Education Officer
ASRLM	Assam State Rural Livelihood Mission
BDS	Business Development Services
BDSP	Business Development Service Providers
CBS	Copenhagen Business School
CEMCA	Commonwealth Educational Media Centre for Asia
CEO	Chief Executive Officer
CFC	Common Facility Centre
Crs	Community Radios
DC	Development Commissioner
DFO	Divisional Forest Officer
DI	Development Institute
DIE	Deutsches Institut für Entwicklungspolitik (German Development Institute)
DRDA	District Rural Development Agency
DSR	Diagnostic Study Report
EU	European Union
FA	Facilitating Agency
FCRA	Foreign Contribution Regulation Act
FI	Financial Institution
FMC	Foundation for MSME Clusters
GDP	Gross Domestic Product
IBF	Institute of Business Forecasting & Planning
ICAI	Institute of Chartered Accountants of India
IEC	Information Education and Communication
IIE	Indian Institute of Entrepreneurship
IVR	Interactive Voice Response
KYC	Know Your Customer
LCA	Life Cycle Assessment



MEPP	Micro Enterprises Promotion Programmes
MFIs	Micro Finance Institutions
MLA	Member of Legislative Assembly
MoU	Memorandum of Understanding
MSME	Micro, Small and Medium Enterprises
MSME-DI	MSME Development Institute
NABARD	National Bank for Agriculture and Rural Development
NBFC	Non-Banking Financial Companies
NPC	National Productivity Council
NRLM	National Rural Livelihood Mission
OBDA	Odisha Bamboo Development Agency
OHS	Occupational Health and Safety
PD	Project Director
RGVN	RGVN (North East) Microfinance Ltd
SAARC	South Asian Association for Regional Cooperation
SC	Scheduled Caste
SCP	Special Component Plan
SFURTI	Scheme of Fund for Regeneration of Traditional Industries
SHG	Self Help Group
SIDBI	Small Industries Development Bank of India
ST	Scheduled Tribe
TOR	Terms of Reference
TOT	Training of Trainers
TRIFED	Tribal Cooperative Marketing Development Federation of India
TRLM	Tripura Rural Livelihood Mission
WP	Work Package



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Forewords from Shri. Suresh Prabhu

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Forword

Bamboo sector has an immense potential for India. I have been advocating and propagating the development of this sector over the last several decades through different forums, and when I was also a minister across different ministries be it environment and forests railways, commerce, aviation etc. On several occasions where I have been invited for propagating the idea of bamboo development, I have particularly emphasised the potential that this sector has and have made my own contribution in building up and strengthening of organisations like KONBAC and bringing in, Inbar to India. In 2020, I conceptualized the India Bamboo Forum (IBF) as a stakeholder forum of the leaders of the Bamboo sector to bring together stakeholders from across the Bamboo sector to both, spur the replication of their achievements and address the systemic gaps that inhibit the growth of the Bamboo sector, and keep it from holding its place as the driver of the green economy generating exponential livelihoods. Today the IBF has a membership of 70 bamboo sector leaders across the Bamboo value chain; like farmers, foresters, entrepreneurs, architects, designers, contractors, R & D organisations, skilling institutions, academic organisations, policy makers, bankers, machinery suppliers, and primary & secondary producers Our resolve is to provide opportunities to all these stakeholders to come together on one platform to share, deliberate and resolve the challenges faced by the Bamboo sector.

I have also been working on ensuring that bamboo is no longer considered as a forest tree and rather is considered as a grass. I am very happy that our prime minister Honourable Narendra Modi ji acceded to my request and requests of many others who have been working towards this change to free bamboo from the clutches of high degree of regulations and now, that bamboo has been deregulated in terms of its usage, I am very happy that it has led to opening of a large number of opportunities at the national level. Using bamboo as a bio fuel can leads to significant amount of attraction for the farmers to grow bamboo and supply it to thermal power plants. Working in continuation to this, state governments like Maharashtra government has already started and came up with a tender to procure bamboo and other biomass pellets for co firing along with coal. This will make sure that as a country we use more sustainable biomass which otherwise will just go waste and reduce our dependence on unsustainable energy sources like coal which would also help in reduction of our carbon footprints. It is a very useful step in line with honourable prime minister's speech where he stated that by 2070 India will become a carbon neutral country. Bamboo as a resource material can also be used now in making ethanol which is used for blending in petrol and diesel that leads to a reduction in our carbon footprints and thus will reduce our dependence on imported fuels as-well. Besides these usages of bamboo there is also a scope of using it for furniture, artifacts, construction, replacement to plastic, steel, aluminium and other less sustainable materials. However the knowledge related to bamboo material that exists in India is quite limited and I am very happy that Foundation for MSME clusters along with its different partners under the EU funded project have compiled this very enriching document and I am very pleased to release it under my signature and wish that this body of knowledge will be made available to different institutions in our country including our private and public sector stakeholders who are currently in charge of strengthening and building of this sector. Wishing the project and the organisation all its best for picking up this venture which I fully endorse.

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Forewords from Shri. Nagendra Nath Sinha

नागेंद्र नाथ सिन्हा, आई.ए.एस

सचिव

NAGENDRA NATH SINHA, IAS
Secretary



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FOREWORD


Bamboo is a strategic economic and environmental resource. Bamboo plays an important role in providing livelihoods for millions of people particularly those living in the forest fringes across India. The market for bamboo products in the world is expanding in size from local to global. This offers potentially huge opportunities for rural communities to generate income, which can be done in along with protection of the environment.

The Bamboo market size value was around US\$ 52.10 billion in 2021 and is expected to reach US\$ 98.30 billion by 2025. Production of bamboo is only the starting point. The real benefits accrue from value-added products. Handicrafts (mats, baskets, tools, toys, and utensils) and furniture are established possibilities.

In the years and decades ahead, bamboo's economic role is also likely to expand at an accelerating pace — as supply of other forest resources become constrained due to impact of climate change. Further, the imperative to mitigate climate change will impel less dependence on fossil fuels, which this plant may be able to substitute to a significant extent and research may discover new applications for this valuable plant.

I have been a strong advocate for the promotion of bamboo for creating millions of livelihoods and its usage in rural housing. In the pursuit of universalizing livelihoods for SHG members, DAYNRLM has initiated Bamboo subsector interventions. Bamboo is important not only for creating livelihoods but also to mitigate climate change and sequestration of Carbon.

The importance of bamboo is reflected in an old Asian proverb "A man is born in a bamboo cradle and goes away in a bamboo coffin. Everything in between is possible with bamboo". There are about 1500 uses of Bamboo which have been documented. This book throws light on several innovative products made out of Bamboo such as 3-D woven products, bamboo bikes, jewelry etc.



I really appreciate the efforts of Foundation for MSME Clusters for publishing this book on ecofriendly products and business opportunities of Bamboo. This book provides an in-depth analysis of such product and business portfolio. This book will be immensely useful for entrepreneurs, livelihoods professionals and policymakers.

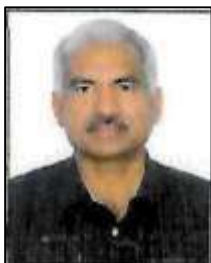
I congratulate the authors and Foundation for MSME clusters for coming up with this book at the most appropriate time.



(Nagendra Nath Sinha)

Forewords from Shri. Manoj Ahuja

MANOJ AHUJA
SECRETARY



भारत सरकार
कृषि एवं किसान कल्याण मंत्रालय

Government of India
Ministry of Agriculture & Farmers Welfare
Department of Agriculture & Farmers Welfare

MESSAGE

Bamboo is a fast growing, durable and versatile natural resource which can be substituted for timber. Bamboo Plantations can not only rehabilitate wastelands/ non arable/ degraded lands but can also play a vital role in improving livelihoods and stimulating rural industry. Bamboo can survive in different agro-climatic zones and types of soils, can also be grown in degraded mines, canal and river banks, on embankments etc. and can be utilized economically by farmers. Bamboo can be grown and cultivated on a wide variety of soil except for rock-strewn soil.

Carbon credit is an additional source of benefit. Farmers can utilize their own lands or community and panchayat lands for this, but it is important that farmers adopt proper harvesting techniques, understand market demand and skilling for pre-processing operations is undertaken. This can lead to higher returns from Bamboo. The new policy for bio fuels and co-firing expands bamboo farmers' market significantly and will lead to increasing in farm incomes while simultaneously fulfilling India's commitment of being carbon neutral by 2070.

However, to achieve this, we need to increase and disseminate the knowledge related to the bamboo sector, its potential and business opportunities available right from the farmer to MSMEs and big industries, I congratulate Foundation for M SME Clusters (FMC) along with its partners, Small Industries Development Bank of India (SIDB I), CEMCA and CBS under the EU funded project to have materialized this in the form of an "open source" document which is easy to read and yet gives an excellent idea about the nuances of bamboo sector, and the various opportunities across different value chains.

I wish FMC and its project partners all the best in this endeavor.

(Manoj Ahuja)



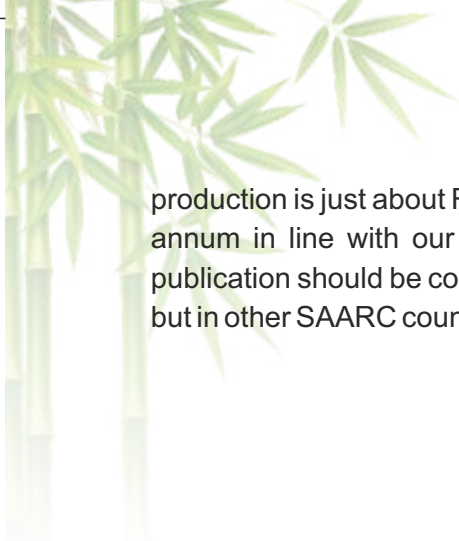
From the Executive Director's Desk

Covid-19 brought a lot of challenges for the Indian economy with serious implications on the implementation of our project: Promote bamboo MSME clusters for sustainable development. However, such calamities are accompanied by both opportunities and new innovations as well. Internationally digitization, work from home, video-based meetings, hybrid systems of working have all evolved and have taken deep roots in the functioning of different organizations. Several organizations have gone one step ahead and made systems of offline and online working in such a manner that their costs have reduced with increase in productivity.

As far as our project is concerned, we were very much concerned as to how our staff will be able to imbibe new knowledge and learnings during the period of lockdown which was quite critical for the implementation of the project therefore, we also shifted and started working on developing of audio-visual communication systems for outspreading information among our colleagues and implementing team. We decided to segregate the entire bamboo sector into various segments of the value chain like tissue culture, plantation, pre-processing, cultivation, harvesting, post-processing, production, marketing, etc. We created 21 modules that we felt might be useful for our knowledge and effective implementation of the project. We had a choice of selecting experts for knowledge rollout through lectures and classroom sessions and the other way was to not focus on teaching but on learning. So, we decided to become students rather than teachers by taking the onus of learning on our own. This is what some universities and colleges nowadays are doing where the focus on teaching is lesser and more time is spent by the students in self-learning mode through Google searches and talking to experts and later compiling the same as a presentation. The entire staff of the project including our then Executive Director, Dr. Tamal Sarkar, our Lead Project Manager, Mr. Iqbal Ahmed, and the implementing team took up earnestly a challenge of picking up 2-3 topics each for building up of their own learning and sharing the same with others. Rather than writing lengthy reports, we decided to compile the information and learning in the form of presentations. We also worked the on recording of all the AV modules. Over a period of 3 months, each one of us picked up one topic at a time and gathered the necessary knowledge by reading about the topic and talking to field-level experts. Every session was roughly for an hour-and-a-half including the question-and-answer session between the attendees, 2 discussants who were supposed to understand the document and a field-level expert. This ensured that the deliberations held were very enriching and based upon the discussions, later the presenter was supposed to make the necessary modifications. The topic-based experts helped by bringing in practical insights that we missed related to the module. Once this exercise was completed, we decided to compile information gathered in the form of a document which could be used by various stakeholders working or planning to work with bamboo. Our experts also felt that this compilation would be very enriching and would be a complete repository of knowledge on bamboo.

We requested the honourable Mr. Suresh Prabhu (Ex-Minister Railways, Civil Aviation, Environment and Forest, Commerce and Industry) for sharing his wisdom through the foreword which we felt was necessary because of his passion for bamboo sector development.

We hope that this document will not only help the bamboo sector stakeholders in India but will also help our neighbouring countries, particularly the SAARC countries which have been engaged with FMC in not only the ongoing EU project but also through SAARC Development Fund-funded project: "Promoting Integrated Bamboo-based Enterprises Development among SAARC Countries-India Component". At the national level, we understand that the bamboo sector ecosystem is still at a nascent stage. The total volume of



production is just about Rs.15,000 crore per annum, whereas it has a potential to reach Rs.1 lakh crore per annum in line with our national policies of “Atmanirbhar” and building up livelihoods. Therefore, this publication should be considered as a contribution for building up the national ecosystems not only in India but in other SAARC countries as well.



(Mukesh Gulati)
Executive Director
Foundation for MSME Clusters



Introduction

India entered into its first lockdown in March 2020 during our second year of implementation of the project. To overcome the issue of not being able to reach the clusters and artisans and to enhance our knowledge, we decided to become self-learners rather than being taught by trainers who themselves were not easily available at that time due to various restrictions imposed by the government. Starting from July 2020 to November 2020, we did 21 online training programmes, covering 587 artisans across 9 states of India. This document is a compilation of our understandings and research work done during those online training programmes.

The document covers chapters on bamboo nurseries, ways of growing bamboo, process of setting up of a bamboo nursery, financial aspect associated with setting up of a bamboo nursery, bamboo cultivation process, bamboo species, harvesting process, challenges in bamboo harvesting, bamboo preservation procedures, various products that can be made through bamboo like jewellery, blinds, incense sticks, quality compliances and financial planning for setting up of a bamboo-based enterprise.

Our intention behind this document is to share our experiences that we gained with all the stakeholders, organizations, microfinance institutes, SBM (State Bamboo Mission) employees and other organizations planning to work on or presently working with the bamboo sector in India and other bamboo-producing nations across the world.

This document contains knowledge (circular economic structure) of various steps involved in the value chain of bamboo sector starting from availability of planting material, plantation, cultivation, harvesting, post harvesting, value-added product manufacturing, and usage of bamboo waste material. Thus, this document bridges the gap of availability of similar information about a country in a single compilation.

This document is not a formally edited document, nor it has the technical certification by experts in each area. The subject-matter experts were most often entrepreneurs themselves who had experience on their side and built up knowledge by learning on the job. Thus, the content of the document needs revisions over time.



Chapter 1 : Bamboo Nursery



Author's Name: Mr. Ashutosh Samal (Technical Advisor, FMC)
Discussant's Name: Mr. Ask Sharma (General Manager, FMC)
Subject-Matter Experts: Mr. Ram Narain Pandey (Bamboo Expert), KFRI (Kerala Forest Research Institute), Growmore; Mr. Navin Rao (Bamboo Expert); and Mr. Selim Reza (Director, TRIBAC)

Topics covered: -

- Different Ways of Bamboo Propagation
- Need for a Nursery
- Nursery across Different Sizes
- Quality Control Aspects of a Nursery
- Different Stages in Nursery Operations
- Species Selection for a Nursery
- Range of Investments required

1. Different ways of growing Bamboo plants

Bamboo is a strong, fibrous plant with a variety of usages. It grows quickly and is relatively easy to propagate. There are three main methods of bamboo propagation. The most difficult method of bamboo propagation is growing it from seed. Most species of bamboo tend to flower and produce seeds only at the end of their lifetimes, if at all, and some species of bamboo can live up to 120 years. Flowering is unpredictable and inconsistent, which makes it challenging to collect seeds. Bamboo seeds have a short life and must be kept under carefully controlled conditions to keep them viable. There are four main methods of bamboo propagation.¹

(Bamboo Propagation, 2020)

Table 1: Different Ways of Growing Bamboo Plants

Methods of Propagation	Part of Bamboo	Ease of Propagation
Seed Based	Seed	Easily propagated and Cost Effective
Rhizome cutting	Underground stem (rhizome)	Moderately easy
Culm burial	Stalk (culm)	Somewhat difficult
Tissue Culture	Tissue	Complicated but effective

2. Why there is requirement of a Bamboo nursery?

Bamboo fulfils twin concerns of livelihood enhancement and environmental protection in rural areas and it is the most frequently utilized material for handicrafts, food and housing component. To provide material benefits and livelihood, there is an opportunity to commercially cultivate bamboo on a large scale. For this purpose, a large quantity of bamboo saplings is required. So, a nursery is a place where bamboo plants are propagated and grown to a desired age in a controlled environment and care. Supply of good quality planting material/bamboo saplings also can fetch a premium price. The raising of a bamboo nursery is quite a labour-intensive work. So, this provides an opportunity to create employment as well.

¹Bamboopropagation.info

3. The process of setting up of a bamboo nursery follows the following steps:

a. Selection of Site

The site of a commercial bamboo nursery is selected keeping in mind that it must have a perennial source of water in the nursery with minimum necessary shade and protection for the saplings, convenience of transportation with minimum damage.

Table 2: Selection of Site

Space for (75,000 Samplings)	Sq. m.
Poly-bag nursery	650
Nursery beds	550
Stock cum distribution	500
Work-shed	27
Poly-house	36
Store cum office	27
Total	1790
15% additional for passage, drainage, etc.	268.5
Grand Total	2058.5
Approx.	0.5 acre

b. Selection of Species

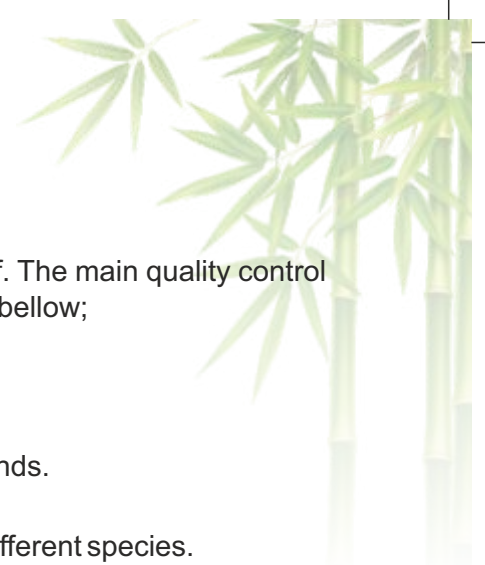
The product choice primarily depends on the market demand in nearby areas and agro-climatic conditions. A list of some popular bamboo species with commercial importance is given below:

- Bambusa balcooa (Veema Bamboo/vulki bans)
- Bambusatulda (Mohali/Taral bans)
- Bambusa nutans (Ropa, Dehati bans)
- B. Bambos
- B. Cacharensis
- B. Polymorpha
- D. Hamiltonii
- D. Asper
- Thyrostachys Oliveri
- Melocanna Baccifera
- Dendrocalamus stocksii

4. Different Nursery Operation:

(As per a paper submitted to October University for Modern Sciences and Arts (MSA):

- Initiation phase:** It concerns the establishment of bamboo plant tissue in vitro by sterilizing the material and initiating it into culture.
- Multiplication phase:** At this stage, the in vitro plant material is re-divided and placed in a medium with plant growth regulators. This process is repeated many times until the number of plants desired is reached.
- Root formation phase:** It involves the introduction of hormones to induce rooting and the formation of complete bamboo plantlets.
- Primary hardening:** At this stage, rooted bamboo plantlets are carefully shifted from bottle to cocopit medium and kept in a fan shed for primary hardening for 30 days.
- Then, secondary hardening** is done for 90 days in polybags containing soil medium of 20% farm yard manure, 40% soil, and 40% paddy husk. Once the bamboo saplings are grown up to 1-1.5 feet, they become commercially sellable.



5. Quality control aspects of a Bamboo nursery:

Since construction and installation, all quality aspects are to be taken care of. The main quality control aspects which are more crucial to produce quality planting materials are given below;

a. Minimum required quality of the soil mix for bamboo cultivation:

- Phytosanitary treatments, using anti-germinative herbicides
- pH of the soil mix must be to an optimum value of 5.5
- During repotting, plants must be protected from direct sunlight and dry winds.

b. General maintenance

- Plants should be orderly and properly labelled to avoid mixing between different species.
- Proper maintenance of equipment, tools and inventories should be done.
- Soil moisture, structures, paths and plots should be periodically inspected.
- Frequent inspection of root and shoot development is required.

c. Pest & diseases control

- Timely inspection and remedial measures for rodents, termites and diseases are necessary for bamboo cultivation.
(UNIDO, 2009)

6. Nurseries across different sizes

Al though there is no proper size of the Bamboo nursery that is defined but according to the different stages of operation and facilities a Bamboo nursery can be categorised as follows:

Table 3: Nurseries across different sizes

Type	Small	Medium	Large
Facilities	» Secondary Hardening » flowering/ ornamental plants (optional)	» Primary Hardening » Secondary Hardening	» Tissue culture » Primary Hardening » Secondary Hardening
Minimum Area Required	» 0.5 Acre	» 0.5 Acre	» 0.75 Acre
Minimum Investment Required	» INR 15 Lakh	» INR 25 Lakh	» INR 75 Lakh

7. Financial Projection

Here is a sample of the financial projection of a medium type of bamboo nursery. It demonstrates limited profitability, if it operates only on one bamboo cycle/year.

Table 4: Financial Projection

Rs. in Lacs

PARTICULARS	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Infrastructure, Irrigation, Fencing	4.23					
Tools & Equipment	0.25					
Planting material & pot mixture	4.50	6.00	7.75	9.50	9.75	37.50
HR & Utility	1.68	1.63	1.72	1.81	1.90	8.74
Labour cost	0.21	0.18	0.22	0.26	0.27	1.13
Total	10.87	7.81	9.68	11.56	11.92	47.36
Unit cost capitalised up to 3 year	28.36					
INCOME						
No. of Sapling Prepared (in thousand)	0	30	45	60	75	210.00
Survival/success rate	NA	80%	80%	80%	80%	80%

PARTICULARS	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Saleable Saplings	0	24	36	48	60	168.00
Sales price per sapling	35	35	35	40	40	
Income from sale of Saplings	0	8.4	12.6	19.2	24	64.20
PV of Benefits	0	7.7	9.72	13.6	15.6	46.62
EXPENDITURE						
Capital Expenditure	10.87	-	-	-	-	10.87
Recurring Expenditure (operational costs)	-	7.81	9.68	11.56	11.92	40.97
Repairs and maintenance	-	-	-	0.38	-	0.38
Total Expenditure	10.87	7.81	9.68	11.94	11.92	52.22
PV of Cost	9.97	6.57	7.47	8.85	7.74	40.60
Net Income	-10.87	0.59	2.92	7.26	12.08	11.98
Present Worth – Costs	40.60					
Present Worth – Benefits	46.62					
Net Present Worth	6.02					
BCR	1.14					
IRR	0.25					

8. Experts Opinion

- Calculations in the aforesaid business plan done are very conservative and for one cycle only. That's why profitability is low in the initial years. The profitability of a bamboo nursery can be enhanced by increasing the sales cycles to minimum 2-3 times/ annum.
- Minimizing the expenditure and identifying the locally available resources/ inputs is very much crucial for the success of a bamboo nursery. For example, use paddy husk instead of coco peat where paddy is largely grown.
- Some other varieties of plant saplings along with bamboo, can be grown and sold like saplings of fruit-bearing plants like guava, lemon, etc. during the rainy season or maybe flowering plants during the winter season.
- There are different varieties of bamboo saplings that can be grown, but it completely depends on the demand and agro-climatic conditions of the nursery, and our focus should be on the profitability of the farmers.
- Management of a bamboo nursery requires certain skills and understandings. The entrepreneurs, who are new to this field, should opt for secondary hardening initially instead of primary hardening to minimize mortality of the sapling. Once they get seasoned, then they can try primary hardening.
- Low-cost tissue culture labs can be started with minimal investment of Rs.5-7 lakh only with a min. 1.5-month training.

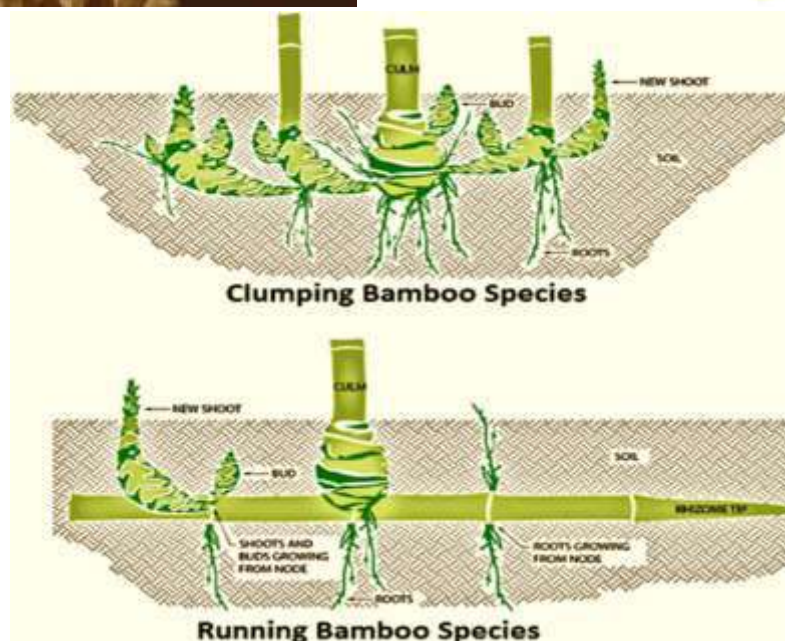
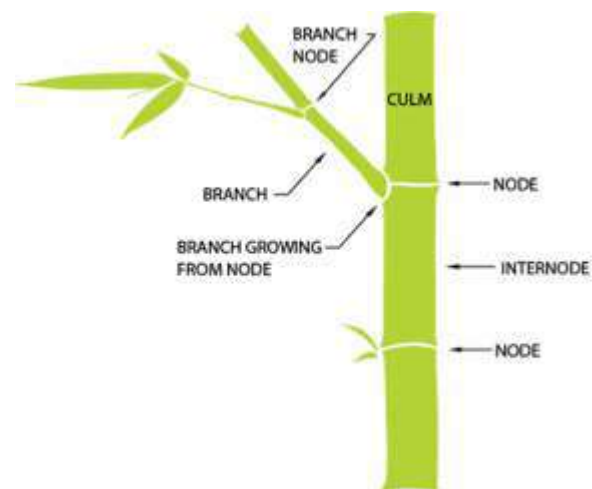
Chapter 2 : Bamboo Cultivation



Author's Name: Mr. Kshitij (Technical Advisor, FMC)
Discussant's Name: Mr. Chandrabhan (Technical Advisor, FMC)
Subject-Matter Experts: Mr. Ram Narain Pandey (Bamboo Expert), KFRI, Growmore; Mr. Navin Rao (Bamboo Expert); and Selim Reza (Director, TRIBAC)

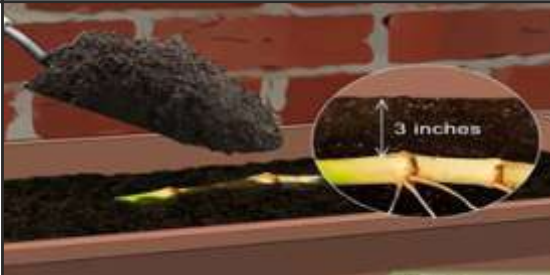
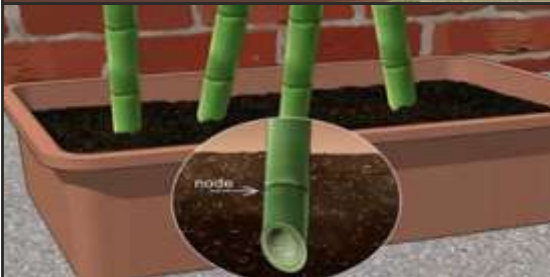

Topics covered:-

- Different ways of plantation of bamboo across different sizes of plot areas
- How to select species for plantation
- Bamboo cultivation process
- Methods of bamboo maintenance. Basics of bamboo harvesting
- Range of investments and finances required in commercial method of cultivation



1. Methods of Bamboo Cultivation

Table 5: Method of Bamboo Cultivation

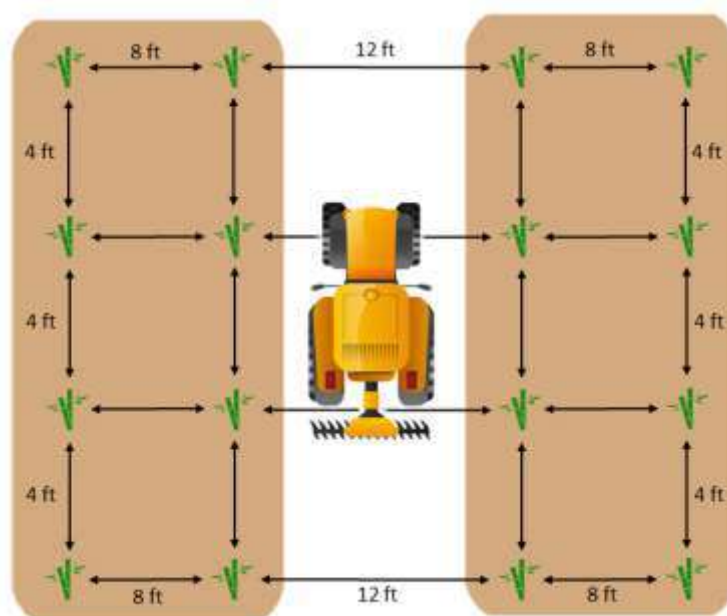
S. N.	Method	Suitability	Picture
1	Rhizome Cutting/Seed sowing	Artisanal/Homestead	
2	Culm Cutting		
3	Tissue Culture	Commercial farming/Block Plantation	

2. Various Models of Plantation

Table 6: Various Models of Plantation

Model	Specification	Distancing in feet	Remark
I	Homestead Bamboo Plantation	12*12 or 10*10	
II	Block Plantation (Farm Bunds)	12*12 , 10*10 and 16*16	
IIIA	Intercropping Plantation (With Irrigation)	6*12 or 9*11 or 15*15	With assured irrigation using drip/flood, the Kharif intercropping can be done in the first year of plantation only. Second year onwards, shade-loving crops like turmeric, ginger, aloe vera, etc. can be grown. Intercropping can be done round the year..
IIIB	Intercropping Plantation (Without Irrigation)	6*12 or 9*11 or 15*15	The Kharif intercropping can be done in the first year of plantation only. Second year onwards, shade-loving crops like turmeric, ginger, aloe vera, etc. can be grown.
IV	Energy Plantation	4*8*12	1,000 Plant / acre Model

3. Layout of Plantation Commercial 4*8*12 Model



4. How to select Species for Plantation:

Table 7: How to select Species for Plantation

S. N.	Distancing in Feet	Variety of Tissue Culture	Per Acre Plants	Average Height in Tropical Condition in Feet	End use
1	10*4	Bambusa Balcooa	1000	25	Industrial Biomass, Charcoal, Bio-CNG, Bio-Ethanol, Vegetable/orchard Stacking, Construction
2	11*9	Bambusa Tulda	450	30	Agarbatti Incense sticks, Vegetable/orchard Stacking, Timber Market, Furniture, Bamboo Lumber, Paper pulping
3	11*9	Bamboosa Nutans	450	35	Biomass, feedstock, Vegetable/orchard Stacking, Handicrafts, Furniture, Housing, Charcoal, Timber market
4	12*6	Dendrocalamus Stocksii	400	20	Construction, Furniture, Agricultural implements, Sticks for Police force, etc.
5	11*9	Dendrocalamus Brandisii	200	40	Construction, Timber market, Strip Board Making units, Agarbatti Incense sticks, Household Units
6	11*9	Bambusa Vulgaris	200	30	Vegetable and orchard Stacking, Paper Pulp, Timber market, Fibre Products, Household Units
7	11*9	Dendrocalamus Hamiltoni	200	40	Vegetable and orchard Stacking, Furniture, Agricultural implements, Paper Pulp, Basketry Items, Village consumption items, Mats, etc.

5. Bamboo Cultivation Process

Table 8: Bamboo Cultivation Process

S. N.	Major Activity	Description			
1	land Preparation	1) Deep Plough and Levelling of land, marking based on Commercial Model			
		2) Pit Digging 2*2*2 feet, Application of 20-25 Kg of FYM/Compost and cover the pit			
		3) Apply Anti-termite solution 0.2% in each pit			
		4) During monsoon, apply DAP, MOP and Neem Khali 50 gm, 50 gm and 200 gm, respectively.			
2	Plantation	Without harming roots, cut the polybag and plant tissue culture.			
		Ideal season is June/July.			
3	Irrigation	1) Commercially, drip should be installed before plantation. One day earlier to plantation land should be wet.			
		2) Immediately after plantation, 20-30 litres of water is required based on season and soil condition.			
		3) After plantation in the first month, water is required in every 2-3 days.			
		4) First year per plant/per day requires 4-5 litres of water; second year requires 8-10 litres of water and in summers it requires up to 20 litres of water per day per plant.			
4	Fertiliser application	Fertilizer requirement in commercial farming of B Balcooa 4*8*12 total of 1000 plants in 1 acre			
		Year	Urea	DAP	MOP
		1	200	55	200
		2	250	70	270
		3	300	90	335
		3rd year onwards, the quantity of fertilizer will remain constant. FYM and vermicompost may also be applied 30 kg/plant 1&2 kg per plant, respectively.			
5	Diseases Management	1) Diseases are rare in bamboo. Blight and rot are the major diseases which infect bamboo plants.			
		2) Blight can be managed by burning affected culm in March and treatment in June/July by Bavastin Dithane and Fytolan.			
		3) Rot can be managed by cleaning all garbage near clump.			
6	Mulching/Mounding and Clump Management	1) To Avoid weed and preserve moisture mulching in around clump should be done.			
		2) To strengthen the culm, the excavated soil should be mounded.			
		3) Clump management by cleaning decayed/dead culm.			

6. Basics of Harvesting

- Scientifically grown bamboo should be harvested only from 4th year onwards.
- Best season for bamboo harvesting is post-rainy season till winter season.
- Bamboo culm should be marked based on the age with different colours.
- The culm should be cut leaving at least 1st node above the ground.
- Not more than 1 internode should be left as the branches will hinder growth of the culm.
- The culm should be harvested using tools/chain saw in 45 degrees to avoid water logging.
- In the fourth year, the harvesting of matured culms(Z) in Y/2 ratio



7. Investment and Financial Analysis

Table 9: Financial Analysis of Bamboo cultivation for six years assumed in 1 Hectare of Land in 4*8*12 model

Table 9: Financial Analysis of Bamboo cultivation for six years assumed in 1 Hectare of Land in 4*8*12 model							
(Rs. In Lacs)							
Particular	Year-1	Year-2	Year-3	Year-4	Year-5	Year-6	Total
Expenses							
Infrastrcture (Trench, Fencing)	1,43,750	-	-	-	-	-	1,43,750
Tools and Equipments-Drip (40% Subsidy)	75,000	-	-	25,000	-	-	1,00,000
Plants - Tissue Culture (2500 Plant)	87,500	-	-	-	-	-	87,500
Other raw Materails-Manure	9,000	9,450	9,720	9,900	9,990	10,886	48,060
Utility	12,000	12,720	13,483	14,292	15,150	16,059	67,645
Labour Cost	37,500	15,000	15,600	45,600	47,424	49,321	1,61,124
Total	3,64,750	37,170	38,803	94,792	72,564	76,266	6,08,079
Incomes							
Selling of Raw Bamboo	-	-	-	3,00,000	4,00,000	4,00,000	11,00,000
Selling of Intercrops	1,50,000	1,50,000	1,50,000	-	-	-	4,50,000
Gross Profit/Loss (Before tax)	-2,14,750	1,12,830	1,11,197	2,05,208	3,27,436	3,23,734	8,65,655
Less Taxes/Mandi Charges/GST @5%	7,500	7,500	7,500	10,260	16,372	16,187	
Net Profit	-2,22,250	1,05,330	1,03,697	1,94,947	3,11,065	3,07,547	

Key Assumptions:

1. Irrigated Land with Drip Installed
2. 1 Hectare of Land
3. Harvesting from 4th year Onwards@30MT/Acre
4. Harvesting from 5th Year Onwards@40MT/Acre

8. Comparison of Species of Bamboo on different parameters

Table 10: Comparison of Species of Bamboo on different parameters

Varieties of Bamboo	Clump Diameter (CM)	No. of culms/ Clump	Culm Diameter (CM)			Internode Length (CM)	Hollowness (CM)			Fibre Length ((μ m)	Culms Weight (t/Ha)	
			Base	Middle	Top		Base	Middle	Top		Culm fresh	Culm dry
Bambusa nutans	587	70	4.6	3.7	2	35	1	2	1.4	17	154	91
Bambusa Vulgaries												
Bambusa Bamboos	347	26	5.5	3.6	1.8	23	1.2	1.1	0.7	17	106	62.2
Bambusa Tulda	320	27	4.9	3.2	1.6	22	1.2	1.5	0.8	17	67	39.1
Bambusa Balcoa	273	204	2.1	1.6	0.8	32	0.5	0.8	0.3	15	39.4	23.3
Dendrocalamus Strictus	365	39	4.8	3.4	2.1	20	0.7	1.8	0.6	25	80	50.3
Range	273-587	26-204	2.1-5.5	1.6-3.7	0.8-2.1	20-35	0.5-1.8	0.8-2	0.3-1.4	15-25	39.4-154	23.3-91

Chapter 3 : Bamboo Harvesting

Author's Name: Mr. Anijit (Technical Advisor, FMC)
Discussant's Name: Ms Miranda Zadang (Technical Advisor, FMC)
Subject-Matter Expert: Mr. Ram Narain Pandey (Bamboo Expert)



Topics covered:-

- Basics of Harvesting, its methods, or practices
- Challenges
- Ages of Bamboo and its uses
- Parts of Bamboo

Kingdom: Plantae

Family: Poaceae

Sub-family: Bambusoideae



1. General Information about bamboo:

- Worldwide, there are 1,250+ species under 75 genera.
- In India, there are 136 species (125 indigenous and 11 exotica).
- India has 13.96 million ha area which is covered with bamboo plantation.

A few salient features:

- Bamboo is considered as a grass and falls under the same family.
- It grows very fast and is considered as the fastest-growing grass on the planet.
- It grows well in humid tropical, sub-tropical and temperate regions.
- It has capacity to regenerate without replanting, if harvested and managed properly.
- It prevents soil erosion through rhizome network.
- It has a high capacity of nitrogen consumption, and also can be used for waste water management. It produces 30% more oxygen comparing to hardwood of same size.

Morphology

- It is monocarpic.
- It is made up of an underground axis and above ground axis.
- Underground axis - rhizome, roots, buds.
- Above ground axis - culm, branches, foliage.
- Buds on the rhizome may develop into shoots that emerge from the soil.
- Each young shoot develops into a culm by elongating vertically.
- Growth of culm completes in one growing season which lasts between 3 to 6 months, depending on the species.
- Culm diameter remains unchanged throughout its lifespan.
- Culm undergoes lignification process, making it harder and woody.
- As a culm matures, it becomes harder and after full maturity, it starts deteriorating and then it dies.
- Bamboo plant is sustained by its rhizome system. Though the old culms die, but the plant generates new culms, till it flowers. Flowering marks the end or death of the plant².

2. Harvesting

Why is Harvesting done:

- To supply quality bamboo to bamboo-based industrial sector units and enterprises.
- To ensure continuous production for a long time. As harvesting helps in increasing the production.

When is bamboo harvesting done:

- During the dry season
- At the time of the year when moisture content and starch content is lowest.

Do's for bamboo harvesting:

- Identify the age of culms
- Mark the mature culms
- Select the culms to the intended application

Don'ts

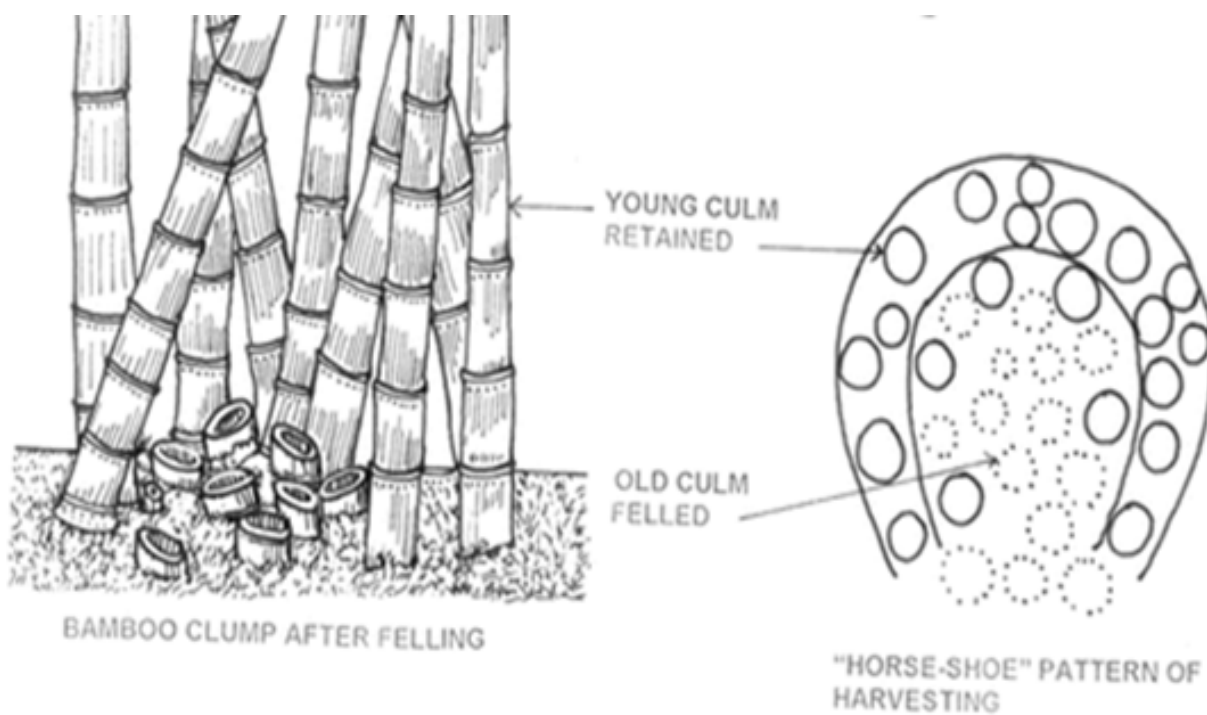
- Harvest during rainy season or growth season
- Damage or expose rhizome during harvesting
- Throw culms on the hard ground

² Understanding the anatomy of bamboo | Green Pot (greenpotenterprises.com)

3. Harvesting Methods & Practices

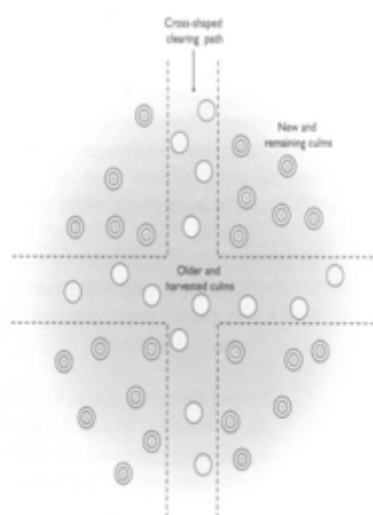
Horseshoe Method

- In a clump of bamboos, new culms are normally cultivated towards the periphery of the clump and the older culms are left in the centre. Harvesting of bamboo therefore should be done from the centre and not from the outer layer of the clumps.
- It is necessary to maintain clumps in the shape of a horseshoe, keeping the apex towards the side where the new culms are growing. The open end of the horseshoe facilitates entry inside the clump for cutting the mature culms.



Cross tunnel Method

- The clump can be managed by creating a cross-tunnel also, which divides the clump into 2 or 4 sections and allows full access for harvesting the mature culms.³



Culm Harvesting^{4 5 6}

- A culm should be harvested only after maturing which happens after 4 years. Small diameter bamboo can be harvested from third year onwards.
- Culms growing on the periphery of the clump and clumps which are less than 1 year old and have less than 6 mature culms should not be harvested.
- Cutting should be restricted to the oldest culms in the centre of the clump.
- All dead and dry culms should be removed.
- Heavily congested clumps may not be salvaged to productive state and should be clear-felled.
- Current year's and one-year-old culms should never be harvested unless in cases where they are curved and twining around other culms or are infested by a disease or insects.
- The number of older culms retained should not be less than the number of current year's culms.
- The new culms which attain an average height of over 10m within the first few months, under suitable conditions, are soft and tend to bend unless supported by mature erect stems of earlier years.
- Rhizomes of the plant should not be dug out.



3 Guidelines for Growing Bamboo By Bernard Kigomo (Based on Guidelines for Establishment and Managing Plantations of Bamboo in Kenya) Revised version by Victor Brias.

4 efrwatertowers.org

5 ripurabamboo.com

6 www.caneandbamboo.org

- Culms should be cut between 45 to 15cm from the ground, but not below the first prominent node above the ground.
- The cut should be in a slanting position, so that water does not accumulate in the protruding internode. The accumulation of water may invite pests and infestation.
- Sharp tools should be used for cutting the bamboo. It is highly advisable to disinfect harvesting tools using bleach before cutting. It lowers the risk of infection in the plants.
- In the case of sporadic or gregarious flowering, all flowered clumps which have shed their seeds should be clear-felled.
- Mulch each clump after harvesting using branches and leaves of harvested culms.
- If the plantation is situated near a river or a water body, the culms may be allowed to soak in water for a few weeks to aid in the removal of starch and protect them from insect attacks. Otherwise, they should be hauled to an area where they are sorted and air-dried. Good practices to enable drying will help minimize losses due to biodegradation of the culms.
- The large culms should be stacked horizontally on parapets where there is good air circulation. Smaller culms may be piled horizontally at a 60° angle to form a “tepee shape” allowing air to circulate around them to aid the drying process⁷.

Shoot Harvesting:

- A bamboo shoot is a young culm harvested at the time, or shortly after it appears above the soil surface⁸.
- The emergence of new shoots begins during the rainy season of the year after planting. These new shoots should not be harvested⁹.
- A small amount of edible young shoots may be harvested in the third year of plantation, i.e., two rainy seasons after planting. Shooting for some species may start earlier than for others. Harvesting of shoots may be done only for well-established clumps.
- At the onset of pre-monsoon rains, check for bumps or swellings on the ground around the clump and beside the culms. These bumps are signs of the emergence of new shoots.
- Shoots of some species may emerge as early as April or May, while others shoot may appear several months later.
- Proper mulching should be done around the clumps to maintain moisture content for proper growth of shoots.
- Shoots should be harvested within one to two weeks after they appear above the ground. Shoots harvested too late will be hard and difficult to eat.
- A new shoot can be 10 to 30cm tall, depending on the species.
- The tender shoot should be harvested using a sharp harvesting blade (resembling a large chisel). The cut should be made about 10cm to 15cm below the soil at the soft section where the shoot emerges from hard rhizome¹⁰.
- Do not cut shoots that have grown beyond the average edible shoot size. These will be fibrous, tough, and inedible and should be allowed to grow into culms.
- Never harvest all the shoots of a clump. Several shoots should be allowed to grow into culms for a healthy clump formation.



7 www.unido.org

8 www.nbm.nic.in

9 www.nce.gov.in

10 www.caneandbamboo.org

4. Major challenges in harvesting

- Identification of mature culms
- Availability of skilled labour
- Geographical differences
- Cost of labour
- Transportation
- Post-harvest management



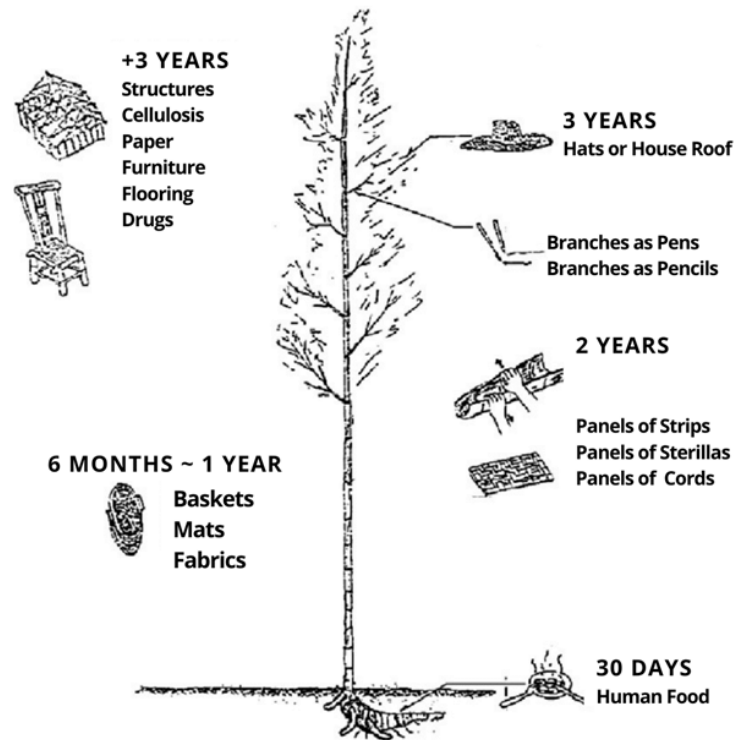
Table 11: Number of mature poles to be harvested after 4th Year

Year	Activity	food	damage	new pole	1 st year	2 nd year	3 rd year	4 th year	5 th year	6 th year	7 th year
2020	Plantation										
2021	10shoots	3	2	5	-	-	-	-	-	-	-
2022	10shoots	3	2	5	5	-	-	-	-	-	-
2023	20shoots	6	4	10	5	5	-	-	-	-	-
2024	40shoots	12	8	20	10	5	5	-	-	-	-
2025	80shoots	24	16	40	20	10	5	5	-	-	-
2026	160shoots	48	32	80	40	20	10	5	5	-	-
2027	320shoots	96	64	160	80	40	20	10	5	5	-
2028	640shoots	192	128	320	160	80	40	20	10	5	5

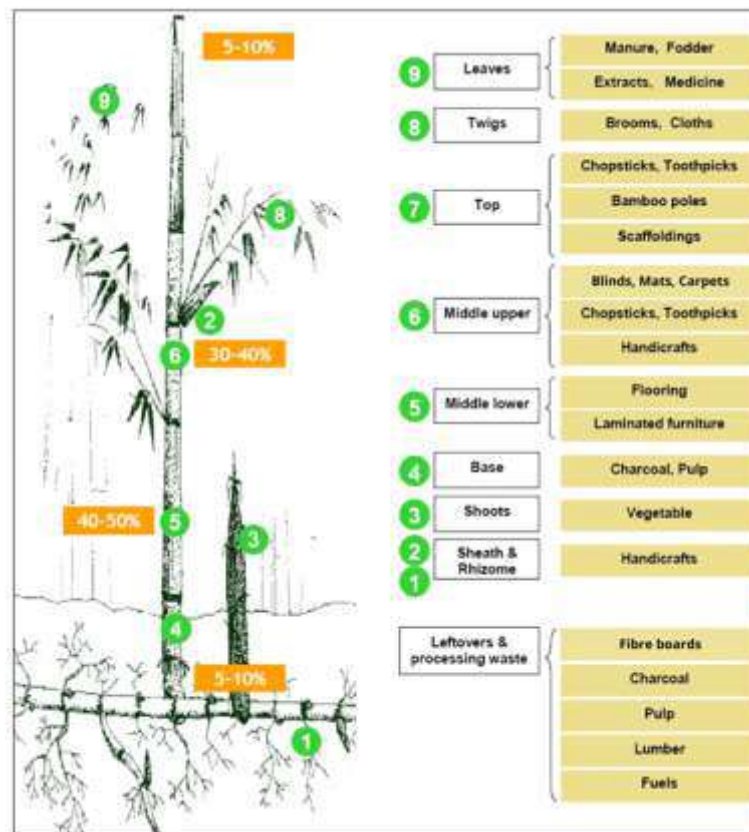
- 3 poles per Clump after 4 years
- 4 poles per Clump after 5 years
- 5 poles per Clump after 6 years
- 6 poles per Clump after 7 / 8 years onwards
- Average of 2,000 Culms per hectare after 7th year of plantation¹¹

¹¹ www.caneandbamboo.org

5. Ages of Bamboo and its uses



6. Parts of Bamboo



Source: Study Presentation by Prof. Zhu, INBAR (2006)



Chapter 4 : Bamboo Preservation¹²

Author's Name: Dr. Tamal Sarkar (Senior Advisor, FMC)
Discussant's Name: Mr. Dilip (Former Technical Advisor, FMC)
Subject-Matter Expert: Mr. Sanjeev Karpe (Bamboo Expert)

Topics covered:-

- Summary
- Harvesting
- Types of treatment
- Pre-treatment
- Traditional Physical Treatments
- Chemical Treatment
- Different Treatment Processes

1. Summary

- Bamboo needs preservation as it is susceptible to fungal attack, insect attack and cracking.
- Prior to treatment, proper harvesting of bamboo is important.
- Pre-processing management is also critical.
- Treatment of bamboo is done keeping in mind its freshness and end-usage which, in turn, defines the treatment methodology to be used that is physical or chemical-based.
- Post-treatment process is also a necessary step.
- Life of preserved bamboo can be 20 to 50 years, whereas of an unpreserved bamboo it is generally up to 2 to 5 years.

2. Need for Treatment

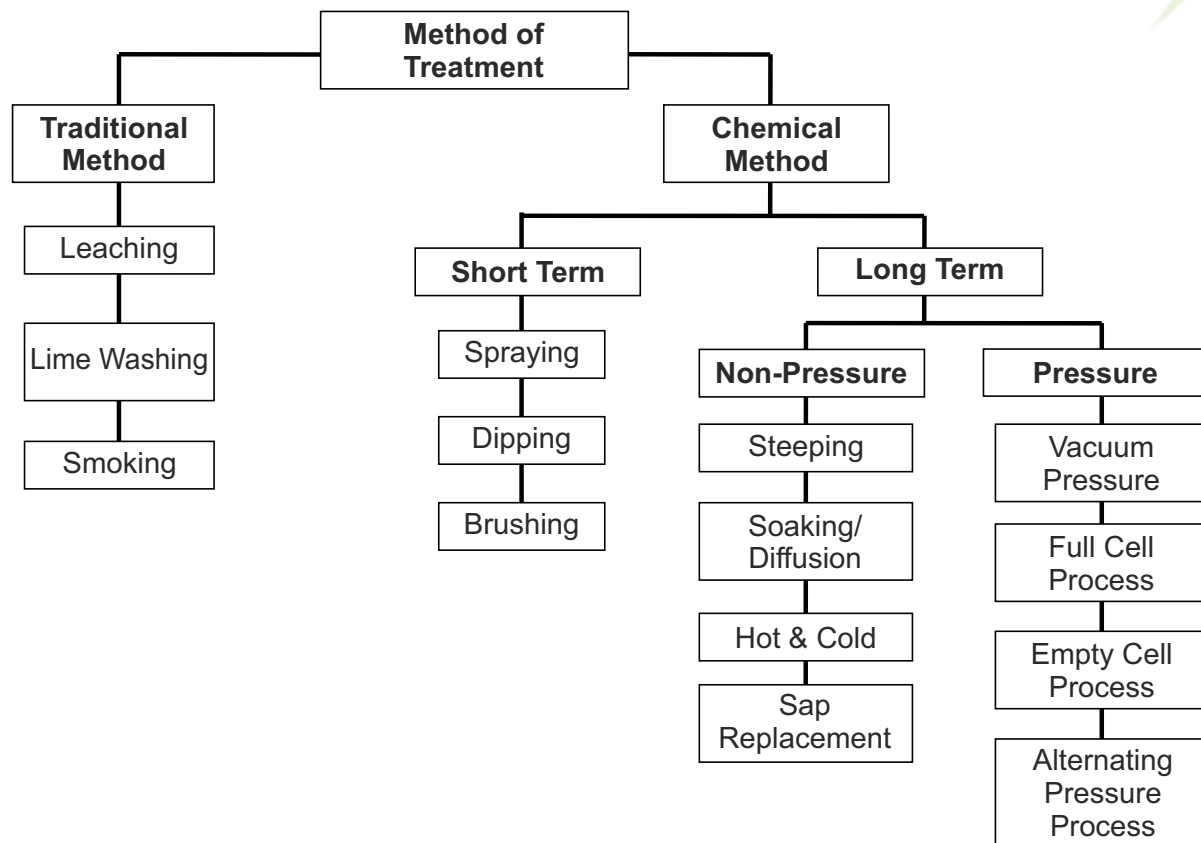
- Life of bamboo without treatment is 5 years.
- Life of bamboo with proper treatment can be 20 to 50 years.
- Treatment stops decay.
- It also neutralizes the possibilities of splits and cracks.
- Probability of strains and blotches also gets reduced.

3. Pre harvesting: Things to be kept in mind

- Rhizome should not be damaged; bamboo culm should be cut between the first and second node or about 15 to 20cm above the ground.
- Immature bamboo culms (ageing less than 3 to 4 years) should not be harvested, unless it needs to be used for woven products such as mats, etc.
- Harvesting of bamboo should not be done in the rainy season as the moisture and starch contents are the highest during monsoons.
- Harvesting should be done during the dry season.
- It is important to mark bamboo culms for their age.
- Mature bamboo culms are mostly inside the clump.
- Harvest healthy culms – poor quality culm gives poor result.

12 This presentation is mostly based on "Training Manual (TM 05 07/06): Preservation of Bamboo National Mission on Bamboo Application"; Technology Information Forecasting, And Assessment Council (TIFAC); Department of Science and Technology, Government of India

4. Types of treatment¹³



5. Pre-Treatment

- Remove branches.
- Cut the culms into sections as per usage.
- Place above the ground on a raised platform.
- Provide adequate ventilation in the storage space.
- These will minimize fungal, pest attacks and cracking.
- Water storage is good if the bamboo is to be processed green.

6. Traditional Physical Treatments

- Leaching: Place in river or water tank (replace water for minimizing fungal and bacterial attack) to leach out the starch. Not an effective solution for long-run usage.
- Smoking in heat chambers or keeping above the fireplace, but it might lead to blackening and/or cracking of bamboo.
- Lime washing – It reduces moisture absorption but does not help in preservation.
- Baking on an open fire: Helps straighten crooked bamboo culms and high temperature destroys the starch and other sugar and kills existing infestations, if any. But it produces tar in the structure and can lead to cracking and/or change in the colour of bamboo as well.
- Natural dyes, varnishes and paints are also applied.

¹³ Timing Manual TM 05 07/06 Preservation of Bamboo NATIONAL MISSION ON BAMBOO APPLICATION Technology Information, Forecasting, And Assessment Council (TIFAC) Department of Science and Technology, Government of India (Page 24)

Table 12: Types of chemical preservatives and solvents¹⁴

S. N.	Combination of Chemical Compounds	Acrony	Nature of fixation	Toxicity
1	Coal tar and creosote	CTC	Chemical	High
2	Copper Chrome Arsenic	CCA	Chemical	High
3	Acid Cupric Chromate	ACC	Chemical	High
4	Copper Chrome Boron	CCB	Chemical	High
5	Copper/Zinc Naphthenate	CZN	Physical	Low (acidic)
6	Boric Acid – Borax	BB	Physical	Low

7. Measuring quantity of chemical required¹⁵

- Q = Quantity to be dissolved in water
 C = Concentration of solution required (8%)
 V = Volume of solution to be prepared (100 litres)
 S = Concentration of salt/paste (95%)
 $Q = (C \times V) / S$

If you have to prepare 8% CCA solution where the strength/ concentration of CCA is, say, 95 and the required volume is 100 litres: $(8 \times 100 / 95) = 8.42$ kg.

8. Treatment Processes

- **Short-Term Impact:** Spraying, Brushing, Dipping
 - **Long-Term Impact:** Non-pressure
1. Butt end treatment (BET): Vertical – capillary action and diffusion make a fresh cut and put in 25cm deep treated solution (7 to 10 days).
 2. Vertical Soak Diffusion (VD): Clean - punch all nodes except last - seal borer holes with wax – place the bamboos vertically in the container – Fill it up with liquid at 300 C (8 to 10 days) – take it out - punch the last node and prepare the solution for reusing.
 3. Horizontal Dip Diffusion (HD): All nodes to be punched - place concrete block on the culms –takes about 7 days.
 4. Hot and Cold treatment (HnC): Diffusion can be done also by using creosote oil and with CTC, Heat at 700 to 800 for water
 5. Cool and drain excess preservatives, ready in 2 to 3 hours, depending on wall thickness – 3 to 4 loads can be done per day.
 6. Boucherie process: Preservative is fed by gravity from a container placed at a higher level than the bamboo through pipes into its base end. The bamboo is fastened to the tubes using rubber sheaths and clamps. The treatment is terminated when all the sap has been displaced by the preservative¹⁶.

¹⁴ Compiled from Free Standard provided by BIS via BSB Edge Private Limited to Mukesh Gulati - New Delhi (mukesh@msmfoundation.org) 49.207.157.122 [for non-commercial use only]

¹⁵ Training Manual TM (05 06/07) Preservation of Bamboo National Mission of Bamboo Application Technology Information, Forecasting and Assessment Council (TIFAC), Department of Science and Technology, Government of India (Page 47)

¹⁶ Presentation by Mr. Sanjeev Karpe, KONBAC, Sindhudurg



Long-Term Impact: Vacuum and Pressure Process

- Empty cell process
- Full cell process: Here a vacuum is again created to eliminate bleeding
- Fast-fluctuating pressure process: repeated vacuums are created.

9. Boucherie and Vacuum Pressure Process¹⁷

1. Empty cell process
2. Full cell process: Here a vacuum is again created to eliminate bleeding
3. Fast fluctuating pressure process: repeated vacuums are created



Boucherie Process



Vacuum Pressure Process

10. Preservatives and Methods of Treatment¹⁸

Applications	Preservative	Method
Structures exposed to weather and in ground contact (posts, fences, etc.)		
Dry Bamboo	Creosote	Hot & Cold
Dry bamboo	CCA	Pressure
Green bamboo	CCB	„
Structures exposed to weather but not in contact with ground - bridges, ladders, scaffoldings		
Dry bamboo	Creosote	Hot & Cold
Dry bamboo	CCA	Pressure
Green bamboo	CCA	Soaking/Diffusion
Structures under cover - rafters, walls, doors		
Dry bamboo	CCB	Pressure
Green bamboo	CCB	Soaking/Diffusion
Outdoor furniture		
Dry bamboo	CCA	Pressure
Green bamboo	CCA	Soaking
Indoor furniture		
Dry bamboo	BB	Pressure
Green bamboo	CCB	Soaking
Handicraft items		
Green/dry bamboo	CCB	Soaking/Dipping
Green/dry bamboo	BB	Dipping

¹⁷ Presentation by Mr. Sanjeev Karpe, KONBAC, Sindhudurg

¹⁸ Training Manual (TM 05 06/07) Preservation of Bamboo National Mission of Bamboo Application Technology Information, Forecasting and Assessment Council (TIFAC), Department of Science and Technology, Government of India (Page 57)

11. Vacuum Pressure Process

1. Bamboo is loaded in the vacuum pressure machine.
2. Vacuum is created.
3. Liquid is poured in the machine.
4. Pressure is maintained at (8 kg/sq cm).
5. Time duration for the process is 30 minutes for pressure and 150 minutes for full cycle.
6. Vacuum created to drain liquid.
7. Bamboo is unloaded.
8. Time duration of 1 cycle is 2 hours/cycle.
9. For 4-inch diameter, 75 poles per batch and for 2-inch diameter bamboo 300 poles per batch for 1.1-metre diameter cylinder.
10. Rates of various species of bamboo are: Rs.30, Rs.50 and Rs.70 for palida, tulda and balcooa, which increases to about Rs.70, Rs.100 and Rs.150 per bamboo due to transportation charges and damage. (prices in 2020).
11. Tank size to be used: 5,000 litres
12. Continuous reuse of water
13. CCB is the preferred choice.
14. CCB cost is Rs.160 per kg (price in 2020).
15. 8% CCB = 400 kg

12. Vacuum Pressure Process: Calculating Absorption

BALCOOA			
	Diameter (CM)	Radius (CM)	Area (SQ CM)
Outer	0.1	0.05	0.00785
Inner	0.085	0.0425	0.005671625
Coverage for treatment			0.002178375
Tulda			
Metre	Diameter	Radius	Area
Outer	0.05	0.025	0.0019625
Inner	0.04	0.02	0.001256

	TULDA	BALCOOA
Length (CM)	450	1800
Volume (CU CM)	0.98	1.27
Chemical (KG/CU METRE)	14	14
Chemical per bamboo (KG)	13.7 = 14 (appx)	17.80 = 18 (appx)



13. Preservative Treatment Process – Occupational Health and Safety Standards¹⁹

- The treatment area should be well ventilated; unauthorized entries, smoking, drinking and consumption of food should be avoided in the treatment area.
- Proper work clothes like apron, gloves, protective goggles, footwear, etc. should be worn.
- Spraying of chemicals should be done in the direction of wind.
- Empty containers should be kept away from the reach of non-technical personnel and children.
- After spraying of chemicals: The hands should be cleaned with soap; proper shower should be taken and work clothes should be changed.
- Preservative solutions should not be disposed of in the drain or river.
- The used solution should be decanted and reused and the residues should be mixed with saw dust and buried in the ground.
- Sludge generated during treatment should be reclaimed for chemicals and reused by adding Chromic acid and the pH should be brought to 2.5.

14. Readings and References

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2. Training Manual TM 05 07/06: Preservation of Bamboo, NMBA, TIFAC, DST
3. Bamboo Preservation Techniques: A Review, INBAR and ICFRE, 1994
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5. Preservation of Bamboo for Structural Purposes – Code of Practice: IS 9096: 2006
6. Preservation of Bamboo and Cane for Non-Structural Purposes – Code of Practice: IS 1902: 2006
7. PPT of Mr. Sanjeev Karpe during Facilitating Agency Training
8. Humanitarian Bamboo, Draft 2, 2009, Benchmark Consulting, Seown, Indonesia
9. Bamboo Nursery Development and Management, Dr. Selim Reza (Phase II)
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¹⁹ Erba Cycles Handmade bamboo bicycles for commuting and comfort cruising

Chapter 5 : Bamboo Products

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Subject-Matter Experts: Mr. Sanjeev Karpe (Bamboo Expert), Sampooran Bamboo Kendra, Nagpur, and Mr. Pratap Goswami (Bamboo Expert)

The following bamboo products are covered in this section:

- Bamboo Bicycles
- Bamboo Jewellery
- Bamboo LED Stream Lighting
- Bamboo Non-Woven Products
- 3-D Woven Products
- Plain Bamboo Woven Products
- Bamboo Water Bottles and Straws
- Incense Sticks (Agarbattis)
- Bamboo Blinds
- Round Bamboo Furniture



5.1 Bamboo Bikes

Why to use bamboo bicycle?

- Eco-consciousness is doubled by riding a bike built with natural resource like bamboo.
- Bamboo is the ideal cash crop for developing market, with virtually no-entry barriers, no-toxic pollution or by-products, and no complex infrastructure needs.
- Bamboo dampens the impact of road vibrations with its thick cellulose structure and is significantly smoother on the road than bikes built from other materials (steel, aluminium, and carbon).²⁰

Why are other materials better?

- Steel – It is much lighter yet it is just as strong and has greater tensile strength.
- Aluminium – It is strong, light and more cost-effective.
- Carbon – It is light and stiff, and avoids risk of catastrophic failure.

²⁰ Erba Cycles Handmade bamboo bicycles for commuting and comfort cruising

Assessment of bamboo bicycle frames (Environmental and social life cycle):

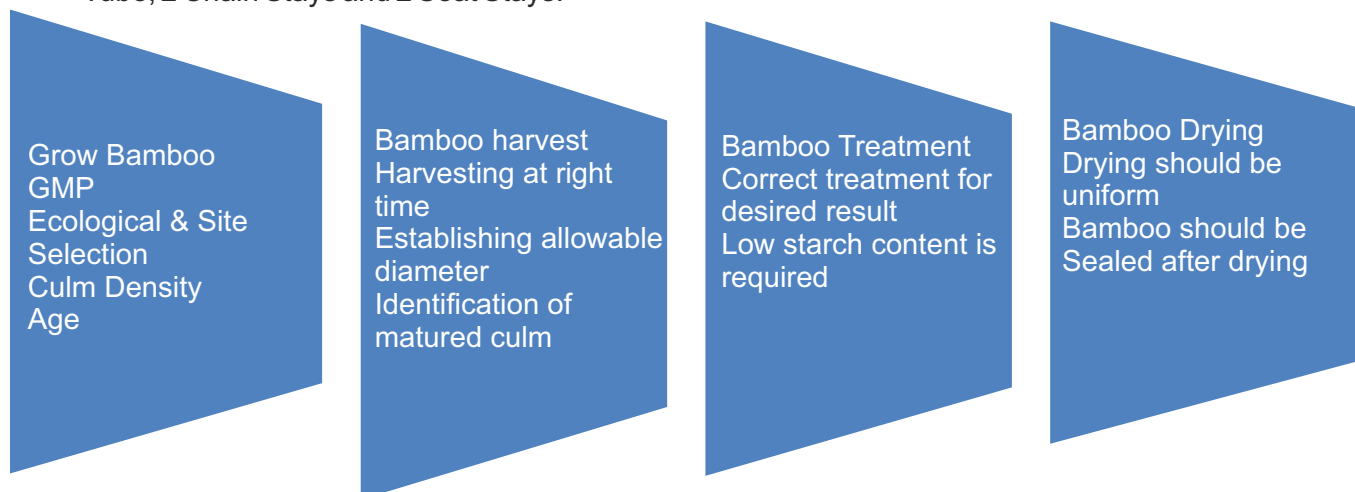
- **Environmental LCA:** The findings indicate that the bamboo bicycle frame's total environmental impact is about 50% lower than aluminium and about 30% lower than steel bicycle frames.
- **Social LCA:** The findings indicate that the bamboo bicycle companies in Ghana performed well and had no adverse socioeconomic effects. Even so, businesses should have made the owners of bamboo resources aware of the importance of bamboo and negotiate a competitive price to contribute towards the growth of community.

What species of bamboo is suitable for bamboo bikes?

- The frame of the bike is made from a specific species of bamboo that are known for being light and incredibly strong.²¹
- Species used are: Bamboosa balcooa, Bamboosa nutans, Thrysostachysoliveri (kankaj), Pseudosasa amabilis (Tonkin cane) and Dendrocalamusstrictus, Dendrocalamusstocksii
- Cost: Rs.5,000-50,000, depending on customization
- Lifespan: 10-15 years
- Time required to make bamboo bicycles: 1-2 days (depending on customization level it may take up to 2-5 weeks)

Parts of a bicycle that can be made from bamboo:

- Basically, the frame of the bicycle is made of bamboo and the joints are held together by hemp fibre or carbon fibre, treated with an epoxy-resin. The wheels, handle bars, brakes, and pedals have metal parts.
- The bike frame consists of 7 bamboo tubes. They are the following: 1 Top Tube & 1 Down Tube, 1 Seat Tube, 2 Chain Stays and 2 Seat Stays.



The four stages before the bamboo can be used for manufacturing and the accompanying standardizing strategies.

Bamboo growth & Harvesting

- Density: Use of low-density bamboo
- Age of bamboo to be used: 3-4 years
- Best time to harvest bamboo is before sunrise from 12am to 6am, most of the starch is then in rhizomes at the roots.
- The advantages of harvesting bamboo before sunrise are: The bamboo is less attractive to insects; the bamboo is lighter for transportation purposes, and the bamboo dries faster.
- Season: The best season for harvesting bamboo is after the rainy season. The culms are more resistant to microbes after monsoons.

²¹ Erba Cycles Handmade Bamboo Bicycles for commuting and comfort cruising

Treatment:

Types of Treatment

- Chemical Method
 - Fixing Solution
 - Non-Fixing Type solution- It washes away in rainy season, so it is good for bamboo that is to be used indoor.
- Non-Chemical Method
 - Usage of Margo leaves and cow dung solution



Methods of chemical treatment:

Soaking or diffusion: The freshly-cut culms are stripped of branches etc. and are cut to size and submerged in a water-based solution.

The vertical soak or diffusion method: The whole culm is filled with solution, except the lowest node, which is fractured later to drain the solution.

Hot and cold treatment: The bamboo is heated, the air in the cells escapes and leaves a vacuum when the bamboo is cooled. This results in the preservative draining into the cells.

Pressure treatment: The pressure treatment results in deep and uniform penetration.

Drying of bamboo:

Air Drying: Removal of moisture by exposing bamboo to atmospheric conditions. Stacking bamboo upright dries the bamboo in half the time when compared to stacking them horizontally.²²

Kiln Drying: It is a more efficient way compared to air drying. In this process, the bamboo culms are stacked or split a chamber where the air circulation and the temperature are maintained and controlled so that the moisture content can be reduced to the required levels.²³

Tools and machines to be used

- Hemp/carbon fibre (25 metre)
- Grinder
- Epoxy
- Propane torch
- Basic hand tools: Hack Saw, knife, drill and dermal rotatory tool
- Electrical tape
- Aluminium angle bar
- Threaded rod and nuts
- Spar varnish
- Sand paper
- Brackets
- Autoclave
- industrial ovens
- Stainless steel dropouts
- Two mitre jigs
- Assortment of gloves, goggles and aprons

22 Strategies to Standardise Bamboo for Manufacturing Process Chains Science Direct
23 Strategies to Standardise Bamboo for Manufacturing Process Chains Science Direct



Making of bamboo bike:

Step 1 – Bamboo preservation

- Cutting of bamboo poles and heat treatment in autoclave



Step 2 – Joint Assembly

- Mitering
- Hemp fibre reinforcement



Step 3 – Frame Assembly

- Assembly of front triangle



- Assembly of rear triangle



- Construction of cross braces



- Hemp fibre & epoxy reinforcement



- Making of seat tube shim



Step 4 – Cable Routing
Step 5 – Reaming and Facing, Installation of Headset



Step 6 – Finishing

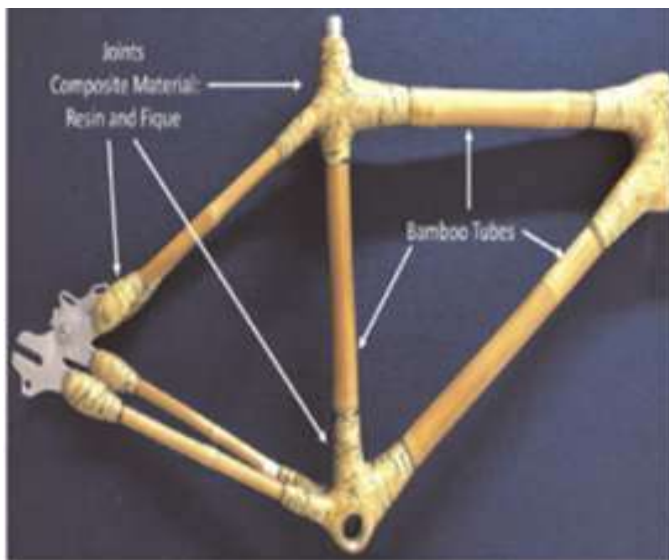


Table 13: Cross sectional of the bike frame parts²⁴

Name of the part	Outer radius (mm)	Thickness (mm)
Down tube	15.5	5.0
Top tube	15.5	5.0
Seat tube	15.5	5.0
Seat Stay	10.25	3.5
Chain Stay	10.25	3.5
Thicker Seat Joint	25.0	10.5
Thinner Seat Joint	13.0	3.25
Headset Joint	23.0	7.5
Thicker bottom bracket joint	25.0	10.5
Thinner bottom bracket joint	12.2	1.95
Dropouts joint	10.5	0.25

Problems associated with bamboo bicycles – Raw material aspect²⁵

- **Shrinkage:** Bamboo shrinkage can be 10-16 percent in diameter and 15-17 percent in wall thickness. If shrinkage occurs after assembling the bicycle, it may lead to the disengagement of joints, which will lead to product failure.
- **Splitting:** When the change in moisture content occurs too rapidly, splitting of bamboo may occur. If bamboo dries non-uniformly on the one hand, it will contract unevenly. This will cause tension inside the tube, leading to splitting in the end.
- **Potential Solution:** Bamboo must be properly sealed off with a waterproof polyurethane varnish when the moisture content varies. Special attention must be paid to the inside of the seat tunnel, as humid air can penetrate and infuse the bamboo.²⁶
- **Thermal Expansion:** Bamboo has a high thermal expansion coefficient, which means it expands and contracts with changes in temperature. When designing the joints, this must be considered.
- The most vulnerable region of the bicycle was described as being the tubes near the bottom bracket, during assembly, extra carbon fibre/hemp wrapping is suggested for the frame during manufacturing.

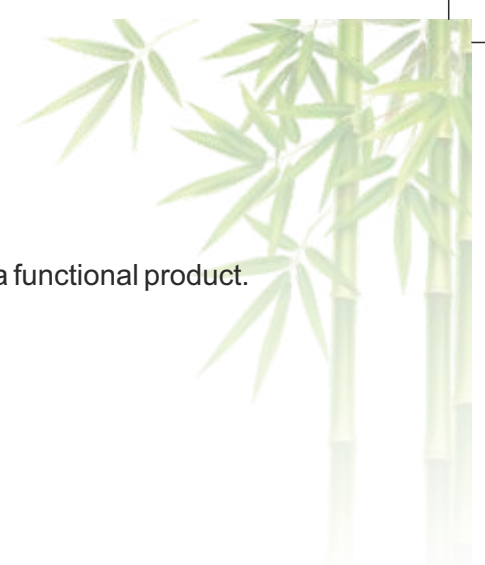
Design Problem:

- **Design Problem – 1:** The existing method of boring a hole in the seat tube is both unsafe and incorrect.
- **Counter Measure:** Use of V-blocks: The self-canting V-blocks are built to minimize the complexity of aligning the bamboo shaft with the drill press and ensures that the middle of the bamboo lines is up to the centre of the drill regardless of the diameter of the bamboo.
- **Design Problem – 2:** Carbon fibre and epoxy wrapping takes time and is risky.
- **Counter Measure:** Align the fixture with the table of the drill press and protect the table with the fixture. Aligning the fixture to the drill press table guarantees that it is possible to complete the attachment step securely and quickly. It is necessary to lock the fixture to the drill press to make sure the fixture does not move during the drilling process.

²⁴ Structural Evaluation of Bamboo Bike Frames: Experimental and Numerical Analysis | Intech Open

²⁵– Strategies to Standardize Bamboo for Manufacturing Process Chains Science Direct

²⁶ M.D. Burger, G.A. Oosthuizen, J.F. Oberholzer, P. De Wet, C.I. Ras. "Strategies to Standardize Bamboo for Manufacturing Process Chains", Procedia Manufacturing, 2017



Problems faced by manufacturers:

- Low demand – Customer's mindset needs to change to accept bamboo as a functional product.
- Passion-driven industry with low institutional support
- Presence of few skilled trainers
- Non-availability of spare parts

Bamboo Bicycle Manufacturers²⁷

India

- Godrej Bambusa: Started manufacturing since 2014. Manufactures 3 types of bikes - Urban, sports and kids' bike (B2B).
- Hero bikes: Cater for the DIY enthusiasts who want to manufacture their bicycles on their own. Included in the purchased kit is the jig used to assemble the bicycle (B2B).
- TRIBAC-Dr. Selim Reza, in association with SIDBI, is working to manufacture bamboo bikes in India.
- Bamboochi bicycles -- Founded by Captain Shashishekhar Pathak. Bamboochi, in addition to customized bikes, offers jigs to assemble bikes.

Abroad²⁸

- IN'BÔ: A small, American company, Boo Bicycles has been building bicycles since 2009. The handcrafted bikes are made of Tam Vong bamboo, cultivated by the company in Vietnam.
- Boomers: This social enterprise, founded in 2014 by Kwabena Danso in Ghana, has a team of 50 people that crafts handmade products using local, sustainable materials.
- BamBoo Cycles: Was founded in Mexico City in 2008
- Bamboo Bicycles Beijing: Started in 2013 in Beijing
- Eco cross bamboo bikes: Hybrid bamboo bikes under green star brand. Available on Amazon
- BamBoo bee – Singapore - based company. Frames available on Amazon
- Spotter Bikes: Available on Amazon

Table 14: Investment Required:

S No.	Category	Investment (US \$)
1	Initial Setup Costs	84,000
1.1	Business formation	1,669
1.1.1	Environmental Impact Assessment	67
1.1.2	Registration with government agencies	748
1.1.3	Municipal Licence	854
1.2	Equipment	77,930
1.3	Training (for 20 assemblers)	4,000
2	Operation costs of manufactured components (assuming the factory will produce at 75 percent capacity)	7,90,000
2.1	Manufactured component	29
2.2	Labor	0.46
2.3	Indirect cost	3.80
2.4	Bamboo	1.62
	Cost of bamboo cycle	35

27 Southern African Institute for Industrial Engineering (saie.co.za)
28 www.euronews.com

Key Assumption for Investments:

- Production: 30,000 bicycles/year
- Number of trained assemblers: 20
- 31,600 bicycles each year will be assembled by 20 qualified bicycle assemblers in an assembly format.
- Scrap rate: 5%
- 100% of the bicycles produced are sold annually.
- The average bicycle price is US\$37, based on the average bicycle markup of 7% and the willingness to pay.
- The bicycle industry's growth rate is zero percent.
- 20 percent discount rate set
- In the first year, only 75% of the potential output is projected to be achieved.



Break-Even Analysis:

- Approximate fixed cost US\$101,000 in the first year, variable cost per bicycle is US\$30.6 and a selling price of US\$37 per bicycle - the number of units it will take to break even. This technique gives us 15,780 bicycles in total to break even.

Occupational Health and Safety Precautions:

The following safety measures should be taken:

- Usage of Safety Cap
- Protective Glass
- Apron
- Rubber Gloves
- The flame should be subjected to the bamboo at a distance of 3"-6".
- Well-ventilated workspace
- Workspace should be Free of Flammable Material.

5.2 Bamboo Jewellery

Introduction:

Jewellery is a product which needs less raw material and tools compared to other crafts and can be classified as:



Solid



Weaved



Coiled

Advantages of bamboo Jewellery:

- Yellow colour sheen of bamboo makes it an appropriate choice as an alternative to valuable jewellery.
 - Its ability to retain dyes expands its variety in colours.
 - It adds elegance to jewellery crafted with gold, especially when accompanied with pearls or diamonds.
 - It is less expensive compared to metal jewellery and still gives aesthetic appeal.
 - It can be easily combined with Silver, Gold and Cloth.
- It is resistant to termite attacks (unlike wood).



Gold Plated Bangles



Silver Bamboo Bangles



Earrings With wool

Market Scenario

- Total domestic market in terms of value is Rs.300 crore. (Source: Shodhganga)
- Major supplying regions are Kerala, Arunachal Pradesh, Assam, Madhya Pradesh, and West Bengal.
- Major domestic markets are Delhi, Bangalore, Cochin, Kolkata, entire North East and Bihar.
- Major suppliers are Swaraj Fashion, Bally, Kolkata, Hood Decors, Krishna Nagar, Delhi; Snehatrayee Handicraft Jewellery, Gariahat, Kolkata; Ukerala, Wayanad, Kerala (only online); Kalpetta Bamboo Cluster Pvt. Ltd (SPV under SFURTI), Design Touch, Kharguli, Guwahati.
- Major B2B & B2C portals that operate are exportsindia.com, alibaba.com, indiamart.com, eworldtradefair.com, amazon.com, yourgiftclub.com, etsy.com (huge collection and all types)
- Major international bamboo jewellery brands are Mesmerizing Bamboo (Dr. Alina Talukdar), Nordstorm, John Hardy. L Raveene.
- It is exported to UAE, Singapore, Malaysia, Japan, Europe, USA and Thailand from Assam, West Bengal and Kerala. (Estimated value of export of bamboo jewellery is Rs.90 crore in 2019. Source: Shodhganga)

Major Bamboo Jewellery clusters are Kalpetta bamboo cluster, Kerala, Kyoto in Japan

Product Mix – Assam:



Bangles – Rs. 60 to Rs. 300 per set



Necklace set – Rs. 300 to 600



Rings – Rs. 50 to 150



Earrings – Rs. 70 to 200 per set



Plain Bracelet – Rs. 40 to 120



Product Mix – Kerala



Rs. 50 to Rs. 200



Rs. 400 to Rs. 800



Rs. 30 to Rs. 100



Rs. 700 to 1200



Rs. 80 to 200 per set



Rs. 400 to Rs. 800

Types of bamboo used for Jewellery making:

- Type of bamboo used for jewellery making:
- Hollow bamboo, solid bamboo, reed bamboo, bamboo branches, bamboos having small diameter, etc.
- Species used are Dendrocalamus giganteus (Elephant bamboo), Thyrsostachys Siamenesis (Ornamental Bamboo), Ochlandra Travancoria (Reed Bamboo), Bamboosa Vulgaris (Yellow)



Accessories Used



Men's Components



Beads



Jump Rings



Split Rings



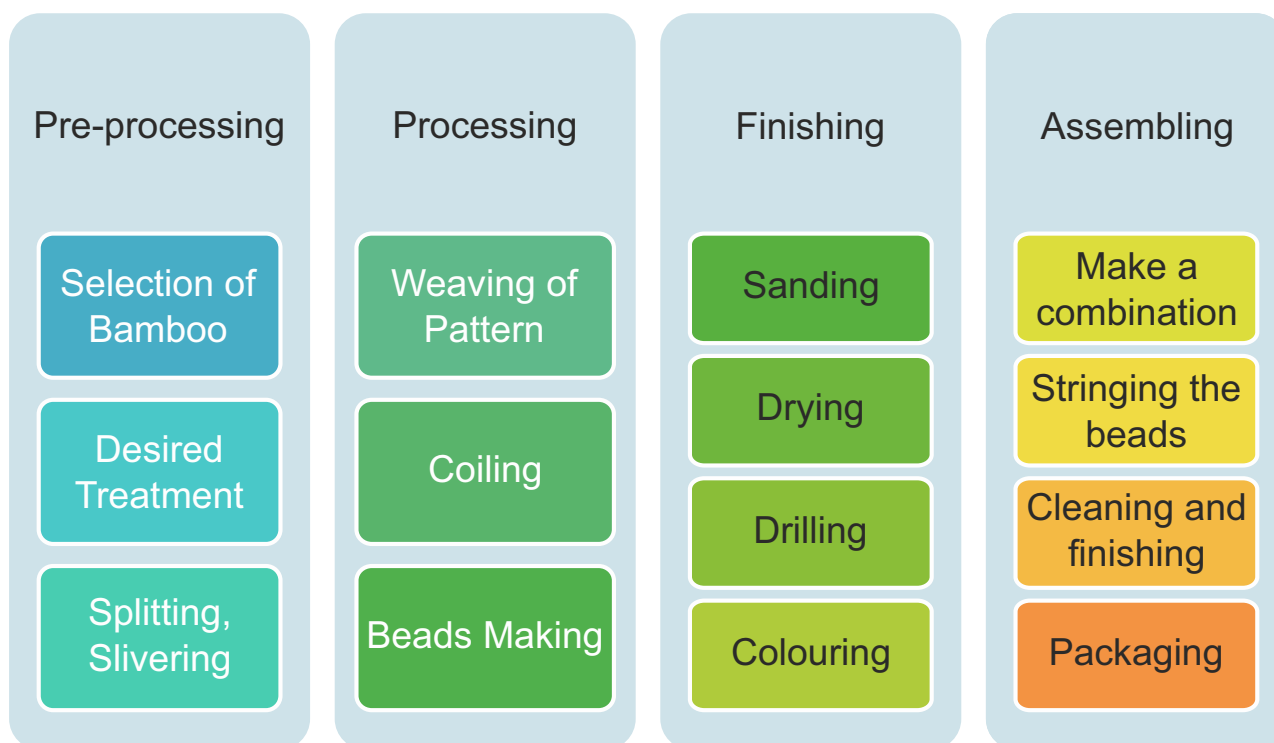
Pinstems & Components



Settings



Production Process



Videos of Bamboo for Jewellery making

Bamboo stud making

<https://www.youtube.com/watch?v=7-XHDsIIBkw>

Bamboo Bangle making

https://www.youtube.com/watch?v=-slmu_vPWvk

Bamboo Chain Making

<https://www.youtube.com/watch?v=fV5QvRGb7W8>



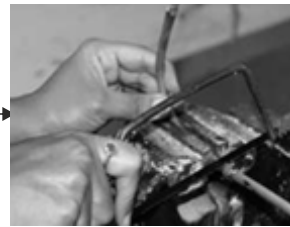
Making of necklace using bamboo beads:



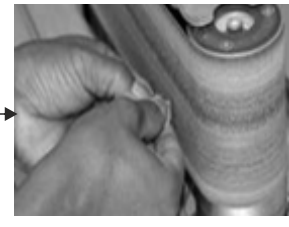
(Cutting to pieces)



(Bending with airgun)



(Cutting excess post bending)



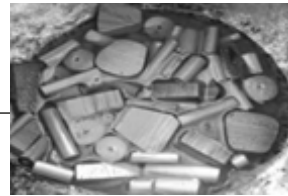
(Finish on sanding m/c both)



(Make combination preassembly)



(Finish with melamine preassembly)



(Various cut forms of beads)



(Drilling on bamboo beads)



(Stringing beads with thread & metal wear)



(Make combination pre-assembly)



(One assembly created)

Precautions – Wearing and Storing:

- To be stored in a dry container free from any chemical contact – Perfumes, Naphthalene balls, etc.
- Making sure that sweat gets dried up after wearing and prior to storing.
- Avoid any sprays after wearing jewellery.
- Never throw jewellery on hard top surface – always use delicately.
- Do not get bamboo jewellery wet as it may result in damage.
- Use only tea tree oil or Jojoba oil for cleaning and polishing.
- Any jewellery made of natural material is sensitive of high temperature variations – avoid during bath.

Machinery & Tools required:

- Hacksaw
- Chisel set
- Callipers digital
- Measuring Tape
- Divider
- Plier (Cut and Nose)
- Screwdriver Set
- Measuring Gauge
- Measuring Right Angle, G-set
- Hand Files, Belt and Disc Sander
- Hand drill and Grinder Kit
- Heat Gun, Bench vice

Table 15: Project Cost and Income Statement

	(in Rs.)
Income Expenditure Statement	
Sales	
Production hours (4 pesons)	6 hours
No. of working days per month (only 50% of time used for jewelry, remaining other crafts)	15 Days
Avg. production per day (in Nos. for 4 persons) assuming each one will make one necklace, one set bangles, and 12 pairs of ear rings (14 Nos. x 4 persons)	60 (pieces)
Total production per month in Nos.	900 (pieces)
Average price of Jewellery per piece (in Rs.)	60
Average sales per month (in Rs.)	54,000
Cost of production	
Bamboo poles requirement (1 pole gives 14 pieces average x 5 poles per day x 15 days)	75 (poles)
Cost of pole(50 per no.) (in Rs.)	3,750
Cost of accessories (50% of bamboo pole cost) (in Rs.)	1,875
Cost of enamel and colours, dyes (50% on bamboo poles cost) (in Rs.)	1,875
Cost of power (250 units PM @ 6 per unit) (in Rs.)	1,500
Sales cost (including wastage) @ 30% of bamboo poles cost (in Rs.)	1,125
Rent & other expenses (5000 per month) (in Rs.)	5,000
Total Production cost (in Rs.)	15,125
Income per month (for 4 persons) (in Rs.)	38,875
Income for one person per month (in Rs.)	9,719
Cost of the Project	
Component	
1. Tools & Machinery Cost (Hand tools, Drilling Sanding, Polishing, Laser engraving Stick Making) (in Rs.)	2,20,000
2. Shed admeasuring 400 SFT (On lease)	-
3. Working Capital	-
Cost of Raw material (Bamboo, accessories and enamel. Colours etc.) (in Rs.)	6,000
Stocking of finished goods (15 days) (in Rs.)	6,700
Cost of other recurring expenses (excluding labour) for one month (in Rs.)	7,400
Total Working Capital (One cycle) (in Rs.)	20,100
Total Project cost (in Rs.)	2,60,200
Optional Machineries	
laser engraving	35,000
Stick making	70,000

Note1: Average price of Necklace considered was 220, bangle set 110 & Par of ear rings 30 (Manufacturer price)

Note2: Above machinery also be used for making of other handicrafts

Comparative disadvantages India v/s S. Korea, Japan, China:

- Limited emphasis on blends (with metals, cloth)
- Poor finishing and quality of accessories
- Lack of awareness on mechanized cutting, polishing and blending
- Limited use of eco-friendly dyes and colours
- Lack of thrust on design development
- Low emphasis on diversification (like brooches, prayer beads, good-luck bands, etc.)
- High exploitation by traders, middlemen, poor linkages with major e-commerce portals
- Absence of propagation through Indian diaspora
- Limited consumer acceptance of traditional items

5.3 Bamboo LED Stream Lighting

Overview

- Project is into the bamboo handicraft sector.
- Developing industrial environment for production process of bamboo lamps
- Incorporate LED lighting into bamboo lamps
- Focuses on sustainable module to produce the affordable and quality products

Objective

- To acknowledge and assist an industrial process in bamboo craft sector
- To provide new and contemporary designs in the market
- To develop supply value chain of bamboo LED stream lights
- Justifying bamboo as an industrial material for livelihood upliftment and employment generation

About Manpower

- People know the traditional and domestic uses of bamboo
- Have been practising on bamboo since ancient times
- Know how to cultivate and produce raw material
- Various communities still practise bamboo craft for their livelihood as a main occupation
- Being the second-most populous country, India has a huge manpower.
- Also, policy towards producing sustainable products, making people aware about the traditional businesses, generating skilled manpower

Bamboo as a material

- It has 1,642 identified species.
- There are about 128 genera.
- It has 100 commercial species.
- Out of 100, 20 are identified as a priority species of bamboo in India.



Types of LED²⁹

- Colour led
- Dimmer switches
- LED lighting tubes
- SMD led
- COB led
- Graphene light



²⁹ Types of LED | Top List of 9 Different Types of LED (educba.com)

Why should bamboo be used?³⁰

- It is widely available all over the world.
- It is the fastest-growing plant in the world.
- It takes maximum 3-7 years for a bamboo to mature for harvesting, whereas hard wood can take about 100 years to be ready for commercial usage.
- A bamboo sapling can be reused as it grows back post harvesting.
- Bamboo produces 35% more oxygen as compared to trees.
- It is a natural CO2 sink.
- Bamboo regulates the levels and flow of rivers and streams.
- It prevents soil erosion and restores degraded land.
- Bamboo forests create biodiversity for flora and fauna.
- Bamboo can replace the use of wood for any application.
- Bamboo provides sustainable biomass for the production of renewable energy.

Bamboo Availability

Type # 1. Bambusa Polymorpha (Assam—Betua-, Beng—Jamabetua)

Type # 2. Bambusa Striata = B. Vulgaris Var. Striata (Bengali—Basni Bans; Marathi- Kalaka;; Tamil—Ponmungil)

Type # 3. Bambusa Tulda (Bengali—Tulda; Hindi—Santal—Mak)

Type # 4. Dendrocalamus Giganteus:

Type # 5. Dendrocalamus Hamiltonii (Assam—Kokua; Bengali—Pecha; Hindi—Kaghzi Bans)

Type # 6. Dendrocalamus Strictus (Hindi—Nar bans; Marathi—Nanvel; Oriya—Saliabhanso; Tamil and Malayalam—Kalmungil-, Telugu—Sadanapaveduru):

Type # 7. Drepanostachyum Falcatum = Arundinaria Falcata (Hindi—Ringal):

Type # 8. Gigantochloa Rostrata= Oxytenanthera Nigrociliata (Bengali—Kalia; Oriya—Bolangi; Garo—Washut; Bastar—Pani bans)

Type # 9. Indocalamus Wightianus = Arundinaria Wightiana (Tamil—Chevani)

Type # 10. Melocanna Baccifera (Bengali—Muli; Assam—Tarai):

Type # 11. Ochlandra Scriptoria (Malayalam—Ammei, Ottal):

Type # 12. Ochlandra Travancorica (Malayalam—Eetta; Tamil—Eeral, Odai):

Type # 13. Pseudoxytenanthera Ritcheyi = Oxytenanthera Ritcheyi (Kannada—Chiwa, Choua- Maraihi—Huda, Manga):

Type # 14. Schizostachyumpolymorphum= Pseudostachyumpolymorphum (Assam—Bajal, Tolli):

Type # 15. Thamnocalamusspathiflorus= Arundinaria spathiflora (Hindi—Nigal, Ringal):

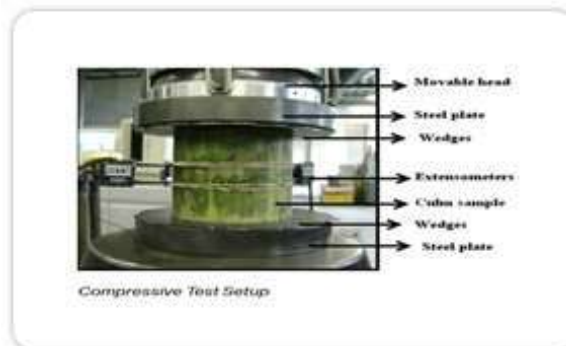


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Bamboo as a Material:

Characteristic

- Energy Efficiency
- User Safety
- Environment Impact
- Durability
- Fire Safety



Mechanical Properties of bamboo:

- Shear Strength
- Compressive Strength
- Bending Strength
- Tensile Strength



Why LED



- LED are more energy efficient
- LEDs are safer as compared to bulbs, CFLs etc.
- LEDs generate directional emissions:
- LED have dimming capability:
- LEDs operates well in both cold and hot weather
- LEDs have a longer lifespan
- It consumes lesser electricity
- LEDs have great colour rendering index (CRI):
- LEDs have tremendous design flexibility:
- LEDs produce zero UV emissions:
- They have correlated colour temperature (CCT)

Range of products:

1. Bamboo LED wall lamps design range and inspiration Material Used: of bamboo slivers, bamboo pulp, bamboo rod Led series, tubes, bulbs, panels are used
2. Bamboo LED table lamps Made up of bamboo sticks, bamboo net
3. LED bulb, LED panels< LED tube are used> Bamboo LED floor lamps made up of bamboo net, slivers, bamboo rod LED bulb, diffused light effects are used

4. Bamboo hanging lamps Made up of bamboo net, bamboo slivers, direct bamboo
5. Spotlight, point light LED are used



What is Research and Development?

Initial and important segment of the industry

- Primary and secondary research data and analysis
- To maintain competitiveness
- Helps in analysing current trends and can develop new trends
- Helps in understanding market status
- Helps in solving the design problem
- Helps in planning the production process

What is designing?

- Finding the elements to make new designs
- Design development considering trends and need of the market
- Upgrading the previous designs
- Selection of the raw material according to design
- To make artisans understand the designing of product
- Value addition like graphics, packaging, designing

What is Raw material procurement?

- Selection of raw material
- Sizing
- Prevention Treatment
- Storage



Selection of raw material

Bamboo

- Primary material
- Designing structure
- Designing mounting
- Aesthetical designing

LED

- Secondary material
- Using for mechanism(lighting)
- Functional
- Aesthetical use

Miscellaneous

- Includes accessories/trims/wires etc. extra material for value addition

Sizing

- Sizing is nothing but the segregation of the identical bamboo for the quality production
- It gives ease to production process as a material is ready for the particular design
- Helps to select the secondary material for assembly
- Easy to develop components

Treatment³¹

- Durability of Bamboo
- Bamboo Insect Infestation
- Remove Bamboo Mould
- Leaching Bamboo
- Chemical Bamboo Preservation
- Drying Bamboo Poles

Why is storage of bamboo important?

- It is a necessary process
- It helps to protect the raw material and components
- It's easier to pick raw material required if it is stored and segregated properly.
- Proper storage reduces time



31 www.guaduaabamboo.com

Why is proper packaging important?

- It augments the product
- It is needed for product safety and protection
- It enriches the visual appeal
- Helps in brand identification and identity,
- Describes the product significance
- Helps in developing brand image



5.4 Bamboo Non-woven craft products

How are non-woven bamboo products different from woven? Non-woven products requires special skills for material handling, cutting, marking, analysis to produce minimum waste, maintaining workflow, assembling, finishing, and packaging.

- Round/ Split/ Slat/ Stick
- Joining, bending, sanding, positioning, preservation technique
- Control over inner moisture, shrinkage pattern
- Green and dry

A few examples of craft-based utility products that depends mostly on craftsmanship & design are:

- Kitchen utility (Fruit tray/ serving basket, mug, jug, glass, straw)
- Office utility (table organizer, pen stand, visiting card holder, storage tray, stationary items, gift items)
- Fashion Utility (Hanger, Jewellery, Gift boxes)
- Lifestyle utility (home décor item, lamps, wall hanging, photo frames, bin baskets, wind chimes, planters, containers)
- Furniture
- Toy





Furniture



Toys



Table 16 : Production Process

Steps	Tools
Cross cutting	Hacksaw/ Circular saw
Peeling of upper layer	Knife
Marking	Pencil/Pen, measuring tape, scale
Splitting	hand splitter
Bending	Blow lamp/ heat gun
Carving	Sandpaper/ hand sander/ carving tool/ turning machine
Designing	Chisel/ jigsaw
Hole making	Hand drill/ drill machine
surface finishing	sandpaper/ hand sander

Common tools that are used are:



Circular Saw, Planner, Hand Splitter, Callipers Digital, Divider, Hand Sander, Jig Saw, Hand Saw, Measuring Tape, Chisel Set, Heat Gun, Measuring Gauge, Hand Drill Kit, Hack Saw, Plier (Cut, Nose), G Clamp, Screw Driver, Bench Vice etc.

Pre-Requirements:

- The enterprise should have a understanding of raw material
- The craftsmen should know how to use tools
- The enterprise should have basic idea about consumer's/ buyer's preference
- It should be aware of the market segment being catered.
- Price at which the final product is to be sold.
- Enterprise should have knowledge of supply chain management

Table 17 : Tentative Equipments, Capital Investment, etc. required

S.No.	Product	Raw material	Equipment/ Machinery/ Facilities	Tentative Capital Investment Range (in Lakh)	Market
1.	Craft making unit	Round bamboo	Hand Saw, Small and Big Knife, Plier, Screwdriver, Chisel, Drill and bits, Hand Sander, Measuring tape, Hand splitter, Jig saw, Heat gun, Blow lamp, Turning machine, Treatment facilities, Adhesive, Finishing material	0.3-0.7	Delhi, Mumbai, Bangalore, Bhopal, Jaipur, Chandigarh, Chennai apart from NE India
2.	Furniture making unit	Round bamboo	Circular saw, Planner, Hand sander, Plier, Jig saw, Hand Drill kit, Chisel set, Right angle, measuring tape, Scale, Heat gun, Blow lamp, Treatment facilities, Finishing material	0.6-1	Delhi, Mumbai, Bangalore, Bhopal, Jaipur, Chandigarh, Chennai apart from NE India
3.	Furniture making unit	Round bamboo and Slat	Circular saw, External knot remover, Plier, parallel splitting machine, Four side planer machine, Dust collector, Chain splitting machine, Planer, Hand sander, Disc belt sander, Turning machine, Jigsaw, Hand Drill kit, Pole drill, Chisel set, Right angle, Measuring tape, Scale, Heat gun, Blow lamp, Knockdown accessories, Treatment facilities, Spray gun with compressor, Finishing material	2-20	Delhi, Mumbai, Bangalore, Bhopal, Jaipur, Chandigarh, Chennai apart from NE India
4.	Furniture making unit	Engineered bamboo	Circular saw, hand splitter, Plier, Planner, Hand sander, Jigsaw, Hand Drill Kit, Chisel set, Right angle, G clump, Fixtures to hold the bamboo wood, Measuring tape, Scale, Heat gun, Blow lamp, Treatment facilities, Bending facilities, Finishing material	1.5-5	Delhi, Mumbai, Bangalore, Bhopal, Jaipur, Chandigarh, Chennai apart from NE India
5.	Utility product making unit	Bamboo split, slat, round	Circular saw, Planer, Hand sander, Plier, Jigsaw, Hand Drill Kit, Chisel set, Right angle, Measuring tape, Scale, Heat gun, Blow lamp, G clump, Bench vice, Bamboo profile machine, Dryer machine Treatment facilities, Adhesive, Varnish, wax, Finishing material,	2-5	Delhi, Mumbai, Bangalore, Bhopal, Jaipur, Chandigarh, Chennai. European countries

5.5 Plain Bamboo Woven Products

Introduction³²

- Bamboo the “Wonder Grass”.
- Strong and hard in its natural form, however when converted into a thin sliver, it can be very flexible owing to its strong fibre property.
- This special property has given a way to bamboo-weaving that has opened multitude of employment-generation activities. Woven articles are made of different widths , thicknesses, lengths and sizes of bamboo splits made from bamboo culms, based on the design of the products.³³

³² www.cemca.org.in

³³ ca2534en.pdf (fao.org)

- Range of products can be produced with bamboo like carry baskets, fruit baskets, storages, containers, mats, lampshades, dustbins, jars, boxes, trays, bamboo painting canvas



Market Avenues

- **Major domestic markets for bamboo woven products** are Delhi, Mumbai, Bangalore, Bhopal, Jaipur, Chandigarh, Chennai apart from NE India
- **Major supplying regions** are Kerala, Arunachal Pradesh, Assam, Gujarat, Madhya Pradesh, West Bengal, Jharkhand, Chhattisgarh, and Odisha
- **Major B2B & B2C Portals for bamboo woven products** are exportsindia.com, alibaba.com, indiamart.com, amazon.com, and etsy.com
- **Major Bamboo clusters where bamboo-woven products are made** are Assam (Lakhimpur, Bongaigaon, Guwahati, etc.) and Tripura (Agartala, Nelaghar, etc.) are recognized as prominent places of bamboo products both nationally as well as internationally. Other major bamboo plain woven products centres are Manipur, Arunachal Pradesh in North Eastern region, West Bengal, Kerala, and Orissa.

Technical Stages of Production



TOOLS REQUIRED

- There are various tools used for working with bamboo specially for making thin slivers.
- Many of these are required for various purposes related to making products out of a mat or a basket etc.
- The process of weaving begins from measuring to cutting, splitting, drilling, bending, grinding etc.³⁴
- Although cross-cutting, splitting of bamboo culms and making strips and threads can be done manually, machines are normally used to increase productivity, reduce wastage of raw materials, increase the yield of bamboo strips, and remove drudgery in the primary processing of the culms.³⁵
- The main machines are cross-cutting machine, sliver-making machine, splitting machine and width sizing machine.

Raw material

Type of Bamboo used for weaving

- Thin wall, longer nodes, smaller diameter bamboos can make better quality slivers for weaving. Mostly freshly harvested thin walled, long internode type bamboos are good for weaving.
- The reed bamboo varieties are used mostly for making mats and baskets in Kerala and in North East part of India. The baskets made from thin flexible slivers are very sturdy.³⁶
- Type of Bamboo species used are: *Bambusa tulda*, *Bambusa balcooa*, *Bambusa polymorpha*, *Dendrocalamus hamiltonii*, *Melocannabaccifera*
- The other auxiliary raw materials in common use are as follows
 - A) Direct dyes, electropositive and acid dyes;
 - B) Bleaching agents: hydrogen peroxide, sodium hydroxide, sodium silicate, oxalic acid, and sodium sulphite.
 - C) Preservatives: PCP, alum, boric acid, sodium borate, and sodium fluoride.³⁷



³⁴ www.cemca.org.in

³⁵ ca2534en.pdf.fao.org

³⁶ www.cemca.org.in

³⁷ <https://www.inbar.int/wp-content/uploads/2020/05/1489452143.pdf>



General Process for making bamboo woven products is:

- Treatment of Bamboo
- Splitting of bamboo
- Cutting of bamboo
- Sanding of the product
- Drilling
- Finishing

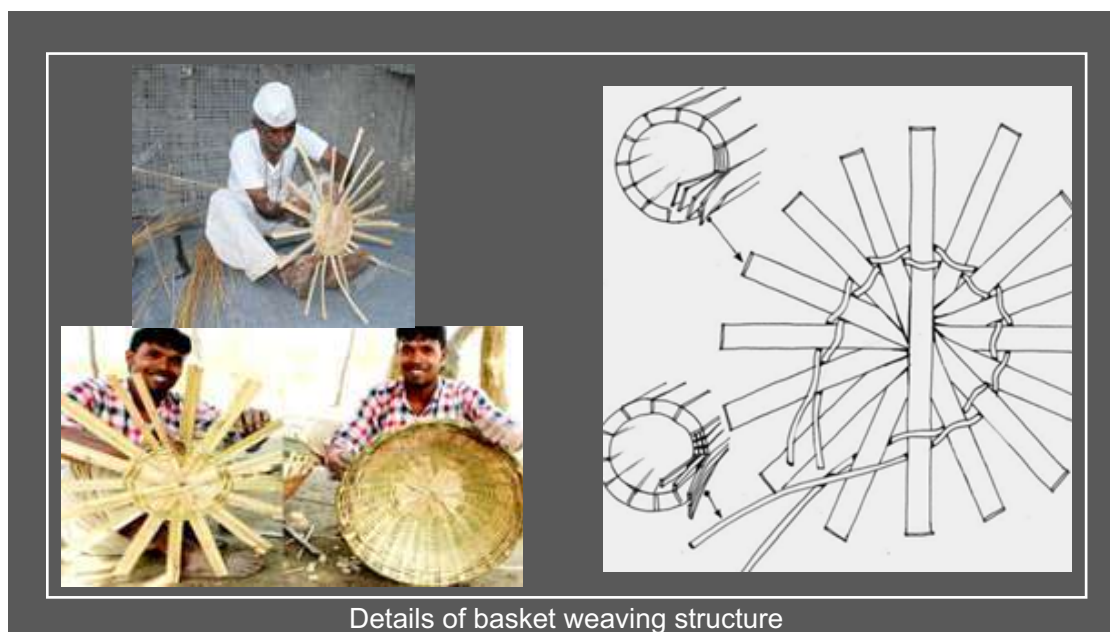
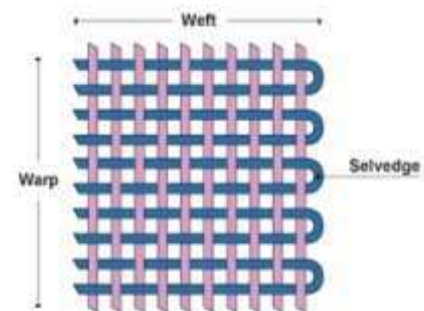
Dyeing Process³⁸

- For aesthetic beauty, bamboos are dyed into vibrant colours.
- Since, bamboo has an off-white colour, it can absorb colour well which enhance the beauty of it. Preferably green or non-dried bamboos in sliver form are good for better absorption of dyes.
- Once good quantity of the sliver is made, it can be dyed in various colours and preserved well and can be utilised whenever needed.



WEAVING TECHNIQUES³⁹

- Warp is the set of parallel bamboo strips that provide a basis for weaving patterns. In plane bamboo weaving, the warp strips are positioned vertically on the work bench.
- The weft is made up of the bamboo strips that are inserted perpendicularly under and over the warp to create a design. In plane bamboo weaving, the weft strips are positioned horizontally on the work bench.
- There are 5 common weaving methods, namely, vertical weaving method, multi-angle weaving method, round weaving method, cross weaving method and other.



Details of basket weaving structure

38 www.cemca.org.in
39 www.cemca.org.in



Method of weaving a mat

Design Resource

Bamboo Mat Painting - Thrissur, Kerala



Mats Size- 11 x 18", 15 x 24" and 30 x 60" and the excess waste is removed from the mat using burner

VIDEO LINKS

Bamboo Bread Basket– <https://www.youtube.com/watch?v=MIYyKs9t58Y>

Bamboo Handcraft lampshade -<https://www.youtube.com/watch?v=r7eye5vtbtQ>

Bamboo Weaving technique -<https://www.youtube.com/watch?v=saexnVWd6GQ&pbjreload=101>

KEY ATTRIBUTES OF THE BUSINESS

Key attributes of this business are:

- It is a labour-intensive business
- It increase the usage of bamboo resources which are sustainable.
- The enterprise will have flexibility of time and place.
- The enterprise builds upon the weaving skills which are inherently present within the communities.
- The enterprise will benefit from the inherent weaving skills that exists in the community.

The success parameters essentials for a unit are:

- Consistent availability and supply of clums
- Availability of labour (Both skilled and unskilled)
- Low startup capital required-Negligibly small land requirement for unit setup.
- Market access

INVESTMENT REQUIRED & WAY FORWARD⁴⁰

- Land requirement for setting up the unit is negligibly small and the investment required is low.
- As a micro enterprise, it can be established near the resource and can form a significant part of both the monetary and non-monetary economies in bamboo growing regions.
- The percentages of economic component in total output value (%) are:
 - Raw material -12%
 - Wages – 75%
 - Energy – 3%
 - Rent charge – 1.5%
 - Other expenses – 1.5%
 - Profits – 7%
- Technical assistance for production, prototype development of value-added products, exposure to technologies, organizing seminars and training courses (management, production and maintenance), conducting relevant research and development are all required to ensure success, especially in the establishment phase.

WAY FORWARD

- Manufacturers rarely conduct market surveys to keep updated on new business trends and innovative products. In the export markets, the low prices offered for relatively high-quality products deter them from entering these markets and so assistance is required to disseminate information on marketing.
- Institutional and economic policy support is also required to guide the enterprises in new product development, to introduce preferential financial investment policies and to set up networks of technical and information services to train workers.

⁴⁰ <https://www.inbar.int/wp-content/uploads/2020/05/1489452143.pdf> WOVEN BAMBOO PRODUCTS MANUFACTURING UNIT by Xiao Jiang Hua and Wu Liang Ru INBAR AND Bamboo Research Division, Research Institute of Subtropical Forestry, Chinese Academy of Forestry, 73 Daqiao Road, Fuyang, Zhejiang Province, China

5.6 Bamboo 3-D Woven Products

The section covers:

- The range of products that can be made from 3-D weaving of bamboo (baskets for flowers/vegetables/fruits/eggs/bread/jewellery/dry fruits/cereals/pulses/ chocolates etc., fancy items for gifting; lampshades; hats & caps)
- Process of marketing these products (Raw materials required, equipment/tools, etc.).
- Key market areas and ways of reaching them.
- What investment is required set up and manufacture.

Products that can be made through 3 D weaving of Bamboo



Process of Making 3 D woven Bamboo Product:



Treatment of Bamboo for woven products

Traditional Method:

- Immerse felled culms in water which prevents and protects it from Bostrychid beetles.
- After immersing the bamboo culms, they are stored in a dry and well-lit place
- Then, the smoking of bamboo is done which reduces moisture content, thereby preventing it from fungal infection.
- The next step is heating of culms on fire. Boiling the water prevents the bamboo culms from borere's attack.



Chemical Treatment of Cut Bamboo and Bamboo Strips:

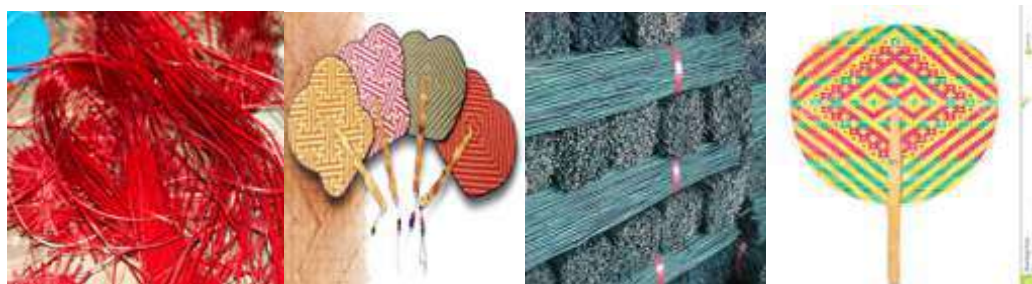
- Borax Boric acid treatment with usage of 6% solution (3% Boric and 3% Borax).
- The cut Bamboo and strip are boiled in this solution for 20 minutes, Soaking can also be done to prevent from borer's attack.
- Humidity in the bamboo should be less than 80%. If the moisture content in bamboo culm is above 80%, than none of the treatments will be effective



Table 18: Various Natural Dyeing ingredients

Dyeing and Various Colours Obtained					
S. N.	Ingredient of Dyeing	Specification of ingredient used	Safe for food grade Products	Requirement of Bamboo Strips (Approx 1 Metre Length)	Colour Obtained
1	Turmeric	Turmeric 50 gm, Water 5 litre, Stainless steel vessel	Yes	150	Yellow
2	Tea	Tea Leaves 100 gm, Water 5 litre, Stainless steel vessel		100	Light Dull Brown
3	Cow Urine	Cow Urine - 5 litre	Yes	100	Very Light Brown
4	Katha	Kattha 90 gm, Copper Sulphate 45 gm, Potassium Dichromate	Yes	150	Brown
5	Harra	Harra 200 gm, Ferrous Sulphate 100 gm, Water 10 litre, Stainless steel Vessel	Yes	150	Black
6	Alta	12gm Alta, 5 litre water	No	100	Dark Pink/Light Pink
7	Alta and Haldi	Haldi Powder 50 gm, Alta 2 tsp, Water 6 Litre, Bamboo Strip 130	No	130	Orange Colour
8	Indigo	One Large Spoon Indigo, Sodium Hydroxide, Sodium Dithionate, Water	No	150	Light shade of Blue/Indigo

Products after Dyeing:



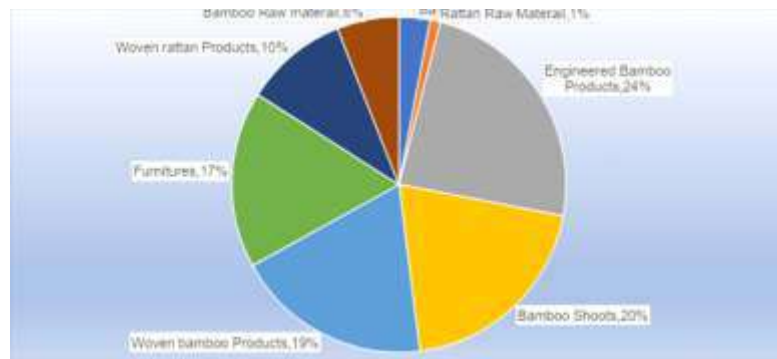
Tools and Equipment's



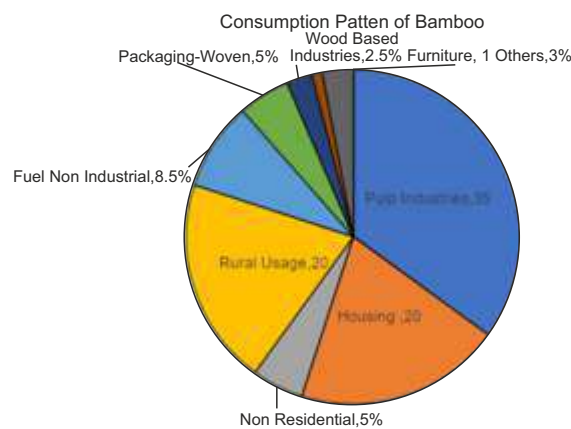
Table 19: Dimensions of Sliver of Woven Products

S. N.	Name of Product	Dimension of Sliver	
		Width	Thickness
1	Bamboo Mat	3 MM	1 MM
2	Bamboo Packaging Boxes	3MM	1 MM
3	Bamboo Baskets	6 mm	Less than 1 mm
4	Bamboo Boxes (Oval Shape)	3 mm	Less than 1 mm
5	Bamboo Laundry Bin/Dustbin	2mm	2mm
6	Hanging Lamp	3 mm	2mm

Bamboo and Rattan sub-products contributors in trade in 2016 in % (Size USD \$1.69 billion)- SOURCE UN com Trade



Consumption Pattern of Raw bamboo in various segments In India



Some Major Buyers of 3-D Woven Bamboo based products are:

- Government of India, Through Interventions like TRIFED, Emporiums and Handicrafts.
- Event Organizers.
- Gifting Industry.
- Lighting Industries.
- Organic Packaging stores.
- B2B Portals

Table 20: Costs Share and Profitability of Some Woven Products

Type of Unit	Cost of Raw Material	% of Labour Expenses	Shipping	Margin
Micro/Small Unit	15%	40%	15-30%	15-30%
Own Account unit	25%	0	20-40%	35-55%

Table 21: Projected Profit and Loss Account

(Rs. in Lacs)

Projected Profit & Loss Account:					
Particulars	0 Year	1st Year	2nd Year	3rd Year	4th Year
Sales / Receipts		26,88,000	30,72,000	34,56,000	34,56,000
		26,88,000	30,72,000	34,56,000	34,56,000
Manufacturing Expenses					
Raw materials		3,36,000	3,84,000	4,32,000	4,32,000
Wages		2,68,800	3,07,200	3,45,600	3,45,600
Repairs & Maintenance		26,880	30,720	34,560	34,560
Power & Fuel		80,640	92,160	1,03,680	1,03,680
Other Overhead Expenses		10,752	12,288	13,824	13,824
Depreciation		94,966	83,921	74,213	65,673
Production Cost		8,18,038	9,10,289	10,03,877	9,95,337
Administrative Expenses					
Salary		4,80,000	5,04,000	5,29,200	5,55,660
Postage Telephone Expenses		5,376	6,144	6,912	6,912
Stationery & Postage		4,03,200	4,60,800	5,18,400	5,18,400
Advertisement & Publicity		26,880	30,720	34,560	34,560
Workshed Rent		0	0	0	0
Other Miscellaneous Expenses		32,256	36,864	41,472	41,472
Administrative Cost		9,47,712	10,38,528	11,30,544	11,57,004
Interest on Bank credit @ 11%					
Term Loan		84,985	84,985	67,988	50,991
Working Capital Loan		26,059	26,059	20,847	15,635
Cost of Sale		18,76,794	20,59,861	22,23,256	22,18,967
Net Profit Before Tax		8,11,206	10,12,139	12,32,744	12,37,033
Less Tax		2,35,249.75	2,93,520.28	3,57,495.72	3,58,739.46
Net Profit		5,75,956	7,18,619	8,75,248	8,78,293

5.7 Bamboo Water Bottle and Straw

Need of Bamboo Bottles and Straw⁴¹

- Plastic leads to pollution
- Plastic products like bottle, bowls, cups, etc can leech chemicals into the food that you eat. This is especially true when eating foods high in acidic content.
- Bamboo dinnerware will not only add an elegant, earthy look to your table, it is also a giant leap away from ingesting latent chemicals from the plastic manufacturing process.
- Bamboo is 100% biodegradable and degrades in a year, whereas plastic takes centuries to degrade.

Bamboo Bottles



Bamboo-covered Bottles

These bottles are bamboo-covered bottles with steel or copper used inside. The price for these bottles starts from Rs 600. The bamboo mainly used for this product is Bambusa balcooa.

Production Process

- The bamboo is cut and treated naturally by boiling, drying and smoking. Boiling purifies and strengthens the wall around the hollow of the culm.
- The different parts of the bamboo bottle such as body, base, neck or cap are carved using lathe or turning machine. These parts are smoothed using sanding machine.
- Optionally, the formed outer cup can be fitted with an inner liner. A glass filter or a stainless-steel filter is placed inside the cup. The cap of the bottle may be made of plastic, metal or even bamboo
- Polish the bamboo body of bottle with waterproof oil polish or coating of camphor and mustard oil, as needed. The cap can have round or threaded finishing.

Equipment

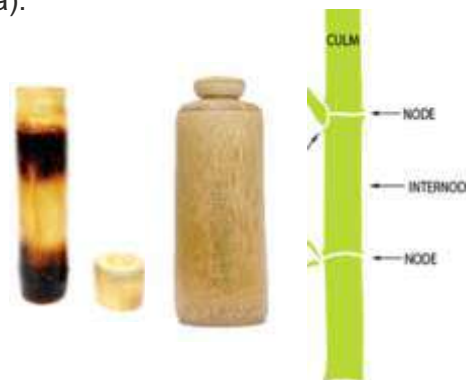
Bamboo Cutting machine, Chisel and Hammer, Rotary Tool, Sandpaper, Readymade water bottle, large rectangular steel pot, etc.

SOLID BAMBOO WATER BOTTLE

- These bottles are purely made from bamboo (Bambusa balcooa).

Production Process Equipment

- Bamboo is cut below the node. Then, it is treated to prevent fungal infection.
- The wall thickness is reduced using chisel and hammer. Sandpaper is used to sand outer and inner parts of the bamboo for smoothness.
- Wax or vegetables oil are heated to furnish the outer layer.
- Both the nodes are used as bottom and lid of the bottle.



⁴¹ Benefits of Bamboo Products - Clean (eleandezign.com)

Tools Required

Bamboo Cutting Machine, Large Pot, Chisel and Hammer, Rotary Tool, Sandpaper.

Bamboo Fibre Coffee Mug

- It is usually made in China
- Melamine resin is used to reinforce with bamboo powder, corn starch, wheat barn and rice hull. They are moulded by forming machines at high temperature.
- Price starts at around Rs. 200.
- Chemical compounds like monomers – 1,3,5-triazine-2,4,6-triamine and formaldehyde – are toxic and can cause cancer⁴².



Projected Production Volume Of Bamboo Bottle

DB Industries, Assam, produced 1000 bamboo bottles per month without lathe machinery and drying oven, assuming that 1000 bamboo bottles can be made by artisans

Table 22: Projected Production Volume of Bamboo Bottles

1	Production Hours (9 labours)		8 hrs.
2	Capacity of bamboo bottle per hour (8 hours shift)		9 bottles
3	Total Production per day (One Shift)	9*8	72 bottles
4	Per Month (25 days, 80% capacity utilization)	72*25*0.8	1,440 bottles
	Assumption = 1 pole of Bambusa balcooa (20m length) gives 63 bottles of 30cm length.		
5	1,440 bottles per month requires raw material	1440/63	23 poles
6	Cost of Production per Month Assume cost of Bambusa balcooa = Rs 70 per pole	23*70	Rs 1,610
7	Sale Price of Product @ Rs. 400 per bottle per Month	1440*400	Rs 5,76,000

Table 23: Tools and Investment needed to make Bamboo Bottles

S. No	Machines	Cost/ Unit
1	Bamboo Cutting Machine	Rs.26,000
2	Eternal knot removing machine	Rs.38,000
3	Steel pot for boiling bamboo with herbs	Rs.5,000
4	Rotary Tools	Rs.6,000
5	Electric Chisel Hammer	Rs.15,000
6	Sandpaper	Rs.2,000
7	Wax/vegetables oil polishing	Rs.3,000
8	Safety kits	Rs.1,000
	Total	Rs.96,000

42 <http://www.ilpi.com/>

How to Make Straws from Bamboo



Harvesting
Schizostachyum blumei.



The bamboo is cut and left to firm up and dry naturally in the sun for a few days.



Cutting the stems of bamboo into length of 20-21cm.



Using sandpaper to smooth bamboo outer surface



Hoisting the straws with jet washed hot water.



Sun dry after washed.



Bamboo straws after being washed and cleaned.



The stems cut-off are used for firewood, kindling or food skewers.



Coconut brushes for bamboo straw packs.

Bamboo Species Which can be Used for Bamboo Straws in India

- *Dendrocalamus strictus*
- *Schizostachyum arunachalensis* - Arunachal Pradesh
- *Schizostachyum beddomei* - India
- *Schizostachyum griffithii* - Assam, Myanmar
- *Schizostachyum mandamanicum* – India
- *Melocannabacifera* – Tripura and Mizoram



Projected Production Volume of Bamboo Straws

Artisans in Vietnam produced 50,000 – 100,000 bamboo straws per month without lathe machinery and drying oven, assuming that 50,000 bamboo straws can also be made by artisans.

Table 24 Projected Production Volume of Bamboo Straws

1	Production Hours (9 labours)		8 hrs.
2	Capacity of bamboo straw per hour (8 hours shift)		313 straws
3	Total Production per day (One Shift)	313*8	2504 straws
4	Per Month (25 days, 80% capacity utilization)	2,504*25*0.8	50,080 straws
	Assumption = 1 pole of <i>Dendrocalamus strictus</i> (20 m) gives 100 straws of 20cm length.		
5	50,080 straws per month requires raw material	50,080/100	501 poles
6	Cost of Production per Month Assume cost of <i>Dendrocalamus strictus</i> = Rs 70 per pole	501*70	Rs. 35,070
7	Sale Price of Product @ Rs 8 per straw per Month	50,080*8	Rs. 4,00,640

Table 25 : Tools and Investment needed to make Bamboo Straws

S. No	Machines	Cost/ Unit
1	Bamboo Cutting Machine	Rs. 26,000
2	Steel pot for boiling bamboo with herbs	Rs. 5,000
3	Rotary Tools	Rs. 6,000
4	Electric Chisel Hammer	Rs. 15,000
5	Sandpaper	Rs. 2,000
6	Wax/vegetables oil polishing	Rs. 3,000
7	Water jets	Rs. 7,000
8	Safety kits	Rs. 1,000
	Total	Rs. 65,000

Treatment of Bamboo for Food Products

1. Boron Salts (Non fixing type preservatives).

- Effective against borers, termites and fungi (except soft rot fungi). These boron salts are dissolved in water. After treatment, the water evaporates leaving the salts inside the bamboo. They are **not toxic** and can be used for treating bamboo products like baskets, dry containers, etc. which come in contact with food products. Treatment 45 min., concentration 6 – 8%.⁴³

2. Boil with neem, turmeric and other herbs.


- Effective against wood-decaying fungi. Protect against both brown and white rot fungi. Antifungal efficiency of the extract along with copper sulphate and boric acid showed high levels of resistance against *S. commune* fungi. The treatment was found to be effective in improving the water resistance, anti-swelling efficiency, and dimensional stability of bamboo.⁴⁴

3. Dip as well as pressure treated bamboo – Dip bamboo in the water with pressure for few days.

4. Bio-oils – neem extract, cinnamon oil, etc.

43 www.guadubamboo.com

44 www.bioresources.cnr.ncsu.edu

- 
5. Wax impregnation
 6. Infrared ray drying oven

Challenges and Requirements

◆ Right age

- ✦ Mature bamboo: 4 years old bamboo culms are apt.
- ✦ Bamboo culms that are more than 6 years old, are more prone to cracking.

◆ Wall thickness.

- ✦ The bamboo should have 10 mm wall thickness at least.
- ✦ For the bottle, it should be 5 mm thickness.

◆ Size (diameter)

- ✦ Finding the perfect diameter is difficult.

Penetration of the Market

- Awareness among the consumers about to the pollution from single- and multi-use plastic is required. 25,940 tonnes of plastic waste⁴⁵ is generated annually in India itself.
- Promotion – Target Segment and Target businesses.
 - Target segment – Green customers, millennial, etc.
 - Target Businesses -
 - Restaurants with forest theme, oriental restaurants, etc
 - Hotels and resorts as a contribution towards sustainability and ambience.

How are Indian Bottles Different from Chinese Bottles?

- Chinese bamboo bottles have a thin sheet of bamboo plywood covered to plastic or steel bottle.
- For decoration, weight and price.
- India bamboo bottle have pure thick bamboo, covering the bottle from the bottom or solid bamboo bottle using food-grade silica coating for the inside.
- Bamboo contribution is more in India bamboo bottles.

Standardization⁴⁶

- **Eco Mark:** The earthen pot symbol categorizes that the product is environment friendly. It is a government operated seal of approval program for environmentally preferable consumer products. The criteria follow a cradle-to-grave approach, i.e., from raw material extraction, to manufacturing, and to disposal. The label is awarded to consumer goods that meet the specified environmental criteria and the quality requirements of Indian Standards.
- **Recycling Mark:** The universal recycling is an internationally recognized symbol for designating recyclable materials. It is composed of three mutually chasing arrows that form a Möbius strip (an unending single-sided looped surface).

Impact on Sustainable Consumption and Production

- According to TERI, Plastic accounts for 8% of the total solid waste generated in the country annually.⁴⁷
- Out of which water and soft drink bottles form a large number.
- If we sell 1,000 bottles of 1 litre per month, then we can say bamboo bottles leads to reduction of 0.003% of pollution caused due to plastic.

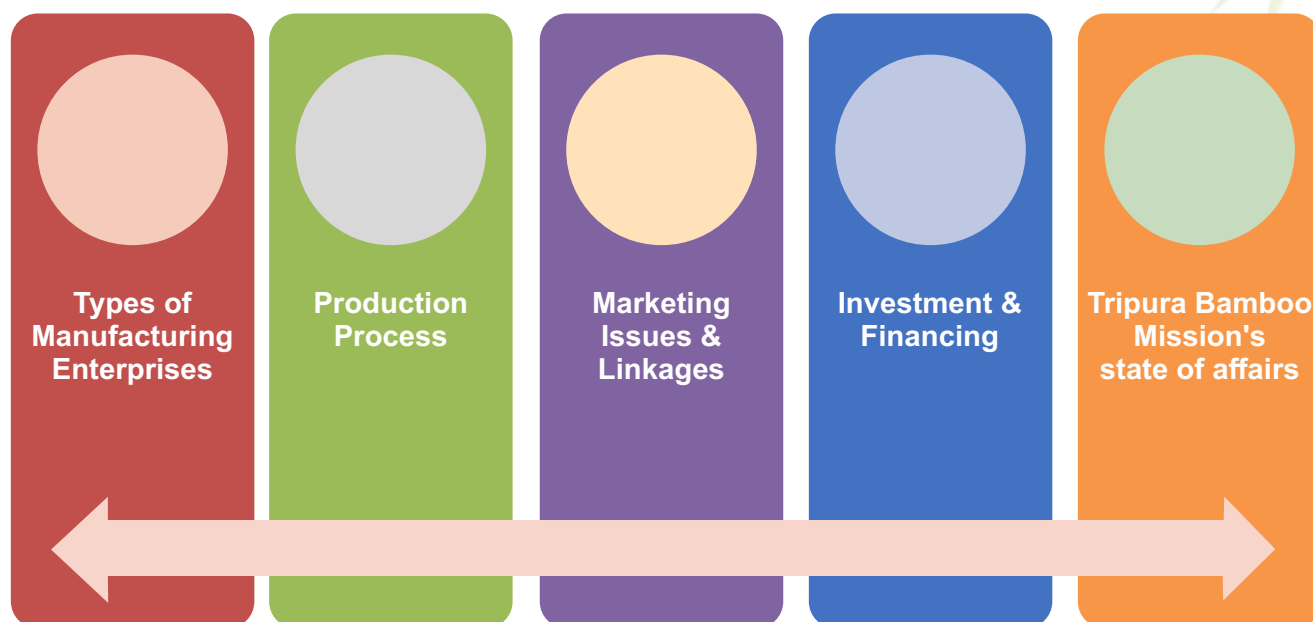
⁴⁵ [India has a 26,000-tonne plastic waste problem | India News - Times of India \(indiatimes.com\)](#)

⁴⁶ [INGRAM | Integrated Grievance Redressal Mechanism \(consumerhelpline.gov.in\)](#)

⁴⁷ [India's plastic waste crisis is too big, even for Modi | Quartz India \(qz.com\)](#)

5.8 Incense Sticks (*Agarbatti*)

Significant Presentation Contents



Different Types of Enterprises & What They Make

Altogether there are 3 types of enterprises that are involved in incense making: –

- Bamboo Stick processing unit (Mechanized Round Stick unit & Handmade square stick unit)
- Raw Batti Manufacturing Unit (by using paddle type manual machine and fully automatic machine)
- Perfuming and Packaging unit.



Production Process

There are five to six major steps of the production process in the entire value chain of bamboo to perfumed incense stick. Currently, majorly two (2) types of production process are carried out in the cluster.

#1. Hand Made Square Stick for Agarbatti:

#2. Mechanized Round Stick Production:

#1 Step 1- Cut the bamboo pole (cross section) into small cylinders avoiding nodes.



Step 2- Remove the green portion (silica) from the outer surface of bamboo



Step 3-Split the bamboo radially of required width



Step 4- Draw out thin bamboo sticks from the splits



Step-5: Separate out sticks of desired sizes & quality, dry and keep them in bunches



#2 Step 1 – Bamboo Cutting

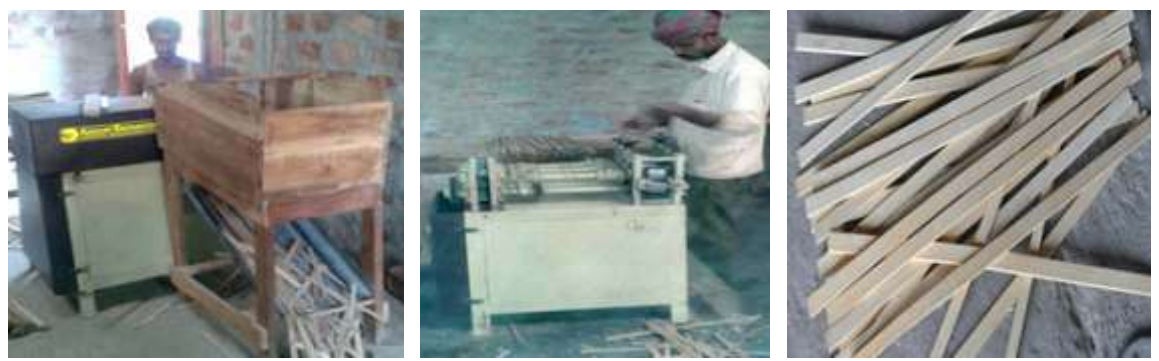




Step 2- Hand Splitting of Bamboo



Step 3- Slicing of Split Bamboo



Step 4- Bamboo Stick Making:



Step 5- Stick Washing & Polishing



Step 6- Cutting the bamboo sticks at desired size & keep them making bunches



Raw Agarbatti Production (Mechanized Process):

Step 1- Weighing & mixing all ingredient in proper proportion and preparing a pastes



Step 2- Pouring paste to the machine and applying paste to bamboo sticks



Step 3- Drying of raw sticks and making bundle



Step 4- Perfuming and Branding (Packaging)



Raw Materials Requirement

- Various Sizes of Bamboo Sticks: 8” to 12” inches depending upon the order
- Packing: It should be airtight in order to prevent fragrance loss.
- Colour Powder: Colour powder of different colours to make the “agarbattis” attractive.
- Crude Paper
- Charcoal Powder
- Gelatine Papers
- Gum /Sticky Powder)
- Jikit Powder
- Nargis Powder
- Sandalwood oil
- Perfume of different fragrances

Table 26 Agarbatti Making Machine

Production Capacity	10-15 kg/hr
Machine Speed	200-250 strokes/min
Length of stick	8 inches
Type of sticks	Round
Automation Grade	Automatic
Item Weight	Greater than 150 Kg

Capacity	25kg
Brand	RISHABH industries
Model Number/Name	25-R
Design Type	Customized
Power	1hp three phase /single phase
Machine Weight	75kg
Voltage	440/220



Table 27: Agarbatti Mixer Machine

Capacity	25kg
Brand	RISHABH industries
Model Number/Name	25-R
Design Type	Customized
Power	1hp three phase /single phase
Machine Weight	75kg



Table 28: Agarbatti Dryer Machine

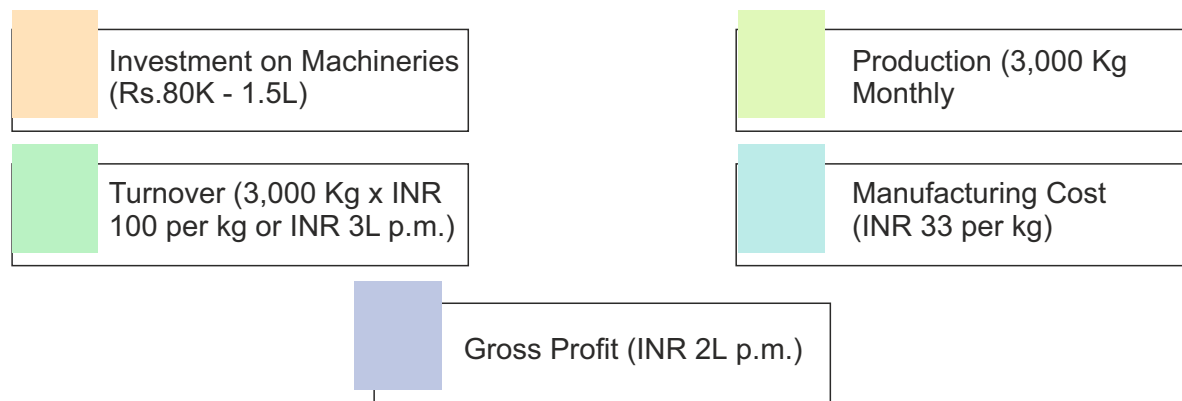
Frequency:	50 Hz
Capacity:	100 Kg /hr
Brand:	Krishna
Max Temperature:	35 c
Material:	Mild Steel
Automation Grade:	Automatic



Investment & Financing

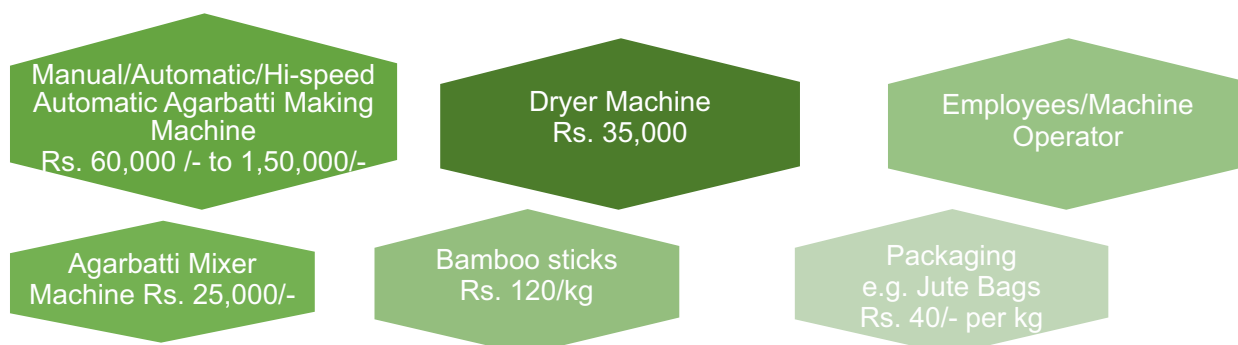
Initial investment in incense stick manufacturing unit is low as its not technology intensive and does not require long and automated production process. The return is also lucrative.

A moderate and guesstimate investment and financing model looks like -



Rent, Transport, Staff Exp, Insurance & Taxes are to be paid out of Gross Profit. The rest is entrepreneur's Net Profit

Capital Expenditure, Raw Materials and Revenue Expenditure

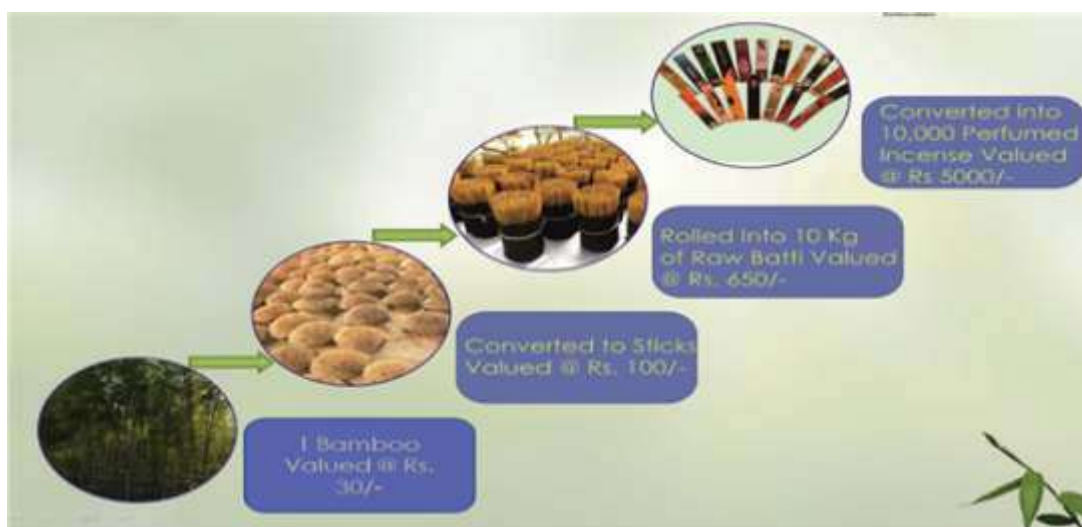


Pre-requisites prior Machine Procurement

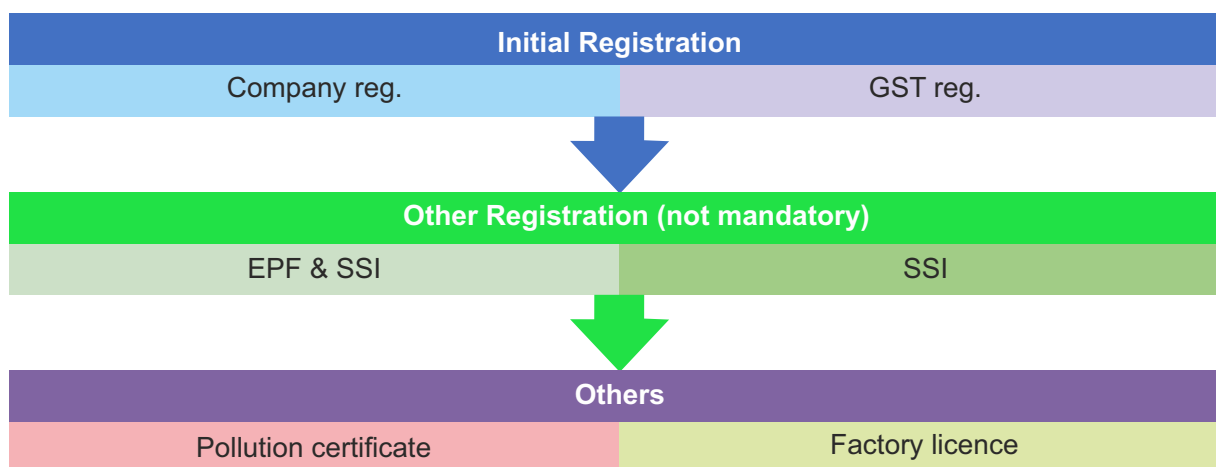
- Production capacity
- Capital
- Maintenance & Service Provider

Dryer Machine & Powder Mixer Machine

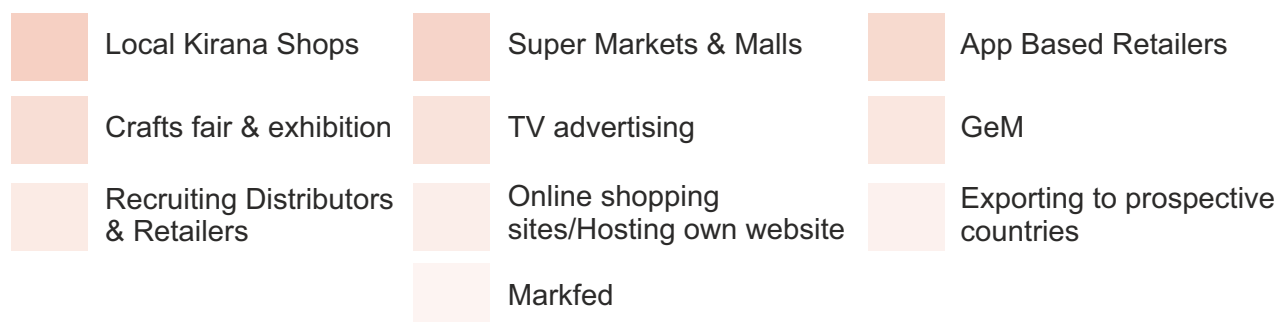
Value Addition in Agarbatti Business



Regulatory Compliances



Market Linkages



Export Destinations of Indian Incense Sticks



Recent Developments⁴⁸

Ministry of Micro Small and Medium Enterprises (MSME) further expanded the reach and support to artisans, involved in Agarbatti making, and to the agarbatti Industry, by issuing new guidelines on 4th September 2020.

- i) Continuously supporting the artisans through training, raw material, marketing and financial support;
- ii) Working on all aspects of this product, like innovation in the fragrance & packaging, use of new / alternate raw materials like re-usable flowers, coir pith etc., supply of bamboo sticks by closely working with Ministry of Agriculture etc. A 'Centre of Excellence' for this purpose is being set up in FFDC (Flavour and Fragrance Development Centre) Kannauj;⁴⁹
- iii) Setting up 10 clusters with proper marketing linkages under SFURTI (Scheme of Fund for Regeneration of Traditional Industries) scheme of the Ministry of MSME at a total cost of about Rs. 50 crore, to benefit about 5000 artisans for their sustainable employment and enhanced earnings.
- iv) Strengthen the machine manufacturing capability to achieve self-sufficiency in the country and develop various other products by setting up "Centres of Excellence" with IITs/NITs etc. at a cost of Rs. 2.20 crore. The Khadi and Village Industries Commission (KVIC), one of the statutory organizations, under the M/o MSME, will implement the program and will handhold the artisans and SHGs with proper backward & forward linkages and needful support.⁵⁰

Intervention by TBM (Directorate of Industries & Commerce)

Incense sector occupies a very important role in the development of bamboo sector in the state. It is estimated that this sector alone employs over 2 lakh rural artisans and generates revenue over 88 crore (as per 2013-14 estimate). Tripura Bamboo Mission has been working in various clusters across the state to bring a paradigm change in the agarbatti Stick sector by encouraging artisans to produce higher value fibreless polished stick from non-polished fibrous stick through mobilization of artisans, forming artisans-owned enterprises, providing required training, infrastructure support and market linkages etc. The higher levels value additions in incense sector such as raw agarbatti production and perfuming & packaging are also an integral part of TBM strategy. Appropriate rural technology has also been introduced in the clusters to improve the productivity of the poor engaged in the sector and improve their earning opportunities. New local producer groups and enterprises have been promoted in raw agarbatti production which generates livelihood support to large number of rural poor communities especially the women and minorities.

Marketing tie-ups with agarbatti major like ITC and CYCLE have been forged to ensure buy-back of

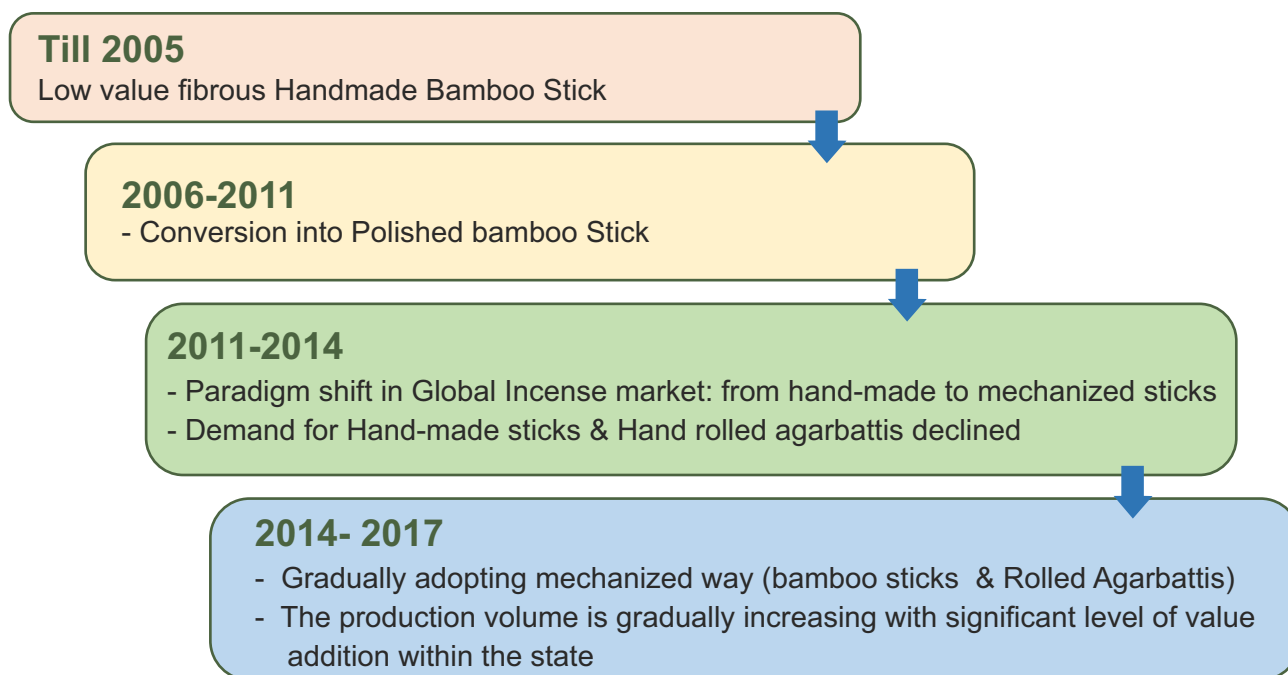
⁴⁸ The Hindu Centre: The Hindu Centre for Politics and Public Policy | Home Page

⁴⁹ domain-b.com: The first online Indian business magazine

⁵⁰ Latest News from Hyderabad, Telangana, Bollywood, India | Siasat.com

the production.⁵¹ TBM has made very significant impact in 'agarbatti sticks' sector. TBM has been promoting 'polishing of Agarbatti sticks' and 'rolling of Agarbatti sticks', which increases the value of the product manifold, on a massive scale. TBM has introduced Mechanization in incense sector by adopting the globally acceptable technology. TBM's interventions have resulted in extensive level value addition of bamboo stick to raw & perfumed agarbatti. **More than 900 Agarbatti rolling machines are being installed by TBM across various Agarbatti clusters in the state.** Tripura is gradually transforming itself from manual stick producer to mechanized stick producer reciprocating to the change in global business regime and market demand. Similarly, the demand for round bamboo stick has forced TBM to promote bamboo round-stick units across the state with active support of the various state govt and central govt schemes like Swavlamban, PMEGP etc. One round bamboo stick unit has been set up at Kumarghat with 50 round stick making machines with monthly production capacity of 60 MT.⁵²

Evolution of Agarbatti Sector in Tripura



TBM's Development Projects in current fiscal

- Twelve (12) Round Stick Making Units
- Five (5) Raw Agarbatti Units
- Five Hundred (500) units are to be grounded for making bamboo strips.
- Establishment of Bamboo deptt in Chakmaghat & Kumarghat
- Bamboo treatment & seasoning plant in Ratachara area of Kumarghat.

India-Fact File

- India is world's leading & largest incense stick producer
- India exported the idea to China, Japan and other Asian countries (Source- Vedas)
- The method of incense making with a bamboo stick as a core originated in India at the end of 19th century.⁵³
- In 2020, Govt launched new scheme for artisans on agarbatti
- For strengthening local manufacturing in incense sticks import duty increased from 10 to 25 %.

⁵¹ TBM Sub-sectors Tripura Bamboo Mission
⁵² industries.tripura.gov.in
⁵³ Incense in India - Wikipedia

Leading Incense Sticks brands of India



Major Issues Posing threats to Agarbatti Industry

- Low biomass (productivity) approach in bamboo plantation programmes by Forest dept.
- Lack of coordination with industries for species to be planted
- Lack of source for adequate & certified planting material
- Entrepreneurs/ Traders are facing legal & policy hurdles on account of requirements of multiple point forest transit pass within the state
- There was no dedicated scheme/ fund for large scale bamboo plantation in private lands
- Slow adaption of technologies & lack of effective collaboration with global partners
- Inadequate supply/production of Jigat/ Charcoal greatly hindered growth of Agarbatti (coated incense sticks) industry in Tripura
- Lack of exploration for extraction & use of natural fragrant also resulted in low growth of perfumed incense stick industries
- High demand of imported Sticks in Indian agarbatti market. Imported mainly from China and Vietnam.
- High investment requires to set up any mechanised Round Stick Processing unit.
- Shortages of agarbatti - specific bamboo in India.

Recommendations

- Support from NBM Implementation. (60% subsidy)
- Proper training from Govt and training agencies to artisans
- Raw material availability (price is ok)
- Mitigating red-tapism in government departments
- Fee (FTL) hiking & hassle-free service

5.9 Bamboo Blind Making

Bamboo blinds is a typical covering for your window, verandah and balcony made up with several long horizontal bamboo sticks/ strips which are held together by cords that run through the bamboo slats.



The Aesthetic look of bamboo blinds



Why Bamboo as a Material?

- Easy availability
- Fastest growing
- Resistance to moisture and ultraviolet ray
- Durable
- Economical
- Eco- friendly
- Appealing rustic look
- Low maintenance

Types of Bamboo Blinds

Round in Shape

Flat in Shape



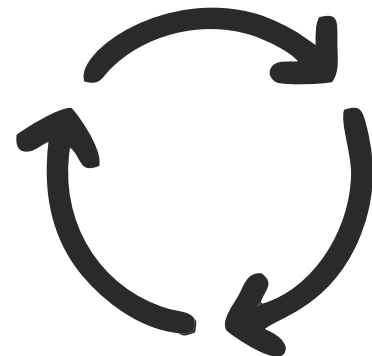
Round in Shape
Round bamboo sticks are used to make the products



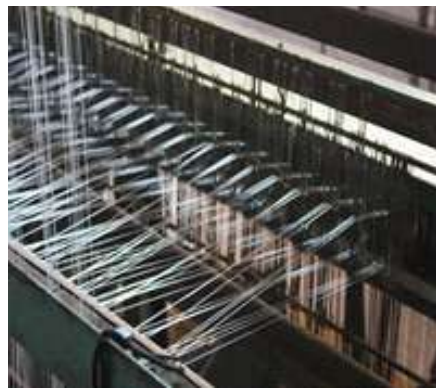
Flat in Shape
Flat bamboo strips are used to make the products

Production Process

- Procurement of suitable bamboo
- Splitting
- Planing
- Treatment of bamboo strips/ sticks
- Polishing
- Weaving (Manual/ Loom)
- Fixing Pulley and Lock
- Packaging
- Cross cutting
- Knot removing
- Stick/ Strip Making
- Drying
- Dyeing, if required
- Edging/ Trimming
- Quality Checking



The Process





Basic Raw Material

- Straight bamboo 3+ year
- Preferably hollow bamboo
- Nylon Thread
- Pulley
- Lock
- Polypropylene strap (Edging)



Major Tools and Equipments Required

- Cross Cutting Machine
- Splitting Machine
- Knot Removing Machine
- Two side Planner/ Four Side
- Stick Making Machine/ Strip Making Machine
- Treatment Tank
- Dyeing Tank
- Dryer
- Polishing Machine
- Looms (Hand loom/ Power loom)
- Edging Cutter
- Basic tools for a factory set up

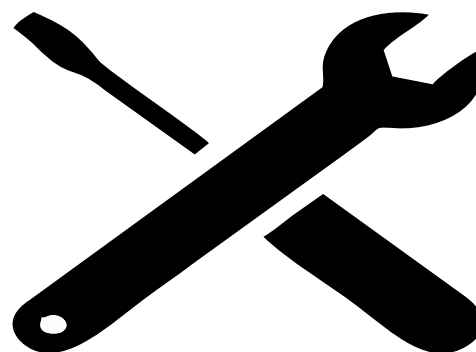
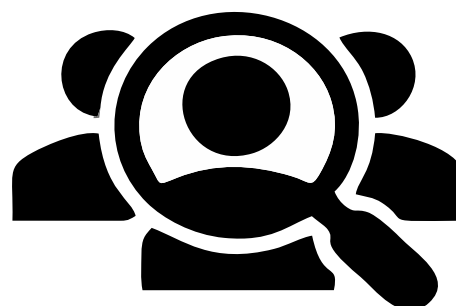


Table 29: Investment required for Bamboo Blinds

Tools and Machines Required	Tentative Cost of Investment (in Rs.)
Cross Cutting Machine	Rs.26,000.00
Splitting Machine	Rs.1,85,000.00
Knot Removing Machine	Rs.38,000.00
Two -Side Planner/ Four -Side Planner	Rs.72,000.00
Round Stick Making Machine	Rs.2,10,000.00
Treatment Tank	Rs.40,000.00
Dyeing Tank	Rs.20,000.00
Dryer	Rs.10,000.00
Polishing Machine	Rs.75,000.00
Loom	Rs.6,50,000.00
Edge - Cutting Machine	Rs.24,000.00
Stitching Machine	Rs.31,000.00
Standard Tools and Equipment's	Rs.50,000.00
Total	Rs.14,31,000.00

Market

- Retail Outlets Selling Curtains
- Home Decor Agencies
- Real Estate Groups
- India Mart and other B2B Portals
- Amazon
- Flipkart and other B2C portals



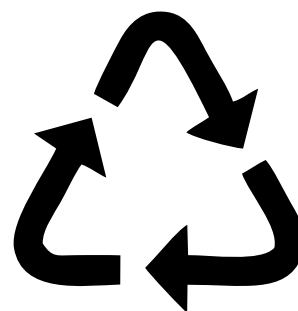
Major Players

- RIHNO Blinds, Assam
- Zebra Blinds, Turkey
- TJ Global Blinds
- Flora Blinds, Kerala
- Hastakala Karkhana, Kamrup
- Ikaamuddin Anasari, Ghaziabad

Waste Management

The cut-outs of bamboo blinds may be used judiciously to make –

- Gift Boxes
- Bottle covers
- Light Shades
- Interior patch works
- Many more



5.10 Round Bamboo Furniture & Basic Construction Structures

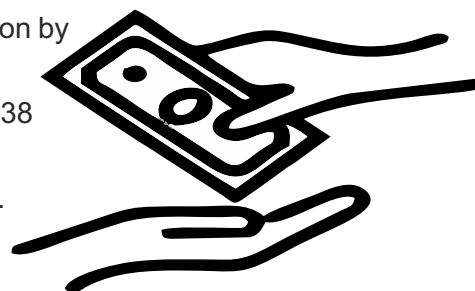
Background

- Bamboo has been widely used as a construction material in India and other parts of the globe.
- Being a fastest-growing plant in the world, the physical properties of bamboo make it one of the most preferable materials for construction and making household utility products.
- Easy availability coupled with low material cost is another reason of its popularity across the masses.
- Bamboo performs well in earthquakes as it sways and absorbs energy.



Market Scenario: Furniture

- The Indian furniture market is anticipated to reach \$32.61 billion by 2018 by registering a CAGR of 13.38%.⁵⁴
- The global bamboo furniture market is expected to reach \$14.38 billion by 2025 with a CAGR of 5.2%.⁵⁵
- The Asia-Pacific market only accounted for 59% share in 2018.



⁵⁴ India's Furniture Market, Forecast to 2023: \$61+Billion (globenewswire.com)

⁵⁵ Bamboo Furniture Market worth \$14.38 Billion by 2025 | CAGR: 5.2% (grandviewresearch.com)

Market Scenario: Housing & Construction

- In India, the housing and construction material market is dominating product category, accounting for 50.02% of total market with a growing CAGR 8.9% from 2019-2028
- The global bamboos market size was estimated at US\$ 72.10 billion in 2019 and is expected to reach US\$ 75.75 billion in 2020. The bamboos market is expected to grow at a compound annual growth rate of 5.0% from 2019 to 2025 to reach US\$ 98.30 billion by 2027

Suitability of Bamboo for Furniture and Constructions

- Widely accepted material
- High-tensile strength
- Grow faster than wood
- Easy availability
- Eco-friendly
- Gives more oxygen than other plants
- Economical
- Long Lasting
- Appealing look
- Many others



Round Bamboo Furniture – Few Modern Products



Round Bamboo Construction- Some Products

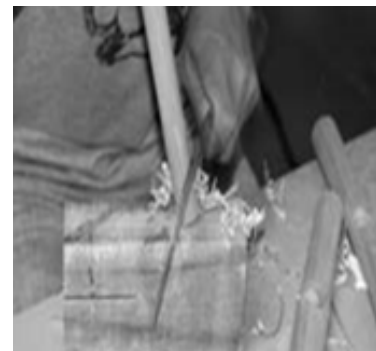


Production Process

- Procurement of suitable bamboo
- Curing and Drying
- Straightening/ bending of bamboo
- Outer knot removal
- Smoothing of bamboo
- Cutting of bamboo into size
- Grilling and trimming
- Joinery Making
- Assembling of parts
- Polishing
- Colouring, if required
- Quality Checking
- Packaging

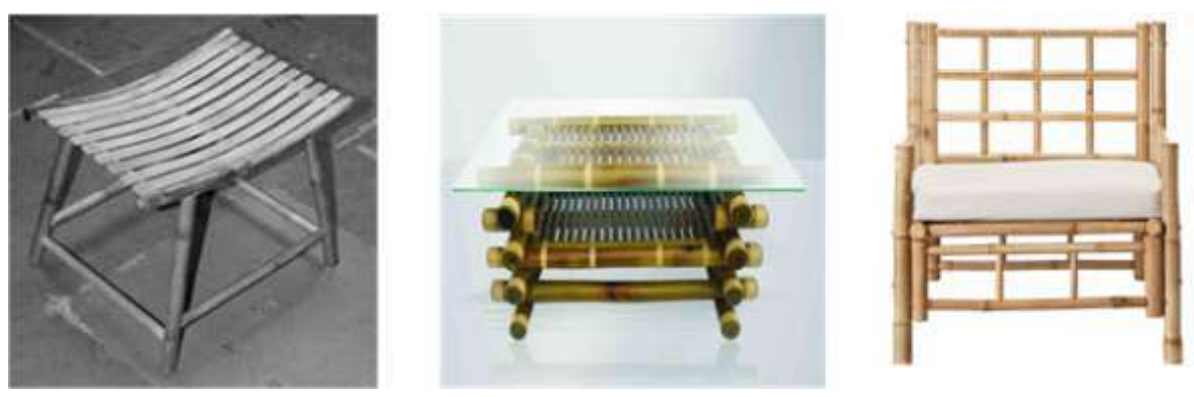


Process Pictorial- Making of a Bamboo Stool

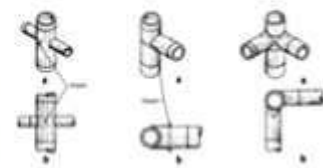
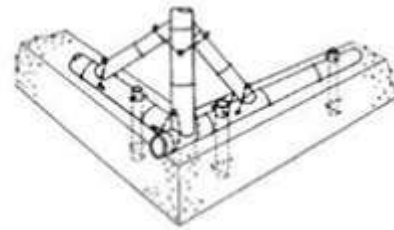
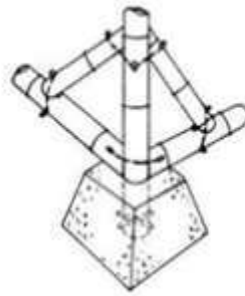
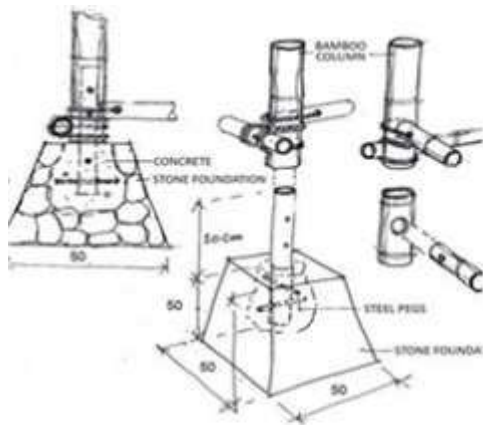




Same process may be followed to make the following:



Construction Joinery



Raw Material Required

- Bamboo 3+ years
- Boric and Borax
- Adhesives
- Component for fitting
- Sandpaper
- Burnish



Tools and Machine

- | | | |
|--|--|---|
| <ul style="list-style-type: none"> • Right Angle • Steel Ruler • Measuring Tape • Angle Scale • Knife • Hand Saw • Mallet and Hammer • Cutting Plier and Nose Plier • Half Round File and Flat File | <ul style="list-style-type: none"> • Marking Tool • Various Chisels • Mortise Chisels • Various Files • Hand planer • Manual splitter • C Clump • Bench Vice | <ul style="list-style-type: none"> • Jack Planer • Hot Air Gun • Power Drill • Sabre Saw • Handheld Grinder • Handheld Jig Saw • Vacuum Treatment Plant • Angle Grinder |
|--|--|---|

Table 30: Investment required for Furniture

Capital Investment	(In Rs.)	Recurring Monthly Cost	(In Rs.)
Construction of workshed (1000 sq.ft @ Rs.1,000)	10,00,000	Pay roll	1,00,000
Vacuum treatment Plant	7,00,000	Raw material	1,50,000
LPG Blow torch and accessories	2,000	Electricity	50,000
Straightening wooden column	2,25,000	Insurance	2,000
Air sprayer and compressor	3,000	Office supplies	10,000
Portable cutting machine	20,000	Logistics	1,00,000
Angle grinder and knot removing machine	50,000	Interest on 20 lakhs @ 14% CI per annum	65,000
	20,00,000	Machine maintenance	3,000
		Depreciation @ 10%	2,00,000
			6,80,000
Turnover Calculation		Profit Calculation	INR
Production per month (Sets)	48		
Selling price	20,000	Gross profit	33,60,000
Total turnover per month	9,60,000	Tax @ 30%	10,08,000
Total annual turnover	1,15,20,000	Net profit	23,52,000
Break-even calculation	Months		
Break-even	11 months		

Major Players

- Native Konbac Bamboo Products Pvt. Ltd, Kudal
- Sarangi Bamboo Enterprises, Sambalpur
- ESAF Retail Private Ltd
- Team Inspire
- Green Gold Bamboo Tech Pvt. Ltd, Haryana
- Ananda Mohanta, Mayurbhanj
- Bamboo Pecker Lifestyle Crafts, Bengaluru
- Assam Kenwood Furniture, Zirakpur, Punjab
- India Cane House, Mumbai
- Chooral Furniture, Kerala
- CIBART Bamboo Furniture Ukai, Gujarat
- Other North East Manufacturers

Waste Management

The wastage of bamboo from a furniture and construction unit may be used judiciously to make –

- Round Bamboo Light Shades
- Small Round Shape Boxes
- Beer Mug
- Coffee Mug
- Tables Top using Waste
- Partition Boards using Waste

Product Possibilities from Wastage



Market

- Retail Outlets selling Furniture
- Real Estate Groups
- Eco Tourism Destinations
- Wildlife Departments
- India Mart and other B2B Portals
- Flipkart and other B2C portals
- Furniture Wholesalers
- Hotel and Resorts
- Tourism Departments
- Local Haats and Bazars
- Amazon

Occupational Safety⁵⁶

Workshop is the place where various kinds of machineries are being used and it carries the risk of potential safety hazards. The purpose of safety measure is to prevent fatal accidents and provide emergency help. Therefore, it is very important that the rules and guidelines are followed.

In a bamboo furniture/ construction workshop you must wear the following products to protect yourself from various hazards:

- Safety Cap
- Protective Glass
- Apron
- Gloves
- Recommended shoes

It is always advisable to keep a first aid box in workshop



5.11 Engineered Bamboo

Major Points covered:

1. Why is Engineered Bamboo (EB) required?
2. What are the major types of EBs, their constituents and applications?
3. What are the main manufacturing processes?
4. What machines/ equipment are required for both types?
5. Global scenario: Comparison between India and China?
6. What are the product specifications?
7. Market Prospects for Wood Sector in India -- that EB Aims to Serve
8. What is the extent of EB being used in India? Way Ahead & Recommendations

1. Why is Engineered Bamboo (EB) required?

- **Declining availability of natural materials:** Demand for high-quality wood for construction is growing, but forests wood availability is much lesser now. Comparison excludes inferior products made from coir, bagasse, banana stems-based products
- **Need for** inexpensive, fast growing, permanently available, comparable physical properties, environmentally-friendly and compatible to existing processing technologies
- **Need** for engineered composite products from small wood type (bamboo) elements; use adhesives and shape them for structural applications, just as it done in case of wood also
- Bamboo is however round & hollow inside, so there are limitations

2.1 Various types of Engineered Bamboo⁵⁷

- Bamboo mat board
- Particle board
- Bamboo-oriented strand Board
- Parallel gluelam
- Bamboo strip board
- Bamboo strip and wood veneer
- Corrugated roofing sheet
- Parallel curved gluelam

⁵⁶ cemca.org.in

⁵⁷ INBAR Bamboo & Rattan for inclusive and green development

- Bamboo curtain board
- Bamboo “zephyr” board
- Bamboo-moulded products
- Bamboo mat overlaid particle board
- Bamboo strip, bamboo particle and wood veneer
- Cement-bonded bamboo particle board
- Bamboo particle plaster board
- Experimented
- Bamboo fibre reinforced plastic
- Bamboo lath board
- Bamboo net board
- Ply bamboo
- Bamboo mat overlaid rice husk board
- Veneer overlaid bamboo slivers moulded beating club
- Gypsum-bonded particle board
- Technologies Being experimented
- Arc-shaped decorative board

Major 5 Types of Engineered bamboo:

Major EB Products (24/28 as per INBAR): First panel in China in 1940. But in Indian & South Asian context there are majorly 5 types, while the rest can be considered as sub- categories. All use glue as a binder.

- Bamboo Mat Board (Press mats to make board)
- Strand Woven Board (Strips cold pressed at high pressure)
- Bamboo Strip Board (Strips hot pressed)
- Bamboo Particle Board (Bamboo particles pressed)
- Bamboo Veneer (Thin slices cut from strip board)

2.2 Main Constituents of EB:

3 Main Constituents of EBs: constitute 50% of final cost

- Slivers
- Strips
- Particles, fibres, wafers or strands (In different combinations)

Bamboo Material requirement: Nutans, Bandissi, Asper, Dendrocalamus, Gigantens, but as a filler any other woody materials

Glues must resist long exposure to moisture & water. 12-40% of cost

- 99% of glues are synthetic polymers
- All glues are thermosetting glues under pressure & temp.
- 3 Major types of glues.
- Best price and quality comes from Melamine Urea Formaldehyde and so it is universally used.

2.3 Major Applications of EBs

- **Generic applications for table tops, panels, partition boards etc:**
 1. Bamboo mat boards (can replace plywood)
 2. Corrugated sheets (replace cement/ steel sheets)
 3. Particle boards & MDFB
- **High-end applications for buildings & hard Furniture e.g.,** Flooring & Roofing tiles, Wall panels, doors, windows & their frames, Furniture tops & structures
 1. Strand Woven Board (SWB)
 2. Bamboo Strip Board (BSB)

Table 31: Key features of 5 types of Engineered Bamboo and their Status in India 2020

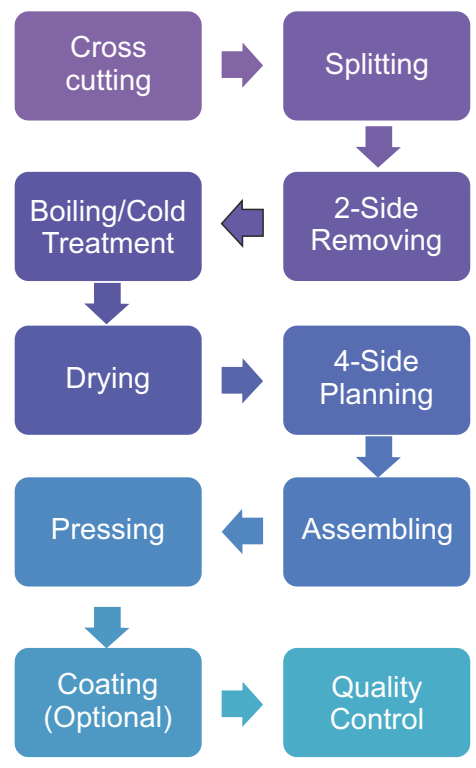
Bamboo Mat Board (Inv. Rs. 2 Cr)	-Phenolic resin based (Turns dark red); -Urea Formaldehyde (Transparent. Emissions); 1200 Tonnes press	-Density 0.65 MT/m ³ ; Colour darkens. Leaks in 3-4 years. Little demand.	-12-14 units started. -Tinpac (WB); Kerala; Assam (3 units survive)
Strand Woven Board (SWB) (Inv. Rs. 4-5 Cr but Mutha Rs. 30 Cr.)	-Melamine resin (w/wo emissions) -Strips. needn't be straight. Cold Pressed 3000-5000 Tonnes.	-Density 1.1-1.4 MT/m ³ (V. High); Rs. 500/ sq. m 15 mm. Exterior apps.; Looks natural wood grains.	-5 started. 2 running (Mutha in Tripura and Sourav Saikia in Assam) Ambee (2002) Assam & Unitech Nagpur closed.
Bamboo Strip Board (BSB) (Inv. Rs. 4-5 Cr)	-100-200 Tonnes Hot Pressed w/wo 6 mm thick sheets on top/ bottom for 25 mm	-Density: 0.7 MT/m ³ . Teak look. Square shaped. Rs. 400/ sq. m 18 mm.	-4 units started. All practically closed (2 running on paper)
Particle Board (Inv. Rs. 300-400 Cr) Artisan: 2,200 Cr.) 1000 Ton particles p.d.	-Press with glue. Mostly agri residues.	-Density: 0.5-0.6 MT/m ³ ; No nail/ screws -Rs. 250-1000/sq. m. (25 mm)	-No unit in India (Artisan company to start in MP. Dev Mukherjee)
Veneer (Rs. 5-6 Cr)	-1-3 mm slices from 25 mm strip board.	-Density 0.7 MT/m ³ . Teak look.	-None

3. Main Manufacturing Process of EB:

1. Cross cutting
2. Splitting
3. Bamboo split 2-side removal
4. Boiling or Carburising
 - BOILING either for 45 min to 3 hours in a tank (200 litres of water & 1 litre of H₂O₂) for bleaching OR mix 1% Borax i.e., 8 Kg of Borax Oxide & 2 Kgs of Boric Acid in 1000 litres of water at 0.3 MPa steam pressure for 40-120 minutes
 - CARBURISING (Heating strips leading to change of colour, drying for 32 hours (8 hours @ 80 degree C; 8 h @ 60 C; 8 h @ 80 C and 8 h @ 60 C) to get moisture level at 6%
5. 4-side planing
6. Assembling (Same coloured sheets outside for floor tiles)
7. Gluing (150 g/sq. m per surface of the middle sheet) in a 3-layered floor tiles
8. (a) Pressing with 200 Tonnes Press in one direction and 100 Tonnes press the sides at 100-140 degree C with steam for 10-15 minutes or Pressing time depends on temp, board thickness, thermal conductivity and initial moisture content.
 - (b) Pressing at room temperature for 2 hours followed by baking
9. Sanding (80 & then 240 grits) & Painting (multi coats on the top side)



Production Process



4. Machines/ Equipments required for both types:



Cross Cutting Machine



Parallel Cutting (Also Splitting Possible)



Two/Four side removal machine



Boiling tank (Low cost one, else with industrial boiler)



Bundles of dried bamboo strips



Side Moulding Machine (Small Sized)

Assembling

Layout of a 3-layered laminated horizontal board and Layout of a vertical layered laminated board





Gluing



Press Machine (1000-2000 mm Length) Hot:10 15 Min Cold: 2 Hrs



After Pressing the board looks like this. It requires sanding and cutting around all sides



Finished Product: Bamboo stripped Board

Floor tiles (Bamboo stripped Board)



Interior using EBs : Strand Woven Board



Bamboo Material component: 15%; @ Rs. 12,000 PMT

An important determinant of the Cost

- Processing of bamboo should be done within 3 days of its harvesting. Otherwise, the cost of processing goes up significantly.
- Chinese enterprises therefore undertake primary processing up to the stage of getting dried bamboo strips close to harvesting locations.
- The dried bamboo strips are then supplied to the secondary processing facility in industrial area.
- The binding of dried bamboo, gluing it and pressing & finishing it is then undertaken in the industrial areas.
- However, if the integrated facility of primary and secondary processing is closer to the harvesting place, this problem is not there.
- Yet, other problems pertaining to the maintenance of factory machines, availability of skilled human resources and other support requirements remain if the integrated plant is remotely located, as in the case of India.
- Since during the monsoon period, there will be no or little harvesting of bamboo, it is necessary to stock the dried bamboo strips for 3 months for secondary processing and this has working capital implications for the project.

5. Global Scenario: Comparison between India and China

India

- 100-200% higher priced as compared to China
- Our species conducive to Indian conditions of moisture. Doesn't get warped, but the Chinese does.
- Problem is also economies of scale.
- Estimated gross production in India is Rs.30 Cr and we have a potential to grow 25 times more to reach a value of Rs.750 Cr in a period of 10 years.
- Total employment: 375; Bamboo used: 3,750 MT p.a. Hectares of bamboo used p.a. 37.24

China

- Bamboo wood cheaper than comparable wood & wooden composites (Burma teak)
- China makes 1/3rd of plywood and wooden furniture of the world.

Global

- Industrialized bamboo products: Rs.40,000 Cr. (incl. bamboo flooring, tableware, furniture, partitions)



Bamboo Wood Doors & Windows: Stranded Woven Board

Typical Costing per sq. meter

Global costing typical breakup: (12 mm thickness density 0.7)

- Bamboo Material: 6.5
- Chemicals: 2.5
- Water & Purification: 0.7
- Wages: 1.4
- Mfg. cost: 0.8
- Other materials: 0.5.
- **Total: 12.4 USD (Rs. 900 per sq. m)**

India: (As per Mutha) (12 mm thickness density 1.1)

- Rs. 4500 per sq. m
- Estimated labour component: 15%; @ Rs. 1.20 lakh p.a.

6. Product Specifications

Table 32 : Product Specifications

Technical Details of ESES

S.No.	Performance Characteristics	Test Method	Criteria	Result Obtained
1	Density	IS: 1708 (Part 2) 1986	0.65-0.9	1.11g/cm ³
2	Hardness	IS: 1708 (Part 10) 1986	480-1000 Kgf	>1462 Kgf
3	Modulus of Rupture (MOE)	IS: 1708 (Part 5) 1986	>150 N/mm ²	260.72 N/mm ²
4	Modulus of Elasticity (MOE)	IS: 1708 (Part 5) 1986	>17500 N/mm ²	>41076 N/mm ²
5	Moisture Content	IS: 1708 (Part 1) 1986	>12% (oven dry method)	6.79%
6.	Screw Withdrawal Resistance	IS: 2380 (Part 14) 1977	>200 Kg (Edge)	322 Kg
7.	Screw Withdrawal Resistance	IS: 2380 (Part 14) 1977	>250 Kg (Flat Face)	355 Kg

Source: INBAR & other documents

Table 33: Relevant Indian Standards⁵⁸

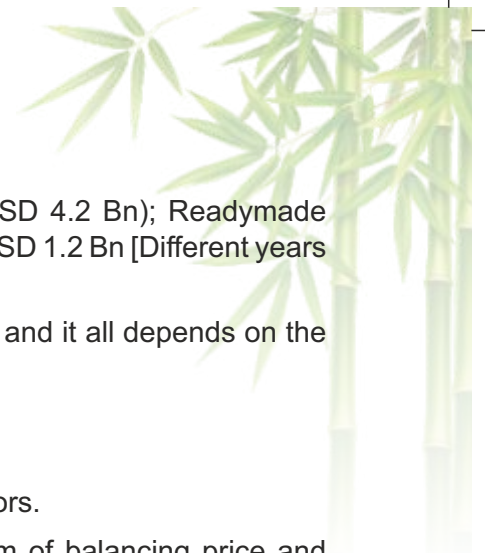
IS No.	Title
303 : 1989	Specification for Plywood for General Purposes (Third Revision)
401 : 2001	Code of Practice for Preservation of Timber (Fourth Revision)
707 : 2011	Glossary of Terms applicable to Timber Technology and Utilization(Third Revision)
848: 2006	Specification for Synthetic Resin Adhesives for Plywood [Phenolic and Aminoplastic] (Second Revision)
1902 : 2006	Code of Practice for Preservation of Bamboo and Cane for Non-Structural Purposes (Second Revision)
2380 : 1977	Methods of Test for Wood Particle Boards and Boards from other Lignocellulosic Materials (First Revision)
6874 : 2008	Methods of Test for Round Bamboos (First Revision)
13958:1994	Specification for Bamboo Mat Board for General Purposes
14588:1994	Specification for Bamboo Mat Veneer Composite
15476:2004	Specification for Bamboo Mat Corrugated Sheet
Draft Indian Standard: FLATTENED BAMBOO BOARD – SPECIFICATION: (ICS No. 79.060.99) May 2020	

7. Market Prospects for Wood Industry

That EB aims to serve:

- High growth in domestic demand: 58 mn. m³ (Yr. 2000) that increased to 85 mn. m³ (2008) & further to 153 mn. m³ (2018) estimated. Gross: USD~30 Bn of which 6 mn. m³ worth USD 1.3-2.0 Bn was imported (2010-18).
- 85% of domestic industry is unorganised with wood logs (70%) and not sawn timber; also due to higher import duties for the latter
- Popular species: Sandalwood, Teak, Sheesham, Deodar, Ebony, Redwood, Rosewood, Red cedar and Sal

⁵⁸ Softwood Export Council - News

- 
- Primary drivers: Wooden furniture (USD 5.4 Bn); Interior decoration (USD 4.2 Bn); Readymade wooden doors (USD 0.52Bn); Flooring (USD 113 Mn); Plywood industry: USD 1.2 Bn [Different years 2010-15]
 - **Conclusion:** The size of gross demand is indeed very high (7000 times) and it all depends on the offering by the Engineered Wood as to how much can it substitute timber.

8. Extent of usage of EB in India and way forward:

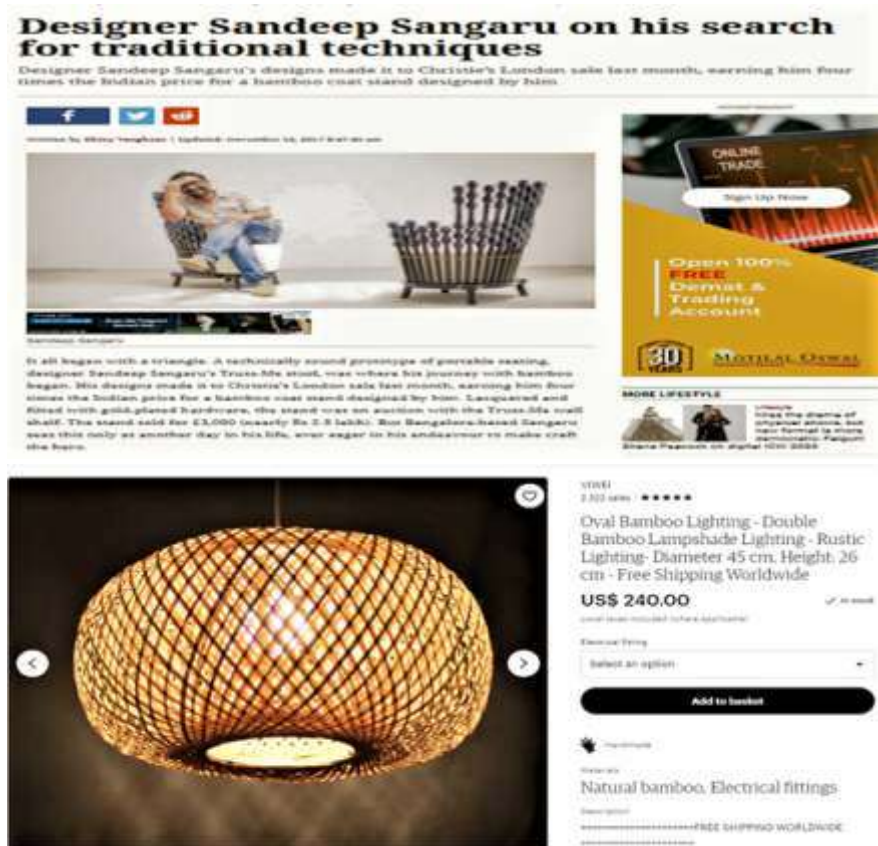
- Lack of ecosystem, poor supply chains for bamboo supply are inherent factors.
- Higher costs and therefore higher prices lead to chicken & egg problem of balancing price and demand.
- Suggested to National Bamboo Mission for reserving partial public procurement to ensure increased usage of this material or by giving non-financial incentives through increased Floor Area Ratio concession to the builders.
- Lack of awareness has been the bottleneck inhibiting bamboo from taking shape in construction. So, support demonstrative projects in every district.
- Strengthening institutions and government scheme can proliferate bamboo use in construction.
- Better to target BSB that requires lesser material in quality as compared to SWB, provided the manufacturer has the capacity to create the market for its products.

Chapter 6 : Quality Compliance

Authors' Names: Mr. Ashutosh Samal (Technical Advisor, FMC); Mr. Sanjeev Karpe (Bamboo Expert); Mr. Mukesh Gulati (Current Executive Director, FMC); Mr. AG Rao (Retired Professor IIT Mumbai) and Mr. ASK Sharma (General Manager, FMC)

Discussants' Names: Mr. Anit (Technical Advisor, FMC); Mr. Mukesh Gulati (Current Executive Director, FMC); Mr. Abhishek (Entrepreneur); Mr. Tamal Sarkar (Current Senior Advisor, FMC); Mr. Karan Butalia (Retired Banker Axis Bank)

Subject-Matter Expert: Mr. Ajith Sen (Regional Director, ESAF)



The Temple Hotel is the only Beijing-based hotel and one of the only two hotels in China named to Conde Nast Traveller’s 2014 Hot List of The Best New Hotels in the world.



The Temple Hotel, Beijing

These standards are being followed:



- The International Organization for Standardization (ISO) is an international standard-setting body composed of representatives from various national standards organizations. Founded in 1947.⁵⁹
- The Bureau of Indian Standards is the national Standards Body of India working under the aegis of Ministry of Consumer Affairs, Food & Public Distribution, Government of India. It is established by the Bureau of Indian Standards Act, 1986.⁶⁰
- The ISI mark is a standards-compliance mark for industrial products in India since 1955. The mark certifies that a product conforms to an Indian standard (IS) developed by the Bureau of Indian Standards (BIS).⁶¹
- The National Accreditation Board for Certification Bodies (NABCB) undertakes assessment of Certification and Inspection Bodies applying for accreditation.⁶²

Table 34: Bureau of Indian Standards

S.No	Title	Standard No.	Year
1	Preservation of Bamboo and Cane for Non-Structural Purposes-Code of Practice ⁶³	IS 1902	2006
2	Preservation of bamboo for structural purposes - Code of practice	IS 9096	2006
3	Method of tests for bamboo	IS 6874	2008
4	Methods Of Tests for Split Bamboos	IS 8242	1976
5	Bamboo Tent Poles	IS 7344	1974
6	Bamboo Supports for Camouflaging Equipment	IS 10145	1982
7	Bamboo Chicks: Part 1 Fine ⁶⁴	IS 8295 :Part 1	1976
8	Bamboo Chicks: Part 2 Coarse	IS 8295 :Part 2	1976
9	Structural Design Using Bamboo — Code of Practice (First Revision)	IS 15912	2018
10	Bamboo Mat Board for General Purposes - specification	IS 13958	1994
11	Bamboo Mat Corrugated Sheets -Specification	IS 15476	2004
12	Bamboo mat veneer composite for general purposes - Specification	IS 14588	1999
13	Bamboo-jute Composite Corrugated & Semi-corrugated Sheets Specification	IS 15972	2012
14	Bamboo-Jute Composite Panel Door Shutter - Specification	IS 16073	2013

59 ISO International Organization for Standardization - IDMP Wiki (idmp1.com)

60 Bureau of Indian Standards celebrates the 74th foundation day (10pointer.com)

61 ISI mark - Wikipedia

62 National Accreditation Board for Certification Bodies...(qci.org.in)

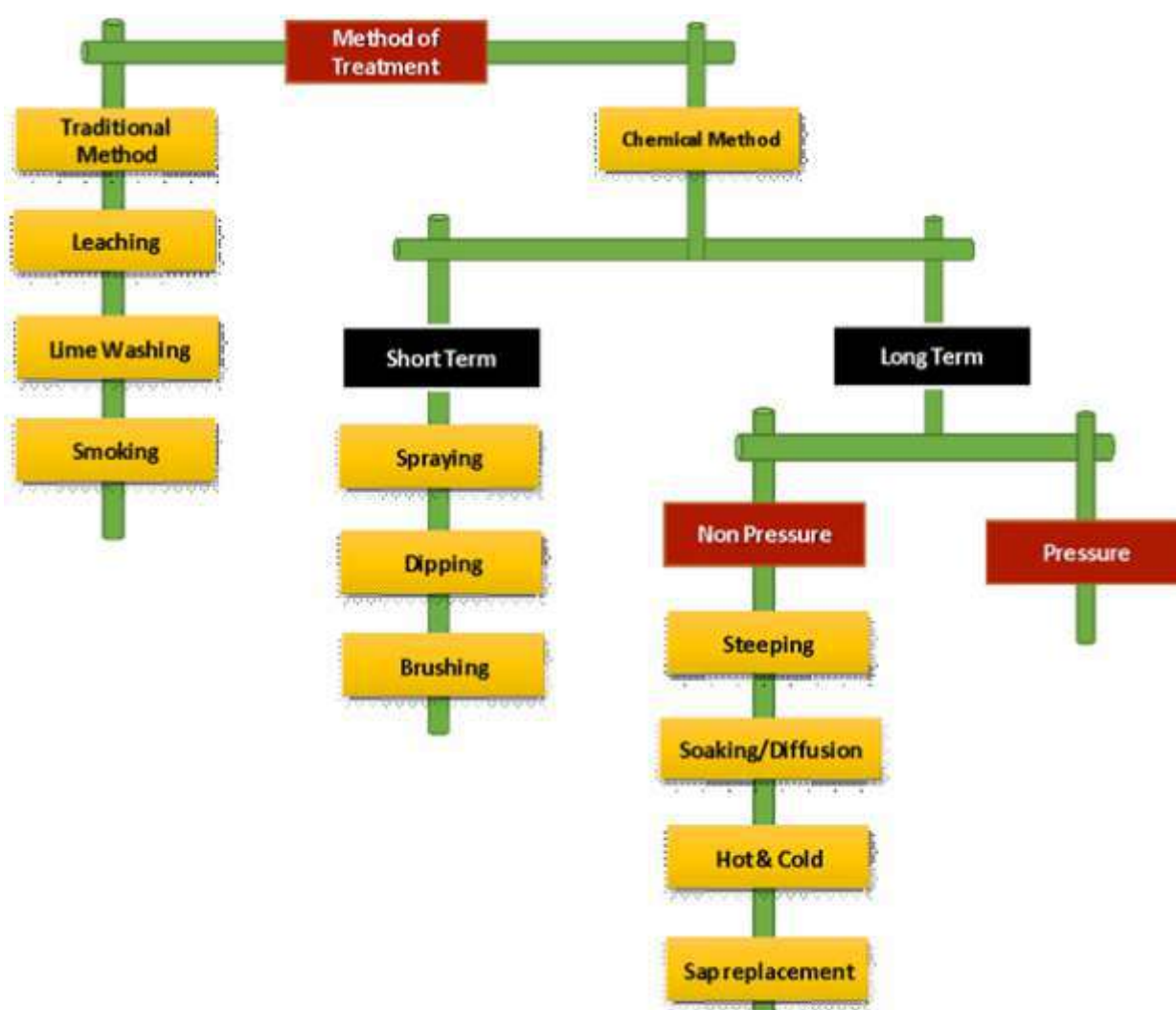
63 IS 1902: Preservation of Bamboo and Cane for Non-Structural Purposes-Code of Practice: Bureau of Indian Standards: Free Download Borrow, and Streaming: Internet Archive

64 IS 8295-1 (1976): Bamboo Chicks, Part 1: Fine (resource.org)

S.No	Title	Standard No.	Year
15	Canned bamboo shoot	IS 15688	2006
16	Bamboo shoot in brine	IS 15689	2006
17	Dry salted bamboo shoot	IS 15690	2006
18	Dehydrated bamboo shoots	IS 15698	2006
19	Guidelines for storage and transportation of bamboo shoot	IS 15691	2006
20	Guidelines for production of nursery stock for bamboo	IS 8663	1977

Treating of Bamboo (Preservation of Bamboo for Structural Purposes Code of Practice - IS 9096-2006)

Methods of Treatments:



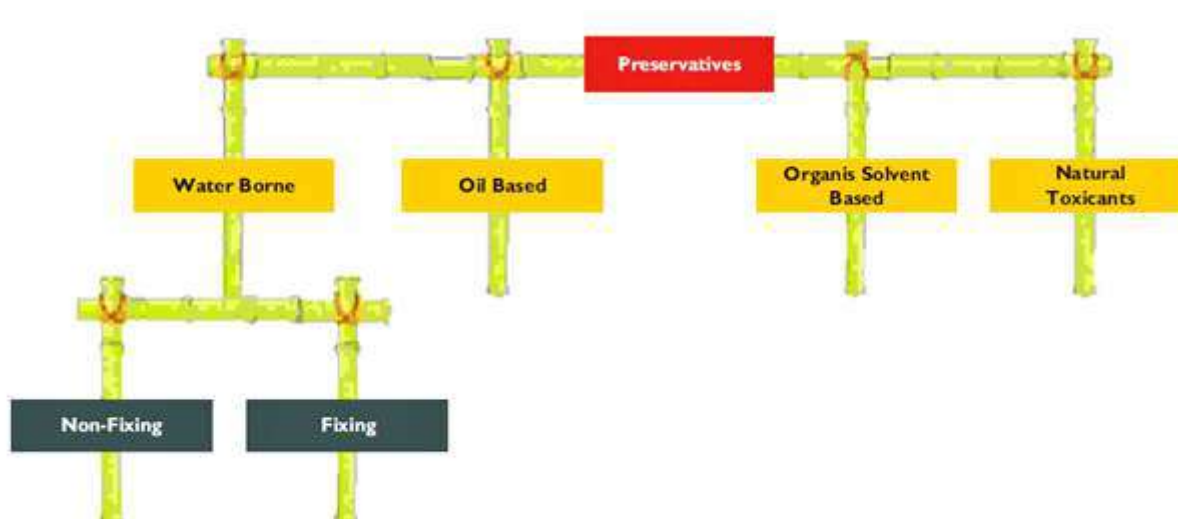
Natural Toxicants

- Some naturally occurring materials can prevent decay to some extent.
- Long-term protection is not possible through these preservatives.
- The Giant Indian Milkweed is deadly to beetles and fungi. Boiling of slivers with fresh leaves and stems of this plant for 30-60 minutes will prevent attack.

Chemical Preservatives

- Use of chemical preservatives ensures long-term protection.
- Depending upon the method of treatment, chemicals can impart short-term or long-term protection.

Types of preservatives



Non-Fixing type preservatives⁶⁵

- These are leachable solutions and their use is restricted to bamboo used in dry conditions and under cover. Bamboo treated with these preservatives
- Should not be exposed to rain or ground contact.
- Common example - Boric acid: Borax & copper sulphate

Fixing type preservatives

Copper - Chrome - Boron (CCB)

- Copper is effective against decay fungi and soft rot.
- Chromium is responsible for fixation.
- Boron acts against insect and fungus.
- Boric acid, copper sulphate and sodium dichromate in the ratio 1.5:3:4. (IS 10013 (Part 3))

Pressure Treatment

- Pressure methods ensure quick and uniform penetration of the preservative deep inside bamboo.
- The principle of the process is to force the preservative into the bamboo tissue.
- This can be achieved by increased pressure upon the preservative in a pressurized cylinder.
- Bamboo treated by this method will last for about 50 years for building components.

Grading for Structural use

- Species – Dendrocalamus stocksii/ Bambusa balcooa
- Age of culm – 3 to 4 years
- Diameter at bottom – Min 45 mm

⁶⁵ Timing Manual TM 05 07/06 Preservation of Bamboo NATIONAL MISSION ON BAMBOO APPLICATION Technology Information, Forecasting, And Assessment Council (TIFAC) Department of Science and Technology, Government of India

- Diameter at top – Min 35 mm
- Length – Min 4 Mt.
- Taper of culm – Max 4 mm/Mt. length
- Straightness of culm - The maximum curvature should not be more than 75 mm in a length of 6 Mt.
- Wall thickness – Min 10 mm

Age Grading



Dry Bamboo



Freshly cut Bamboo

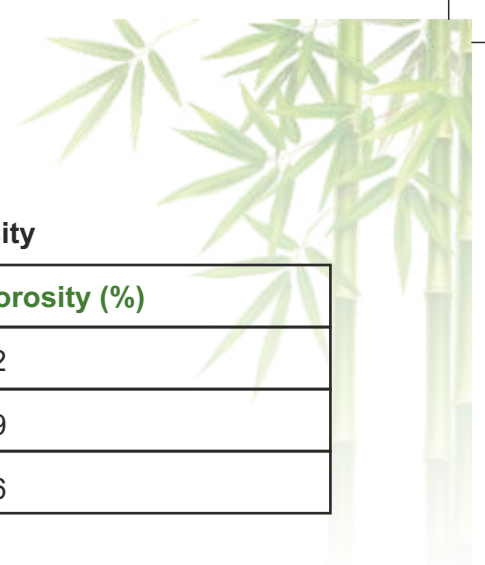


Table 35: Influence of Age on the Density and Porosity

		Density (kg/m ³)	Porosity (%)
Age (Years)	2	755	42
	3	877	29
	4	782	36

Table 36: Influence of Age on the Shrinkage

		Shrinkage (%)			
		Longitudinal	Radial	Tangential	Volumetric
Age	2	0.88	7.69	15.17	22.24
	3	0.91	5.21	8.80	14.34
	4	0.90	5.60	10.72	16.50

Table 37: Influence of Age on the Shrinkage

Sl. No.	Tariff Item HS Coade	Unit	Item Description	Export Policy	Nature of Restriction
90B	1401 10 00	Either Tons or Square Meter or number	Bamboo products made from bamboo obtained from legal source; except bamboo charcoal, bamboo pulp and unprocessed bamboo shoots	Free	<p>1. All the bamboo products made from bamboo obtained from legal sources are permitted for export subject to proper documentation/Certificate of Origin (CoO) proving that the bamboo used for making products has been obtained from legal sources.</p> <p>2. The CoO shall be issued by the concerned State Forest Department/ Agriculture Department from where bamboo has been precured by the purchaser of making handicrafts/ machine made products.</p>

**Forest Department/Agriculture Department
state Government of Certificate of Origin**

Reference: Export of bamboo products as per the provision of export policy

Certificate No.

Date:

1	Name and Address of Applicant	
2.	Registration No. and date of registration (attach a copy of registration)	
3.	Address of location of goods in question	
4.	Dates(s) of inspection	
5.	Transit Pass No. and data	
6.	Source of Bamboo (Location and Name of the State)	
7.	Details of bamboo products* proposed for export (In metric Ton/sq. Mt./Number) Products (specify) Furniture: -----units Mats : -----units Artifacts: _____units	

Not: *The finished products of define shape are to be photographed when appropriate measuring tape/scale kept basic to give an indication of size and the photograph must be included and certified.

1. It is certified that bamboo used for making its products has been verified to have been obtained from legal source.
2. The certificate is valid for the period of two months from the date of issue.

Given this _____ days of _____ month and year at _____ (Place)

(Authorized signatory of State Government)

Glue⁶⁶

- There are different types of glue in the market, with some containing complex ingredients that may contain formaldehyde, one of the banned substances in EU. It is important to test the glue before use to ensure that it complies with the requirements of EU market as products with formaldehyde in glue are prohibited from being imported into EU.
- Studies have indicated that formaldehyde is a known human carcinogen. Forbiddance of formaldehyde is mentioned in German chemicals prohibition ordinance and EU food contact regulation.

66 General Technical Requirements for Handicraft Products (tuv.com)



Chemicals in prevention of mould

- Chemicals are used on bamboo to make them resistant to mould. Some chemicals used to prevent mould, such as Chlorinated Phenol (Pentachlorophenol – PCP, Tetrachlorophenol – TeCP, Trichlorophenol - TCP), are banned and strictly controlled in products imported into EU.
- PCP is very toxic and is regarded as a human carcinogen. These chemicals are restricted by REACH 1907/2006/EC Annex XVII and banned in some EU countries (Germany, Switzerland, Denmark).
- During agriculture and forestry, chemicals like Carbendazim are widely used as a fungicide for trees. When these trees are harvested, they are placed close to raw materials used for handicrafts such as bamboo and wood. This can lead to cross pollution in material and should be noted in manufacturing as Carbendazim residual can be found on the raw materials used to make handicrafts.
- High doses of Carbendazim can cause infertility and destroy the testicles of laboratory animals. As Carbendazim is a pesticide, it must not exceed the acceptant limit, which varies according to product.

Paint and varnishes

- Paints and varnishes used for decoration of handicrafts must strictly adhere to the requirements as follows:
- Colours shall not fade and will not leave stains on clothes.
- Phthalate content shall not exceed the acceptable limit.
- They shall not contain banned azo dyes, Polycyclic Aromatic Hydrocarbons (PAHs), Formaldehyde.
- Lead content shall not exceed the acceptable limit.

Regulations applying for special types of products

- Many products are designed for dual purposes, such as bowls made of bamboo or wood. They can be used as decoration as well as serve as food containers. EU requires these products to be tested according to the requirements of decoration articles and also food contact articles. The requirements of colour, chemical, smell infection need to be strictly controlled.
- Products which can be used as toys for children will be checked even more stringently. The limit of chemical is much lower than the products that are designed for adult use. Sharp edges and sharp points which may be dangerous for children are also one of the EU restrictions.

The Forest Stewardship Council (FSC)⁶⁷

- The Forest Stewardship Council (FSC) is to promote environmentally sound, socially beneficial, and economically prosperous management of the world's forests.
- FSC certification ensures that products come from responsibly managed forests that provide environmental, social, and economic benefits.
- FSC Chain-of-Custody certification traces the path of products from forests through the supply chain.
- FSC is one of the most rigorous, credible forest certification systems.

67 Teragren Bamboo - Seeking Perfection in what we bring to market

- The most common use is to convince investors to fund a business, and the second most common is to support a loan application
- EBP (External Business Plan) is a reflection of IBP, but presented in a more professional way
- External plan details how potential funds are going to be used and what the expected return on their (donors/ funding agencies) investment is.

External plans put a strong emphasis on the team that is building the company- Investors invest in people rather than ideas, it is critical that the business plan includes CVs of key team members and how their background and experience is going to help grow the company.

Pre-Requisites of a Business Plan

- Market growth assessment
- Machine capacity assessment
- Quotations for entire machinery and misc. fixed assets
- Civil estimates for construction/ alteration (if required)
- Component-wise rates as fixed by concerned state (if applied under grant)
- Prices of raw materials, and consumables
- Prices of utilities (power, water, diesel, etc.)
- Estimates for power consumption
- Details of manpower requirement along with wages/ salaries
- Assessment of taxation & depreciation
- Latest profiles of promoters
- Bank interest, term loan moratorium, repayment period (if any bank loan involved)
- Sale deed/ Lease deed
- Details on insurance, selling, maintenance expenses
- Details of electricity deposit, lease deposit, caution deposits, if any

Appropriate Time for Business Plan:

Ideally After

- Self assessment by prospective entrepreneur
- After confirming which bank/ FI to submit and under what scheme
- Assessing financial commitment
- The necessary quotations, civil estimates (if required) and statutory approvals.

Who should prepare a business plan?

Ideally

- The entrepreneur with the help of a chartered accountancy firm
- Facilitating Agency/ Nodal Agency (not in all cases)
- Any TCO

Who should appraise a business plan?

- Concerned Bank
- Nodal agency nominated by funding agency
- Banks
- Any Technical Institution

Chapter 7 :

Financial Planning for Bamboo

Author's Name: Mr. ASK Sharma (General Manager, FMC)

Discussant's Name: Mr Karan Butalia (Retired Banker Axis Bank)

7.1 Prepare a business plan

What is Business Plan?

It is a roadmap for your business that outlines goals and details how you plan to achieve those goals.

Types of Business Plans

1. For Start-ups

- Prior to plan – Requirement of money needed is unknown, and when it is needed, without laying out projected sales, costs, expenses, and timing of payments.⁶⁸
- Plan helps the founders break uncertainty down into meaningful pieces – like the sales projection, expense budget, milestones and tasks.
- Focus of business plan is explaining the what and how of the business, who will do it and why the business is required and why are the promoter(s) the right fit for the business.
- Also, details of the amount of money needed to get the business off the ground, and through the initial growth phases that will lead (hopefully!) to profitability.⁶⁹

2. For Existing Business

- Use business plans to manage and steer the business, not just to address changes in their markets and to take advantage of new opportunities.
- Focus is to reinforce strategy, manage responsibilities and goals, track results, and manage and plan resources, including critical cash flow basically for regular review and revision.

3. Internal

- The internal business plan focusses almost exclusively on business strategy, milestones, budgets, and forecasts.⁷⁰
- Also includes the review schedule for monthly review and revision.
- IBPs (Internal Business Plans) skip details about company's history and management team since such information is already known.
- They are management tools used to guide the growth of both startups and existing businesses.
- Help promoters think through strategic decisions and measure progress towards goals.⁷¹

4. External

- Known as formal business plan documents and are designed to be read by outsiders to provide information about a business

68 What is a Business Plan? (bplans.com)

69 www.issuu.com

70 (1) Assignment on: Content of Business Plan - What is a Business plan | tanvir Khan Jewel - Academia.edu

71 www.issuu.com



Selection of right kind of business plan:⁷²

- Need to think about who the audience is and what are the goals of plan (Internal or External, grant or loan, startup or existing)
- BP (Business Plan) formats vary, depending on the type of business and audience. Only few components are common (sales forecasts, market plan, resource strategy, etc.)
- Business plan for a development venture (like CFC) vastly differs from individual enterprise – First one may be targeting grant whereas the latter one is purely commercial.
- Business plan of a manufacturing unit (emphasis may be more on technology) varies from a service unit (emphasis may be on HR planning).
- Casual language may be used for internal BP, but for submitting to banks and FIs, they should appear more professional.

Component of a formal Business Plan:

- **Executive Summary:** An aid to decision making by managers which summarizes a longer report or proposal in such a way that readers can rapidly become acquainted with a large body of material without having to read it all.⁷³

Major Points to remember

An executive summary should⁷⁴

- Present the company's mission (Purpose)
- Describe the company's product and/or service offerings.
- Give a summary of the target market and its demographics.
- Summarize the industry competition and how the company will capture a share of the available market.
- Give a summary of project cost & means of finance

Industry and Company Overview:

- Concerned industry scenario -Information about the industry that the business will operate in, estimated revenues, industry trends, government influences, as well as the target market should be provided.
- Describe the company's position in the industry – including existing competition and major players of industry
- Rationale for establishment/ expansion of the unit

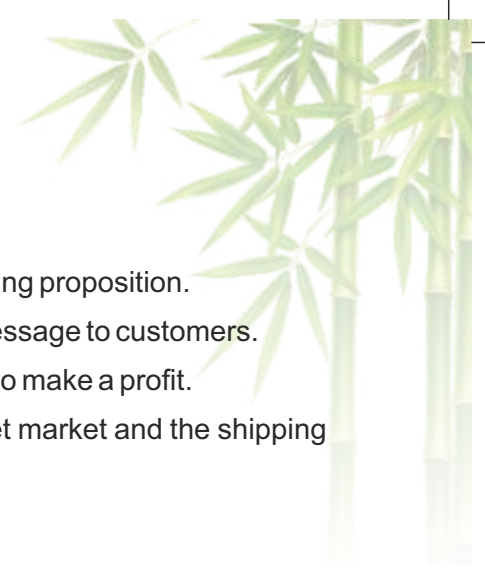
Market Analysis and Competition:

- Define your target market, their needs, and their geographical location.
- Describe the size of the market, the units of the company's products that potential customers may buy, and the market changes that may occur due to overall economic changes.
- Give an overview of the estimated sales volume vis-à-vis what competitors sell.
- Give a plan on how the company plans to combat the existing competition to gain and retain market share.

⁷² www.articles.bplans.com

⁷³ What is executive summary-Definition of executive summary-Word finder (findwords.info)

⁷⁴ Corporate Finance Institute | FMVA® | CBCA™ | CMSA® | BIDA™



Sales and Marketing Plan:

- Describe the products that the company will offer for sale and its unique selling proposition.
- List the different advertising platforms that the business will use to get its message to customers.
- Describe how the business plans to price its products in a way that allows it to make a profit.
- Give details on how the company's products will be distributed to the target market and the shipping method.

Management Plan:

- Describe the organizational structure of the company.
- List the owners of the company, their profile and ownership percentages. (Shareholding pattern)
- List the key executives, their roles, and remuneration (Optional)
- List any internal and external professionals that the company plans to hire, and how they will be compensated.
- Include a list of the members of the the advisory board, if available.

Operating Plan:

- Describe the location of the business, including office and warehouse requirements.
- Describe the labour requirement of the company. Outline the number of staff that the company needs, their roles, skills training needed, and employee tenures (full-time or part-time).
- Describe the manufacturing process
- Describe the equipment and machinery requirements, and if the company will lease or purchase equipment and machinery, and the related costs that the company estimates it will incur.
- Provide a list of raw material requirements, how they will be sourced, and the main suppliers that will supply the required inputs.

Financial Plan should Include:

Basic assumptions for financial analysis

Details of various components of expenditure like:

- Preliminary & Preoperative Expenses
- Salaries & Wages
- Working Capital Requirement
- Depreciation
- Profitability
- Balance Sheet
- Funds Flow
- Break-Even Analysis
- IRR
- Sensitivity Analysis

Perceived Risks & Mitigation Measures



Appendices and Exhibits Should include:

- Civil Estimate Statement signed and stamped by Civil Engineer
- Plant Layout
- Quotations – Plant and Machinery, Miscellaneous Fixed Assets
- Registration Certificate & Articles of Association/ Bylaws
- Copy of Bank Account (Current) of SPV
- Trade Licence
- Pollution NOC/ Clearance from concerned authorities
- Registration of SPV
- Registered Lease Agreement (If land/ building taken on lease) or sale deed (if land/ building is owned)
- Valuation report on land & building (if already existing)
- Land Conversion Document (From Agriculture to Industry)
- Approval from concerned power distribution authority, water works department
- In-principle approval from concerned technical institutions (BIS for Testing, FSSAI for food processing, etc.)
- Consent letter from bank/ State/ Central funding agency (for any part finance or for WC)
- Udyog Aadhaar
- Last three years audited statements

Important sections of a business plan for bankers:

- Details of management team, their education and experience (Track Record)
- Creditworthiness of the promoters (past payment record, net worth, involvement in other ventures, etc., CIBIL Report in India)
- Location of the unit (presence of amenities, proximity to market, proper physical infrastructure in place)
- Site of unit – whether leased or owned, devoid of any legal issues, agriculture/ commercial
- Proper market plan (include major buyers, work orders, EoIs, MoUs) including competitor analysis
- Execution strategy – Production, marketing and management AoA and MoA/ Bylaws of the company
- Issues related to pollution
- Presence of statutory requirements related to power, taxation, water connection, land conversion, production process
- Collaterals, guarantors, possibility of grants leveraging
- Any discrepancies between audited statements submitted and financial statements (for existing units)
- Financial Estimates: P&L, BS, Cash Flow, WC assessment ratios like BEP (Break, Even point), NPV (Net Present Value), RoI (Return on Investment), DSCR (Debit Service Coverage Ratio), Current Ratio, etc. – as realistic as possible.



Important tips in preparation of Business Plan:

- A good BP can be of 20 to 30 pages, excluding annexures.
- Use simple language and words which can be understood by all.
- Avoid generic statements as far as possible, use facts and figures.
- Mind that a BP is not a thesis but a business plan; do not give undue emphasis on technology, global and national scenario.
- Give a list of acronyms after the contents page.
- Give bibliography at the end of the report.
- Use pleasing font and font size preferably 10 or 11.
- Check for spelling mistakes and improper sentence structuring
- If any secondary data is used, the source for the same should be provided.
- Always take the help of a technical expert for technology-intensive projects.
- Try to take colour printout; if not possible, at least cover page needs to be in colour.
- ABP may go for 3 to 4 iterations at the time of appraisal and submission to funding agency, do not lose heart, make all necessary corrections/ incorporate suggestions.

7.2 How to make the project bankable

I. Project Cost Estimation:

Table 38: Components: Project Cost Estimation

Sr No.	Cost Heads
1	Land & Land Development
2	Building & Civil Works
3	Plant & Machinery
4	Electrical Equipment's
5	Miscellaneous Fixed Assets
6	Contingencies
7	Deposits
8	Preliminary
9	Pre-Operative Expenses
10	Margin Money for Working Capital ⁷⁵

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Table 39: Project Cost Estimation: Land and Land Development

Sl. No.	Cost Head	Cost
1.	Land (Extent of Land / Survey No. Land Documents are essential and to be enclosed in DPR)	
2	Registration & Documentation Expenses (Proof to be enclosed in DPR)	
3	Land Development (Quantity to be excavated, type of Soil, Quantity to be filled with lead rates, PWD or State SoR followed to be specified and to be prepared by Civil Engineer. To be Enclosed in BP)	

Land and Land Development

- Cost of land to be considered as per Registered Sale Deed and not as per Market Value
- Add the actual cost of registration
- Cost of land is not funded under any scheme.
- Land development can include Land Filling, Green Belt Development, compound wall & fencing and gates

Table 40: Building and Civil Works

Sl. No.	Cost Head	Cost
1.	Factory Shed / Building	
2	Laboratory & Administrative Building	
3	Machinery Foundation	
4	Other Works (OHT, Sump, Drainage)	

- Bill of quantity to be prepared for each category of work separately.
- Market rates, PWD or State SoR followed to be specified.
- It should be prepared by Chartered Civil Engineer.
- To be enclosed in BP
- Under some scheme, land and building cost will be considered as equity and no grant will be given for the purpose.
- Land and building can be taken on lease (Period should be minimum equivalent to repayment period).
- Valuation of the building/ shed to be done in case such building is owned by a promoter
- (Mainly under schemes)


Table 41: Format for Plant and Machinery required

Sl. No.	Machine	Capacity	Rated Power	Supplier	Quantity	Delivery Schedule
1						
	Basic Cost (FoR)	Taxes	Packing	Freight	Insurance	TOTAL

**This is a sample format for reference purposes only*

All Quotations to be Enclosed in BP

Table 42: Format for Electric Equipments and Miscellaneous Fixed Assets

Sl. No.	Equipment's	Capacity	Rated Power	Supplier	Quantity	Delivery Schedule
1						
						
Basic Cost (FoR)		Taxes	Packing	Freight	Insurance	TOTAL

**This is a sample format for reference purposes only.*

All quotations to be Enclosed in BP

Contingencies:

- Contingencies for Civil Works may be between 2 to 5% and for P&M, Electrical Equipments @ 5 to 8%

Deposits:

- Deposits towards Lease rentals to be made part of the project cost
- Deposits towards power connection should be made a part of the project cost
- Deposits are not funded under any Scheme and should be brought in as equity

Preliminary Expenses

- Consultancy Fee for DSR & DPR
- Legal & Administrative Expenses
- SPV Registration Charges

Pre-Operative Expenses

- Travel, Legal & Administrative Expenses
- Salaries During Construction
- Interest During Construction
- Trial Production Cost

Margin Money for Working Capital:

- Ideally 25% of the of the working capital requirement should be made part of the project cost in case working capital loan is proposed to be availed. (However, it may vary).
- If working capital loan is not processed than the entire working capital requirement should be considered as a part of the project cost (Only in schemes like PMEGP or Sfurti)
- Working capital assessment to be done separately and elaborately with proper justification.

II. Means of Finance:

- Project and Means of Finance should match with each other.
- Promoter's equity in general is 25%, however it may vary if applied under any scheme
- State Government Contribution can be cash or in the form of land/ building.
- Bank Loan will normally be 75%, But may vary if applied Under any scheme

Table 43: Format for calculating Means of Finance

Sl. No.	Source Head	Cost
1	Promoter's Contribution	
2	State Government Contribution	
3	GoI Grant	
4	Term Loan	
5	Other	
6	TOTAL	

**This is a sample format for reference purposes only.*

III. Revenue Projection:

Key Factors

- Installed Capacity
- Capacity Utilization
- No. of shifts & working hours
- No. of working days in a month/ year
- No. of units produced
- Sale price
- Taxes (GST) on products
- Sales Realization

Table 44: An Example:

Description	2018-19	2019-20	2020-21
Installed Capacity (Tons per Shift of 8 hours)	5	5	5
No of Shift	1	1	1
No of Working days per annum	165	330	330
Capacity Utilization	50%	60%	65%
Actual Production (TPA)	412.50	990	2145
Sales Price (Rs. Per Ton)	50,000	50000	50000
Sales Realization (Rs. Lakh)	206.25	495.00	1072.50
GST @ 5% (Rs. Lakh)	10.31	24.75	53.63
Gross Sales (Rs. Lakh)	216.56	519.75	1126.13

IV. Raw Material Projection:

Key Factors:

- Consumption of Raw Material should be as per Industry standard and realistic
- Similar way assessment of Consumable and fuel should be done
- Taxes of Raw Material should be considered.

Table 45: Raw Material Projection

Description	2018-19	2019-20	2020-21
Raw Material 1 Consumption @ 1.5 Tons per ton of Output (TPA)	618.75	1485.00	3217.50
Raw Material 2 Consumption @ 0.5 Tons per ton of Output (TPA)	206.25	495.00	1072.50
Basic Price of Raw Material 1 (Rs. Per Ton)	10000	10000	10000
Basic Price of Raw Material 2 (Rs. Per Ton)	20000	20000	20000
Annual Cost of Raw Material 1 (Rs. Lakh)	61.88	148.50	321.75
Annual Cost of Raw Material 2 (Rs. Lakh)	41.25	99.00	214.50
GST on Raw Material 1 @ 5% (Rs. Lakh)	3.09	7.43	16.09
GST on Raw Material 2 @ 12% (Rs. Lakh)	4.95	11.88	25.74
Net of Taxes (Rs. Lakh)	8.04	19.31	41.83
TOTAL COST OF RAW MATERIAL (Rs. Lakh)	111.17	266.81	578.08

V. Power and Water Consumption

Key Factors:

- Consumption of power should be assessed for each machine separately based on the number of hours.
- Power consumption for other facilities like lab, administrative building and external lighting should be done separately.
- No. of units consumed should be clearly mentioned with calculation.
- Per Unit cost of power should be mentioned.
- Total cost of power should be mentioned clearly with above calculations.
- Similar way water consumption for industrial use and domestic use should be evaluated.
- Sources and total cost of water should be mentioned clearly.
- If water is being treated in the factory premises before or after use, the cost calculation should be mentioned properly.

VI. Manpower Requirement

Key Factors:

- Category-wise, manpower requirement should be mentioned.
- Variable and Fixed Manpower to be identified separately.
- Monthly salaries with 25% fringe benefits and 5% annual escalation can be shown.

Table 46: Manpower Requirement

Sl. No.	Category/Designation	No of Persons	Monthly Salary (Rs.)	Annual Salary (Rs. Lakh)
Variable Manpower				
	Machine Operator	2	20000	40000 X No of operating Months
	Skilled Labour	5	10000	50000 X No of operating Months
	Unskilled Labour	10	8000	80000 X No of operating Months
	Supervisor / Shift In charge	2	30000	60000 X No of operating Months
Fixed Manpower				
	Administrative & Marketing Staff	10	25000	250000 X No of operating Months
	General Manager	1	50000	50000 X No of operating Months
	Security Staff	3	10000	30000 X No of operating Months

VII. Other Cost Projections

Key Factors

- Administrative expenses not more than 2 to 3% on sales
- Selling Expenses up to 3% on sales
- Repairs & Maintenance up to 5% On sales
- Preliminary expenses can be written off in a period of 2, 4 or 6 years only.

Depreciation:

- Written Down Value (WDV) Method must be calculated as the same is required for Income tax assessment
- Civil - 10%, P&M – 15%, MFA – 15% (May Vary depending on nature and hours of usage of Machinery)
Example Solar panels are allowed accelerated depreciation
- Straight Line Method (SLM) can be followed for calculation of PAT under companies act.
- Civil - 3.34%, P&M – 5.28%, MFA – 10% (May Vary depending on nature and hours of usage of

Interest of Loan:

- Interest on Working Capital Loan to be calculated
- Term Loan (If Any) schedule should be presented properly and should show monthly disbursement repayment and interest.
- Interest Rate should be little bit higher than the actual bank lending rate

VIII. Working Capital Assessment:

Key Factors:

- Holding period of each item should be realistic and justification to be given
- Should be done for every year separately
- If working capital loan is proposed, Margin money should be made part of project cost or else full working capital requirement should be made part of the project cost (Based on the scheme)

Table 47: An Example:

(Rs. in Lacs)

Description	Holding Period in Months	2018-19	2019-20	2020-21
Raw Material	1.00	18.53	22.23	48.17
Work In Progress	0.10	1.85	2.22	4.82
Finished Goods	1.00	36.09	43.31	93.84
Bills Receivable	0.25	9.02	10.83	23.46
Less Current Liabilities	0.75	13.90	16.68	36.13
Working Capital		51.60	61.92	134.17

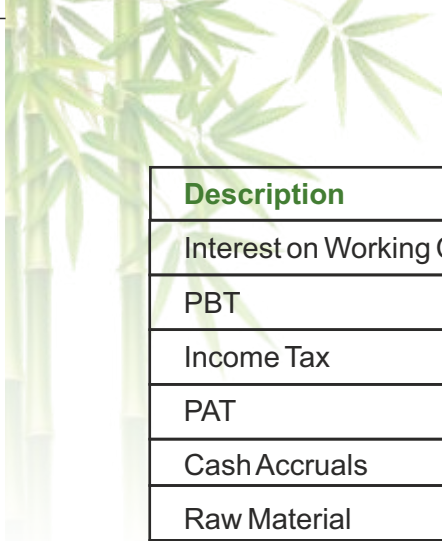
IX. Projected Profitability

Key Factors:

- Gross and Net Revenue should be mentioned clearly.
- Tax paid on raw material should be shown as input credit.
- Variable and fixed expenses should be shown separately.
- PBIDT, PBT, PAT & Cash Accruals should be presented clearly.
- Income tax calculation should be shown clearly.
- Normal rates 29.12% (25% Tax + 12% SC. + ED Cess 4%)
- MAT 17.48% (15% Tax + 12% SC. + ED Cess 4%)

Table 48: Format for Projected Profitability

Description	2018-19	2019-20	2020-21
Gross Revenue			
Less Tax Collected			
Add Tax paid in Raw Material			
Net Revenue			
Variable Expenses			
Description	2018-19	2019-20	2020-21
Fixed and Semi-variable Expenses			
Fixed Manpower			
Administrative Expenses			
Selling Expenses			
Sub Total			
Total Expenses			
PBIDT			
Depreciation			
Interest on Term Loan			



Description	2018-19	2019-20	2020-21
Interest on Working Capital			
PBT			
Income Tax			
PAT			
Cash Accruals			
Raw Material			
Consumable			
Power & Fuel			
Variable Manpower			
Maintenance			
Sub Total			

**This is a sample format for reference purposes only.*

X. Fund Flow Statement

Table 49: Format for Fund Flow Statement

Description	Construction Period	2018-19	2019-20	2020-21
Sources of Fund				
PAT				
Increase in Share Capital				
Increase in State Government Contribution				
Increase in GoI Grant				
Increase in Term Loan				
Increase in Working Capital Loan				
Depreciation				
Increase in Current Liabilities				
Preliminary Expenses W/O				
Sub Total (A)				

**This is a sample format for reference purposes only.*

Disposition of Fund				
Capital Expenditure				
Repayment of Term Loan				
Increase in Current Assets				
Preliminary Expenses				
Sub Total (B)				
Surplus (A – B)				
Opening Balance				
Closing Balance				

**This is a sample format for reference purposes only.*

XI. Projected Balance Sheet

Table 50: Sample Format for Balance Sheet

Description	Construction Period	2018-19	2019-20	2020-21
Sources of Fund				
SHAREHOLDERS FUNDS:				
a) Share Capital				
b) Reserves and SURPLUS				
GRANT –IN- AID				
a) Gol Grant				
b) State Govt. CONTRIBUTION				
LONG TERM LOANS:				
a) Term Loan				
CURRENT LIABILITIES:				
a) Working Capital Loan				
b) Other CUrrent Liabilities				
TOTAL				

Description	Construction Period	2018-19	2019-20	2020-21
Application of Fund				
FIXED ASSETS:				
a) Gross Block				
b) Less Depreciation				
c) Net Block (a – b)				
d) Deposits				
CURRENT ASSETS:				
a) Raw Material				
b) WIP				
c) Finished Goods				
d) Bills Receivable				
e) Other cURrent assets				
f) Cash and Bank Balance				
Preliminary Expenses				
TOTAL				

**This is a sample format for reference purposea only.*

XII. Financial Ratios⁷⁶

- **Return on Capital Employed (ROCE):** The total return generated by the project over its entire projected life will be averaged to find out the average yearly return. The simple acceptance rule for the investment is that the return (incorporating benefit of grant-in-aid assistance) is sufficiently larger than the interest on capital employed. Return in excess of 10% to 15% is desirable.
- **Debt Service Coverage Ratio:** Acceptance rule will be cumulative DSCR of 3:1 during repayment period. (But it may vary based on size of the units and also from sector to sector.)
- **Break-Even (BE) Analysis:** Ideally, break-even point should be below 60 percent of the installed capacity. (At least by 3rd year which was normally considered as optimal year)
- **Sensitivity Analysis:** Sensitivity analysis will be pursued for all the major financial parameters/ indicators in terms of a 5-10 percent drop in sales or fall in capacity utilization by 10- 20 percent. Increase in raw material prices can also be considered a factor.
- **Net Present Value (NPV):** Net Present Value of the project needs to be positive and the Internal Rate of Return (IRR) may be above 10 percent. The rate of discount to be adopted for estimation of NPV will be 10 to 15 percent (depending on bank interest).

Table 51: Example of Sensitivity Analysis

	% age	BEP	ROCE	IRR (pre tax)	IRR (post tax)	NPV (Pre tax)	NPV (post tax)	DSCR
Base Case		35.7%	25.87%	21.7%	16.4%	173.94	88.11	6.00
Decrease in sales by	10%	40.6%	21.30%	17.7%	13.3%	111.06	44.66	4.80
Decrease in sales by	30%	54.3%	13.24%	9.4%	9.1%	-5.01	-43.20	2.40
Decrease in Production Capacity Utilisation by	10%	40.4%	21.04%	17.1%	12.9%	103.03	39.34	4.60
Decrease in Production Capacity Utilisation by	30%	54.5%		8.9%	8.7%	-6.50	-46.00	2.30
increase in cost of raw material by	10%	44.20%	19.02%	16.10%	11.50%	90.12%	29.21%	3.80%
increase in cost of raw material by	30%	62.10%	8.34%	7.60%	2.80%	-28.45	-78.05	-0.34

Table 52: Example of Working Capital Analysis

Rs. in Lacs

Particulars	No. of months	FY 2020
Current Assets		
1. Raw materials	2.00	9.00
2. Consumables, Stores and spares	1.00	0.55
3. Stock in process (Month's cost of production)	0.20	3.55
4. Finished Goods (Months cost of sales)	1.00	17.03
5. Export's recievables	0.00	0.00
6. Receivables other than exports	0.50	9.16
Total Current Assets (A)		39.30
Current Liabilities		
1. Creditors for purchases	0.50	2.19

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Particulars	No. of months	FY 2020
		0.00
Total Current Liabilities (B)		2.19
Working Capital Gap (A-B)		37.10
Less: Bank Borrowing for working capital		27.83
Margin money for working capital		09.27

Table 53: Example of BEP

(Rs. in Lacs)

DETAILS	2020	2021	2022	2023	2024
Production Capacity Utilisation	50.00%	55.00%	60.00%	65.00%	70.00%
A. Variable Expenses					
1. Raw material consumed	52.64	63.70	69.49	75.28	81.07
2. Consumable Spares	6.60	7.26	7.92	8.58	9.24
3. Power, Fuel & other utilities (Variable Cost)	1.61	1.77	1.93	2.09	2.25
4. Factory Salaries & Wages (Variable)	126.45	126.45	126.45	126.45	126.45
5. Other variable expenses	0.00	0.00	0.00	0.00	0.00
6. Selling, Packaging & distribution expenses (Variable)	4.40	4.84	5.28	5.72	6.16
7. Interest on bank borrowing	0.00	0.00	0.00	0.00	0.00
Total Variable Cost	191.70	204.01	211.06	218.11	225.16
B. Fixed Expenses					
1. Power, Fuel & other utilities (Fixed Cost)	1.07	1.18	1.29	1.39	1.50
2. Factory Salaries & Wages (fixed)	9.90	9.90	9.90	9.90	9.90
3. Repairs & Maintenance	4.40	4.84	5.28	5.72	6.16
4. Depreciation	6.16	6.16	6.16	6.16	6.16
5. Administrative & Misc. Expenses	4.40	4.84	5.28	5.72	6.16
6. Interest on term loans	0.00	0.00	0.00	0.00	0.00
7. Interest on unsecured loans	0.00	0.00	0.00	0.00	0.00
8. Lease rentals	0.00	0.00	0.00	0.00	0.00
Sub Total	25.93	26.92	27.90	28.89	29.88
C. Sales	219.94	241.93	263.93	285.92	307.91
D. Contribution	28.24	37.92	52.86	67.81	82.75
E. Break Even Point (B/D)	91.81%	70.99%	52.79%	42.61%	36.11%
F. Cash Break Even	70.00%	54.73%	41.13%	33.52%	28.66%
G. Break Even Sales	201.92	171.74	139.32	121.83	111.18

Table 54: Example of IRR (Before Tax)

(Rs. in Lacs)

	Const. Period	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Out Flows											
Capital Investment	-183.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Increase in WC Gap	-183.24	37.10	4.49	2.51	2.49	2.49	1.49	2.49	0.03	0.00	0.00
Total outflows	0.00	37.10	4.49	2.51	2.49	2.49	1.49	2.49	0.03	0.00	0.00
Inflows											
Profit before tax	0.00	6.55	6.45	19.75	33.26	46.78	60.29	73.81	73.49	73.49	73.49
Add Depreciation and non cash expenses	0.00	6.16	6.16	6.16	6.16	6.16	6.16	6.16	6.16	6.16	6.16
Add: Preliminary & Preop Expenses	0.00	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Add : Interest	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Add : Salvage Value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	36.49
Total Inflows	0.00	12.96	12.86	26.16	39.67	53.19	66.71	80.22	79.91	79.91	116.40
Net cash flows	-183.24	-24.14	8.37	23.65	37.18	50.70	65.22	77.73	79.88	79.91	116.40
NPV before tax(Rs. in lakhs)	62.82		Discount Rate taken =		10.00%						
Before - Tax IRR	14.92%										

Table 55: Example of Bank Term Loan Repayment

(Rs. in Lacs)

DETAILS	Opening Bal	Repayment	Closing Bal	Interest (12%)	TOTAL Interest	Total Repayment
1 st year- I Quarter	40.00	0.00	40.00	0.00		
II Quarter	40.00	0.00	40.00	0.00		
III Quarter	40.00	1.82	38.18	1.20		
IV Quarter	38.18	1.82	36.36	1.15	2.35	3.64
2nd yar- I Quarter	36.36	1.82	34.5	51.09		
II Quarter	34.55	1.82	32.73	1.04		
III Quarter	32.73	1.82	30.91	0.98		
IV Quarter	30.91	1.82	29.09	0.93	4.04	7.27
3rd year 2007- I Quarter	29.09	1.82	27.27	0.87		
II Quarter	27.27	1.82	25.45	0.82		
III Quarter	25.45	1.82	23.64	0.76		
IV Quarter	23.64	1.82	21.82	0.71	3.16	7.27
4th year 2008- I Quarter	21.82	1.82	20.00	0.65		
II Quarter	20.00	1.82	18.18	0.60		

DETAILS	Opening Bal	Repayment	Closing Bal	Interest (12%)	TOTAL Interest	Total Repayment
III Quarter	18.18	1.82	16.36	0.55		
IV Quarter	16.36	1.82	14.55	0.49	2.29	7.27
5th year 2009- I Quarter	14.55	1.82	12.73	0.44		
II Quarter	12.73	1.82	10.91	0.38		
III Quarter	10.91	1.82	9.09	0.33		
IV Quarter	9.09	1.82	7.27	0.27	1.42	7.27
6th year - I Quarter	7.27	1.82	5.45	0.22		
II Quarter	5.45	1.82	3.64	0.16		
III Quarter	3.64	1.82	1.82	0.11		
IV Quarter	1.82	1.82	0.00	0.05	0.55	7.27

Table 56: Example of Debt Service Coverage Ratio

(Rs. in Lacs)

DETAILS	2020	2021	2022	2023	2024	2025
CASH INFLOW						
1. Profit after Tax	6.69	8.03	13.81	23.30	32.92	42.24
2. Depreciation	6.16	6.16	6.16	6.16	6.16	6.16
3. Prel.Expenses	0.25	0.25	0.25	0.25	0.25	0.25
4. Interest on Term Loan	2.35	4.04	3.16	2.29	1.42	0.55
TOTAL	15.45	18.47	23.39	32.00	40.75	49.20
DEBT						
1. Interest on Term Loan	2.35	4.04	3.16	2.29	1.42	0.55
2. Repayment of Term Loan	3.64	7.27	7.27	7.27	7.27	7.27
TOTAL	5.98	11.31	10.44	9.56	8.6	97.82
DEBT SERVICE COVERAGE RATIO	2.58	1.63	2.24	3.35	4.69	6.29



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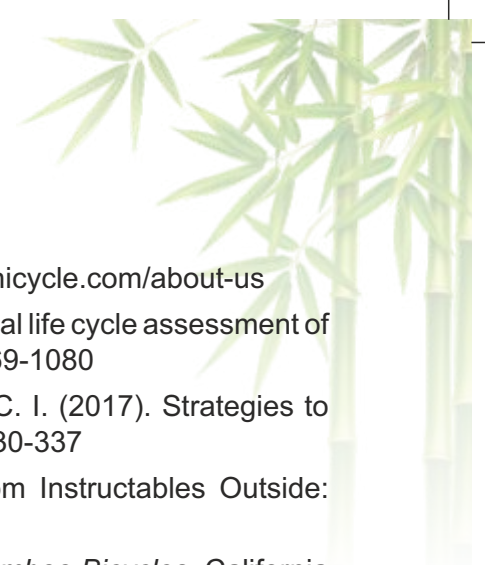
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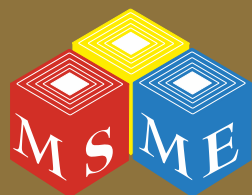
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