DRAFT STUDY MATERIAL

Bamboo Work Artisan

(Qualification Pack: Ref. Id. HCS/O8702)

Sector: Handicraft and Carpet Sector

(Grade XI)

PSS CENTRAL INSTITUTE OF VOCATIONAL EDUCATION
(A constituent unit of NCERT, under MOE, Government of India)
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Preface

Vocational Education is a dynamic and evolving field and ensuring that every student has access to quality learning materials is of paramount importance. The journey of the PSS Central Institute of Vocational Education (PSSCIVE) toward producing comprehensive and inclusive study material is rigorous and time-consuming, requiring thorough research, expert consultation and publication by the National Council of Educational Research and Training (NCERT). However, the absence of finalized study material should not impede the educational progress of our students. In response to this necessity, we present the draft study material, a provisional yet comprehensive guide, designed to bridge the gap between teaching and learning, until the official version of the study material is made available by the NCERT. The draft study material provides a structured and accessible set of materials for teachers and students to utilize in the interim period. The content is aligned with the prescribed curriculum to ensure that students remain on track with their learning objectives.

The contents of the modules are curated to provide continuity in education and maintain the momentum of teaching-learning in vocational education. It encompasses essential concepts and skills aligned with the curriculum and educational standards. We extend our gratitude to the academicians, vocational educators, subject matter experts, industry experts, academic consultants and all other people who contributed their expertise and insights to the creation of the draft study material.

Teachers are encouraged to use the draft modules of the study material as a guide and supplement their teaching with additional resources and activities that cater to their students' unique learning styles and needs. Collaboration and feedback are vital; therefore, we welcome suggestions for improvement, especially by the teachers, in improving upon the content of the study material.

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Institutes Involved

- Bamboo & Cane Development Institute (BCDI), Lichubagan, Agartala, Tripura
- Bamboo Technology Park, Assam Industrial Development Corporation ltd., Chhaygaon, Kamrup, Assam
- Geetanjali Crafts, Ranir Bazar, Mohanpur, Tripura
- North East Cane and Bamboo Development Council (NECBDC) Ministry od Development of North East Region, G.S. Road, Burnihat, Guwahati
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Table of Contents

Module 1 Handicraft and Handloom Industry in India

Module Overview

This unit offers a comprehensive overview of the Handicraft and Handloom Industry in India, emphasizing its rich cultural heritage, unique features, challenges and career opportunities. Handicrafts in India showcase the skill and creativity of artisan working with various materials like bamboo, clay, textiles and metal, while handloom fabrics are renowned for their quality and intricate weaving techniques. The unit highlights the growing role of bamboo in sustainable product design, its eco-friendly benefits and the challenges faced by the bamboo handicraft sector. Additionally, it examines the career opportunities emerging within the industry, spanning from traditional craftsmanship to modern fields such as sustainable architecture and product design.

Learning Outcomes
After completing this module, you will be able to: • Explain handicraft, handloom and bamboo industry • Analyze and describe scope of bamboo industry • Explain roles and responsibilities of "Bamboo Work Artisan"
Module Structure
Session 1: Introduction to Handicraft, Handloom and Bamboo Industry
Session 2: Scope of Bamboo Industry
Session 3: Roles and Responsibilities of "Bamboo Work Artisan"

Session – 1
Introduction to Handicraft, Handloom and Bamboo Industry

This session introduces the traditional craftsmanship of handicrafts and handlooms in India. Handicraft involves creating handmade objects from materials like clay, bamboo, textiles and metals, reflecting the skill and creativity of artisans. Handloom, on the other hand, refers to fabrics woven

manually using natural fibres such as cotton, silk and wool. Both industries are vital to India's cultural heritage, contributing significantly to the economy and preserving artistic traditions. These industries employ millions of artisans and play a key role in defining India's identity through unique, high-quality products.

Introduction to Handicraft and Handloom Industry

Handicraft is a skill-based activity in which objects are made in a traditional way with hands, rather than being developed by machines in an industry. It reflects skill and dexterity of working with hands and applies to a wide range of creative and artistic abilities. There are different kinds of handicrafts in India which involves usage of various materials such as clay, bamboo, textile, paper, terracotta, wood, leather, brass, silver etc. It refers to the term 'handmade'.

Fig. 1.1: Different craft

Handloom is a handicraft which involves weaving by hand without the use of any electricity. Handloom is the name given to the fabric that is woven by a hand operated weaving machine or 'loom'. They are generally made with high quality natural fibres such as cotton, linen, silk and wool which are resilient to last for a long time. It refers to the term 'handwoven'.

India is renowned for its rich handloom and handicraft culture with artisans producing unique and high quality products through traditional techniques. These products have been an integral part of our culture and traditions for centuries. Many Indian festivals and celebrations are incomplete without handloom and handicraft products, such as clothes, jewellery, home decor etc. These unique art forms are not only beautiful but also hold immense cultural value and historical significance. They are an expression of our creativity, our history and our identity as a nation.

The Handicraft and Handloom Industry is one of the richest and most vibrant aspects of the Indian cultural heritage. The handicraft sector is estimated to employ 68.86 lakh artisans in 2024, which constitutes 4.85% of the Indian population. Out of them, 30.25 lakhs are male and 38.61 lakhs are female. Simultaneously the handloom sector with 23.77 lakh looms engages over 35 lakh persons with 25 lakh female weavers and allied workers.

Bamboo Handicraft around the World

Bamboo includes a diverse range of 1,600 species globally, but it is not native to all seven continents. Though bamboo can grow in many areas, its full potential is limited by climate. It needs abundant rain and sunshine to thrive which is common in tropical and subtropical regions. In colder climates, such as northern Europe or North America during winter, bamboo can freeze, hindering its growth. The availability of bamboo in different regions influences its use in local handicrafts and industries.

China: China is the world's leading bamboo producing country, renowned for its extensive bamboo resources and production capabilities. Dominating the global market, China accounts for 65% of world bamboo exports. China's bamboo industry is not only an economic powerhouse but also a symbol of cultural heritage and offers opportunities for rural economies.

Vietnam: Vietnam is renowned for having one of the world's most productive bamboo forests. The country accounts for 80% of the world's total output of bamboo timber production. The bamboo industry is an essential part of

Vietnam's economy, culture and heritage. It provides livelihoods for hundreds of thousands of people and contributes significantly to the country's GDP.

Brazil: Brazil is the second-largest producer of bamboo in the world with vast areas dedicated to bamboo cultivation. Bamboo plays a crucial role in Brazil's economy, especially in the context of environmental conservation and sustainable development. The Brazilian government is developing public policies to enhance the economic potential of bamboo forestry, which can contribute significantly to the reforestation of the Amazon Basin.

Ethiopia: Ethiopia is home to the largest bamboo resources in Africa, representing a significant proportion of the continent's total bamboo resources. The country has the most extensive natural bamboo forests in Africa. Bamboo in Ethiopia contributes to livelihood improvement and has the potential for landscape restoration and carbon sequestration.

Indonesia: Indonesia is recognized as the fourth-largest bamboo producer in the world, showcasing its rich biodiversity and commitment to sustainable forestry. Bamboo is an important part of Indonesian culture and economy, used for building, making household items, musical instruments and crafts. It also helps restore land, store water, absorb carbon and provides renewable energy.

Apart from these countries, bamboo products are also seen in Netherlands, Spain, Nigeria, Myanmar and Thailand. India is one of the richest developers of bamboo handicrafts in the world, which shall be discussed in the next section.

Scenario of Bamboo Handicraft in India

India has nurtured handicrafts since ancient times and continues to do so today. It operates as a decentralized system that supports sustainability by using local resources, simple tools, reducing waste and meeting reasonable consumer needs. This system has a minimal impact on the natural environment while involving the community and economy.

India boasts a long history of bamboo handicrafts with a wide variety of products that appeal to both local and international markets. Generally, Indian bamboo products can be divided into two categories:

Day-to-Day Use Articles: These are of medium quality and are appropriate to local requirements and traditional ways of life. Some typical products in this category are baskets, chalani (sieves), kula, khorahi, dukula or tukuri,

dala dukula or tali, doon or kathi and bamboo mats. They have practical functions in rural homes and are embedded in local customs.

Decorative and Functional Products for Contemporary Markets: This segment involves well-crafted bamboo items that would be attractive to urban and foreign markets. They are functional as well as decorative and their artistic beauty is a testament to the craftsmanship of the artisans.

Assam is especially noted for its richness of raw materials and variety of bamboo and cane products. The state manufactures exquisitely designed baskets, chalani, dolls, toys and an interesting assortment of leaf-headgear used by tea garden laborers and farmers.

Bamboo has even been incorporated in modern interiors as well with all kinds of furniture pieces being constructed to fit homes nowadays. Also, bamboo mats are widely employed for functional building work like sheds, temporary partitions, big pandals, boating country rooves and rural dwelling homes.

The old craft of bamboo in India persists, marrying traditional methods with contemporary looks and establishing its place in rural functionality and urban design.

While bamboo and cane are often mentioned together, they are distinct materials. Bamboo is a fast-growing, hollow-stemmed grass known for its strength and versatility. Cane, on the other hand, is derived from the rattan plant, characterized by its solid core and flexibility. Perhaps cane is used and combined with the bamboo in through different techniques and procedure.
Cane grows mainly in the North-Eastern states like Assam, Manipur and Tripura and in parts of Kerala. Bamboo is widely grown across India, especially in North-East India, Central India (like Madhya Pradesh and Chhattisgarh) and the Western Ghats.
Cane is flexible and used for weaving fine furniture and decorative items while Bamboo is strong and used for structures, furniture, baskets and utility crafts

(a) Bamboo Plant

(b) Cane Plant

Fig.: 1.2 (a & b) : Bamboo plant & cane plant

India is the second-largest producer of bamboo in the world, showing its strong farming abilities and commitment to sustainable practices. The country produces over 50 lakh tones of bamboo each year, which reflects its rich plant life and advanced farming skills. India has the largest area for bamboo cultivation globally, covering 139.6 lakh hectares, holding 148 different species of bamboo. It is the third-largest exporter of bamboo products, sending goods to countries like Bhutan, Canada and the Maldives. With about 23% of the world's bamboo resources, India plays an important role in the global bamboo market.

Bamboo grows primarily in the states of North-East India, Madhya Pradesh, Maharashtra, Kerala, Orissa andhra Pradesh and Karnataka. Different types of bamboo are found in each of these regions. Bamboo is a fast-growing and versatile non-timber forest product and it can easily support local livelihoods through handicrafts. The bamboo handicraft sector provides employment to around 85 lakh livelihoods in India. Bamboo is used in making houses, furniture, baskets, fishing equipment, musical instruments, ornaments, biofuel, fabric, paper and charcoal.

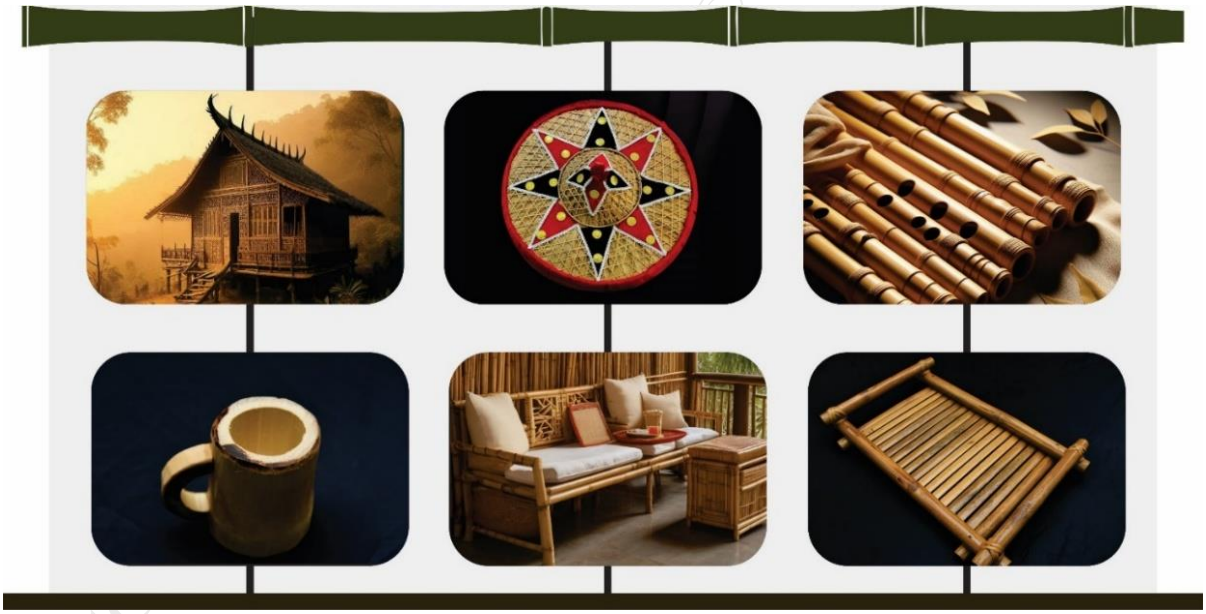


Fig. 1.3: Different kind of uses of bamboo in India

Bamboo Handicraft Clusters in India

A cluster is a group of people, businesses, or activities that work together in one place to make or grow similar things. In a bamboo cluster, farmers, craftsmen, factories and sellers all work closely to grow bamboo, make bamboo products and sell them in the market. Clusters are helpful because they bring everything together in one area. This makes it easier to share ideas,

tools, machines and training. People can learn from each other, improve their skills and make better products. It also helps save time and money.

The National Bamboo Mission (NBM) of India was launched in 2006-07 as a Centrally Sponsored Scheme by the Government of India. The mission's goal is to promote the overall growth of the bamboo sector by using region-specific strategies. It aims to expand bamboo cultivation and improve its marketing. In 2020, the Union Minister for Agriculture and Farmers' Welfare virtually launched 22 bamboo clusters across 9 states: Gujarat, Madhya Pradesh, Maharashtra, Odisha, Assam, Nagaland, Tripura, Uttarakhand and Karnataka. Maharashtra has six clusters, Tripura has five, Odisha has three, Madhya Pradesh and Nagaland each have two and Assam, Karnataka, Gujarat and Uttarakhand each have one. These clusters focus on growing bamboo nurseries and plantations and producing bamboo items like furniture, incense sticks, blinds, chopsticks, toothbrushes, lifestyle products, jewellery, bottles, yoga mats and charcoal.

Activities

Activity: Collect five different bamboo handicraft products from your region then Create a flow chart of the journey of bamboo from raw material to the product.

Materials Required

1. A4 sheets or chart paper
2. Coloured pens or pencils
3. Ruler for neat lines

Procedure

1. Prepare the Base
2. Draw the Main Title Box
3. Draw Arrows for Process Flow
4. Add Descriptions
5. Use Colours
6. Review and Adjust
7. Final Touches
8. Present or Display

Check Your Progress

A. Fill in the Blanks

1. Handicraft is a skill-based activity where objects are made in a _____ way with hands, rather than being developed by machines.
2. The handloom sector engages over _____ lakh persons with 25 lakh female weavers and allied workers.
3. India produces over _____ lakh tonnes of bamboo annually, reflecting its strong farming abilities and sustainable practices.
4. The _____ was launched in 2006-07 to promote the overall growth of the bamboo sector using region-specific strategies.
5. Bamboo handicrafts in India provide employment to around _____ lakh livelihoods.

B. Short Answer Questions

1. Define handicraft and explain its cultural significance.
2. Name any four Indian states where bamboo grows abundantly.

C. Long Answer Questions

1. Discuss the global importance of bamboo handicrafts, citing examples from at least three countries.
2. Explain the role of the National Bamboo Mission in promoting bamboo handicrafts in India.

Session – 2
Scope of Bamboo Industry

Bamboo is a special plant that grows very fast and is found in many parts of India. It is strong, light and eco-friendly, which means it is good for the environment. Because of these features, bamboo is now being used in many areas like construction, furniture, decoration and even food. In this session, we will learn about how bamboo is helping people earn money and build a better future.

Bamboo is not just useful for making traditional items like baskets and mats. Today, it is also used to make modern products like lamps, furniture, flooring, toothbrushes and even houses! This makes the bamboo industry full of possibilities and job opportunities. People can work as farmers, artisans, designers, or even start their own businesses using bamboo.

This session also explains the problems faced by the bamboo industry, such as difficulty in getting bamboo from forests, lack of machines, or people not knowing the full value of bamboo products. But with better ideas, support from the government and awareness, the bamboo industry can grow a lot.
In simple words, bamboo is a green gold that can create many jobs, help nature and improve lives

Unique Features and Future Prospects of the Bamboo Industry

Bamboos are a diverse group of mostly evergreen perennial arborescent grasses belonging to the family Poaceae and are grouped under the family Bambusoideae. Bamboos include some of the fastest-growing plants in the world.

Bamboo has emerged as a key material in the growing Indian market. Its eco-friendly qualities have opened up new possibilities in areas like construction, automobiles, furniture and interior design.

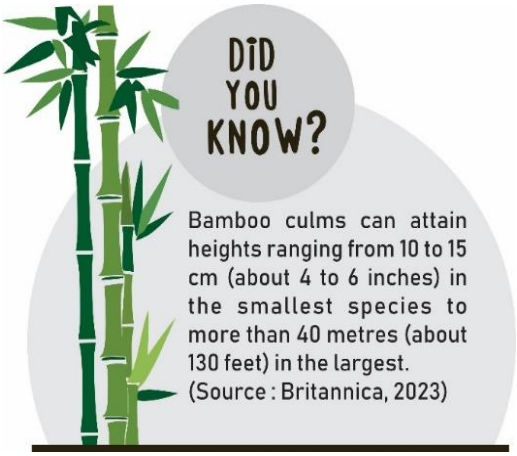


Fig. 1.4: Did you know

Bamboo's strengths, such as its mechanical durability, ease of processing and abundance in tropical and subtropical regions, make it a great renewable option for product design.

Since it's not a timber(wood) product and regenerates quickly, bamboo in product design can help address the issue of depleting natural resources by being a sustainable, fast-growing and eco-friendly material.

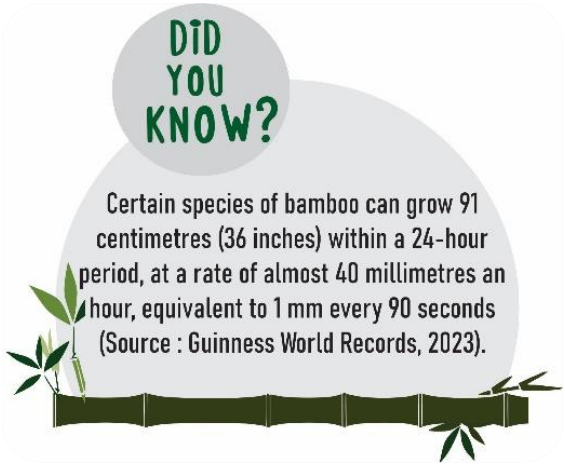


Fig. 1.5: Did you know

Bamboo is a low-cost and useful natural material. It is used to make many things like utility products, home décor, furniture, handicrafts, daily-use items, food products and even houses & Indfrastructure. Bamboo can also be mixed with other materials like jute, cane and PVC in different ways and forms to create new and creative products. Bamboo can even compressed to look like wood and the roots are used to make decorative items. This shows that every part of bamboo from the shoot to the root is used in some way.

In the northeastern states of India, bamboo plays a vital role in everyday life and cultural traditions. These states are rich in bamboo varieties, which are widely used in homes, small businesses and community practices. Bamboo contributes significantly to the local economy by providing income opportunities, supporting cottage industries and being a valuable material in farming, construction and daily activities.

Skilled artisans in the region craft a wide range of bamboo products, including furniture, household tools, musical instruments, baskets and structural elements for buildings. These creations not only meet practical needs but also reflect the rich artistic heritage of the communities. The widespread use of bamboo in both functional and decorative ways highlights its deep connection to the culture, lifestyle and sustainability practices of the people in the region.

Bamboo is also a very eco-friendly material. Its shoots can be eaten and are approved by the Food Safety and Standards Authority of India (FSSAI). The stems are strong and used in carving different crafts. Even after using bamboo for different purposes, it can be recycled or naturally broken down, causing little harm to the environment.

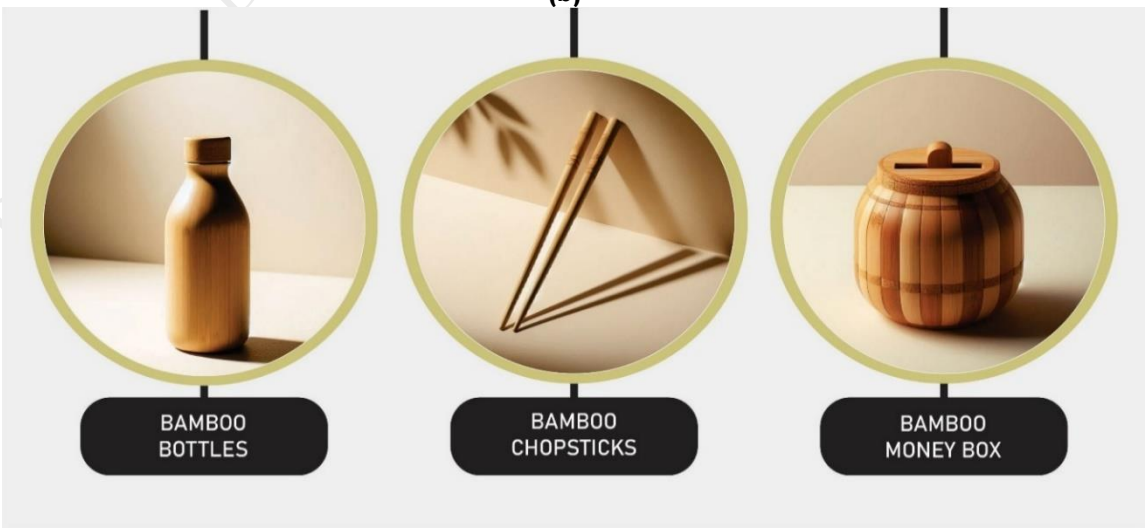
With the growing global focus on sustainability and eco-conscious living, the bamboo handicraft industry holds tremendous future potential. Innovations in product design, rising market demand, supportive government policies and the increasing use of eco-friendly materials have positioned bamboo as a key

driver in promoting sustainable livelihoods and environmentally responsible industries.

Various bamboo products currently available in the markets are shown below:

(a)

(b)



(c)

(d)

Fig. 1.6: (a,b,c & d): Various bamboo products currently available in the markets

Challenges and Limitations Faced by the Bamboo Industry

Bamboo is widely available in India, often found growing in backyards. It plays a key role in bamboo craftsmanship, as it can be easily shaped into different forms using simple tools.

Most bamboo products made today are handmade and serve traditional, practical purposes. However, these products have not been designed or priced for the urban retail market. To make bamboo a prominent, climate-friendly material and boost its potential for socio-economic benefits in India, improvements in design, cost and production are needed.

Bamboo craftsmanship is traditionally tied to small-scale, domestic production, relying on local artisans and simple tools. This makes it challenging to scale up for large-scale manufacturing, which requires industrial infrastructure, standardized processes and modern design. Additionally, the shift to mass production risks losing the cultural and artistic value of handcrafted bamboo products. Thus, investments in technology and training are needed to overcome these challenges.

There isn't enough reliable information about bamboo's quality and durability, which makes investors uncertain about supporting the industry. Without clear facts about how strong bamboo is or how well it lasts, people are hesitant to invest. More research and clear data could help build trust and attract investment in bamboo products.

Bamboo is abundant across India and integral to traditional craftsmanship, yet several challenges hinder its potential as a sustainable and economically viable material. Addressing these issues is crucial for the growth and modernization of the bamboo industry.

1. Design and Market Adaptation

While bamboo products are deeply rooted in traditional practices, they often lack contemporary design appeal and are not competitively priced for urban markets. This disconnect limits their attractiveness to modern consumers, thereby restricting market expansion.

2. Scaling Production and Infrastructure

Traditional bamboo craftsmanship is predominantly small-scale, relying on local artisans and simple tools. This artisanal nature poses challenges for scaling up production to meet larger demands. The absence of industrial infrastructure and standardized processes further complicates efforts to modernize and expand the industry.

3. Quality Standards and Certification

A significant hurdle is the lack of standardized quality assessments and certifications for bamboo products. This absence leads to variability in product quality, making it difficult to establish trust with consumers and penetrate international markets. Implementing uniform quality standards is essential for the industry's credibility and growth.

4. Market Access and Consumer Awareness

Despite bamboo's versatility and eco-friendly attributes, consumer awareness remains limited. Many potential customers are unaware of bamboo's benefits, leading to underdeveloped markets. Additionally, inefficient marketing channels and distribution networks hinder the industry's ability to reach broader audiences.

5. Raw Material Accessibility

India, despite having vast bamboo resources, faces challenges in raw material accessibility. Much of the bamboo grows in protected or remote areas, making harvesting difficult. Consequently, India imports a significant portion of its bamboo, highlighting the need for improved domestic cultivation and supply chain management.

6. Investment and Research Deficits

The bamboo sector suffers from limited investment and insufficient research and development. This lack of financial and intellectual input hampers

innovation, product development and the adoption of modern technologies, all of which are vital for the industry's advancement.

7. Perception and Consumer Trust

Many consumers perceive bamboo products as less durable or of lower quality compared to alternatives like wood or metal. This perception affects consumer trust and willingness to invest in bamboo products. Educational initiatives and quality assurance can help shift these perceptions.

Addressing these challenges requires a multifaceted approach, including policy support, infrastructure development, standardization, consumer education and investment in research and development. By overcoming these limitations, the bamboo industry can realize its full potential as a sustainable and economically significant sector in India.

Career Opportunities in Bamboo Industry

As bamboo expands its reach in the industry, multiple career paths are possible through this domain. Craft knowledge and technical expertise with the material shall be highly appreciated in the near future. As concerns of climate change have become important, integration of change in material of products and production techniques are seen as necessary for a sustainable future.

The bamboo sector offers a wide range of career opportunities across various fields due to its growing importance in sustainability and eco-friendly practices.

Some potential career paths include:

1. **Bamboo Cultivation and Farming**: Jobs in bamboo farming, nursery management and plantation development for large-scale cultivation.
2. **Craftsmanship and Artisanship**: Skilled artisans can work on creating handmade bamboo products like furniture, home decor and traditional crafts.
3. **Product Design and Development**: Professionals can design innovative bamboo products for the modern market, including furniture, construction materials and lifestyle goods.

4. **Sustainable Architecture and Construction**: Architects and engineers can use bamboo in eco-friendly building projects, designing bamboo houses, bridges and other structures.
5. **Manufacturing and Industrial Processing**: Careers in the mass production of bamboo products such as furniture, flooring, textiles and household items.
6. **Research and Development**: Opportunities for researchers focusing on improving bamboo's strength, durability and commercial applications, or its environmental impact and sustainability.
7. **Marketing and Sales**: Professionals who specialize in branding, selling and promoting bamboo products to both domestic and international markets.
8. **Bamboo-Based Entrepreneurship**: Starting businesses around bamboo products, eco-friendly innovations, or export of bamboo materials.
9. **Government and Policy Roles**: Working with government agencies or non-profits to develop bamboo policies, sustainability initiatives and rural development programs.
10. **Training and Education**: Teaching or offering workshops in bamboo craftsmanship, sustainable farming, or industrial applications.

Fig. 1.7: Career paths

These fields offer opportunities for both traditional artisans and modern professionals interested in sustainable development and eco-friendly materials. While bamboo is a diverse and versatile, it is not possible for one person to master every aspect of bamboo craftsmanship. Individuals can choose their area of specialization based on their skills, interests and specific requirements within the field of bamboo work.

Activities

Activity: Explore and identify the different ways bamboo is used in everyday life and industries. Based on your observations and research, prepare a brief report or visual presentation showing the scope of the Bamboo Work Artisan profession. Your presentation should include types of bamboo products, industries that use bamboo and potential career paths in bamboo craftsmanship.

Materials Required

1. Notebook or worksheet
2. Pen/pencil and ruler
3. Internet access (optional)
4. Art supplies (colours, sketch pens, etc.) – optional
5. Chart paper or A4 sheets for presentation
6. Printed images or cutouts from magazines (optional)

Procedure

1. Observation: Look around your home, neighborhood, or local market to find bamboo products. Note down different items made of bamboo, such as furniture, baskets, containers, or decor pieces.

2. Research: Use books, newspapers, or the internet to find out:

a) Different industries that use bamboo (e.g., construction, handicrafts, textiles, packaging).

b) Career options in bamboo work (e.g., artisan, designer, entrepreneur, trainer).

Any successful bamboo-based enterprise in India or abroad.

3. Documentation: In your notebook or on a chart paper, prepare a report or visual representation that includes:

a) Names and images/sketches of at least 5 bamboo products.

b) A list of 3 industries using bamboo.

c) At least 3 career paths related to bamboo work.

d) One real-life example of a bamboo business or initiative.

4. Presentation: Present your findings in one of the following formats:

a) A poster or chart

b) A written mini-report

c) An infographic combining drawings and bullet points

Check Your Progress

A. Fill in the blank

1. Bamboo is a member of the family _____ and is known for being one of the fastest-growing plants in the world.
2. The bamboo industry in India is facing challenges due to a lack of _____ and data on bamboo's quality and durability.

3. Bamboo is a sustainable material due to its ability to regenerate quickly, making it a _____ resource.
4. The bamboo sector offers various career opportunities in areas like _____, craftsmanship, product design and sustainable architecture.
5. To expand the bamboo industry, _____ and investments in modern design and technology are essential.

B. Short Answer Questions

1. What are some of the challenges faced by the bamboo handicraft industry in India?
2. List any two career opportunities available in the bamboo industry.

C. Long Answer Questions

1. Explain the unique features of bamboo that make it a sustainable and eco-friendly material for product design. How do these features contribute to the growing bamboo industry in India?
2. Discuss the challenges and limitations faced by the bamboo handicraft industry and suggest measures to overcome them for better growth and market expansion.

Session – 3
Roles and Responsibilities of "Bamboo Work Artisan"

This session delves into the challenges faced by the bamboo handicraft industry, including issues related to scaling up production, modernizing design and ensuring the quality and durability of bamboo products. While bamboo is widely available and eco-friendly, its traditional craftsmanship methods need improvement for large-scale manufacturing.

The session also explores the growing career opportunities within the bamboo sector, including roles in farming, craftsmanship, product design, sustainable architecture and research. These opportunities are essential for fostering innovation, supporting sustainability and creating a green future through bamboo-based solutions.

Attributes of "Bamboo Work Artisan"

An artisan is a person who makes things skilfully, especially with their hands, while practising a trade or handicraft. The artisan uses creative skills to solve problems in a practical way. The artisan combines careful attention to the process of making with a talent for teaching and guiding apprentices. They possess a deep understanding of specialized techniques and a strong sense of the social value of creating high-quality, skilfully made products. This blend of creativity and cooperation reflects the artisan's commitment to excellence in their work.

Historically, artisans were organised into guilds, which would mean an organisation of people who do the same job and have the same interests. The guild system existed in the form of co-operative associations within the merchant community. Artisans were devoted to the royal practice and capital punishment was inflicted upon any person who impaired the efficiency of an artisan by causing the loss of a hand or eye.

Currently, bamboo work artisan thrives in areas with regional availability of the material. The Indian Government has recognized the skill capacity of the artisans and has developed numerous policies, schemes and missions to enhance the employability of the bamboo work artisans in the Indian economy.

The attributes of bamboo work artisans can be defined as follows:

1. **Attention to Detail**: The artisan must pay close attention to detail to ensure the quality of bamboo products.
2. **Hand-Eye Coordination**: Good hand-eye coordination is crucial for handling tools and crafting precise products.
3. **Logical Thinking and Problem-Solving**: The artisan should be capable of logical thinking to tackle issues during the production process.
4. **Analytical Skills**: Strong analytical skills are needed to evaluate designs, patterns and the overall quality of finished products.
5. **Reliability and Decision-Making**: The artisan should be reliable and able to make quick decisions when it comes to selecting materials or addressing defects.
6. **Physical Attributes**: Good eyesight and vision (including near, distance, colour vision, peripheral vision and depth perception) are necessary.
7. **Technical Proficiency**: The artisan should be skilled in handling basic tools and machinery specific to bamboo work.
8. **Teamwork and Communication**: The artisan should be able to work well with colleagues and supervisors, communicate effectively and maintain a positive work environment.
9. **Safety Awareness**: The individual must be aware of safety standards, maintain personal hygiene and adhere to safe working practices.

These attributes are essential for ensuring high-quality craftsmanship and efficient production in the bamboo handicrafts sector.

Roles and Responsibilities of "Bamboo Work Artisan"

The roles and responsibilities of a bamboo work artisan include understanding the complete procedure of bamboo product manufacture and its integration into the market.

The activity also includes concepts of sustainability and is explained in detail as follows:

1. **Understand Bamboo Material**:
    - Anatomy of bamboo along with its mechanical and physical properties
    - Cultivation and harvesting of commercially viable bamboo species

- Treatment techniques of bamboo
- Different forms of bamboo
- Tools and equipment used in bamboo handicraft

2. Techniques to make Bamboo Products:

- Dyeing, weaving and twinning, applique work, bending and quilling techniques for preparation of bamboo products
- Joinery and finishing techniques for completing bamboo products

3. Green Products, Market and Consumerism:

- Emerging market trends and product diversification in bamboo handicraft
- Sustainable Development Goals through bamboo handicrafts
- Eco-Design Principles and Green Consumerism
- Government organizations, policies and schemes for bamboo work

4. Quality Assurance:

- Inspecting raw materials and finished products to ensure they meet quality standards
- Measurements, Drawings and Models for transfer of knowledge
- Identifying and rectifying defects and reworking on modifiable issues

5. Team Coordination and Safety Compliance:

- Collaborating with colleagues and following safety protocols.
- Maintaining personal hygiene and adhering to safe working practices.

These responsibilities ensure the artisan delivers high-quality bamboo products which can be directed towards the market while maintaining safety and teamwork in their work environment.

Terminologies Related to Bamboo Handicraft

In the bamboo industry, terminology refers to the specific names and terms used for tools, materials, techniques and processes involved in bamboo work. These terms help artisans, professionals and learners to understand and communicate effectively within the craft.

It is important to note that different regions often have their own local term and versions of the same tools or methods. For instance, a knife that is

majorly used to cut bamboo may be referred to differently across Indian states:

- **Dao –** Nagaland, Mizoram, Manipur, Assam, Arunachal Pradesh
- **Narum –** Assam
- **Dhor Koli Tools –** Maharashtra, Gujarat
- **Aruval –** Tamil Nadu, Kerala
- **Kukri –** Sikkim, Northeastern India, Nepal

The shape, size and use of these tools can vary significantly depending on regional traditions and practical requirements. Below is a list of general and commonly used terminologies in the bamboo industry.

1. **Solid Bamboo:** Bamboo pole used as a whole.
2. **Bamboo Splits:** Bamboo pole divided into 4 to 8 sections along its length.
3. **Bamboo Slivers:** Long and thin strips of bamboo that are finer sections of bamboo splits.
4. **Machete/Chopper:** Used for cutting bamboo culms (stalks) during harvesting.
5. **Crosscut Saw:** For cutting bamboo into desired lengths.
6. **Bamboo Splitter:** A hand tool with multiple blades to split bamboo culms into strips.
7. **Bamboo Knife:** For splitting bamboo by hand and for finer cutting tasks.
8. **Hand Plane:** To smoothen and shape the bamboo surface.
9. **Draw Knife:** Used for shaving and shaping bamboo strips.
10. **Bamboo Shaving Machine:** A machine that shaves the outer layer of bamboo to achieve a uniform thickness.
11. **Bamboo Planer Machine:** Used to produce uniform rectangular bamboo splits.
12. **Bamboo Sliver Making Machine:** For making thin slivers from bamboo strips, typically used in weaving.
13. **Bamboo Mat Weaving Loom:** A loom designed specifically for weaving bamboo mats.
14. **Bamboo Sliver Bending Machine:** For bending bamboo slivers into circular shapes (often used in furniture making).

15. **Bamboo Bending Machine:** For bending bamboo poles into desired shapes (often used in furniture making).
16. **Heat Gun/Torch:** Used to bend bamboo with heat.
17. **Sanding Machine:** To smooth the surface of bamboo products.
18. **Hand Drill:** For making holes or precise cuts in bamboo.
19. **Jig Saw:** For cutting intricate shapes and patterns.
20. **Lacquering/Polishing Tools:** Brushes and spray guns for applying finishes.
21. **Glue Gun/Adhesive Tools:** For assembling bamboo parts.
22. **Nail Gun:** For fixing bamboo components together.
23. **Wooden Mallet:** Used in combination with chisels for precise work.
24. **CNC Machine:** For precision cutting, engraving and shaping of bamboo products.
25. **Bamboo Strip Sizing Machine:** Ensures uniform size and thickness of bamboo strips, particularly useful in large-scale production.
26. **Bamboo Veneer Slicing Machine:** Used to produce thin bamboo veneers for use in laminates or decorative surfaces.
27. **Gloves and Goggles:** Essential for protecting hands and eyes during cutting, splitting and machining.
28. **Dust Mask/Respirator:** Protects from bamboo dust, which can be harmful when inhaled.
29. **Ear Protection:** Necessary when using loud machinery.
30. **Apron:** Projects clothes from bamboo dust.
31. **Spokeshave:** For detailed shaping and smoothening.

Activities

Activity 1: Create a Flow Chart of Bamboo Work Artisan's Roles and Responsibilities.

Materials Required

1. Chart paper or large sheets of paper
2. Markers or coloured pens
3. Ruler
4. Laptop/tablet (optional, for digital flow chart creation)

5. Printouts or reference materials on the roles and responsibilities of bamboo artisans (from session content)

Procedure

1. Prepare the Base
2. Draw the Main Title Box
3. Create Main Categories
4. Draw Arrows for Process Flow
5. Add Descriptions
6. Use Colours
7. Review and Adjust
8. Final Touches
9. Present or Display

Activity 2: Imagine you are a bamboo work artisan. Write a short one-day diary entry describing your day at work.

Materials Required

1. Notebook or A4 sheet
2. Pen or pencil
3. Coloured pens/sketch pens (optional)
4. Ruler
5. Chart paper (optional for group activity)

Procedure

1. **Imagine and Write:**
   Include the following points in your writing:
   - What kind of bamboo product you are making today
   - What tools and materials you use
   - How you check the quality of your product
   - How you follow safety rules while working
   - How you work with your team or help others

2. **Draw (Optional):**
   - Draw a simple picture of the bamboo product you made.
   - Label the tools or steps used (e.g., cutting, weaving, finishing).

3. **Group Discussion (Optional):**
   - Share your diary entry with your classmates.

- Discuss what skills are important for a bamboo artisan.

Check Your Progress

A. Fill in the blanks

1. An artisan is a person who makes things _____, especially with their hands.
2. Bamboo work artisans must have good _____ coordination for handling tools and crafting precise products.
3. The process of _____ is crucial for ensuring the quality of bamboo products.
4. Bamboo work artisans should have _____ skills to evaluate designs and ensure finished products meet quality standards.
5. Bamboo work artisans need to be aware of _____ protocols and maintain safety while working.

B. Short Answer Questions

1. What are the key attributes required for a bamboo work artisan?
2. Why is quality assurance important in the bamboo handicraft industry?

C. Long Answer Questions

1. Explain the roles and responsibilities of a bamboo work artisan, including the different tasks involved in bamboo product manufacture and market integration.
2. Describe the attributes of a bamboo work artisan and how these skills contribute to high-quality craftsmanship in bamboo products.

Module 2 Bamboo and its Processing

Module Overview

Bamboo is a quick-growing crop that is robust, light and versatile in numerous ways. In this unit, we are going to learn about bamboo extensively—how it grows, which parts it consists of and how it is utilized in creating various products. Bamboo is referred to as "green gold" since it is eco-friendly and assists people in earning their livelihood through crafts and other purposes.

You will learn how to identify bamboo, how to plant and cultivate it and what to do once it has been harvested. The unit also discusses the unique characteristics of bamboo, such as its strength and pliability and how these make bamboo suitable for furniture production, basketry, mat-making, food items, houses etc.

We shall also learn what bamboo is done to make it durable and how it is stocked safely. Finally, the unit will demonstrate various form of bamboo such as solid pieces, splits, slivers, fibres and charcoal and how the various shapes find application in craft and other merchandise.

By the end of this unit, you will know the process of bamboo from a plant on the ground to a lovely and useful product in our homes.

Learning Outcomes
After completing this module, you will be able to: • Identify, Cultivation and post-harvest management of bamboo • Explain general characteristics of bamboo • Apply various treatment techniques on bamboo • Describe different forms of bamboo used for different purposes
Module Structure
Session 1: Identification, Cultivation and Post-Harvest Management of Bamboo
Session 2: Characteristics of Bamboo
Session 3: Treatment of Bamboo
Session 4: Forms of Bamboo

Session – 1
Identification, Cultivation and Post-Harvest Management of Bamboo

Bamboo is a precious natural resource utilized to create numerous useful and lovely goods. Yet for bamboo to be utilized, it first needs to be identified properly, cultivated suitably and treated well once harvested. What this session aims to assist you with is acquiring these essential steps.

To begin, you will discover how to recognize various species of bamboo based on their size, colour, leaves and form. The identification of the right bamboo species matters because each type is utilized for a specific use, such as building, furniture, weaving, or ornamentation.

Then, you will learn how bamboo is grown, that is, how it is farmed or forested. You will discover the ideal climate, soil and ways to grow healthy bamboo plants. You'll also discover harvesting when and how to harvest bamboo so that it remains strong and useful.
Once bamboo is harvested, it needs to undergo post-harvest management. This involves inspecting the quality, drying it correctly and storing it in a safe manner to prevent damage by insects, moisture, or fungus. These processes ensure that bamboo remains strong, clean and available for use in producing products.

This session provides you with a complete overview of how bamboo is processed prior to arriving at the artisan's workshop beginning at the farm and concluding with treated bamboo for craft.

Identification of Bamboo Species

Identifying bamboo can be challenging due to the diversity of species. However, several techniques help in the identification process, particularly important for bamboo artisans and craftsmen to select the right type for their work.

Culm Characteristics: Bamboo species vary significantly in size, colour, surface, texture and culm sheath, which helps in identifying them; some species are small and delicate, others tall and thick with culms in green, yellow, black, or striped and surfaces that may be smooth, rough, or waxy, while the sheath's presence, size, shape and texture also provide key identification markers.

Culm Characteristics

Phyllostachys edulis (Moso Bamboo): Can grow to a height of 20-28 meters with a culm diameter of 10-20 cm. Its young culms are green, turning pale yellow with age and have a smooth surface with a light waxy coating.

Fig. 2.1: Phyllostachysedulis

Bambusa vulgaris: Reaches a height of 10-20 meters with a culm diameter of 6-10 cm. The culms are bright yellow with green stripes, slightly rough in texture and lack a waxy coating.

Fig. 2.2: Bambusa vulgaris

Leaf Structure: Bamboo species vary in leaf size and shape with some having long, slender leaves and others broader or shorter. Their vein patterns are typically parallel, though the density and visibility of veins differ. Leaves may grow in clusters or pairs with their arrangement offering important identification clues.

Leaf Structure

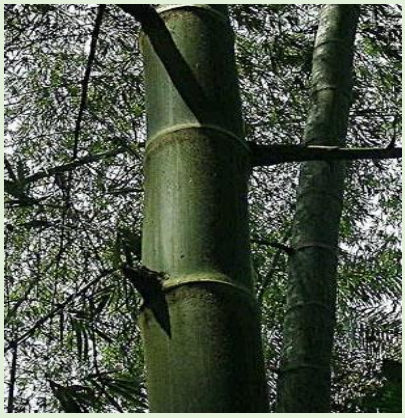
Bambusa oldhamii has larger leaves, around 10-20 cm long.

Fig. 2.3: Bambusa oldhamii

Chusquea culeou has smaller leaves, around 5-10 cm long.

Fig. 2.4: Chusquea culeou

Node and Internode Analysis: Bamboo species differ in node prominence with some having swollen or thickened joints, while others have less pronounced nodes. Internode length also varies with larger species typically having longer internodes and smaller species having shorter ones.

Node and Internode analysis	
Dendrocalamus strictus: Features prominent, swollen nodes and shorter internodes, typically 20-30 cm long.	**Guadua angustifolia**: Has less prominent nodes and much longer internodes, ranging from 50-70 cm.
	
Fig. 2.5: Dendrocalamus strictus	**Fig. 2.6: Guadua angustifolia**

Rhizome System (Clumping vs. Running): Clumping rhizomes (sympodial) grow compactly in clusters, typical of tropical bamboo species, while running rhizomes (monopodial) spread horizontally, producing new shoots at a distance from the parent plant, common in temperate regions.

Microscopic Analysis: The arrangement and density of vascular bundles in bamboo culms, along with variations in cell structure, such as cell wall thickness and fibre cell size, can be observed under a microscope to help distinguish between bamboo species.

Bamboo is a fast-growing, renewable grass with over 1,500 species found worldwide. India is home to more than 136 bamboo species across 23 genera, making it one of the richest countries in bamboo biodiversity. These species vary greatly in size, shape, strength, and usage, making them suitable for a wide range of applications from construction and craft to food and ornamentation.

Bamboo varieties can be classified based on the following criteria:

Growth habit:

- Clump-forming (sympodial) – grows in tight clusters, easier to manage
- Running (monopodial) – spreads quickly and covers larger areas

Culm size:

- Dwarf, medium, or giant species depending on height and thickness

Usage type:

- Construction, craft, food, paper, ornamental, *and more*

The choice of bamboo species plays a crucial role in the success of craft production. Each species has unique characteristics such as wall thickness, fibre texture, node spacing, flexibility, and surface smoothness, which affect its workability and finish. Therefore, selecting the appropriate bamboo for the intended craft technique and product type ensures quality and efficiency.

The selection of the right bamboo variety ensures better design quality, durability, workability, and aesthetic appeal. For bamboo work artisans, understanding the nature of each species is fundamental to mastering the craft and producing high-quality products.

S. No.	Bamboo Species	Local Names	Uses	Dimensions
1.	Bambusa tulda	Jati Baah (Assam), mritinga (Tripura), spineless Indian bamboo.	A wonder Indian species of choice for the whole range of products especially handicrafts, agarbatti sticks, lumbar, paper, edible shoots, etc.	Height : 15-20 m Diameter 5-10 cm, Internode length 40-70 cm Wall thickness: 0.8-1.5 cm Flowering cycle : 30-60 years
2.	Bambusa bambos	Giant Thorny Bamboo Kotoha (Assam); Behor bans (W. Bengal); Mula (Malayalam); Kanta bans (Orissa); Nal bans (Punjab); Saneibo (Manipur); Mungil (Tamil Nadu); Mulla veduru (Andhra Pradesh) Native: Madhya Pardesh, Maharashtra	Construction, scaffolding, ladders, Furniture, Paper/pulp, edible shoots, leaf as fodder	Height : 30 m Diameter : 15-18 cm Internodes' length : 30-45 cm Wall thickness : 1.5-2.5 cm

3.	Bambusa balcooa	Baruwa (Manipur); Bhaluka (Arunachal Pradesh, Assam, Bengal); Beru (Meghalaya); Bhalu bans (Nagaland); Barak (Tripura)	Very strong structural bamboo Used for scaffolding, handicrafts, construction, ladders, Agarbatti sticks, edible shoots, paper	Height: 16-25 m, Diameter: 8-15 cm Internode length: 20-45 cm Wall thickness: 1.9-2.5 cm Flowering cycle: 35-45 years
4.	Bambusa polymorpha	Betwa (Assam), Narangi baah (MP), bari (Tripura) Badia basa (Orissa)	woven matting, baskets, furniture, handicrafts, paper pulp and board making, edible shoots with a distinctly sweet taste and landscaping.	Height:1 5-20m Diameter: 5-10 cm Internode length: 25-45 cm Wall thickness:1-1.5 cm Flowering cycle 35 years
5.	Bambusa nutans	Bidhuli, Mukial or Deo baah (Assam), Mallo, Mahi Bans (Lepcha), Badia Baas (Odisha), Kali/Beng/Makla (Tripura)	Thick-walled, baskets, fences, roofs and roof tiles and paper, for treating inflammation, ulcers and wounds	Height: 06-15 m Diameter: 5-10 cm Internode length: 35-45 cm Wall thickness: Thick Wall Flowering cycle 35 years
6.	Dendrocalamus asper	Sweet Bamboo, Giant Bamboo, Rough bamboo, Thaitama Bans (Sikkim)	Exotic and mainly grown for the high-quality edible shoots. Poles are strong and useful in construction.	Height: 15-30 m Diameter: 8-20 cm Internode length: 40-50 cm Wall thickness: 1.1 - 2 cm Flowering cycle 30-120 years
7.	Thyrsostachys oliveri	Lathi mula (Kerala); Kanak kainch (Tripura)	Construction, Furniture, baskets, umbrellas, fishing rods, Sports goods, Edible shoots	Height: 15-25 m Diameter: 5-7 cm Internode length: 40-60 cm Flowering cycle 48-50 years

8.	Meloccanna baciferra	Muli, monopodial Indian bamboo	Edible shoots, famine food, leaves for brewing liquor, Tabashir - a siliceous concretion found in the culms of the bamboo stem, can be collected from the culms and used as a tonic in treating respiratory diseases.	Height: 10-25 m Diameter: 1.5-15 cm Internode length: 25-50 cm Wall thickness: Thin walls Flowering cycle 30-45 years
9.	Bambusa vulgaris	Common Bamboo, Golden Bamboo	Used for pulp, scaffolding, handicrafts, ornaments, edible shoots, leaves medicinal	Height: 8-20 m Diameter: 5-10 cm Internode length: 30-45 cm Wall thickness: 0.7-1.5 cm
10.	Dendrocalamus hamiltonii	Dropping bamboo, Kako Bans (Assamese), Unep (Manipuri), Phulrua (Mizoram)	Used for walls, posts, basketry, weaving, archery, pulp, rhizome adulterated for rhinoceros horn, Young shoots edible.	Height: 12-20 m, Diameter: 10-19 cm Internode: 30-50 cm, Wall thickness: 1.2-1.3 cm Flowering cycle 35-45 years
11.	Dendrocalamus brandisii	Bengali : Bhulka Manipuri : Wanan Malayalam : Bilathimula	Used for basketry, construction, pulp and young shoots are edible	Height : 20-33 m Diameter : 13-20 cm Internode : 30-60 cm Wall thickness : 1.7-3 cm Flowering cycle : 45-50 years.

12.	Dendrocalamus strictus	Solid Bamboo Bengali : Karali Gujarai Nakur bans Marati Narvel Oriya : Salia Tamil : Kalmungil Telugu Sadanap venduru Malayalam : Kallan mula, Manipuri: Unan	Used for pulp, construction, musical instruments, furniture, handicrafts. Leaves medicinal and shoots edible.	Height: 8-16 m Diameter : 6-10 cm Internode : 30-45 cm Wall thickness : 0.5 to 2.00 cm Base solid, Cultivated widely, most parts of India Flowering cycle : 45-55 years
13.	Dendrocalamus membranaceus	Waya Bamboo	Used for construction, pulp, chopsticks, handicrafts and shoots are edible	Height : 20-24m Diameter : 6-10cm Internodes : 22-38 cm Wall thickness : 0.8-1.2 cm
14.	Ochlandra travancorica	Reed bamboo Local names Malayalam Eeta, Oda, Ottal Tamil : Eeral, Odai, Iral	Used for pulp, mat weaving, basketry, bamboo ply, umbrella handles, fishing rods, handicrafts, walling of huts. Leaves are used for thatching	Height : 2-6 m Diameter : 2.5-5 cm Internode : 45-100 cm Wall thickness : 0.4-0.6 cm Flowering cycle : 07-12 years

Table No. 2.1: Commercially viable Species of bamboo

Bamboo is a plant that can grow in many types of weather and places from cold to hot areas and from mountains to tropical forests. It is found in many parts of the world, such as East Asia, northern Australia, western India, sub-Saharan Africa and the Americas, from the United States all the way to Chile.

India is the second richest country in bamboo resources, after China. Together, these two countries have more than half of the world's bamboo supply. In India, there are 136 different species of bamboo. Out of these, 58 species are found in the northeastern states, which make up about 66% of all the bamboo growing in India. In India, several bamboo species are commercially viable due to their widespread availability, durability and adaptability for various uses. Key species include:

Cultivation and Harvesting of Bamboo

Bamboo cultivation is a relatively simple and sustainable process, offering quick returns due to its rapid growth. It thrives in tropical and subtropical climates, making India an ideal location for bamboo farming. Let us explore cultivation and harvesting process of bamboos.

Site Selection and Preparation

For successful bamboo cultivation, choosing the right site and preparing the land properly is very important. Bamboo grows best in areas that receive 1200 to 2500 mm of rainfall annually and have well-drained loamy soil. However, it is also a strong and adaptable plant that can grow in marginal or degraded lands, making it suitable for many different regions. Once a suitable site is selected, the land should be cleared of weeds and debris, ploughed to loosen the soil and fertilized to ensure that young bamboo plants get enough nutrients for healthy growth.

Climate and Soil: Bamboo grows best in areas with adequate rainfall (1200-2500 mm annually) and well-drained loamy soils. It can also tolerate marginal and degraded lands, making it a resilient crop.

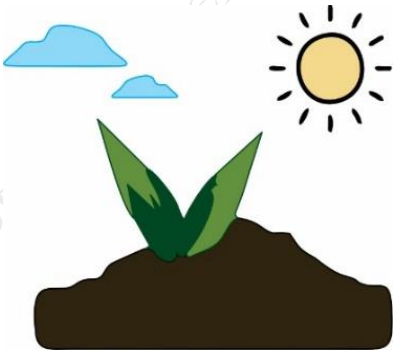


Fig 2.7: Climate and soil

Land Preparation: The land must be cleared, ploughed and fertilized to ensure that young bamboo plants receive adequate nutrients.

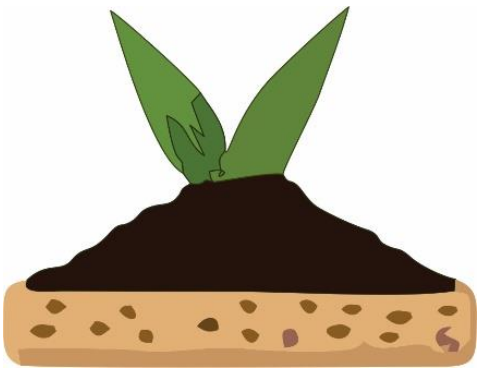


Fig 2.8: Land preparation

Propagation Methods

Bamboo can be propagated in two ways. One is by reproductive method through seeds and the other is by vegetative method by using vegetative parts of bamboo plants such as rhizomes, culms and branches. Seed propagation methods are seldom used because of the irregular flowering of most of the bamboo, poor viability of seeds (between one and six months) and non-availability of seeds around the year. Therefore, vegetative propagation is the most popular and effective of the methods.

Seeds: Though rare due to bamboo's long flowering cycle, seeds are sometimes used for propagation.

Rhizome Cuttings: The most common method, where a portion of the rhizome with buds is planted.

Offset Planting: A piece of the mother plant's culm along with its rhizome is used to grow new bamboo.

Tissue Culture: This advanced technique is employed for large-scale, uniform propagation.

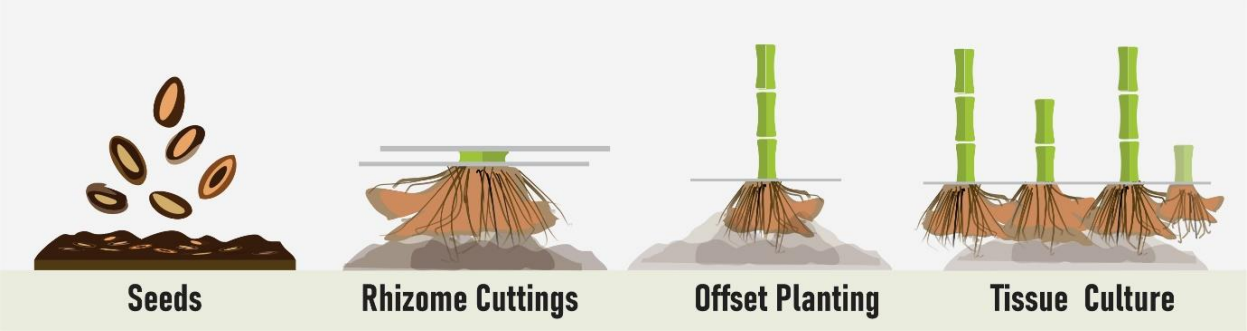


Fig 2.9: Different propagation methods

Planting

Bamboo saplings or cuttings are planted in pits, usually spaced about 5-7 meters apart to allow ample room for growth. It is recommended to plant bamboo during the monsoon season to provide sufficient moisture for the young plants.

Management and Maintenance

Watering: should be watered every 2 to 3 days to keep the soil moist and help the roots grow strong. Once the plant is established, watering can be reduced to once or twice a week, depending on the weather. During dry or hot seasons,

more frequent watering is needed, while in rainy seasons, less is enough. For indoor bamboo, watering every 7 to 10 days is usually suitable. It is important not to overwater, as too much water can cause yellow leaves and root rot. On the other hand, underwatering may cause the leaves to curl or turn brown at the tips.

Fertilization: Fertilizing bamboo helps the plant grow fast and stay healthy. Bamboo needs three main nutrients: nitrogen for leafy growth, phosphorus for strong roots and potassium for overall health. A balanced chemical fertilizer like NPK 20-20-20 works well and should be applied during the growing season. Organic fertilizers such as composted manure or mushroom compost are also very useful, as they improve soil quality and release nutrients slowly. A 1- to 2-inch layer of organic compost can be added around the base of the plant in the spring and early summer. Care should be taken not to use any fertilizers that contain weed killers, as they can harm the bamboo.

Weeding: Weeding is an important part of bamboo care. Weeds compete with bamboo for water, sunlight and nutrients, which can slow down its growth. Regular weeding around the bamboo plants helps prevent this competition and keeps the soil healthy. It also improves air circulation and reduces the chances of pests and diseases. Weeding should be done carefully to avoid damaging bamboo roots, especially in young plants.

Harvesting

Bamboo harvesting depends on the application. It is important to keep in mind the intended application before selecting. Young, one-year-old bamboo culm is suitable for weaving because of its soft and flexible fibre properties. The thickness of the culm wall determines the number of layers and strips. If the culm aged more than three years, it will be too hard to strip. Select culms that are 3-4 years old for making bamboo furniture as they have medium diameter (3 cm) and thick walls pf least 5 mm. Thick walls provide strength and a higher tolerance for nailing and drilling.

At this age they combine strength with low moisture content and low shrinkage. Harvesting should not be done during the rainy as during time bamboos grow well and have high moisture and starch content which makes them susceptible to fungal and insect attacks. Also, harvesting will damage delicate new shoots that emerge during rains will be damaged, hindering regeneration. Therefore, the dry season is the ideal time for bamboo harvesting.

Culms should be cut at a height as low as possible, between the first or second node above the ground, leaving only one internode above the ground. This will prevent damage to the rhizome and allow regrowth. After harvesting all branches of the culm should be removed cautiously without damaging the culm. For making bamboo poles into different sections, use a knife or saw and cut parallel to the node to facilitate transport to the work area. After cutting culms, post-harvest treatment should be done.

Post-Harvest Care

After harvesting, the bamboo culms are dried and treated to prevent insect infestation and fungal growth, ensuring longevity and quality for commercial uses. After post-harvest treatment is done, bamboo poles should be stored in a ventilated shelter and not in a closed area. The poles should be piled in stacks of different diameters with distance splits to allow air flow. Sort and classify the preserved culms based on their size, diameter and quality. An ideal way of storing treated bamboo culms is in horizontal racks

Post – Harvest Quality Check and Storage of Bamboo

Once bamboo is harvested, it undergoes a critical post-harvest process to ensure its durability, strength and suitability for various commercial and craft applications. Proper handling at this stage is essential for preventing deterioration due to moisture, pests and fungal growth. Here's an overview of the key steps involved in post-harvest quality checks and storage of bamboo:

Quality Check

After harvest, bamboo culms are inspected for physical defects and quality assurance. This step ensures that only high-grade bamboo enters the supply chain. The key quality parameters to be inspected are:

- **Culm Straightness**: Bent or irregularly shaped culms are less desirable for most commercial applications. Straight bamboo is preferred for its structural integrity.
- **Diameter Consistency**: A uniform diameter across the length of the culm is essential, especially for construction and crafting purposes.
- **Culm Age**: Ideally, culms between 3 to 5 years of age are harvested. Younger culms are less dense and durable, while older culms may become brittle.

- **Surface Condition**: The culm surface is checked for cracks, splits, or discolouration, which may indicate poor quality or degradation.
- **Moisture Content**: Bamboo with high moisture content is prone to rot and pest infestation. Therefore, drying the bamboo to an appropriate moisture level (about 15-20%) is necessary.

Treatment Methods

To extend bamboo's lifespan and improve its resistance to insects, fungi and decay, proper treatment methods are employed after quality checks.

- **Water Treatment**: Bamboo is submerged in water or left in running water for several weeks. This leaches out starches and sugars, reducing the risk of pest attacks.
- **Chemical Treatment**: Bamboo is treated with preservatives like boric acid and borax solution, which protect against termites and fungal decay.
- **Heat Treatment**: Heat treatment or smoking can also be used to dry and preserve bamboo naturally.

As the treatment of bamboo is a very important step in ensuring its durability and strength, we will explore the various methods of bamboo treatment in the next session.

Drying

Proper drying is crucial to reduce the bamboo's moisture content, which helps prevent cracking and insect infestation during storage.

- **Air Drying**: Bamboo is left in the open air, but protected from direct sunlight and rain, for several weeks or months, depending on the climate and the thickness of the culms.

Fig. 2.10: Air drying

- **Kiln Drying**: In some cases, bamboo is kiln-dried for faster and more controlled moisture removal.

Fig. 2.11: Kiln drying

Storage

Once bamboo is dried and treated, it must be stored in suitable conditions to maintain its quality until use.

The best practices for bamboo storage area are as follows:

- Bamboo should be stored in a well-ventilated area to avoid moisture buildup and ensure airflow around the culms.
- Culms are stacked on raised platforms or racks, tarpaulin sheets or thick plastic sheets, or raised on a PCC platform. to prevent contact with the ground, which can lead to moisture absorption and rot.
- Bamboo should be protected from rain and direct sunlight. Tarpaulins or roofing can be used to cover bamboo stacks while allowing air circulation.
- Periodic inspection for pest infestation is necessary. If pests are detected, immediate retreatment or fumigation may be required.

Fig. 2.12 (a & b): Vertical stacking of bamboo

- Vertical stacking is recommended for applications other than pulping. Vertical stacking gives quick drying and less chances of fungal attack. Culms can be stored in an upright position against the wall.
- Horizontal stacking is generally preferred for large stacks. Stacking should be done on raised platforms without ground contact and allowed to dry uniformly. The culms at the bottom of the stack may crack/bend due to the weight of the stack.
- Storage in water is best suited for bamboo to be processed green. Storage in water causes the leaching of starch and maintains flexibility. In case the bamboo is stored for long periods, needs to be transported over a distance or the ambient conditions are highly favourable for fungal/insect attack, prophylactic treatment should be given. It should be mentioned here that if a fungal attack sets in, the effects of the attack - like fungal stains - cannot be removed completely even after subsequent treatment. Also, the fungal spores may remain within the bamboo and multiply later

Fig. 2.13: Horizontal stacking

Treated bamboo must be stored in a dry, shaded area to protect it from moisture, sunlight and pests. Proper stacking is essential to prevent bending, rotting and accidents. Bamboo poles should be arranged in layers with support to avoid falling. Detailed storage methods and precautions are covered in Unit 5, Session 2. The bamboo pole stacking system is shown in Figure 6.21 under Grading and Sorting.

After the quality check and treatment processes, bamboo culms are sorted and graded based on their size, quality and intended use. This helps in efficiently meeting different commercial demands—whether for construction, handicrafts, or furniture making.

Longevity of Bamboo

With proper post-harvest treatment and storage, bamboo can last for several decades, making it a sustainable and reliable material for various industries. Effective post-harvest handling ensures that bamboo retains its structural integrity, aesthetic appeal and resistance to environmental stressors.

Finally, we studied the post-harvest steps, such as checking the bamboo quality, drying it properly and storing it safely. These steps help protect bamboo from insects, moisture and fungus.
By knowing all these processes, a bamboo artisan can work with better-quality materials and create products that are strong, beautiful and ready for the market.

Activities

Activity: Identify the availability of different species of Bamboo in different locations of India on a map.

Materials Required

1. India Map with clear geographical boundaries, states and key regions.
2. List of Bamboo Species
3. Markers
4. Pen/Pencils

Procedure

1. Get the List of Bamboo Species and Their Regions
2. Look at the India Map
3. Mark the Region
4. Write the Name of the Bamboo Species
5. Repeat the Process for All Species
6. Final Review
7. Completion

Activity 2: Identify different types of bamboo, understand how bamboo is grown and explore how it is handled after harvest.

Materials Required

1. Chart paper or A4 sheets

2. Pens, pencils, coloured markers
3. Ruler and scissors
4. Pictures of bamboo plants (optional: printed or from magazines)
5. Access to the internet/library (optional for extra research)

Procedure

Part 1: Bamboo Identification (Observation)

1. Use your textbook or look up 2–3 **commercial bamboo species** (e.g., *Bambusa bambos*, *Dendrocalamus strictus*, *Bambusa tulda*).

2. Note down the following for each:
   - Local name
   - Size (height and thickness)
   - Leaf shape
   - Colour or texture
   - Common uses

Part 2: Cultivation & Harvest (Drawing/Labeling)

3. On a sheet, **draw a simple step-by-step process** of how bamboo is cultivated:
   - Site selection
   - Planting
   - Watering and care
   - Harvesting
4. Use arrows to show the flow and label each step with 1–2 easy sentences.

Part 3: Post-Harvest Handling (Think & Match)

5. Write short points or draw pictures showing what happens to bamboo after it is cut:
   - Quality check (what to look for)
   - Drying methods
   - Storage methods
6. If working in a group, one student can explain each part to the class.

Check Your Progress

A. Fill in the Blanks

1. The most commonly cultivated bamboo species in India is _____.
2. Bamboo thrives best in _____ and fertile soil conditions.
3. The two main methods of bamboo propagation are _____ and _____.
4. Bamboo is typically harvested at the age of _____ years for optimal strength and durability.
5. Post-harvest treatment of bamboo is essential to prevent attacks from _____ and fungi.

B. Short Answer Questions

1. Which bamboo species is commonly found in the northeastern states of India?
2. What region is Bambusa vulgaris predominantly found in?

C. Long Answer Questions

1. Explain the significance of Bambusa arundinacea in the southern region of India and describe its uses.
2. How do you ensure quality control of harvested bamboo?
3. Explain initial conditions to be considered for bamboo cultivation and propagation.

Session – 2
Characteristics of Bamboo

This session covers the basics of bamboo, a fast-growing and eco-friendly plant widely used in handicrafts. Bamboo, part of the grass family, is known for its strength, flexibility and sustainability. India is the second-largest bamboo producer globally. The session explores bamboo's anatomy, including its culms, rhizomes and leaves and examines its mechanical and physical properties like tensile strength, flexibility and lightweight nature. Understanding these properties is crucial for artisans to create durable bamboo crafts and promote sustainable product development.

Bamboo is a type of fast-growing tall grass from the grass family called Poaceae (formerly known as Gramineae). It is a perennial plant, meaning it lives for many years and grows mainly in tropical, subtropical and mild temperate regions. There are more than 90 groups (genera) and about 1,450 species of bamboo found in various soils and climates worldwide. Bamboo grows in regions such as East Asia, North Australia, West India, sub-Saharan Africa and the Americas, from the U.S. to Chile. Interestingly, Europe is one of the few continents without native bamboo species.

Fig. 2.14: Different bamboo species

India has the second-largest bamboo resource after China and together, these two countries hold more than half of the world's bamboo. India has over 125 native and 11 exotic bamboo species from 23 genera with about 12 to 13 species being economically important for making bamboo products. (Source:

India State of Forest Report (2019), Forest Survey of India, Ministry of Environment, Forest and Climate Change, GOI.)

Bamboo grows naturally across most of India, except in Kashmir. Over 50% of India's bamboo species are found in the northeastern states, including Arunachal Pradesh, Assam, Manipur, Mizoram, Meghalaya, Nagaland, Sikkim, Tripura and West Bengal. Other regions rich in bamboo include the Andaman & Nicobar Islands, Madhya Pradesh, Chhattisgarh and the Western Ghats. India's total bamboo-growing area is estimated to be around 13.96 million hectares. Bamboo species such as Bambusa bambos, Dendrocalamus strictus and Melocanna baccifera are widely distributed throughout India.

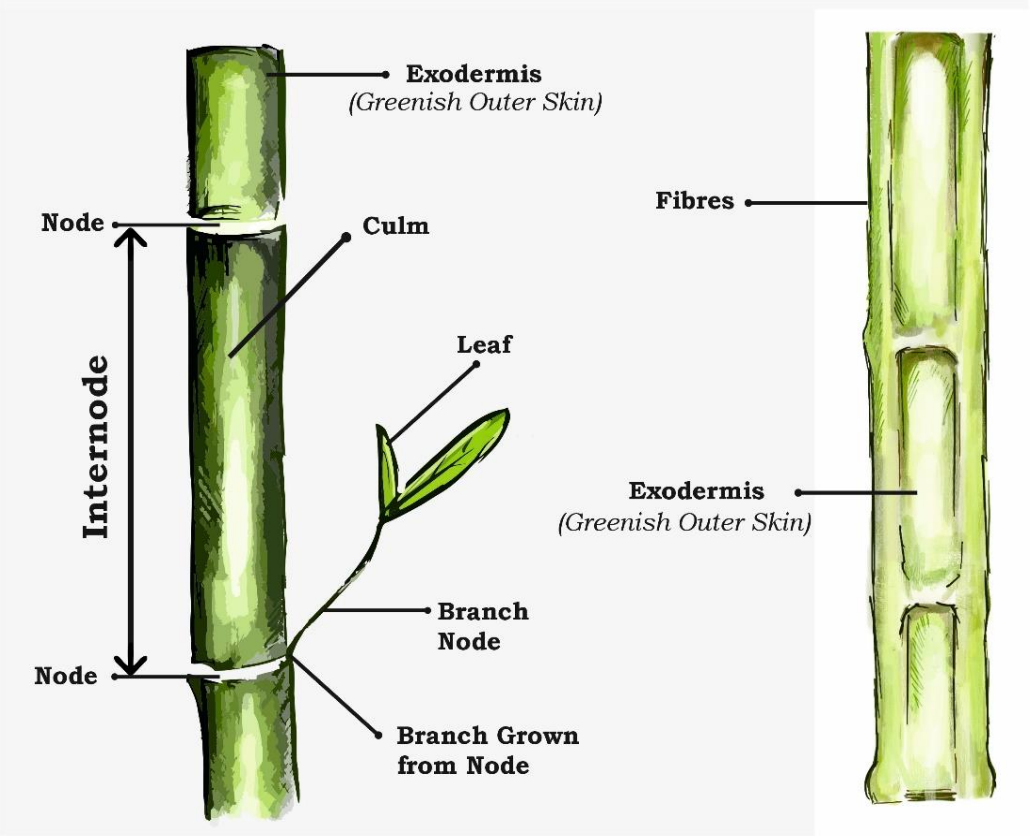


Fig. 2.15: Structure of bamboo

Bamboo is highly valuable and serves many important purposes, which is why it is often referred called "bamboo culture," "poor man's timber," "green gold," and "the people's friend." Bamboo has about 1,500 traditional uses, such as in household items, industry, weapons, energy, transportation, fisheries, agriculture, medicine and construction. Recently, bamboo-based industries have rapidly grown, especially in East and Southeast Asia with China leading the development of new products like laminated bamboo, parquet flooring, bamboo composites and bamboo charcoal. Traditional products like bamboo shoots for food, chopsticks, toothpicks and handicrafts have also become more mechanized.

In India, the bamboo sector has huge growth potential. Around 8 million artisans depend on bamboo crafts for their livelihood and the sector generates an annual turnover of about ₹2,400 crores. Despite this, the industry remains mostly unorganized with bamboo often seen as only useful for crafts or pulp production. The northeastern states have a long history of bamboo craftsmanship and the skills of their artisans have reached levels comparable to those in more developed countries like Japan and China.

Anatomy of Bamboo

Bamboo is a unique plant with several key parts that contribute to its structure and functionality:

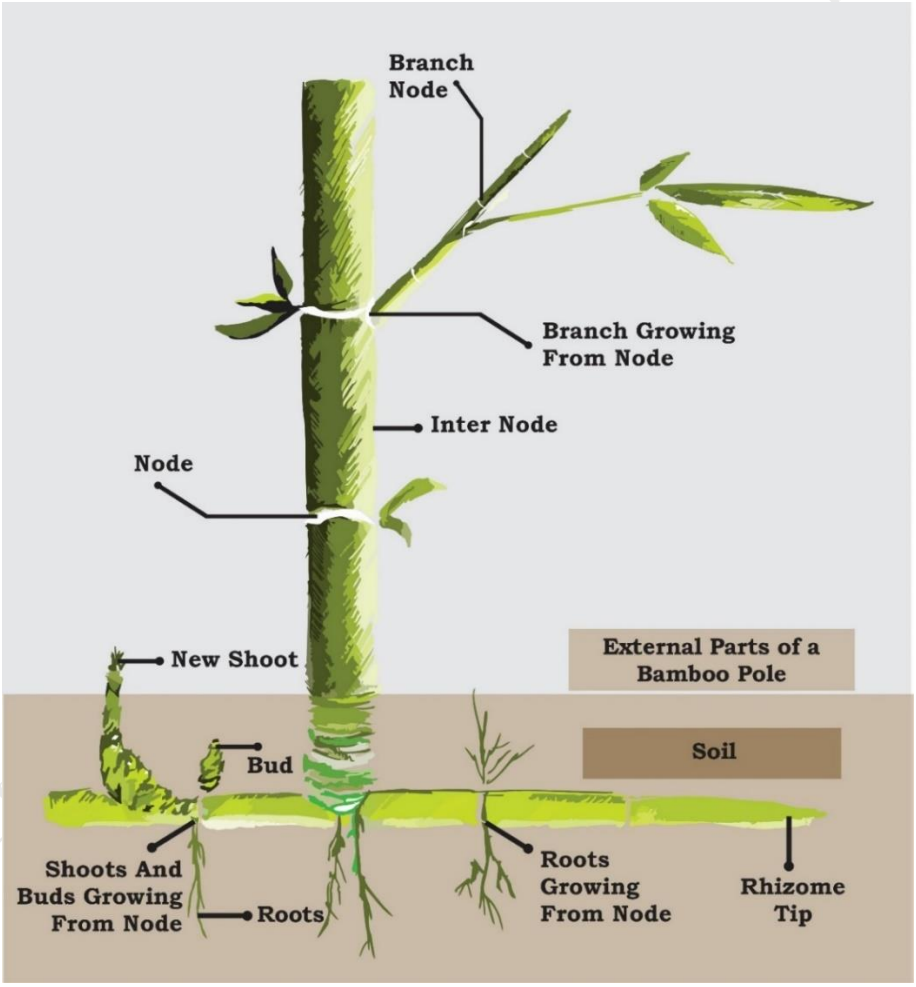


Fig. 2.16: Anatomy of bamboo plant

1. **Culms**: These are the tall, hollow, woody stems that grow straight and have rings or nodes along their length. They vary in size, shape and texture, providing strength and flexibility. The bamboo stem (culm) is the most utilized part of the bamboo plant.

2. **Culm Sheath**: The plant casing (similar to a leaf) that protects the young bamboo shoot during growth, attached at each node of culm. Useful for identification of the species

3. **Nodes**: These are the joints on the culms where branches or leaves emerge. The nodal region also houses branch buds and culm sheaths.

4. **Internodes**: The smooth, hollow spaces between the nodes, which can vary in length and thickness among species.

5. **Rhizomes**: Well-developed underground stems that spread and support the growth of new shoots. Rhizomes store food and facilitate vegetative reproduction. They can be categorized as pachymorph (clumping) or leptomorph (running).

6. **Roots**: Thin, fibrous roots that grow from the rhizomes, helping to absorb water and nutrients from the soil.

7. **Branches**: Thin stems that grow from the nodes, providing support for the leaves.

8. **Leaves**: Narrow, long leaves that grow on the branches, playing a crucial role in photosynthesis.

Bamboo has a complex morphology, including a well-developed rhizome system, hollow culms, branching patterns and petiolate leaves. Its strong yet flexible structure makes it useful in many applications, from construction to crafts. Bamboo's inflorescence consists of compound flowers and it can exhibit various flowering cycles—annual, sporadic, or gregarious. Its fruit can be classified into caryopsis, glans, or bacca, depending on the species.

Bamboo is categorized into woody and herbaceous types and further classified based on growth habit into tree forms, reeds, stragglers, climbers and shrubs, showcasing its incredible diversity and adaptability.

Physical Properties of Bamboo

Physical properties include things we can see and feel like the colour, texture, grain, moisture content and density of bamboo. These features help us identify the type of bamboo and decide how it can be used.

1. **Density**: Density is the measure of how heavy a material is for its size. In bamboo, density varies depending on the species and part of the culm

(stem). Denser bamboo is usually stronger and better for building strong structures.

The diameter of bamboo varies significantly across different species. Some varieties have exceptionally broad culms, making them suitable for crafting a wide range of items such as bottles, cups, vases, and other container-like products. This variation in size plays a key role in determining the potential applications of each type of bamboo in traditional crafts and modern sustainable design.

2. **Colour**: Bamboo changes its colour at each stage of growth, influenced by factors such as moisture, light, and other environmental conditions also the colour changes as it matures or after it is treated. Shades such as light yellow, green, brown, or golden are mostly seen.
3. **Texture**: Texture refers to how the surface of bamboo feels whether it is smooth, rough, or fibrous. Bamboo usually has a smooth outer surface and a slightly rough inner part. Texture affects how bamboo is used in crafts and furniture.
4. **Grain**: Grain describes the direction and arrangement of the fibres in bamboo. Bamboo typically has a straight, linear grain which makes it easier to split and shape. Grain patterns also influence the appearance and strength of bamboo products.
5. **Moisture Content:** This is the amount of water present inside the bamboo. Freshly cut bamboo has high moisture content and is more likely to crack, shrink, or get attacked by insects. Drying or seasoning bamboo reduces its moisture content and makes it stronger and longer-lasting.

Fig. 2.17: Physical appearance of different types of bamboo

A “Bamboo Work Artisan” must know the physical properties of bamboo to create a versatile craft of bamboo. Moisture content and density aid in determining the best techniques for cutting, shaping and joining bamboo. This knowledge not only promotes sustainable practices, as bamboo is an eco-friendly material but also inspires innovation in crafting new products. Furthermore, understanding bamboo's properties equips the artisan to solve problems effectively and enhances their artisanry, paving the way for future career opportunities.

Mechanical Properties of Bamboo

Mechanical properties are related to how bamboo behaves under force like how strong, stiff, or flexible it is. These properties help us understand how well bamboo can support weight, resist pressure, or handle bending and shocks.

Let us discuss the mechanical and physical properties of bamboo one by one.

Bamboo possesses remarkable mechanical properties, making it a valuable material for the handicraft industry and various applications.

1. **Strength:** Bamboo has a high tensile strength, often comparable to steel, which allows it to withstand significant stress without breaking. Its compressive strength is also impressive, enabling it to support heavy loads.
2. **Flexibility:** Bamboo’s natural flexibility allows it to bend without breaking, making it ideal for structures that need to withstand dynamic forces, such as earthquakes.
3. **Lightweight**: Despite its strength, bamboo is lightweight, making it easier to handle and transport compared to traditional building materials like concrete or steel.
4. **Stiffness**: Bamboo exhibits good stiffness, which helps maintain structural integrity under loads. The stiffness varies between different species and parts of the plant.
5. **Durability**: When properly treated, bamboo can resist pests and decay, enhancing its longevity as a building material.
6. **Energy Absorption**: Bamboo can absorb energy, making it suitable for applications in areas prone to vibrations or shocks.

7. **Modulus of Elasticity:** This property measures how much a material deforms under stress. Bamboo has a high modulus of elasticity, which contributes to its stability and strength in construction.

8. **Thermal Properties:** Bamboo has good thermal insulation properties, helping to maintain comfortable indoor temperatures in structures.

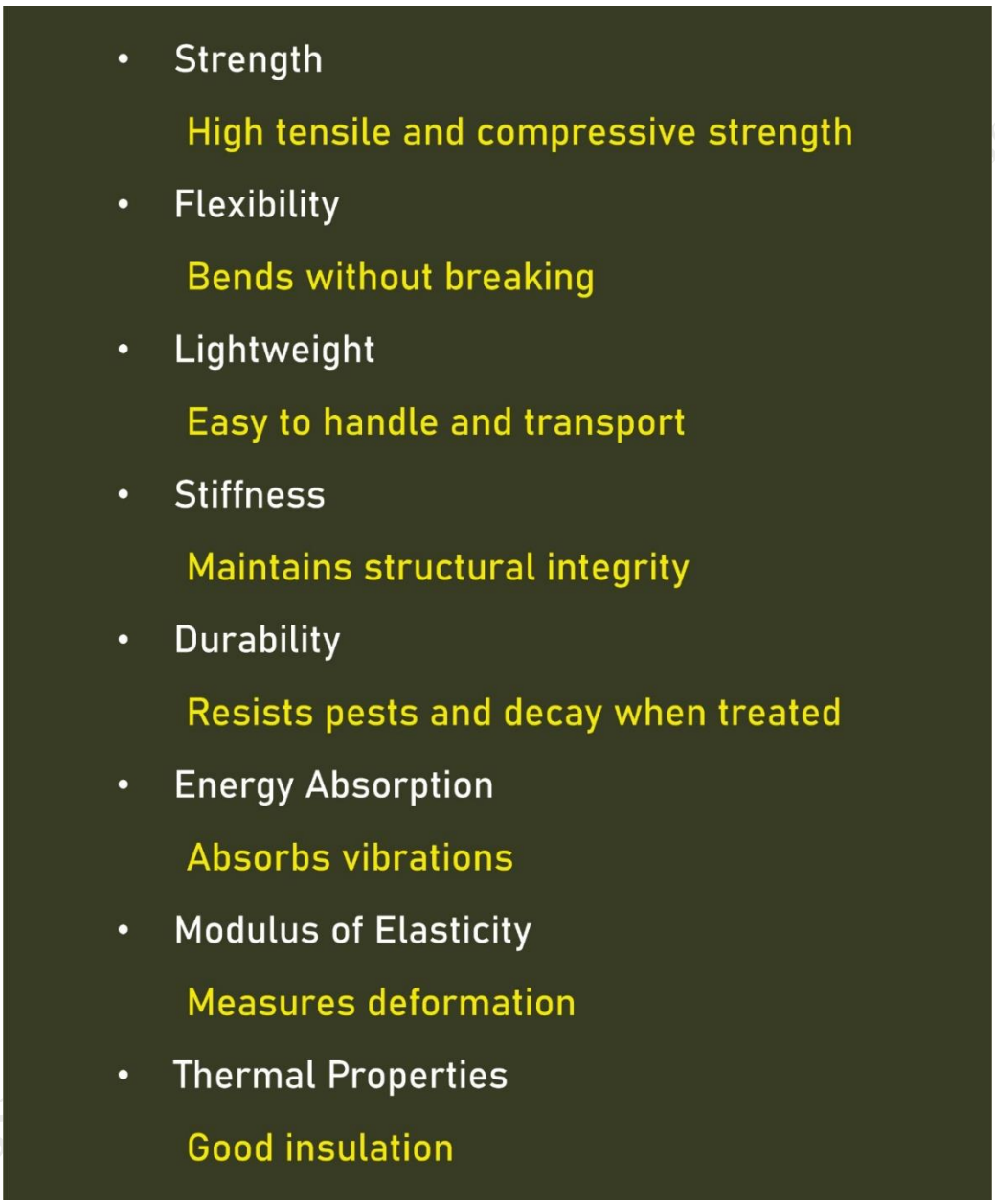


Fig. 2.18: Mechanical properties of bamboo

Understanding the mechanical and physical properties of bamboo is essential for a "Bamboo Work Artisan". Knowledge of these properties enables them to select the appropriate type of bamboo for specific projects, ensuring durability and functionality. Mechanical properties like strength and flexibility inform design choices, allowing for the creation of structures that can withstand loads and stress.

Activities

Activity: Preparing Bamboo Samples and Analyzing Their Properties

Material Required

1. Pen, pencil and eraser
2. Practical file
3. Measuring tape
4. Bamboo samples (various species if available)
5. Scissors or cutting tool
6. Ruler
7. Bamboo strips (pre-cut, if possible)
8. Safety gloves (for handling bamboo)
9. Marker/coloured pens
10. Paper and pen for notes

Procedure

1. Collect Bamboo Samples
2. Measure the Bamboo Samples
3. Identify the Parts of Bamboo
4. Analyze the Mechanical Properties
5. Examine the Physical Properties
6. Create Bamboo Samples
7. Presentation

Check Your Progress

A. Fill in the Blanks

1. Bamboo is a type of fast-growing tall _____ from the family called Poaceae.
2. India has _____ native and 11 exotic bamboo species from 23 genera.
3. Bamboo grows naturally across most of India, except in _____.
4. The underground stems of bamboo that spread and support the growth of new shoots are called _____.

5. Bamboo has a high _____ strength, often comparable to steel, which allows it to withstand significant stress without breaking.

B. Short Answer Questions

1. What are the main uses of bamboo in India?
2. What is the significance of rhizomes in bamboo plants?

C. Long Answer Questions

1. Explain the mechanical properties of bamboo and their significance for bamboo artisans.
2. Describe the anatomy of bamboo and explain the role of each part in the plant's overall structure.

Session – 3
Treatment of Bamboo

Bamboo is a good and hard material, but if we don't maintain it in the right way, it may be damaged by insects, fungus, or moisture. Due to this, bamboo becomes weak and short-lived. To fix this issue, we must treat bamboo before making products from it. This session will teach you various ways to treat bamboo. These treatments preserve bamboo and extend its lifespan. Some of the ways are age-old, such as immersing in water (leaching), treating with smoke (smoking), or using lime. Others are contemporary chemical treatments using safe chemicals to preserve bamboo from pests and rot.

Each process has a specific function and is selected depending on how the bamboo will be utilized. For instance, bamboo that is meant to be used for furniture or building requires more powerful treatment compared to bamboo meant for toys or baskets so we will.

Through knowledge of bamboo treatment, you will know how to maintain bamboo strong, secure and prepared to be converted into lovely and useful products. This knowledge also facilitates the encouragement of green and durable bamboo crafts.

Importance of Bamboo Treatment

Bamboo is a natural material of organic origin. Without any protective treatment, its durability is less than five years. Bamboo treatment is a critical process that enhances the durability, longevity and overall quality of bamboo for various uses, especially in construction, crafts and commercial products. Untreated bamboo is susceptible to pests, fungi and weather damage, which can drastically reduce its lifespan and functionality. Let us now understand the key reasons why bamboo treatment is important:

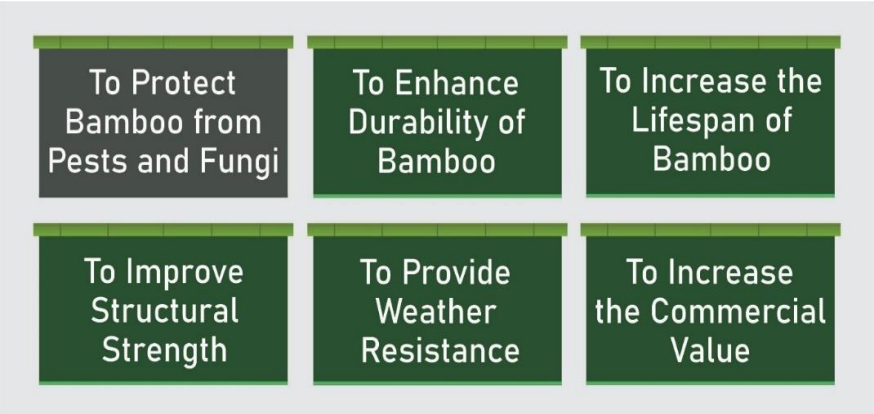


Fig: 2.19: Importance of bamboo treatment

1. Bamboo contains starches and sugars, which attract pests like termites and borers and make it prone to fungal growth. Treatment processes like chemical preservation or water leaching remove these nutrients and provide a protective barrier, preventing insect attacks and mold.

2. Untreated bamboo is vulnerable to moisture, which leads to rotting, cracking and warping. Through proper drying, heat treatment, or chemical treatment, bamboo's moisture content is reduced, ensuring it maintains its structural integrity over time. This makes treated bamboo more suitable for long-term applications in construction, furniture and crafts.

3. Bamboo, when properly treated, can last several decades or even up to a century, depending on the environment and the method of preservation used. This extends its usability in various industries, providing a cost-effective and sustainable material for a range of applications.

4. Bamboo treatment, especially processes like heat treatment and water immersion, improves the culm's strength and flexibility by removing excess moisture and sugars. This allows the bamboo to maintain its original shape, resist splitting and perform well under load, making it ideal for construction and load-bearing applications.

5. Treated bamboo is better equipped to withstand exposure to varying weather conditions, such as humidity, rain and sunlight. Chemical or natural treatments form a protective layer that helps bamboo resist swelling, shrinking and other forms of weather-related degradation.

6. Treated bamboo holds greater market value as it meets quality standards required for various commercial applications. Products made from treated bamboo are more desirable due to their durability and reliability, contributing to higher profitability for bamboo artisans and industries.

7. By treating bamboo, its lifespan and utility are extended, reducing the need for frequent harvesting and contributing to the sustainability of bamboo forests. This allows bamboo to remain a renewable resource with minimal environmental impact while supporting industries that depend on it.

Therefore, bamboo treatment is crucial for unlocking the full potential of bamboo as a versatile, sustainable and durable material. It ensures that bamboo remains a competitive and reliable resource for industries ranging from construction to craftsmanship, supporting both ecological sustainability and economic growth.

Causes of Bamboo Degradation

Bamboo is a natural material that is strong and useful, but it can get damaged over time if it is not taken care of properly. This damage is called degradation and it can happen because of insects, fungus, too much moisture, or sunlight. If bamboo is left untreated, it may crack, rot, or get eaten by termites. This reduces the life and quality of bamboo products.

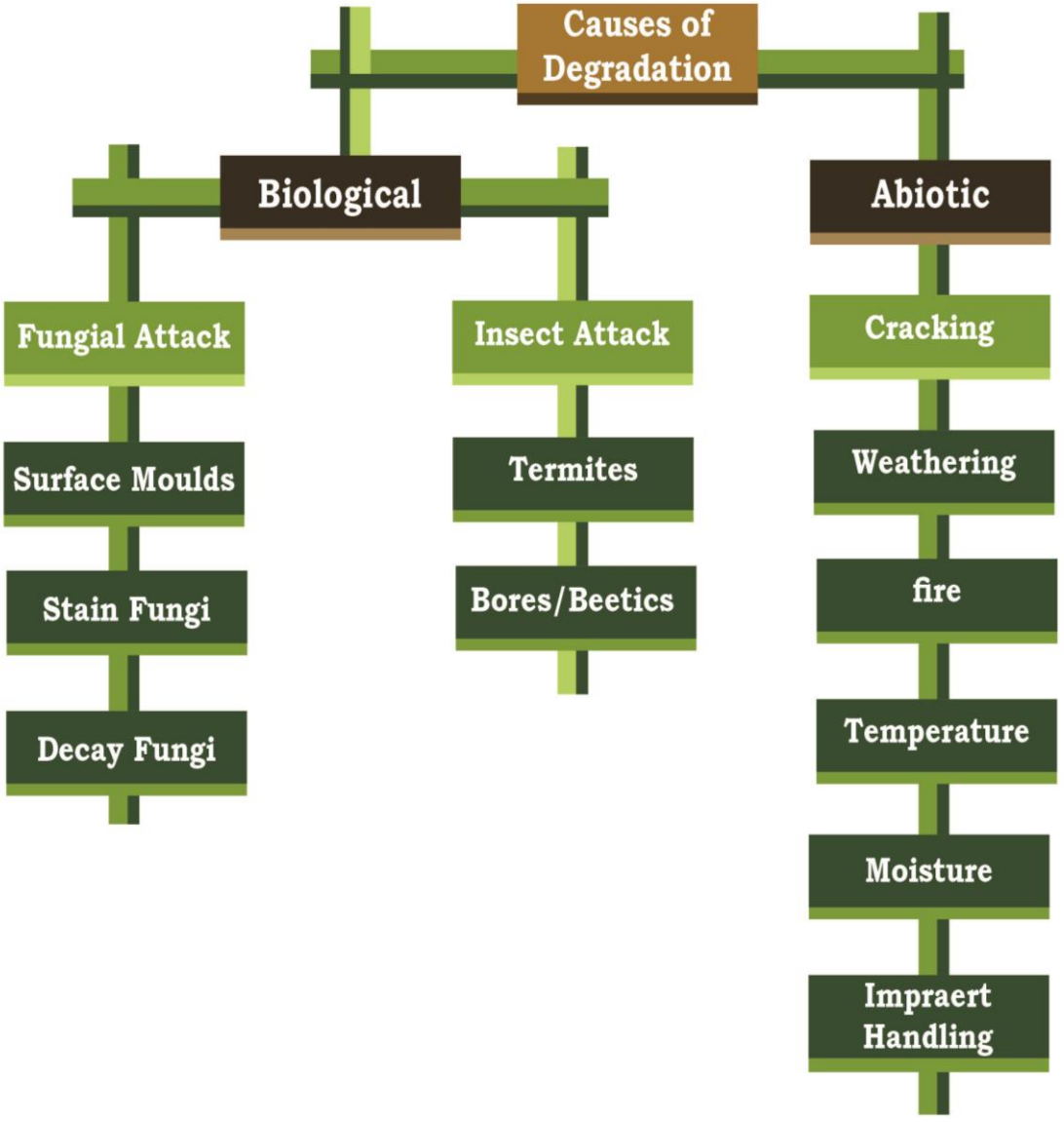


Fig: 2.20: Causes of bamboo degradation

Treatment Methods: Natural and chemical

To protect bamboo from above mentioned degradation, we need to treat it using different methods. These methods help remove harmful substances from bamboo and make it stronger and more durable. There are two main types of treatments:

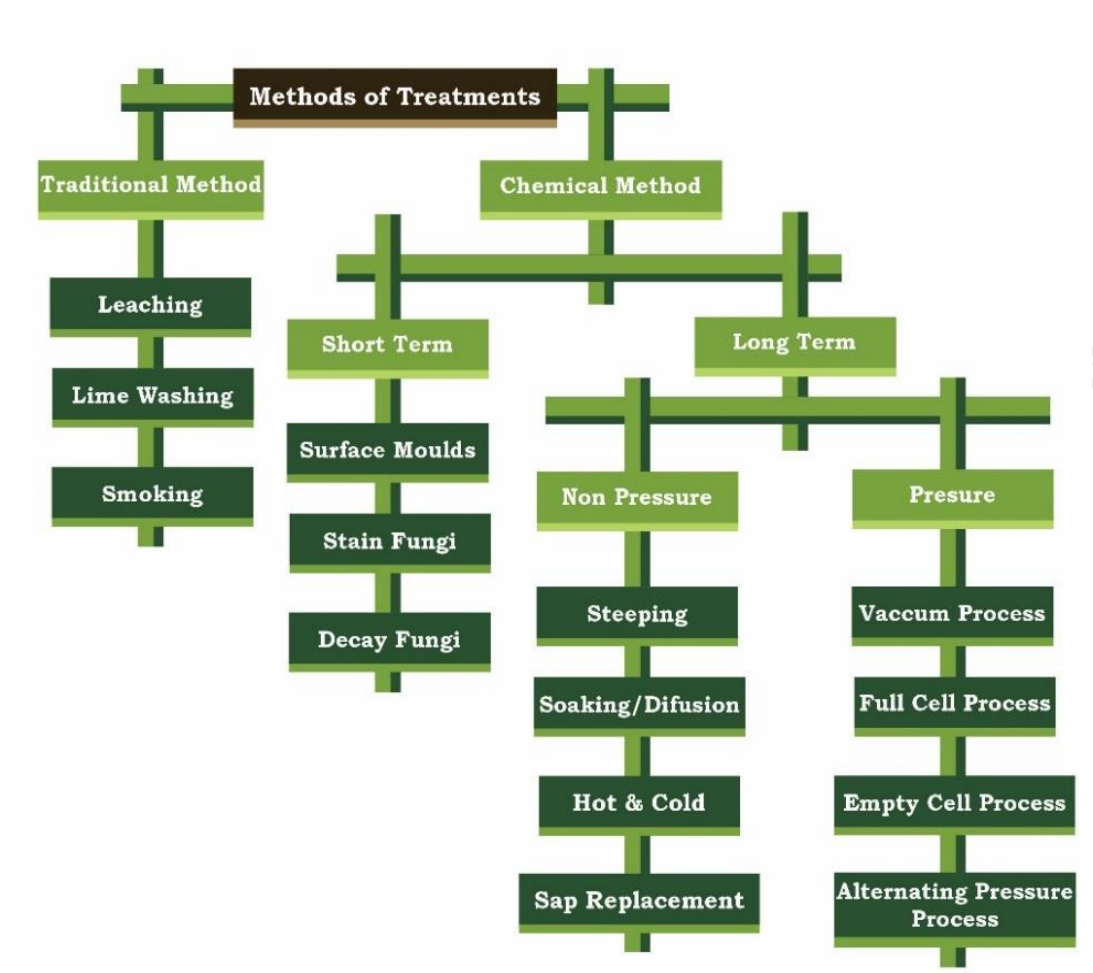


Fig: 2.21: Treatment methods of bamboo

There are many different ways to treat bamboo as mentioned above in fig. 2.21 and these methods can vary from one region to another. Some places use traditional techniques passed down through generations, while others use modern chemical methods. However, in this session, we discussed some of the most common and popular bamboo treatment methods that are especially useful for a bamboo work artisan.

The selection of the treatment method depends on many factors:

- **State of bamboo** - green or dry
- **Form** - round bamboo, splits or bamboo products.
- **End applications** - in-ground contact, exposed to the atmosphere, undercover, structural/non-structural.
- **Scale** - quantity to be treated and time available.
- **Potential causes of decay** - biotic (fungus/insects) and abiotic (cracks/weathering).

Traditional Treatment Methods

These methods have been traditionally practiced in regions where bamboo is widely grown. They are simple, cost-effective and do not require specialized equipment. However, these techniques may not offer long-term protection for bamboo. Common traditional methods like leaching, smoking and lime washing have been used for ages in bamboo-growing areas. In some cases, especially for craft items, natural dyes and lacquers are applied not only for protection but also to enhance the value of the bamboo.

1. Leaching Method

Leaching is used to remove starch from bamboo and increase its permeability for future treatments involving diffusion or pressure. Bamboo is stored in water for up to 2-3 months, which may temporarily affect its mechanical properties. This method is suitable for treating any amount of bamboo, especially for crafting and mat-making, where flexibility is essential. Bamboo culms or splits are bundled and submerged in running water or tanks. To ensure complete immersion, sinker weights are used. If tanks are used, the water should be changed weekly to prevent bacterial growth, which can cause staining and unpleasant odours.

Fig. 2.22: Leaching treatment method

2. Smoking

Traditionally, bamboo culms are stored above hearths or fireplaces, where the heat from the smoke reduces their moisture content. This moisture reduction prevents biological degradation, while the smoke deposits a protective layer on the bamboo. Smoking also minimizes the risk of splitting.

Fig. 2.23: Smoking treatment method

3. Lime Washing

Lime or whitewashing is often used for ornamental purposes. Bamboo culms and mats are coated with slaked lime ($Ca(OH)_2$), which transforms into calcium carbonate ($CaCO_3$). This layer inhibits water absorption and slows down fungal attacks. Bamboo mats can also be tarred, sprinkled with sand and whitewashed after drying to enhance protection. Culms can also be painted with a mixture of tar and sand, or plaster and cow dung. These will also prevent water absorption and makes the surface alkaline thereby preventing fungal and insect attack.

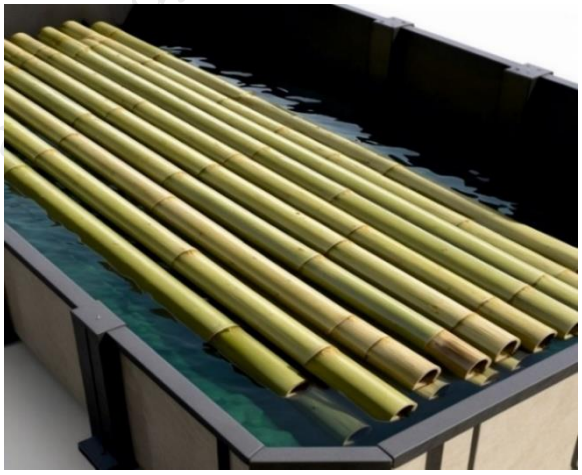


Fig. 2.24: Lime washing treatment method

Chemical Treatment Methods

In these treatment methods, chemical preservatives are used to protect the material from degradation. These are well-established methods providing desired protection even in adverse conditions. Upon treatment, chemicals can

provide either short-term or long-term protection for bamboo. These formulations, consisting of single compounds or mixtures are designed to safeguard bamboo and wood against biological degradation and discolouration caused by pests and fungi. With few exceptions, most chemical preservatives are toxic, so their selection and application must be approached with caution to ensure they meet both performance standards and environmental requirements. Based on the type of carrier solvents used, these preservatives can be categorized into different groups, each with specific characteristics and uses.

1. Open Tank Method (Non-Pressure) for Bamboo Preservation

The Open Tank method is ideal for treating round bamboo, bamboo splits and slivers. In this process, a solution of boric acid/borax (5-8%) is prepared in an open tank, which should have an outlet for draining. For round bamboo, holes should be made through the diaphragms to enhance preservative penetration.

Fig. 2.25: Open tank method (Non-pressure) method

Procedure

1. **Preparation:** Fill an open tank with the boric acid/borax solution. Ensure the tank has an outlet for draining.
2. **For Round Bamboo**: Holes should be drilled through the diaphragms of the bamboo for better penetration of the preservative.
3. **Submersion**: Bundle and tie the bamboo, placing it in the tank. Weights are added to keep the bamboo fully submerged. Cover the tank to minimize evaporation.

4. **Sludge Management**: If sludge forms at the bottom of the tank, do not disturb it, as it can deposit on the bamboo and prevent absorption of the preservative.
5. **Soaking Time**: Round bamboo should be immersed for 15-20 days, while bamboo splits and slivers should be soaked for 7-10 days.
6. **Monitoring:** Regularly check the solution levels and top up if necessary to ensure bamboo remains fully submerged.
7. **Post-Soaking:** After soaking, remove the bamboo and stack it horizontally to encourage further diffusion of the preservative. Ensure the bamboo is air-dried in a covered space.

This method is highly effective for large-scale bamboo treatment (up to 100 culms per month), though it requires a significant number of tanks to accommodate the bamboo culms for proper soaking and preservation.

2. Boucherie Pressure Treatment Method for Bamboo

The Boucherie Pressure Treatment method is appropriate for dry bamboo, ensuring quick and uniform penetration of the preservative deep inside the bamboo tissue. The main aim of this pressure treatment method is to force the preservative into the bamboo by either removing the air inside the culm or applying increased pressure on the preservative in a pressurized cylinder. Bamboo poles treated using this method gain long-lasting durability.

In this process, the preservative is forced under pressure through the entire length of the fresh culm, replacing the sap with the preservative. Since this method is applied to freshly cut culms, it is recommended to store them in water overnight before treatment.

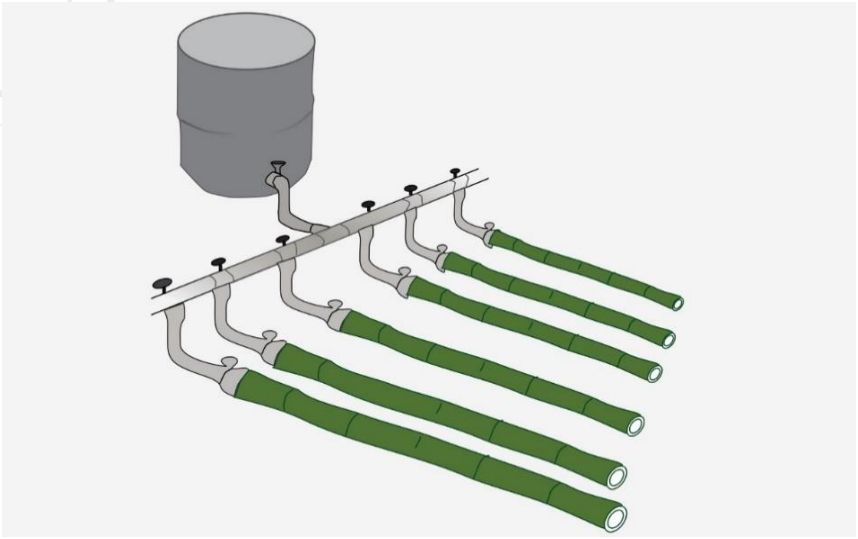


Fig. 2.26: Boucherie pressure treatment method for bamboo

Materials Needed

- Bicycle pump
- Strong, thick steel tank or pipe capable of withstanding pressure
- Metallic clamps
- Rubber hose

Procedure

1. Cut a few centimeters off both ends of the bamboo culm.
2. Join the ends and attach the base to the steel treatment tank, securing with clamps to prevent leaks.
3. Fill two-thirds of the tank with preservative solution.
4. Fit the tank with an airtight screw and a car tyre valve to allow pressure to be applied.
5. Bleed the air out of the system and build up pressure between 1.0 to 1.4 kg/cm² in the tank.
6. Open the valves to begin the preservation process. After about 30 minutes, the preservative will start dripping out from the other end of the bamboo.
7. The process can be stopped when the concentration of preservative exiting the bamboo closely matches the initial concentration of the solution.

This method ensures deep penetration of the preservative, greatly enhancing the durability of the treated bamboo.

3. Butt Treatment Method for Bamboo Preservation

In the Butt Treatment method, freshly cut bamboo culms are placed vertically into a drum containing a water-borne preservative solution, typically a mixture of boric acid and borax. The process relies on capillary action, where the preservative moves upwards through the vessels of the bamboo, followed by diffusion for deeper penetration.

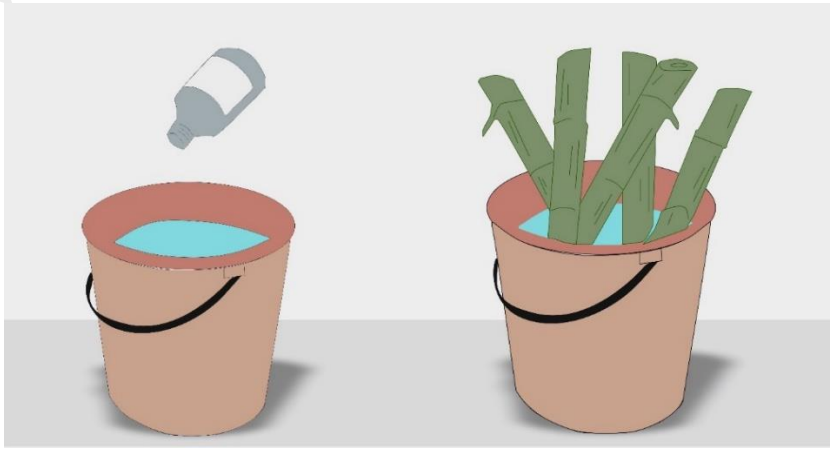


Fig. 2.27: Butt treatment method

Process

1. **Initial Setup:** Place the freshly cut bamboo culms with their bottom ends submerged in a drum filled with the preservative solution.
2. **Capillary Action & Diffusion**: The preservative solution penetrates the bamboo via capillary action and leaves on the bamboo help by creating a pumping effect through the process of transpiration, aiding quicker absorption.
3. **Treatment Duration:** The treatment usually takes one to two weeks, but the exact time depends on factors such as the moisture content and the length of the culms.
4. **Post-Treatment**: After treatment, remove the bamboo culms and place them in an empty drum to drain any excess preservative solution.

This method is useful when only a small number of bamboo culms need treatment, serving as an alternative to the Boucherie method.
All these treatments help bamboo become stronger, more durable and ready to be used in crafts, furniture and construction. Knowing these methods is very helpful for a Bamboo Work Artisan, as it ensures the final product is of good quality and lasts a long time.

Activities

Activity: Create a flow chart of treatment techniques of bamboo.

Materials Required

1. Paper or Cardboard (for the flowchart base)
2. Markers/Pens (for drawing and labelling)
3. Ruler (for neat lines and shapes)
4. Coloured Pencils or Highlighters (to distinguish between different categories or treatment methods)
5. Sticky Notes or Small Paper Pieces (optional, for rearranging if needed)

Procedure

1. Prepare the Base
2. Draw the Main Title Box
3. Create Main Categories
4. Add Treatment Methods
5. Draw Arrows for Process Flow
6. Add Descriptions

7. Use Colours
8. Review and Adjust
9. Final Touches
10. Present or Display

Check Your Progress

A. Fill in the blanks

1. Bamboo treatment is important because untreated bamboo is susceptible to _____ from pests and fungi.
2. The _____ method involves submerging bamboo in water to remove starches and improve permeability for further treatments.
3. Bamboo treated using the Boucherie Pressure Treatment method gains _____ durability due to the deep penetration of preservatives.
4. Lime washing or whitewashing is a traditional treatment that helps prevent _____ attacks and reduces water absorption in bamboo.
5. The _____ method uses capillary action to move preservatives upwards through the bamboo vessels for deeper penetration.

B. Short Answer Questions

1. What is the purpose of the leaching method in bamboo treatment?
2. How does the Boucherie Pressure Treatment method enhance the durability of bamboo?

C. Long Answer Questions

1. Explain the importance of bamboo treatment and describe the various natural and chemical treatment methods used to enhance the durability of bamboo. Provide examples of traditional and modern treatment techniques.
2. Discuss the different factors that determine the selection of bamboo treatment methods. How do these factors influence the effectiveness of treatment in various applications such as construction, furniture and crafts?

Session – 4
Forms of Bamboo

Bamboo is an incredibly versatile resource that can be transformed into various forms, each with unique applications in crafts and everyday life. Solid bamboo is valued for its strength and durability, making it ideal for furniture, construction and decorative items. Bamboo splits, created by cutting bamboo lengthwise are flexible and widely used for weaving baskets, mats and lightweight furniture. Bamboo slivers are thin strips perfect for intricate designs in jewellery and ornamental crafts. Bamboo fibres, soft and antibacterial are used to produce eco-friendly textiles like towels and clothing. Bamboo yarns or fabrics, made from processed fibres are breathable and versatile for garments and home textiles. Bamboo charcoal, obtained through a heating process, is used in air purification, water filtration and beauty products. These forms demonstrate bamboo's adaptability, promoting sustainability while inspiring creativity in craft and design.

Different forms of Bamboo

1. Solid Bamboo

Solid bamboo refers to the entire culm, which is known for its strength and versatility. Artisans often use solid bamboo in furniture making, structural elements and decorative crafts. Its robustness allows for the creation of long-lasting items, from sturdy chairs to intricate wall decorations. The natural aesthetics of solid bamboo with its unique grain patterns, make it a favoured choice for artisans who wish to showcase the beauty of natural materials. Additionally, solid bamboo can be treated for added durability, ensuring that handcrafted items withstand the test of time while maintaining their visual appeal.

Fig. 2.28: Solid bamboo

2. Splits of Bamboo

Splits of bamboo are obtained by cutting the culm longitudinally, resulting in flat pieces that are highly flexible and easy to work with. These splits are widely used in the production of woven items such as mats, baskets and lightweight furniture. Artisans value splits for their ability to create intricate designs and patterns, allowing for a greater degree of creativity in their work. The adaptability of split bamboo makes it ideal for both traditional crafts and modern innovations, enabling artisans to blend heritage techniques with contemporary design trends. Furthermore, the use of splits in handicrafts promotes sustainability by utilizing a readily available resource.

Fig. 2.29: Bamboo splits

Method for Producing Bamboo Splits

- **Bamboo Selection:** For high-quality splits, select mature solid bamboo.
- **Cutting to Length:** Use a saw or knife (manual) or a cutting machine (machine) to cut the culm into the required lengths.
- **Node Removal:** Remove the nodes using a knife, chisel, or small plane (manual) or with a node-removal machine (machine).
- **First Splitting:** Either manually begin splitting the bamboo with a knife or splitter tool, or feed the bamboo into a splitter machine.
- **Splitting**: By machine, the bamboo is split longitudinally into several equal strips in a single pass. Manually, it is carefully divided along the grain into halves, quarters, or smaller strips.

Fig. 2.30: Splitting by machine

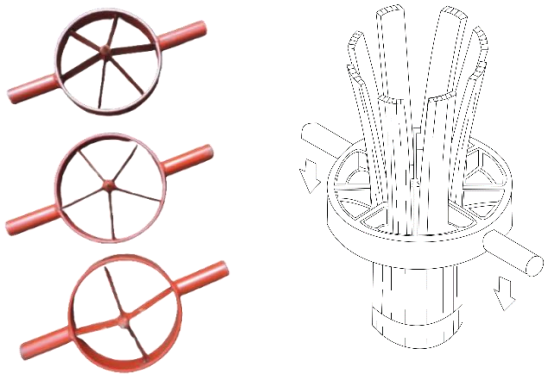


Fig. 2.31 (a & b): Hand splitter

- **Sizing and Shaping:** Manually, each split is trimmed and shaped to the appropriate width and thickness using knives or planes. By machine, thickness planers or width slicers achieve precise dimensions.

- **Surface Smoothing:** Smooth the surfaces either manually (using knives or sandpaper) or mechanically (using surface-finishing or polishing machines).

3. Slivers of Bamboo

Slivers of bamboo are thin strips derived from the culm, prized for their fine detail and versatility in crafting. These slivers are essential for artisans who focus on intricate work, such as weaving delicate jewellery, ornaments and decorative elements. The slender nature of slivers allows for detailed craftsmanship that can enhance the aesthetic value of handmade items. Artisans skilled in using slivers can create complex patterns and textures, adding depth to their creations. This form of bamboo supports a niche market for artisanal products that emphasize uniqueness and craftsmanship, attracting consumers seeking one-of-a-kind items. To learn more about the bamboo sliver-making process, refer unit 3 session 2.

Fig. 2.32: Bamboo slivers

4. Fibres of Bamboo

Bamboo fibres, extracted from the inner part of the bamboo are known for their softness and natural antibacterial properties. These fibres are gaining popularity among artisans for creating textiles and eco-friendly products, such as towels and clothing. The ability to blend bamboo fibres with other materials enhances the durability and functionality of the final product. Artisans appreciate bamboo fibres for their sustainability and comfort, allowing them to produce high-quality items that cater to environmentally conscious consumers. By incorporating bamboo fibres into their crafts, artisans contribute to a growing market for sustainable fashion and home textiles.

Fig. 2.33: Fibres of bamboo

5. Bamboo Yarns/Fabric

Bamboo yarns and fabrics are crafted from processed bamboo fibres, resulting in a soft, breathable material suitable for various applications. Artisans utilize bamboo fabric to create garments, home textiles and accessories that stand out due to their unique properties, such as moisture-wicking and antibacterial qualities. This versatility allows artisans to explore innovative designs while appealing to a growing audience interested in sustainable and eco-friendly products. Using bamboo yarns also enable artisans to blend traditional textile techniques with modern aesthetics, resulting in contemporary items that honour cultural heritage while promoting sustainable practices.

Fig. 2.34: Bamboo yarn/fabric

6. Bamboo Charcoal

Bamboo charcoal, produced through the pyrolysis of bamboo in low oxygen conditions, is celebrated for its purifying properties. The incorporation of bamboo charcoal into handicrafts not only showcases the versatility of bamboo but also aligns with the growing trend of sustainability in consumer goods. By utilizing bamboo charcoal, artisans can create innovative products that cater to health-conscious individuals, further enhancing the appeal of their craftsmanship.

Fig. 2.35: Bamboo charcoal

Bamboo Charcoal Production Process

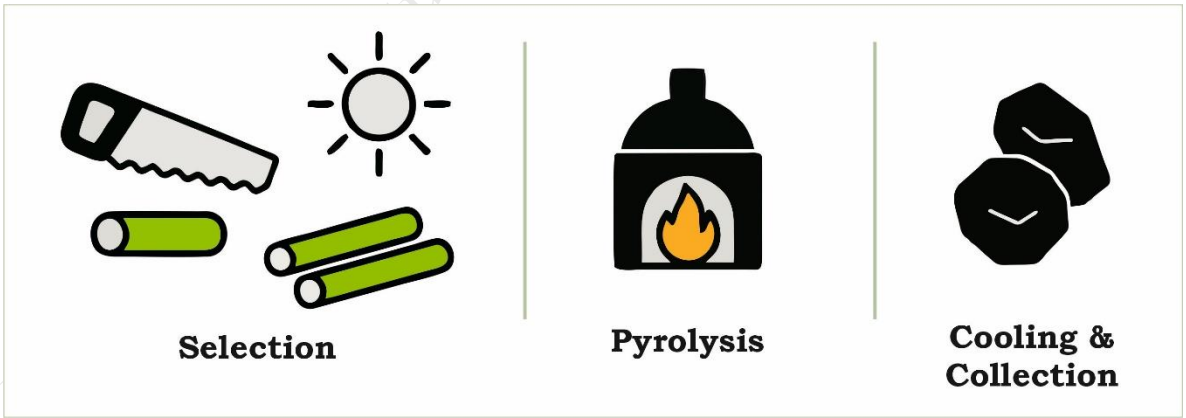


Fig. 2.36: Bamboo charcoal production process

Selection: Collect left over pieces of bamboo.

Drying: Air-dry the bamboo to reduce moisture content.

Pyrolysis: Heat the bamboo in a kiln or furnace under very low-oxygen conditions (around 600–1200°C) to carbonize it without burning.

Cooling & Collection: Allow the charcoal to cool, then collect and process it into desired forms (chunks, powder, or blocks) for various uses.

Artisans use bamboo charcoal in a variety of crafts, including air fresheners, water filters and beauty products. This eco-friendly material appeals to consumers looking for natural alternatives in their daily lives.

Fig. 2.37: Products developed using bamboo charcoal

7. Bamboo Wood

Bamboo wood is not wood from a tree, but rather a processed product made from bamboo grass. The bamboo culms (stalks) are harvested, split, boiled or steamed to remove starch and then laminated or compressed into boards or planks. This creates a material that looks and feels like hardwood.

There are several types of bamboo wood depending on how the strips are arranged. Horizontal-grain bamboo shows more of the natural bamboo "knuckles" and has a lighter, more traditional look. Vertical-grain bamboo has a cleaner, more uniform appearance. Strand-woven bamboo is made by compressing bamboo fibres under high pressure with adhesive, making it extremely hard and durable—often even stronger than some hardwoods.

Fig. 2.38: Bamboo Wood

Process of Bamboo Wood Making

The process of making bamboo wood involves several steps to turn raw bamboo into strong and useful wooden boards or planks. The bamboo strips are then dried, usually in a kiln or under the sun, to remove all the moisture. This step is important to stop the wood from cracking or warping later.

The dried strips are glued together and pressed under high pressure using cold/hot press compressor. There are different ways to press the strips:

- **Horizontally** (showing wider grains),
- **Vertically** (narrower grains),
- **Strand-woven** (crushed fibres pressed tightly).

The pressed bamboo boards are cut into different shapes and sizes. They are then sanded smooth and coated with polish or protective finish to make them shiny, strong and ready to use.

(a) **(b)**

Fig 2.39: (a) & (b) Cold compressing of bamboo to make bamboo wood

Activities

Activity: Prepare a chart and identifying bamboo forms through images.

Materials Required

1. Paper sheets (A4 size)
2. Pens/Pencils
3. Ruler (for neat lines)

4. Coloured markers/pens (for categorizing)
5. Scissors (optional, for cutting out images)
6. Glue stick
7. Access to magazines, newspapers, or printed images from the internet (with pictures of bamboo in various forms)

Procedure

1. Prepare the Material
2. Cut and Collect Images
3. Organize Images
4. Label the Images

Activity 2: Create your own natural incense sticks using bamboo and aromatic ingredients

Materials Required

1. Bamboo sticks (7" or 10")
2. Makko powder (natural binder)
3. Charcoal powder
4. Sawdust (unburned wood powder)
5. Sandalwood powder
6. Essential oils or fragrance oils (e.g., rose, jasmine, sandalwood)
7. Distilled water
8. Mixing bowl and spoon
9. Gloves (optional, for hygiene)
10. Parchment paper or drying tray

Procedure

1. **Prepare the Dry Mix:** In a mixing bowl, combine 3 parts makko powder, 1 part charcoal powder, 1 part sawdust and 0.5 part sandalwood powder.

2. **Add Fragrance:** Incorporate a few drops of your chosen essential or fragrance oil into the dry mix. Adjust the quantity based on the desired scent strength.

3. **Form the Dough:** Gradually add distilled water to the mixture while stirring continuously until it achieves a dough-like consistency pliable but not sticky.

4. **Roll the Incense Sticks:** Take a bamboo stick and evenly coat it with the prepared dough, leaving about an inch at the bottom uncoated for handling.

5. **Dry the Sticks:**
   - Place the rolled sticks on parchment paper or a drying tray.
   - Allow them to dry in a well-ventilated area, away from direct sunlight, for 24 to 48 hours until its completely hard.

Check Your Progress

A. Fill in the Blanks

1. Solid bamboo is known for its strength and _____ in furniture making and structural elements.
2. Bamboo _____ are highly flexible and easy to work with, commonly used in woven items.
3. Bamboo _____ are thin strips derived from the culm, used for intricate work like jewellery and ornaments.
4. Bamboo fibres are soft and have natural _____ properties, making them ideal for textiles.
5. Bamboo _____ is produced through pyrolysis and is used in air fresheners, water filters and beauty products.

B. Short Answer Questions

1. What are the main uses of solid bamboo in handicrafts?
2. How are bamboo slivers different from bamboo splits?

C. Long Answer Questions

1. Explain the process of making bamboo yarns and fabrics and their applications in the textile industry.
2. Discuss the various forms of bamboo and their significance in sustainable handicrafts

Module 3 Tools, Techniques and Development of Bamboo Products

Module Overview

Bamboo artisans rely on various hand tools and equipment to craft quality products. Crafting with bamboo requires the use of specialized tools and techniques that help transform raw bamboo into beautiful and useful items. This unit introduces learners to essential tools, machines and methods involved in bamboo craftsmanship. Through four structured sessions, students will gain practical knowledge of the equipment and creative techniques used in traditional and modern bamboo product-making.

The unit is divided into four sessions, each focusing on a specific aspect of the bamboo craft process. In Session 1, learners will become familiar with different bamboo processing tools and equipment. The focus will be on identifying tools by their names, parts and functions. Session 2 introduces the preparation of bamboo slivers and their enhancement using natural dyes made from plants and minerals. It also covers traditional weaving methods used to create items like baskets, mats and decorative pieces. Session 3 explores three creative techniques appliqué, which involves decorating surfaces with small bamboo pieces, bending techniques, which uses heat to curve bamboo and quilling, which involves rolling bamboo slivers into artistic shapes. These techniques are used to design ornamental and artistic bamboo products. Finally, Session 4 covers the finishing process, including joinery techniques, sanding, polishing and applying protective coatings. This unit helps learners make bamboo products more durable, smooth and visually appealing, whether for daily use or market sale.

Learning Outcomes
After completing this module, you will be able to: • Identify tools and equipment used in bamboo handicraft industry and describe their usage • Demonstrate Sliver making, dyeing and weaving of bamboo slivers • Applique, Bending & Quilling of Bamboo Slivers • Finishing of Bamboo Products • Design and Develop Bamboo Products

Module Structure	
Session 1:	Tools and Equipment used in Bamboo Industry
Session 2:	Slivers Making, Dyeing and Weaving of Bamboo Slivers
Session 3:	Applique, Bending & Quilling of Bamboo Slivers
Session 4:	Finishing of Bamboo Products
Session 5:	Design & Development of Bamboo Products

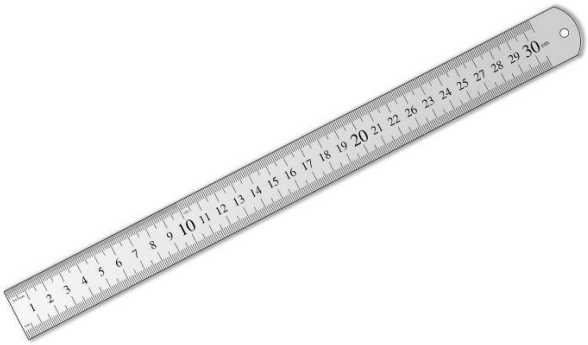
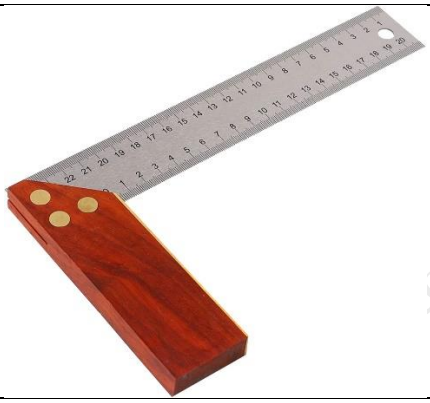
Session – 1
Tools and Equipment used in the Bamboo Industry

This session introduces learners to the wide variety of tools and equipment that form the backbone of the bamboo craft industry. From simple measuring tools like steel rulers and calipers to cutting instruments like saws, chisels and knives, each tool plays a unique role in shaping and preparing bamboo for different types of products. In addition to manual tools, you will also explore advanced machines such as bamboo radial splitters, surface planers and slivering machines, which help artisans work faster and more efficiently.

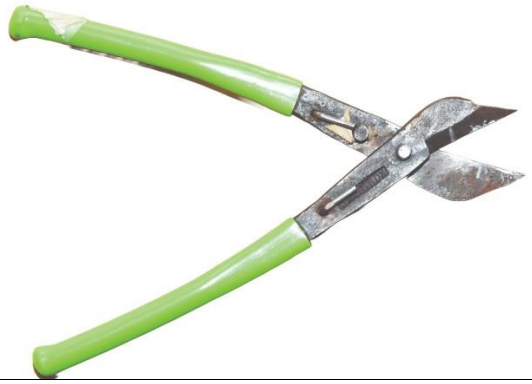
By understanding the purpose and function of each tool and machine, you'll gain a solid foundation to work safely and effectively with bamboo, ensuring both precision and quality in your craftsmanship.

Tools used for making bamboo products

Bamboo work artisans use different tools to carefully measure, cut and shape bamboo for creating beautiful products. Some of the basic tools include steel rulers, calipers, hand saws and chisels. These tools help artisans ensure that each bamboo piece is the right size and shape. For example, rulers and calipers are used to measure the bamboo, while hand saws and chisels are used to cut and carve it. These tools allow artisans to work with precision and create high-quality bamboo items.

1.	**Inch Steel Ruler**		Inch Steel Ruler Used for measuring and marking in inches and In millimeter.
2.	**Right Angle Ruler**		Right Angle Used for marking right angles in various mate.
3.	**Angle Ruler**		Angle Ruler Used for measuring and marking various angles on the materials.
4.	**Measuring Tape**		Measuring Tape Used for measuring longer length in various materials.
5.	**Calipers**		Calipers Used for measuring inside and outside dimensions of various material and pipes.

6.	**Multi Vise Tool**		Multi Vise Tool is used for carrying out drilling, milling, slotting, or shaping. For holding the job for these operations machine vice is used.
7.	**Carpenter's Vice**		A Carpenter's Vice is a woodworking tool that securely holds wood in place for precise and safe crafting.
8.	**Marking Gauge**		Marking Gauge Used for marking on various materials.
9.	**Hand Saw**		Hand Saw Used to cut wood/bamboo based material along or across the grains.
10.	**Cutting Plier**		Cutting pliers Used for cutting & twisting wire, opening and tightening

			nuts & bolts etc.
11.	**Wire cutter**		Wire cutter Used for cutting wire of various diameters.
12.	**Noose Pliers**		Noose Pliers Used for cutting, bending & twisting wire, opening and tightening nuts & bolts
13.	**Fret saw**		Fret saw Used for cutting various intricate shapes from flat sheets.
14.	**Chisel**		Chisels Used for carving out the surface of wood/ Bamboo for making the joints, shapes etc.

15.	**Half Round Rasp**		Half round rasp file Used for shaping and levelling the surface.
16.	**Mortise Chisel**		Mortise Chisels Used for making any grooves for joints.
17.	**Work Bench**		Work Bench A sturdy table with vice used for working with various materials and tools.
18.	**Knifes**		Knifes Used for cutting and splitting bamboo in to various sizes, available in various sizes and shapes.
19.	**Cross Cut Saw**		Cross cut saw Used for cutting wood and bamboo across the grains in any angle.

20.	**C Clamp**		'C' Clamp Used to hold the bamboo tightly while working, joining etc.
21.	**Hammer**		Hammer Used to hit on bamboo, chisel or knifes while working with bamboo.
22.	**Screw Driver**		Screw Driver Used for driving the screws to the material.
23.	**Marking Chisel**		Marking chisel are Sharp pointed chisel used for marking the material.
24.	**Brushes**		Brushes Used for painting or polishing on various material.

25.	**Bending Stand**		Bending Stand Used as a supporting jig while bending the solid bamboo.
26.	**Traditional Hand Drill**		Traditional Hand Drill Used for creating a hole on the surface of any material.
27.	**Hand Splitter**		A tool or machine used to split whole bamboo poles lengthwise into smaller strips or sections called splits for further use.

Table No. 3.1: Tools used by bamboo work artisan

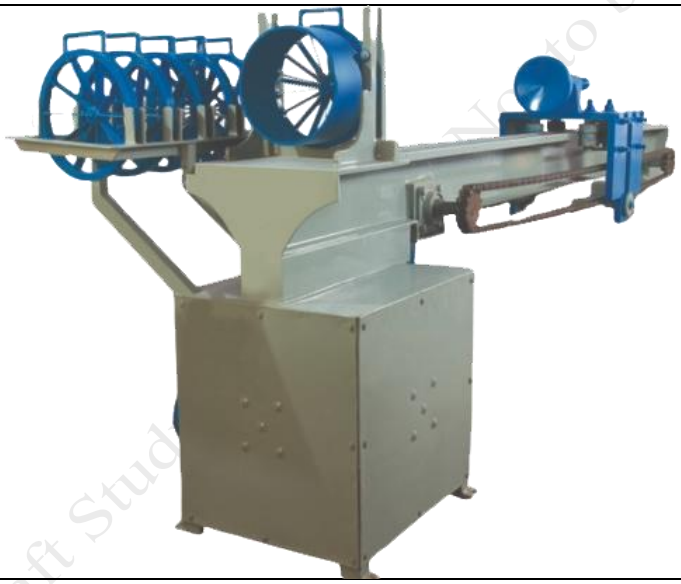
Equipment used for making bamboo products

Machines have made bamboo crafting faster and more efficient. Tools like the bamboo radial splitter, surface planer and slivering machines are used to split, shape and finish bamboo more easily. These machines help artisans split bamboo into smaller pieces, smooth the surfaces and make sure the bamboo is the right shape. By using machines, artisans can save time and produce more bamboo products without losing the quality and detail needed for each piece.

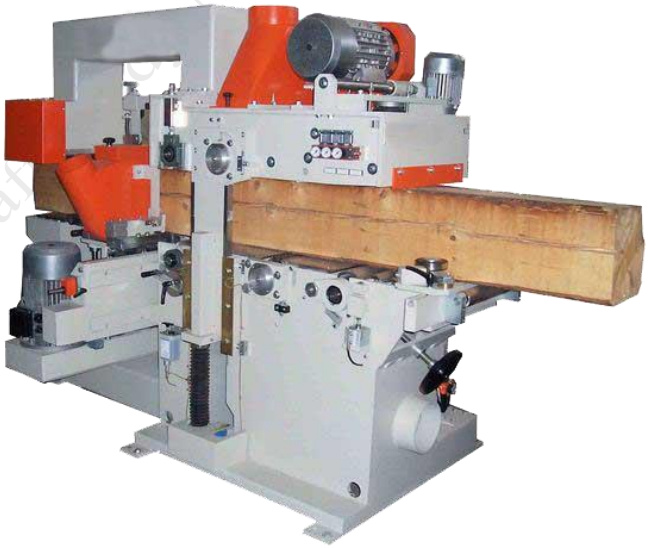
1.	**Hand Drill**		Hand drill is used to make small holes in materials like bamboo, wood, or plastic. It is turned by hand and helps create neat, precise openings for fitting or joining pieces together.
2.	**Hand Held Sander**		Handheld Sander is a tool used to smooth the surface of materials like bamboo, wood, or metal by rubbing or sanding it down. It helps remove rough spots and gives a clean, even finish.

3.	**Hot Air Gun**		Hot Air Gun is used to blows hot air, used to heat bamboo so it becomes soft and can be bent into different shapes without breaking.
4.	**Jig Saw**		A power tool used for cutting bamboo, wood, or similar materials into different shapes or along curved lines.
5.	**Bench Top Table Saw**		A cutting machine placed on a workbench , used to cut bamboo or wood along the length of the grain (fibre) for long, straight cuts.

6.	**Table Saw**		A large cutting machine with a flat table surface, used to cut bamboo or wood along the grain (fibre) for long, straight cuts.
7.	**Benchtop Horizontal Band Saw**		A cutting machine placed on a workbench, used to cut across (crosscut) bamboo at any desired angle. It's useful for making angled or precise cuts.
8.	**Sabre Saw**		A handheld power saw used for cutting bamboo poles or wooden planks, especially when making quick or rough cuts.

9.	**Hand Held Grinder**		A power tool used to smooth, shape, or polish the surfaces of different materials like metal, bamboo, or wood
10.	**Bamboo Radial Splitter**		A machine used to split bamboo into equal parts from the center outward, like slicing a pie. The number of splits can be adjusted as needed
11.	**Surface Planer**		A machine used to smooth and level the surface of wood or bamboo strips, making them even and uniform in thickness.

12.	**Pillar Drill**		Machine used to drill precise holes in materials like wood, bamboo, or metal with the workpiece held steady on a table.
13.	**Vertical Sand Saw**		A cutting tool used to cut wood or bamboo along the grain or into various shapes, making precise, vertical cuts.
14.	**Node Removing Machine**		After bamboo is split, this machine is used to remove the hard nodes (the bumps) from the bamboo, making it smoother and easier to work with.

15.	**Cross Cut Saw**		A machine used to cut bamboo into shorter lengths, usually across the grain
16.	**Parallel Blade Saw**		A machine with blades that run parallel to each other, used to cut bamboo into straight, even splits.
17.	**Four-Side Planer**		A machine that smooths and shapes bamboo or wood into slivers (thin strips) on all four sides, commonly used for making furniture and other products.

18.	**Slivering Machine**		A machine used to cut bamboo or wood into thin slivers (strips), which are then used for producing different craft.

Table No. 3.2: Machines used by bamboo work artisan

Understanding the right tools and machines is key for bamboo artisans to work efficiently, safely and precisely. From cutting and shaping to smoothing and assembling, each tool plays an important role in turning raw bamboo into quality products. Mastery of these tools strengthens the artisan's skills and opens up more creative and professional opportunities in bamboo craft. For the proper use of tools and equipment and to ensure safety while working in bamboo craft, learners should refer to Unit 5 and Unit 6. These units provide important guidelines on how to work safely, handle tools correctly and reduce the risk of accidents in the workplace.

Activities

Activity: Make a chart of various tools used by bamboo artisans.

Materials Required

1. Paper sheets (A4 size)
2. Pens/Pencils
3. Ruler (for neat lines)
4. Coloured markers/pens (for categorizing)
5. Scissors (optional, for cutting out images)
6. Glue stick
7. Printed images of various bamboo tools

Procedure

1. Prepare the Material
2. Cut and Collect Images
3. Organize Images
4. Label the Images

Check Your Progress

A. Fill in the Blanks

1. The _____ is used to measure inside and outside dimensions of various materials and pipes.
2. A _____ is used to split whole bamboo poles lengthwise into smaller strips or sections.
3. The _____ is a machine that smooths and shapes bamboo or wood into slivers on all four sides.
4. A _____ is used to remove the hard nodes from bamboo after it is split.
5. _____ are used by bamboo artisans to hold wood or bamboo securely while shaping or cutting.

B. Short Answer Questions

1. What is the purpose of a 'C' Clamp in bamboo handicraft?
2. Name two machines used for cutting bamboo into specific shapes.

C. Long Answer Questions

1. Discuss the various tools used for cutting and shaping bamboo in the handicraft industry. Include examples such as Hand Saw, Cutting Pliers and Chisels.
2. Explain the role of advanced machines like the Node Removing Machine, Slivering Machine and Bamboo Radial Splitter in modern bamboo handicraft production.

Session – 2
Sliver Making, Dyeing and Weaving of Bamboo Slivers

Bamboo has been an integral part of human life for centuries, serving as a versatile material for crafting products like baskets, mats, fences and storage containers. This traditional craft, rooted in practicality and creativity, can be adapted to meet modern-day needs through innovative techniques. From weaving diverse patterns to enhancing bamboo's aesthetic and functional appeal through natural dyeing, this art form continues to evolve while maintaining its eco-friendly essence.

The weaving employs techniques like alternating warp and weft, creating intricate patterns with applications ranging from everyday storage to decorative purposes.

Adding natural dyes to this craft further enhances bamboo's visual appeal. Using eco-friendly resources like turmeric, tea, manjistha and indigo, along with mordants for durability, bamboo products gain vibrant colours that reflect harmony with nature. Techniques for dyeing and weaving are time-tested, yet they offer immense potential for reintroduction into modern living, making bamboo crafts both sustainable and relevant today.

Method to prepare bamboo slivers

Once the bamboo is harvested, it is necessary to remove all the branches of the culm with the help of a knife. The outer layer of the skin of the culm should be protected very well to avoid scratching them. Cutting the culm into short sections that are easy to carry is an essential step in order to prevent the internodes from cracking or being damaged during transport. To separate bamboo culms, it is necessary to place the saw 0.5 cm away from the node and cut parallel to the node. A straight cross-section will enable one to see the actual thickness of the culm wall.

Bamboo slivers can be prepared either manually or using a machine, depending on the available tools and the purpose of use. The general steps involved are:

- **Selecting Bamboo:** Choose well treated bamboo, straight bamboo for best results. The quality of bamboo affects the ease of sliver making and the final outcome.

- **Cutting Bamboo:** Cut the bamboo into suitable lengths using an hand splitter/bamboo radial splitter machine/ saw or knife, based on the size of slivers required.
- **Slivering Bamboo**: Bamboo is split into thin sections using either a knife (manually) or a slivering machine. These thin strips are known as slivers.
- **Refining Slivers:** The slivers are shaped or trimmed to the required width and thickness using knives or other shaping tools.

Note: You must be very careful while performing the sliver-making process. Always follow proper safety measures and precautions to avoid any accidents or injuries. Students are advised to refer to Unit 5 and Unit 6 to understand the correct methods of handling tools, machines and materials according to the workflow.

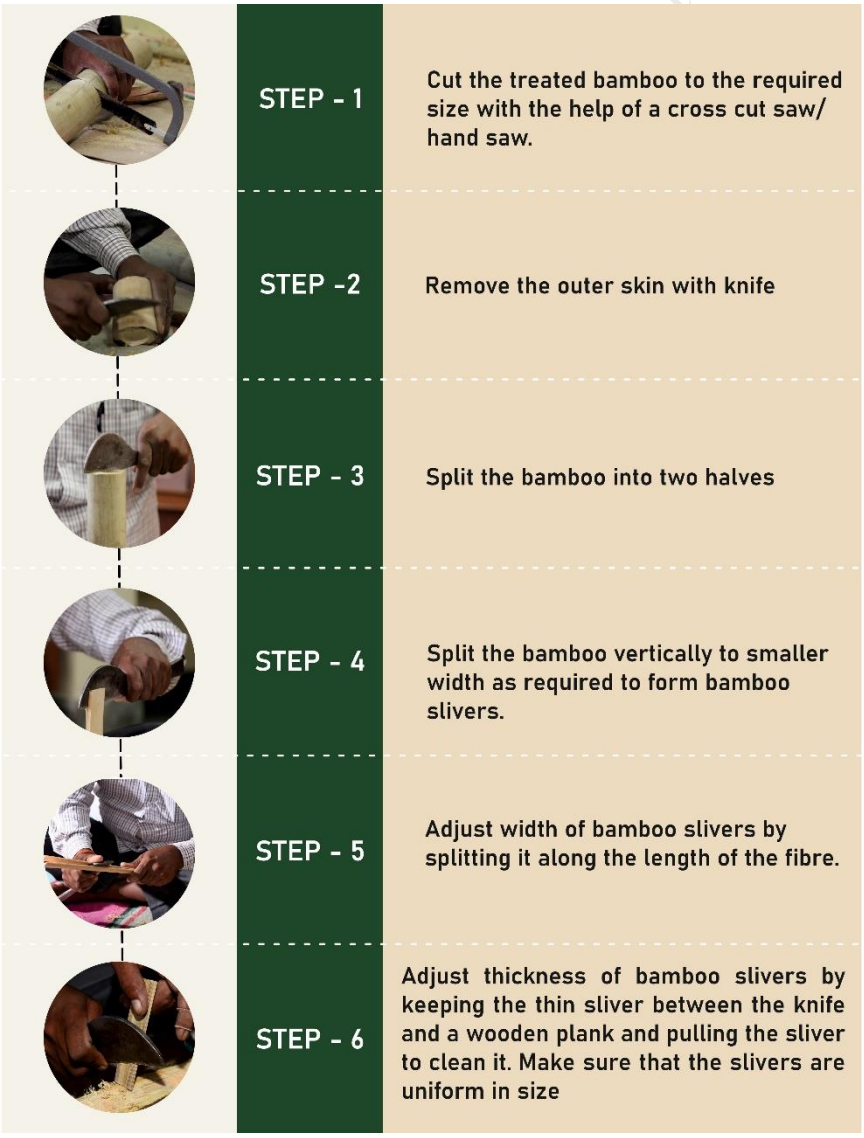


Fig. 3.1: Bamboo sliver making process using saw

Traditionally sliver making is done by hand, this task is now more efficiently performed using a sliver making machine. The machine ensures that the slivers are uniform in size, smooth and ready for further processing such as weaving or molding.

Fig. 3.2: Bamboo sliver making using slivering machine

Dyeing of Bamboo Slivers

Dyeing with natural obtained from natural resources dates back to 3000 BC. In India, traditionally, natural resources such as fruits, flowers and roots were used for colouring until almost the middle of the nineteenth century. Use of natural resources for colouring bamboo establishes empathy between the humans and the natural ecosystem and also improves its commercial quality.

In ancient times, bamboo was widely used to make utility items such as baskets, containers, and storage vessels, many of which were used to hold edible goods like grains, fruits, or cooked food. Because these products came into direct contact with food. relied on natural coloring agents derived from plants, minerals, or soil, ensuring that the items remained safe and non-toxic. The natural materials which can be used for dyeing bamboo are Turmeric, Tea, Cutch tree (katha), harda, Flame of the forest flower, Jungle yellow, Indian madder (manjistha), Indigo and Alta.

A Mordant is a chemical that helps the dye bond to the fibre. They are additives such as Ferrous Sulphate (Iron), Potassium Dichromate (Chrome) and Potassium Aluminium Sulphate (Alum) which are used along with the natural substances to give desired colours. Alum and Chrome brightens the colour whereas Iron darkens the colour.

Leach Test is conducted to know whether coloured bamboo products after mordanting with chemicals are safe to use for different purposes such as storing food items. The test consists of placing small pieces of dyed slivers in water, that is stirred for 24 hours. The residual water is tested for chemicals leached out from the dyed slivers.

Colourfastness to light would mean that bamboo slivers coloured with natural materials can fade when exposed to light for longer durations of time. A protective layer of clear lacquer or melamine can reduce the fading of colour significantly. Natural Dyeing is preferred in bamboo craftsmanship due to its sustainability, aesthetic appeal and eco-friendliness**,** while chemical dyes are more commonly used in large-scale industrial production where efficiency and colour range are prioritized.

Method: The dyeing process involves boiling the bamboo slivers in a dyeing solution derived from various materials. The process consists majorly of the following steps:

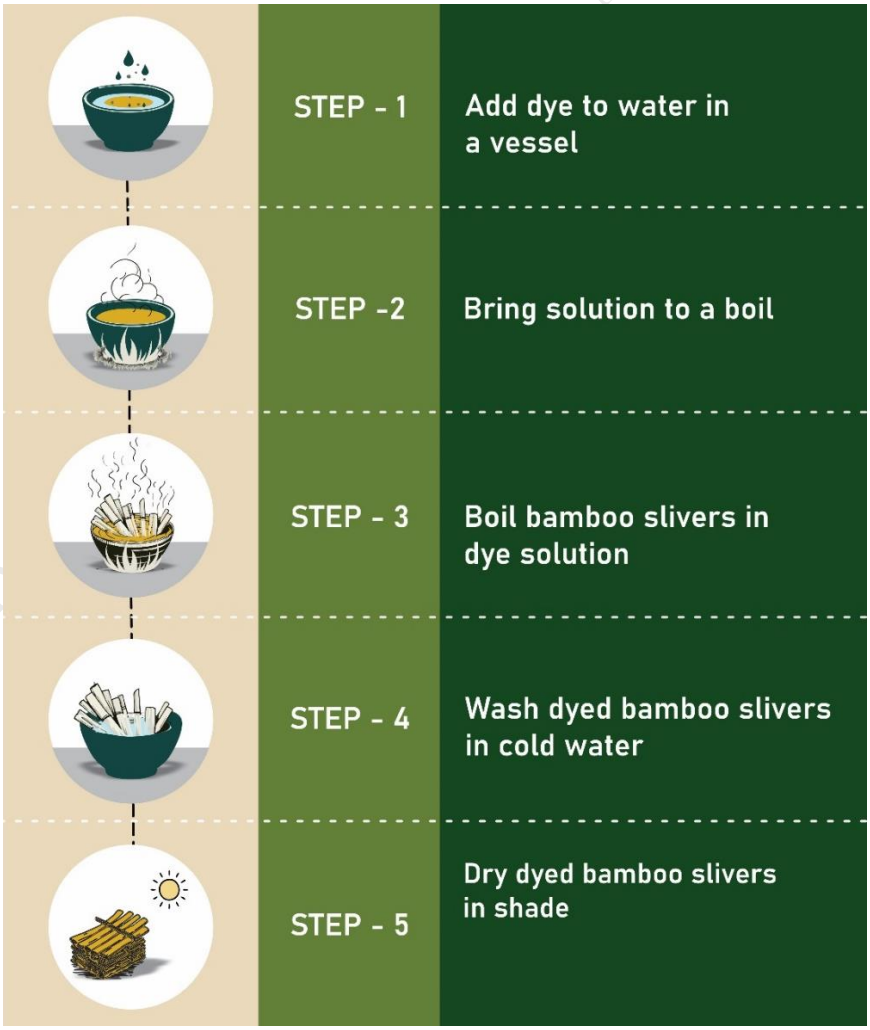


Fig. 3.3: Steps of dyeing bamboo slivers

The following sections provide details of the dyeing processes to get the colours yellow, brown, orange, red, purple, green, pink and black.

A. Turmeric Powder (Yellow Colour): Take 5 litres of water in a deep stainless steel vessel. Add 50 grams of turmeric powder to the water and bring the solution to a boil. Dip the bamboo slivers in the boiling solution and continue to boil for 45 minutes. Remove the slivers from the solution after they turn yellow. Wash the bamboo slivers thoroughly with cold water and dry them in the shade. This dye is not very colour fast to light and hence is good for products that are not exposed to direct sunlight. These proportions can be used to dye 150 bamboo slivers, approximately 1 metre in length.

Fig. 3.4: Natural dyeing – Turmeric powder

B. Tea Powder (Light Brown Colour): Take 5 litres of water in a deep stainless steel vessel. Add 100 grams of loose tea powder to the water and bring the solution to a boil. Dip the bamboo slivers in the boiling solution and continue to boil for 30 minutes. Remove the slivers from the solution after they turn light brown. Wash the bamboo slivers thoroughly with cold water and dry them in the shade. This dye is colour fast to light and hence it can be used for products exposed to sunlight. These proportions can be used to dye 100 bamboo slivers, approximately 1 metre in length.

Fig. 3.5: Natural dyeing – Tea powder

C. Katha from Cutch Tree (Dark Brown Colour): Katha is a solidified form of a thick syrup obtained by boiling hardwood chips of the Cutch Tree. Dyeing with Katha involves 3 stages. The proportions mentioned in the stages can be used to dye 150 bamboo slivers.

Stage 1: Take 5 litres of water in a deep stainless steel vessel and add 90 grams of Katha. Dip the bamboo slivers in the solution and boil for 30 minutes. Remove the slivers from the solution and keep them aside for Stage 2. At this stage, the slivers do not have any colour.

Stage 2: Take 5 litres of water in a vessel. Add 45 grams of Copper Sulphate to the water and bring the solution to a boil. Dip the bamboo slivers from Stage 1 in the boiling solution and continue to boil for 15 minutes. Remove the slivers from the solution after they turn light brown. Wash the bamboo slivers in cold water and keep it aside for Stage 3.

Stage 3: Take 5 litres of water in a deep stainless steel vessel. Add 90 grams of Potassium Dichromate (Chrome) to the water and bring the solution to a boil. Dip the bamboo slivers from Stage 2 in the boiling solution and continue to boil for 15 minutes. Remove the slivers from the solution after they turn dark brown.

Wash the bamboo slivers thoroughly with cold water and dry them in the shade. This final dye is colour fast to light.

Fig. 3.6: Natural dyeing – Katha from cutch tree

D. Harda or Chebulic myrobalan (Black Colour): The powder of Harda fruit is used as a natural dye. Dyeing with Harda is done in two stages. The proportions mentioned in the stages can be used to dye 150 bamboo slivers.

Fig. 3.7: Natural dyeing – Harda

Stage 1: Take 5 litres of water in a deep stainless steel or aluminium vessel. Add 200 grams of powdered Harda to the water and bring the solution to a boil. Dip the bamboo slivers in the boiling solution and continue to boil for 1 hour (60 minutes). Remove the slivers from the solution, wash the bamboo slivers thoroughly with cold water and keep them aside for Stage 2. At this stage, the slivers do not have any colour.

Stage 2: Take 5 litres of water in a vessel. Add 100 grams of Ferrous Sulphate to the water and bring the solution to a boil. Dip the bamboo slivers from Stage 1 in the boiling solution and continue to boil for 1 hour (60 minutes). Remove the slivers from the solution after they turn black. Wash the bamboo slivers in cold water and dry them in the shade. This final dye is colour fast to light.

Fig. 3.8: Did you know

E. Flame of the forest or Palas flower (Yellow or Orange Colour): Collect 10 Flame of the forest flowers and dry them well in the sun and store. Soak the dried flowers overnight in 400 ml water. Next morning, strain the solution and keep it aside. Take the liquid in a borosil glass beaker and dip 5 bamboo slivers to it. Keep the slivers soaked in the liquid for 2-3 hours and then boil the solution for 1 hour (60 minutes). Remove the beaker from the flame and leave the slivers in the solution to cool overnight. Next morning, remove the slivers from the solution, wash in cold water and dry in the shade.

The proportions mentioned in the stages can be used to dye 5 bamboo slivers.

Fig. 3.9: Natural dyeing – Palas flower

F. Manjistha or Indian Madder (Red or Scarlet Colour): The root and stem of Manjistha are used to dye bamboo slivers to a red or scarlet colour. The dyeing process can be done using two different forms of Manjistha - Manjistha powder and Manjistha roots.

Fig. 3.10: Natural dyeing – Manjistha

Manjistha Powder: Take 750 ml of water in an aluminium or stainless steel vessel and add 20 grams of Manjistha powder. Allow the powder to soak in the water overnight. The next morning, add the bamboo slivers to the vessel with the Manjistha soaked. Add more water till the slivers are completely immersed in the solution.

Add 5 grams of Tartaric Acid and 5 grams of Potassium Hydrogen Tartarate to this solution. Heat the solution for 3.5 hours, maintaining the temperature

at 60˚-70˚C. Do not allow the solution to boil, as boiling will not colour the slivers red. Remove the slivers from the solution and wash with cold water. The proportions mentioned in the stages can be used to dye 200 bamboo slivers red or scarlet.

Manjistha Roots: Soak 250 grams of Manjistha roots in water overnight. Strain the solution and keep the dye liquid aside. Add 5 grams of Potash Alum and 2.5 grams of Tartaric Acid To this liquid. Dip the bamboo slivers in the liquid with just enough water to immerse the slivers. Warm the solution for 1.5 hours maintaining the temperature at 60˚-70˚ C. Do not allow the solution to boil. Remove the vessel from the flame and leave the slivers soaked in the dye solution overnight (24 hours).

The next day, remove the bamboo slivers from the solution, wash in cold water and dry in the shade. The proportions mentioned in the stages can be used to dye 100 bamboo slivers red or scarlet. This dye is colour fast to light.

G. Indigo (Blue Colour): Take one large spoon of Indigo powder and add enough water in an enamel or plastic bucket to soak it. Add sodium hydroxide (1.5 times Indigo powder) and sodium dithionite (5 times Indigo powder) to the Indigo dipped water and stir till the solution is clear of particles. Use rubber gloves while operating with the chemicals.
Put bamboo slivers in the solution and keep the tub covered. Shake the tub occasionally. Remove the slivers and expose them to air for the colour to develop. Dyeing with Indigo depends upon the time the silvers are allowed to soak in it. To get various shades one has to just vary the dipping time. Longer the dipping time, darker is the shade of Indigo developed.

Fig. 3.11: Did you know

Fig. 3.12: Natural dyeing – Indigo

H. Alta (Dark to Light Pink Colour): Take 5 litres of water in a deep stainless steel vessel. Add 125 grams of Alta to the water and bring the solution to a boil. Dip the bamboo slivers in the boiling solution and continue to boil for 30 minutes. Remove the slivers from the solution after they turn pink.

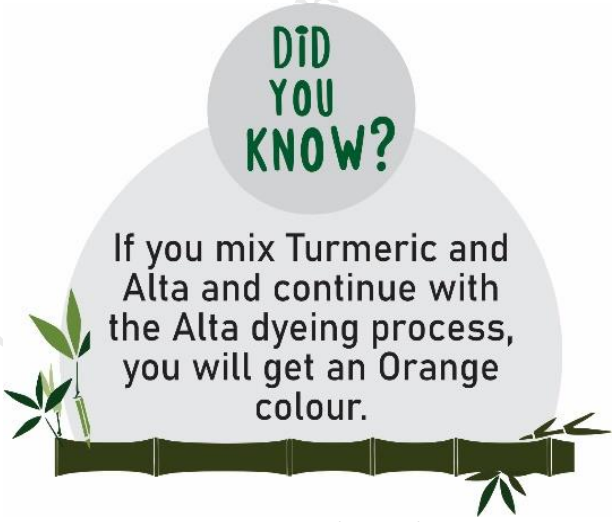


Fig. 3.13: Did you know

Wash the bamboo slivers thoroughly with cold water till no colour runs and dry them in shade. This dye is colour fast to light. These proportions can be used to dye 100 bamboo slivers.

Fig. 3.14: Natural dyeing – Alta

Weaving Techniques

Since ancient times, bamboo has been intricately woven to create a wide range of products such as carry baskets, storage containers, mats, fences and even bridges. These products were crafted to meet daily needs as well as specific functional purposes. The diversity in size, shape, weaving structures and patterns allows bamboo baskets to serve various applications across regions. Depending on the materials to be carried and local customs, different basket designs have emerged to suit those needs. The traditional weaving techniques, passed down through generations, have stood the test of time and can be thoughtfully reinterpreted to align with modern lifestyles. Today, bamboo baskets play a vital role in packaging and transporting fruits and vegetables and are increasingly used as eco-friendly storage and decorative items in contemporary homes. By adapting shapes, forms and sizes, these time-honoured products can remain relevant and functional in today's design and utility contexts.

In bamboo weaving, two fundamental components warp and weft form the structure of any woven item. The warp consists of straight bamboo strips placed vertically on a workbench, serving as the foundational frame. The weft is made of horizontal strips interlaced over and under the warp, creating the weave's pattern and strength. Together, they enable artisans to develop intricate and durable bamboo products with both cultural and practical value.

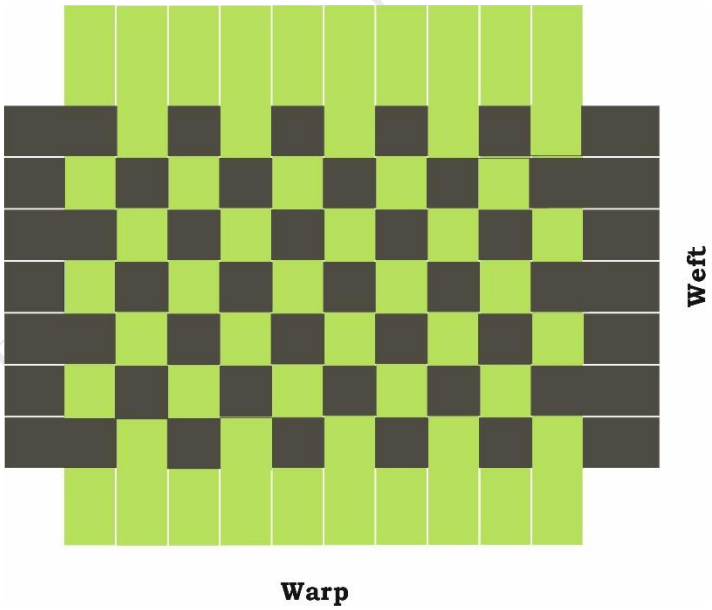


Fig. 3.15: Warp and Weft

Since times immemorial, bamboo has been woven to make various products like carry baskets, storage, containers, mats, fences, bridges etc. People have been weaving bamboo to make various products according to their requirements. The baskets are prepared for various purposes, some for daily use and others for some particular use only. The diversity in the size, shape,

weaving structure and pattern enables these baskets to have a wide range of applications. As per the regional requirements and the materials to be carried, the designs for baskets are made. The weaving techniques are time tested and can be reintroduced in a new way to modern living. Today, baskets are used extensively in packaging and transportation of various fruits and vegetables and used as storages and containers in modern living. Thus, modifying the shapes and forms with appropriate sizes can make these baskets more relevant for modern day requirements.

Weaving of Bamboo Slivers

1. Square/Plain Weave

Plain weave is a basic bamboo weaving technique. It involves making a pattern with horizontal and vertical bamboo strips placed in a balanced way. Because bamboo is stiff, this technique often creates a design with small open spaces. This type of weaving is commonly used for the base or sides of items like baskets.

This weaving is a useful method for making many products such as: Baskets, Mats, Trays and Coasters etc.

This weaving style is simple and quick to do, which makes it good for making large numbers of products.

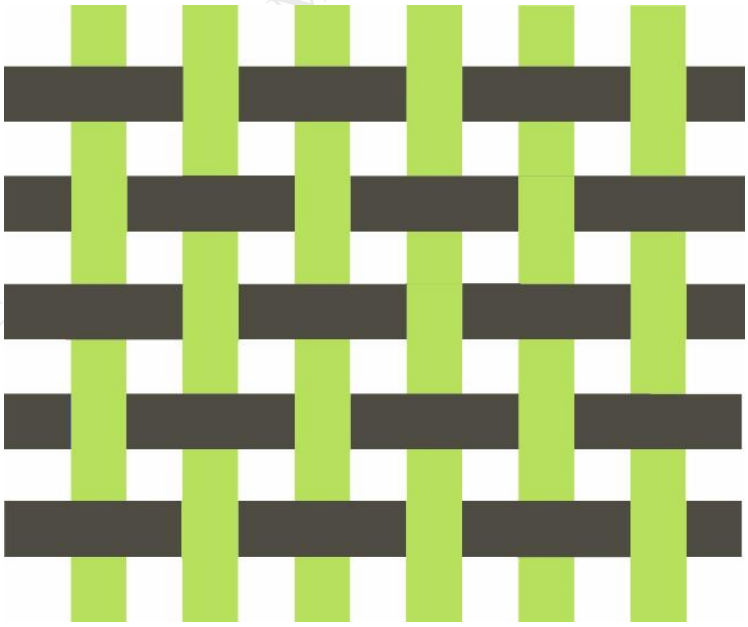


Fig. 3.16: Plain Weave

Artisans can create different shapes and patterns in bamboo weaving by changing the width of the horizontal and vertical strips. Thin slivers make fine, detailed designs, while thick strips create bold and open patterns.

Fig. 3.17: Various types Lamps and basket using weaving techniques

2. Basket Weave

Basket weave is a common weaving pattern used in bamboo work and other crafts. In this technique, thin strips of bamboo are woven together by placing two or more strips over and under another set of strips. This creates a pattern that looks like a checkerboard. It is similar to the plain weave, but instead of using single strips, groups of strips are woven together.

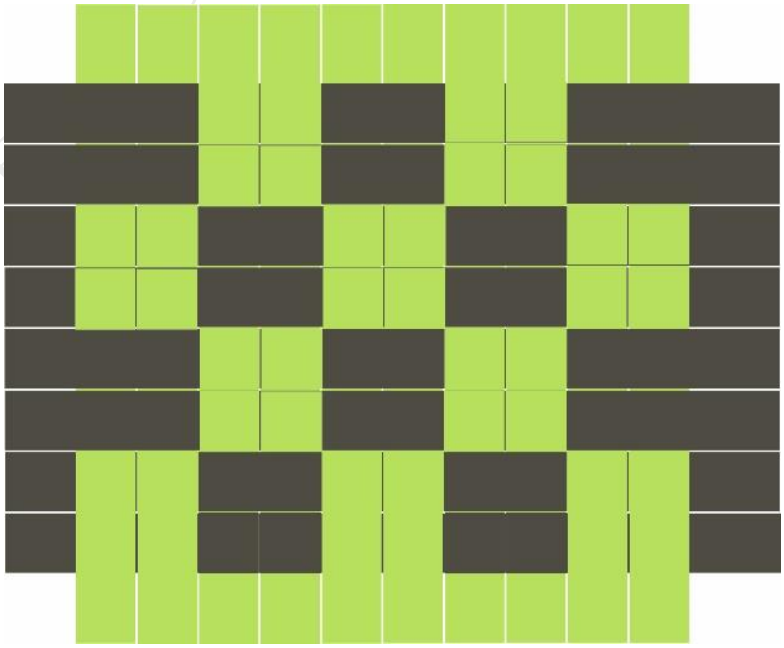


Fig. 3.18: Basket Weave

Basket weave is strong, flexible and looks attractive, which makes it useful for making baskets, mats, trays and even furniture. It is easy to make and helps create beautiful and durable products from bamboo.

3. Twill Weave

Twill weave is a special type of weaving where the pattern looks slanted or diagonal instead of straight like in square weaving. In this method, the weaving strips (called weft) do not just go over one strip and under the next, like in simple weaving. Instead, they go over two or more strips and then under one or more, creating a regular repeating pattern. This over-and-under movement shifts slightly with each row, so the pattern moves in a diagonal direction, forming a beautiful slanted design. The diagonal lines are easy to see and give the weaving a more decorative and stylish look.

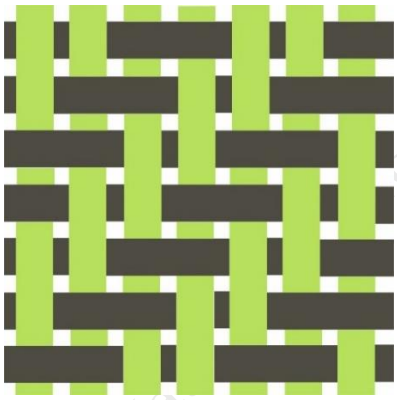


Fig. 3.19: Twill Weave

Twill plaiting is not too difficult to learn but needs careful counting and attention to keep the pattern even and regular. It takes a bit more time than simple weaves but is easier than very complex techniques. There are many weaving patterns that can be made by changing the spacing and the number of slivers (thin strips of material). By adjusting how close or far the slivers are placed, or by using more or fewer slivers together, we can create different designs and textures in bamboo weaving.

a. Netting Pattern

Fig. 3.20: Netting Pattern

Fig. 3.21: Netting Pattern in Utility Box and Basket

b. Double Diagonal Netting Pattern

The double diagonal netting pattern is a weaving style where bamboo strips are placed in two slanting directions, crossing each other to form a strong and neat mesh. This pattern makes a criss-cross design with small diamond-shaped holes. It is useful for making items like baskets, trays and covers that need to be both light and strong. The weave looks pretty and gives good air flow and it is made by carefully placing and fixing the strips at equal spaces.

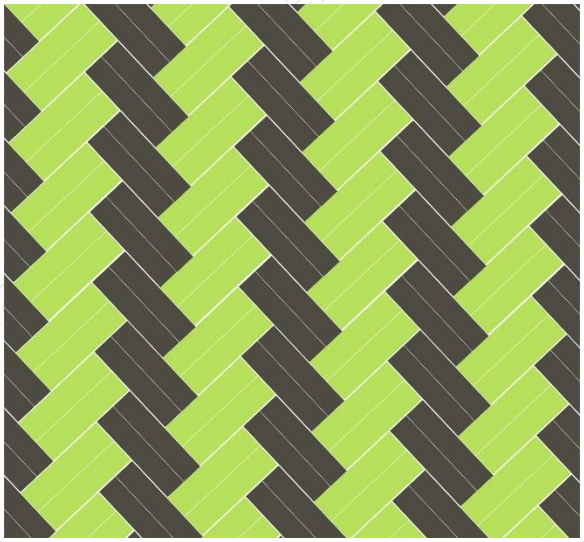


Fig. 3.22: Double Diagonal Netting Pattern

Geometric Weaving Technique

Geometric weaving is a method used to create neat and beautiful patterns made of shapes like squares, triangles and lines. In this technique, strips of material (like bamboo, thread, or yarn) are woven in a special way to form these shapes. It needs careful planning and skill to make the designs look even and clear. Geometric weaving is used in many types of crafts such as

basket making, fabric weaving and wall hangings. It makes the final product look attractive and artistic.

a. Hexagonal Pattern

The Structure of Hexagon Weaving Pattern is a six-sided pattern that resembles a honeycomb. Strips are interlaced to create repeating hexagonal shapes in its weaving style. This weaving pattern used commonly in lanterns, baskets and decorative screens where ventilation and light passage are desirable. In which Light and airy with lots of open space looks very aesthetic.

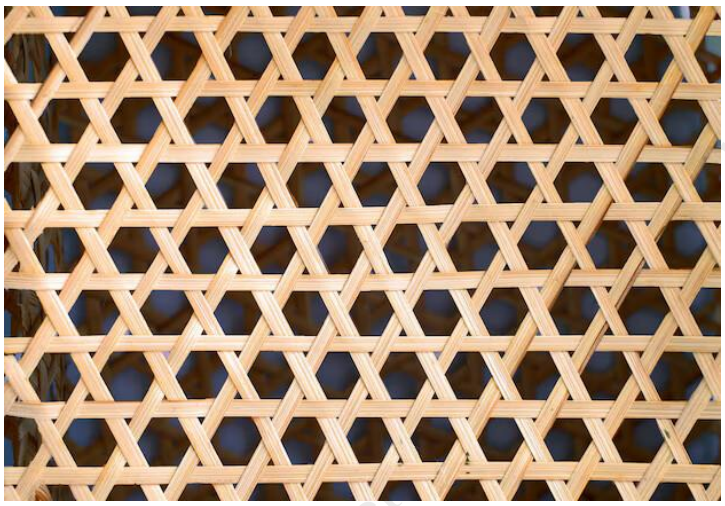


Fig. 3.23: Hexagonal Pattern

b. Octagonal Pattern

The structure of octagon weaving pattern is More complex than the hexagon, this pattern features eight-sided shapes and bamboo strips are interwoven to form octagonal holes, usually with small squares or rhombuses filling the gaps. This weaving pattern is used in fine craftwork like trays, coasters or high-end furniture panels. They are aesthetically intricate and strong.

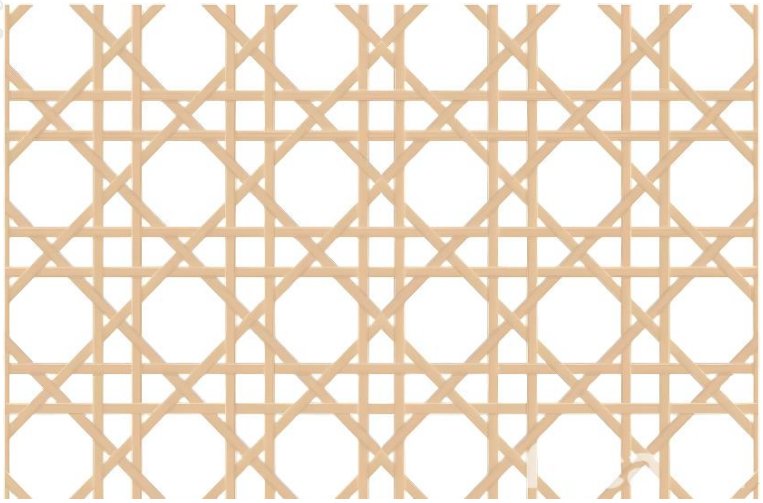


Fig. 3.24: Octagonal Pattern

c. Diamond Pattern

The structure of diamond weaving pattern composed of elongated diamond (rhombus) shapes. In which the slivers are angled and interlaced to create repeating diamond motifs are its weaving style. Diamond weaving pattern is used in screens, placemats and sometimes in architectural panels. It looks aesthetically elegant and dynamic, often appearing more angular and striking.

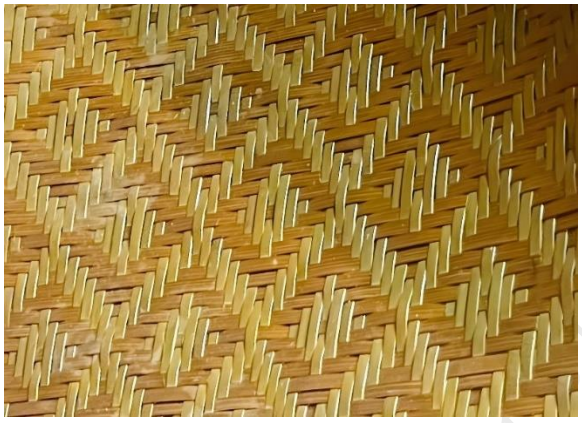


Fig. 3.25: Diamond Pattern

We have discussed weaving and basketry product making in detail in the next session, explaining how these techniques are implemented to produce bamboo products.

You can create beautiful and unique lamps by exploring different weaving techniques combined with armature support. The weaving can be done using natural materials like bamboo, cane, jute, or even coloured threads, depending on the style you want to achieve. The armature, which is the basic frame or structure of the lamp, can be made using materials such as metal wire, bamboo sticks, or wooden rods to give the lamp its shape and stability. By experimenting with patterns, textures and colour combinations, you can design lamps that reflect your personal creativity and aesthetic. Whether it's a traditional design or a modern one, the combination of weaving and structural support allows for endless possibilities in lamp-making.

Fig. 3.26: Variation of various types of lamps

These are some common types of bamboo weaving and patterns. Skilled artisans often take inspiration from textile weaving patterns, which are designs used to make cloth. They observe how threads are woven together to create different pattern and styles. Then, they use similar ideas to weave bamboo slivers. Depending on the product they want to make such as baskets, mats, or containers, they change the weaving style to make the product strong and useful. For example, some weaves are tight and firm to hold heavy items, while others are looser for decorative purposes. This careful adjustment helps create bamboo products that are both practical and beautiful. This process shows how artisans creatively blend ideas from different crafts to make unique and useful items. Each weaving methods features a distinct pattern and technique. Over the years, skilled craftsmen have further refined these methods, developing their own unique styles and innovations through practice and experience.

Fig. 3.27: Products built by using different weaving pattern

Loom Weaving of Bamboo Slivers

Loom weaving of bamboo slivers is a traditional technique where thin, flat strips of bamboo known as slivers are woven using a loom. Although similar to textile weaving, this method is specially adapted for working with rigid, natural materials like bamboo. It is used to create mats, panels and other woven products with both functional and decorative value. Before diving into the process of loom weaving in bamboo craft, it is essential to understand the pre-loom operations. These operations are preparatory steps that ensure the bamboo material is properly treated, split and made ready for the actual weaving process on a loom. Pre-loom operations are crucial for achieving uniformity, durability and flexibility in the final woven products.

Pre-Loom Operations in Bamboo Weaving

Bamboo weaving, especially when adapting techniques from traditional textile weaving, involves unique processes. While bamboo weaving traditionally doesn't use a loom in the same way as cloth weaving, certain modern practices have incorporated basic looms or frames for producing structured bamboo mats and panels used in partitions, furniture, trays and other items. In these cases, certain weaving terms, such as "denting" and "attaching the warp on the loom," are applied either metaphorically or structurally to describe pre-loom preparation steps.

1. Denting in Bamboo Weaving

In textile weaving, "denting" refers to the process of passing warp yarns through the dents (spaces) of a reed to ensure they are evenly spaced. While bamboo weaving does not typically use reeds, the principle of denting is adapted to ensure even spacing of the bamboo strips (warp) before the weaving process begins.

Denting in Bamboo Weaving:

- The primary goal is to align and space bamboo strips (used as warp) uniformly before starting the weaving process.
- In some cases, this involves guiding bamboo strips through a comb-like tool (wooden or metal) or guide slots to maintain equal gaps between them, thus ensuring consistent and smooth patterns.

Process for Denting:

1. Select and prepare uniform bamboo strips, ensuring they are suitable for weaving (refer to the pre-loom steps).
2. Place the bamboo strips in parallel on the loom or frame, ensuring they are straight and even.
3. Use a denting comb (if available) or guiding slots to space the bamboo strips evenly, making sure the gaps are consistent across the entire width.
4. Secure both ends of the bamboo strips to keep them taut and aligned throughout the process.

2. Attaching the Warp on the Loom

In weaving, the "warp" refers to the set of lengthwise strips held in tension on the loom, while the "weft" is the horizontal material woven across. The process of "attaching the warp" prepares the loom or frame to begin the interweaving of the weft.

Process in Bamboo Weaving:

1. After denting, secure the bamboo warp strips to the top beam or frame of the loom, ensuring they are firmly held in place.
2. The other ends of the warp strips are tied or fastened to the bottom beam using threads, nails, or clips to create tension.
3. Ensure the warp strips are tight and parallel, allowing for smooth insertion of the weft strips during the weaving process.

This setup enables the artisan to interweave horizontal (weft) bamboo strips with precision, creating the mat or panel, depending on the desired final product.

Products That Use This Method:

- Bamboo mats and panels
- Backrests or chair bases

- Room dividers
- Bamboo trays and placemats

Key Considerations for Pre-Loom Operations in Bamboo Weaving

In bamboo weaving, the pre-loom operations are adjusted to suit the unique properties of bamboo. Unlike textiles, bamboo is rigid, fibrous and often requires splitting or softening to ensure flexibility and uniformity. The pre-loom steps ensure that bamboo becomes pliable enough for weaving into mats, baskets, or decorative items, allowing artisans to create sturdy, functional and aesthetically appealing products.

Step-by-Step Process of loom weaving

1. Preparation of Bamboo Slivers

The process begins with preparing the bamboo:

- Mature bamboo culms are split into long, thin slivers using a knife or sliver-making tool.
- These slivers are then smoothed and trimmed to ensure they are of uniform size and thickness.
- To improve flexibility and reduce the risk of breakage during weaving, the slivers are soaked in water for a few hours.

2. Setting the Warp on the Loom

- Vertical bamboo slivers are tightly placed along the loom or frame. These vertical slivers are known as the warp, which forms the structural base of the woven item.
- The warp slivers must be tied or firmly fixed at both ends of the loom to maintain tension and prevent shifting during weaving. This ensures a strong and even foundation.

3. Weaving the Weft

Once the warp is in place, weaving begins:

- A shuttle is used to insert horizontal slivers—called the weft—through the warp in an alternating under-over pattern.
- With each row, the weaver changes the order of the weave to interlock the slivers, providing strength and a consistent pattern.

4. Beating and Adjusting

To tighten the weave:

- A reed or beater is used to press the weft slivers down after each row.
- This ensures the weave is compact and even. The weaver checks for proper alignment and adjusts the spacing of slivers as needed.

Fig. 3.28: (a & b): Matt Weaving by power loom

5. Creating Patterns

- Coloured or differently sized bamboo slivers may be used to create decorative patterns.
- Common design styles include basket weave, twill weave and hexagonal patterns, depending on the skill and creativity of the weaver.

6. Finishing

- Trimming any excess material at the edges.
- Securing the ends of the weave using glue, natural twine, or heat pressing to lock the structure in place.
- Optionally, a coat of varnish or polish may be applied to improve durability and enhance the appearance of the finished product.

Fig. 3.29: Products developed using loom weaving

Activities

Activity 1: Manually prepare bamboo slivers using a knife and relevent tools while ensuring safety.

Materials Required

1. Bamboo/Bamboo Splits
2. Sharp knife or bamboo slivering machine
3. Bench vice
4. Hacksaw or cross-cut saw
5. Safety gloves and goggles

6. First-aid kit

Procedure

1. Select mature bamboo and secure it in a bench vice.
2. Cut the bamboo to a required length using a hacksaw or cross-cut saw.
3. Remove the branches and nodes using a knife.
4. Carefully split the bamboo lengthwise into slivers using a knife and mallet or feed it into a slivering machine.
5. Smooth the slivers with sandpaper.
6. Store the slivers in a dry, safe place.
7. Follow all safety protocols and wear protective gear while handling sharp tools.
8. Discuss in class how proper tool handling and safety measures were applied.

Activity 2: Gather bamboo slivers and conduct the dyeing process with any two materials and compare their colour shades.

Materials Required

1. Dyeing vessel
2. Stove/Gas/Boiler
3. Two different dyeing Colours
4. Water
5. Salt

Procedure

1. Gather bamboo slivers
2. Boil slivers according to the process
3. Dry the bamboo slivers
4. Make a report compare the slivers

Activity 3: Use dyed bamboo slivers to weave a simple mat or pattern using traditional techniques

Materials Required

1. Dyed bamboo slivers
2. Weaving board or flat surface
3. Clips or tape

4. Ruler
5. Scissors
6. Example pattern or template

Procedure

1. Choose a simple design or pattern to follow.
2. Secure the vertical slivers on the board using clips or tape.
3. Begin weaving horizontal slivers over and under the vertical ones, alternating with each row.
4. Adjust spacing and tighten the weave after each row.
5. Trim the edges and fix the final shape.
6. Display the woven mat and reflect on symmetry, tension and design accuracy.

Check Your Progress

A. Fill in the blanks

1. The process of adding colour to bamboo slivers is called _____.
2. Bamboo slivers are soaked in _____ before dyeing to help absorb the colour evenly.
3. Natural dyes are commonly prepared using plant parts like _____, bark and leaves.
4. Dyed bamboo slivers must be properly _____ before they are used for weaving.
5. The interlacing of bamboo slivers to create patterns is called _____.

B. Short Answer Questions

1. What is the role of a mordant in the dyeing process?
2. How do bamboo slivers play a role in the creation of a bamboo basket?

C. Long Answer Questions

1. Describe the process of dyeing bamboo slivers using turmeric.
2. Explain the process of preparing bamboo slivers and how they are used in the bamboo weaving technique. Discuss the significance of warp and weft in the creation of woven bamboo products.

Session – 3
Applique, Bending & Quilling of Bamboo Slivers

Bamboo is a versatile and sustainable material, offering endless possibilities for creativity. This chapter explores three innovative techniques: applique work, which assembles bamboo pieces into decorative or functional designs; bending, which uses heat to create elegant curved forms; and quilling, where bamboo slivers are rolled and shaped into intricate products. These techniques showcase bamboo's adaptability in crafting ornaments, décor and utility items, blending traditional artistry with modern applications.

Applique Work

Applique work is the process in which smaller bamboo pieces in different shapes and patterns are stuck onto a larger structure to form an assembled bamboo product. Applique work takes the help of other materials such as metal, plastic, clay, thermocol (Expanded polystyrene) and cotton to use as structure and fillers of the final product. Various products through bamboo applique work are currently being sold in the market as home décor pieces, animals and birds, jewellery etc.

Method for Bamboo Applique Work: Steps involved in making bamboo birds, fish and animals through applique work are as follows:

Fig. 3.30: Steps involved in making bamboo bird (appliqué work)

1. **Step 1:** Bamboo is procured from local market and treated for fungus.

2. **Step 2:** Treated bamboo is then smoothened with appropriate tools to prepare the different shapes and patterns for applique.
3. **Step 3:** The structure of the bird, fish or animal is formed using bamboo splits which can be bent. The members are interlocked and joined using wires, to give strength and form to the main body of the structure.
4. **Step 4:** Other materials like thermocol, cotton, hay and residual bamboo fibres are used as fillers to give shape by inserting it in the main structure.
5. **Step 5:** Bamboo slivers are prepared with appropriate tools (as shown in the previous section) and are woven, inserted or pasted onto the structure of the product after being inserted with filler material. Appropriate tools and adhesives such as Polyninyl acetate (PVA, Adhesive) eg - Adhesive are used in the process.
6. **Step 6:** After finalizing the structure, different bamboo shapes are pasted onto the structure using Adhesive to create the final product.
7. **Step 7:** Along with bamboo pieces, other materials such as coated rice grains are used to make the neck of birds. Eyes availed from the market are added to represent the animal better. Feet are added by adding wires to the structure and epoxy resin eg. - m-seal to act as a filler and create its form.
8. **Step 8:** Wood resin is painted onto the final product to create shine and complete the applique made product.

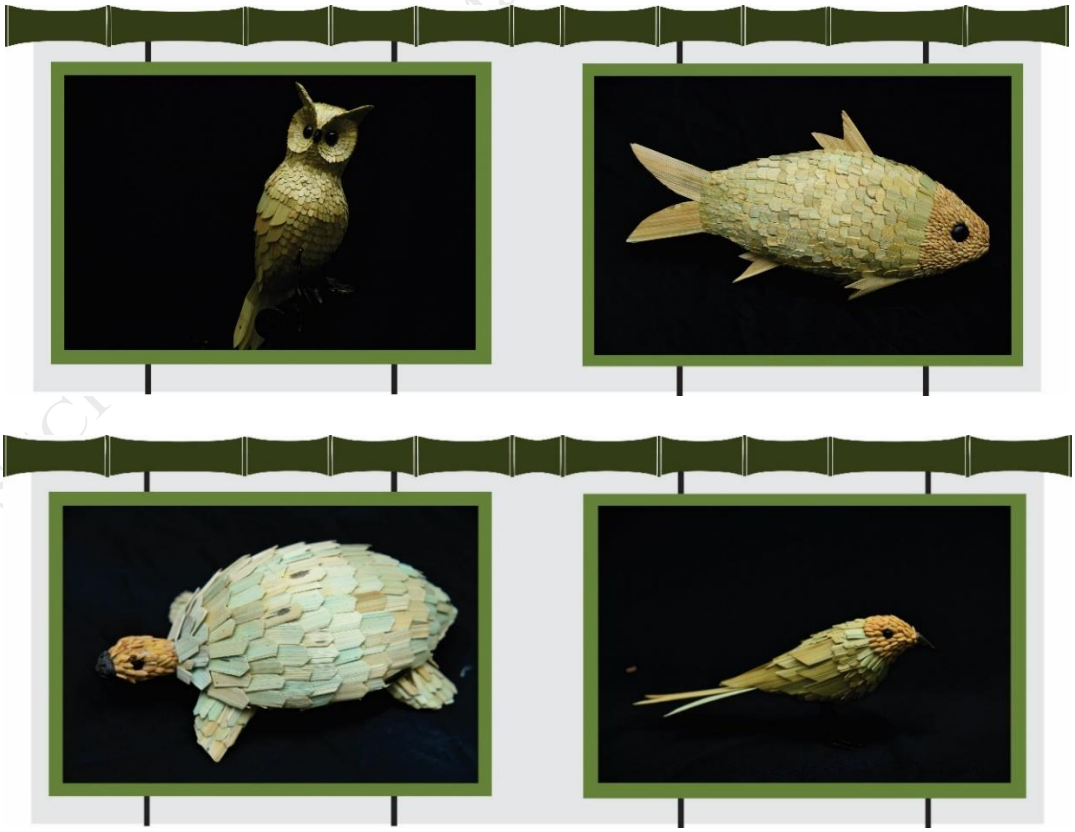


Fig. 3.31: Bamboo applique work products

Bending of Bamboo Splits

Out of its many properties, bamboo can be bent to form curved shapes. To do so, one must understand the proper technique of bending bamboo by bringing it to its appropriate form. Bamboo is bent by using heat. Tools such as heat gun and torch gun are used to bend bamboo. Heat gun used electricity and torch gun generally uses kerosene to operate.

Fig. 3.32: Heat Gun

Fig. 3.33: Torch Gun

Method for Bending Bamboo

Steps involved in bending bamboo are as follows

Fig. 3.34: Steps involved in bending of bamboo

Step 1: Green bamboo poles are procured and treated for fungus. The bamboo poles are cut to a minimum length of 40 cm. The poles are cut using a machete or a mitre saw.

Step 2: The outer skin of the bamboo is removed using a draw knife.

Step 3: The bamboo is split using a splitter to create splits of 3-4cm width each.

Step 4: The bamboo splits are evened out by using a hand plane to create rectangular sections of around 5 mm thickness. The sections are completely dipped in a bucket of water overnight.

Step 5: A reference mould is taken around which the bamboo section must be bent. The wet bamboo sections are placed around the mould and heat is applied with the help of a heat gun. Slowly the bamboo is bent with heat by increasing the pressure gradually.

Note: The nozzle of the heat gun must oscillate within 5 cm of the bamboo section length. The heat must be applied to the area to be bent and not to a single point. Overheating a single point might burn the bamboo fibres.

Fig. 3.35: Bamboo bending torch gun

Step 6: Multiple moulds must be made out of heat resistant materials, according to the desired radius of curvature.

Step 7: The bent bamboo sections must be allowed to cool down completely to retain the desired forms.

Fig. 3.36: Products built by using bending techniques

Quilling of Bamboo Slivers

Bamboo quilling is a technique to make products with the art of quilling of bamboo slivers. Quilling involves rolling, shaping and glueing bamboo slivers. Various bamboo products are made using the technique of quilling such as ornaments, baskets, containers and decorative purposes.

Method for Quilling with Bamboo

Quilling is a technique majorly undertaken with paper. Since thin bamboo slivers imitate the tactile properties of paper, quilling is done with bamboo slivers as well. The steps involved in quilling with bamboo are as follows:

Fig. 3.37: Steps involved in making quilling work

- **Step 1:** Green bamboo poles are procured and treated for fungus. Bamboo slivers are made out of the poles as described in the weaving process.
- **Step 2:** The bamboo slivers are evened out by using a sharp knife to maintain uniform width and thickness along its length.
- **Step 3:** The slivers are run between the blunt edge of a knife and a thumb to allow its fibres to bend.
- **Step 4:** The slivers are curved according to the required shape and simultaneously glued with adhesives to form the desired shape and product.

- **Step 5:** Wood resin is applied to the finished products to maintain lustre.

Fig. 3.38: Bamboo quilling work products

Activities

Activity: Creating a Bamboo Decorative Wall Hanging by combining Applique, Bending & Quilling of Bamboo Slivers.

Materials Required

1. Pre-treated bamboo pieces (various sizes and slivers)
2. Heat guns or torch guns
3. Molds for bending bamboo
4. Adhesives (e.g. wood glue)
5. Decorative fillers (thermocol, cotton, hay, etc.)
6. Paints, brushes and wood resin
7. Small tools (knives, cutters, hand planes)
8. Pre-prepared bamboo slivers

Procedure

1. Prepare the Base (Bending Technique)
2. Create Decorative Shapes (Applique Technique)
3. Add Structural Fillers
4. Craft Intricate Designs (Quilling Technique)
5. Assemble the Elements
6. Apply Finishing Touches
7. Review and Adjust
8. Present or Display

Check Your Progress

A. Fill in the Blanks

1. Bamboo splits are bent into curved shapes using heat from a _____ or _____.
2. The process of attaching smaller bamboo pieces onto a larger structure to create decorative products is called _____.
3. In quilling, bamboo slivers are _____, _____ and _____ to form intricate designs.
4. Materials like _____, _____, or _____ are used as fillers to add shape and structure in applique work.
5. Applying _____ on the finished bamboo products enhances their shine and provides a protective layer.

B. Short Answers Questions

1. What is the purpose of using molds in the bamboo bending process?
2. Name three products that can be made using the quilling technique with bamboo.

C. Long Answers Questions

1. Explain the step-by-step process of creating a decorative bamboo product using the applique technique.
2. Describe how the techniques of applique, bending and quilling can be integrated to create a single bamboo craft product.

Session – 4
Finishing of Bamboo Products

Creating sturdy and market-ready bamboo products requires a combination of precise structuring and meticulous finishing. Structuring involves the use of joinery techniques, such as interlocking mechanisms achieved through drilling and half-cutting, to ensure durability and stability in bamboo designs.

Once the structure is complete, finishing processes refine the product for market delivery. Tools like sandpapers, sanding machines and buffing machines are employed to eliminate unevenness and achieve a smooth, polished surface, enhancing both the aesthetic and functional quality of the bamboo product.

Joinery of Bamboo for Products

Joinery is the joining of two or more pieces of bamboo to make a stable and strong product. Because bamboo is hollow and possesses special properties, wood joinery cannot always be employed. In bamboo craft, specialized joinery techniques are employed to make parts fit well, stay together firmly and enhance the overall appearance and longevity of the product.

Joinery is significant because:

- It provides structural integrity to the product.
- It provides flexibility in design for manufacturing different shapes and designs.
- It prevents the splitting of bamboo by nails or screws.
- It adds to the craftsmanship and artistic value of the product.

Structure of bamboo products require joinery techniques to create a sturdy and finished outcome. Interlocking mechanisms created through drilling and half cutting could be very useful to in making solid bamboo products. Some of the mechanisms are discussed in this session.

1. Types of Joineries: Joinery systems can be used with other material techniques or individually to make products. Some of them are:

1. End to end joinery
2. Middle to end joinery
3. Middle to middle Interlocking joinery
4. Pole and stick joinery
5. Laminated bamboo is similar to wood and thus similar joineries

6. Solid bamboo joinery

1. End to end joinery

- **Step 1:** Take two bamboo rectangular sections derived from the pulp of bamboo.
- **Step 2:** Make 45° marks at the ends to be connected.
- **Step 3:** Remove half the pulp of the triangular section on both bamboo pieces as shown in shade.
- **Step 4:** Apply adhesive on the surfaces to be stuck. Let it dry till firm.

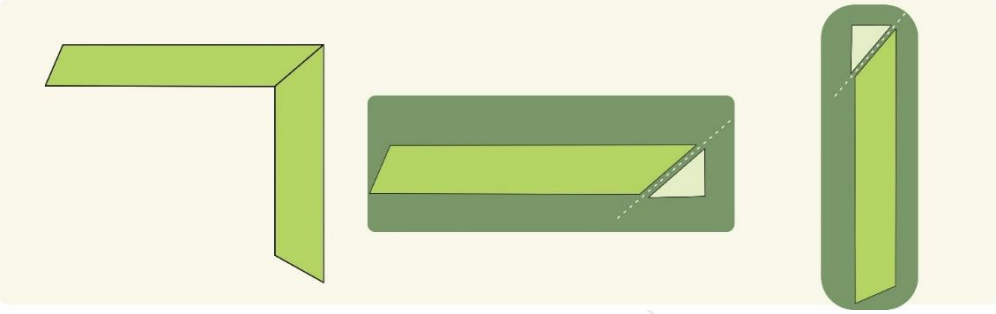


Fig. 3.39: End to end joinery

2. Middle to end joinery at 90 degrees

- **Step 1:** Take two bamboo rectangular sections derived from the pulp of bamboo.
- **Step 2:** Make isosceles triangle marks or rectangular marks at the points to be connected.
- **Step 3:** Remove half the pulp of the triangular section or rectangular section on both bamboo pieces as shown in shade.
- **Step 4:** Apply Adhesive on the surfaces to be stuck. Let it dry till firm.

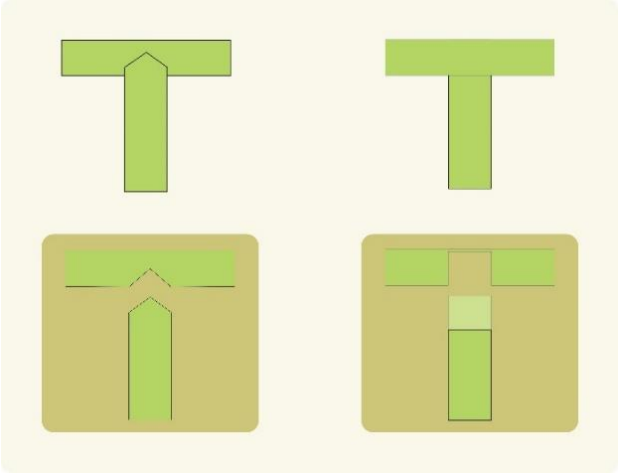


Fig. 3.40: Middle to end joinery steps

3. Middle to middle Interlocking joinery at 90 degrees

This technique interlocks two bamboo sections at right angles using symmetrical cuts.

- **Step 1:** Take two bamboo rectangular sections derived from the pulp of bamboo.
- **Step 2:** Remove material in the shape of rectangle according to thickness of bamboo till the middle of the section in both pieces.
- **Step 3:** Interlock the two by applying adhesive on the inner surfaces to form 90 degrees. Let it dry till firm.

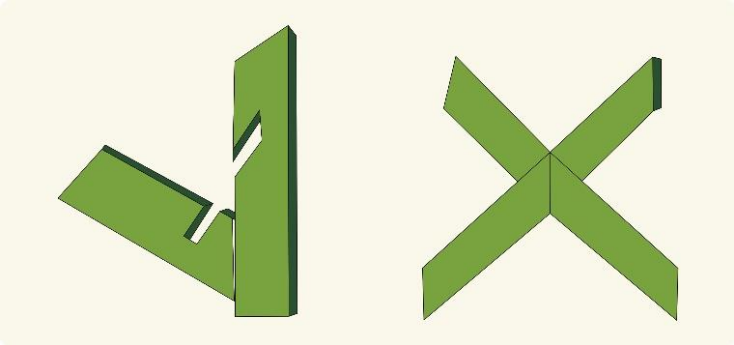


Fig. 3.41: Middle to middle interlocking joinery

4. Pole and stick joinery at 90 degrees

Ideal for connecting a thinner bamboo stick to a larger pole.

- **Step 1:** Take a bamboo pole and a bamboo stick.
- **Step 2:** Drill a hole in the size of the bamboo stick in the bamboo pole.
- **Step 3:** Insert the stick to the pole by applying adhesive on the inner side. Let it dry till firm.

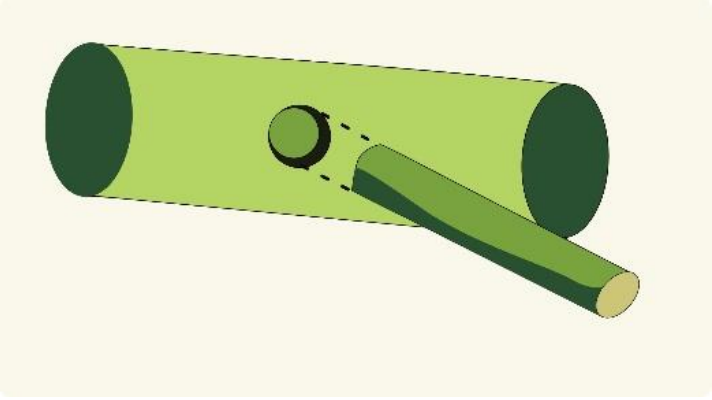


Fig. 3.42: Pole and stick joinery

5. Laminated bamboo is similar to wood and thus similar joineries

Laminated bamboo resembles wood and can be joined using traditional wood joinery techniques like cross lap, half lap, dovetail crossed lap and mitred half lap.

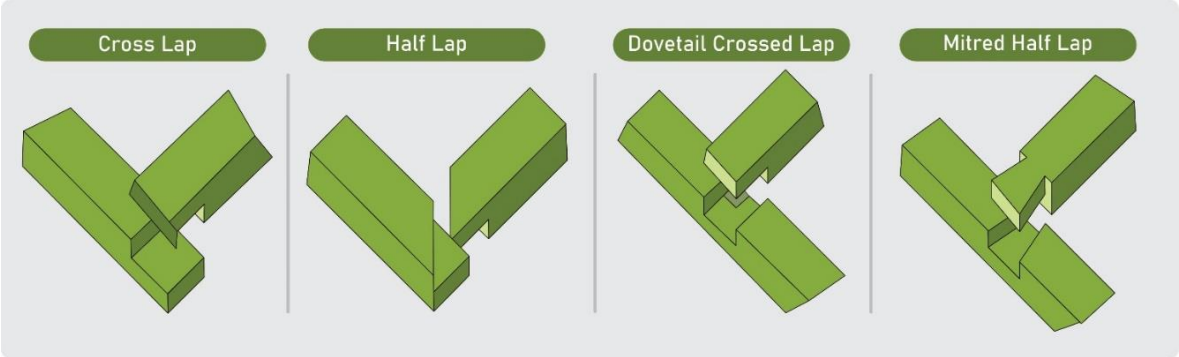


Fig. 3.43: Different type of lap

6. Solid bamboo joinery

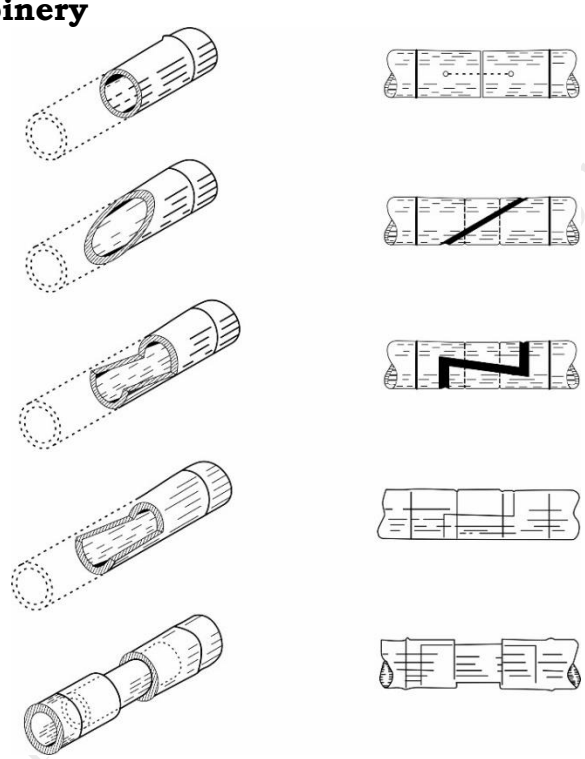


Fig. 3.44: Solid bamboo joinery

Fig. 3.45: Bamboo joinery work products

Joinery techniques are essential in bamboo craft for creating durable, aesthetically pleasing and functional products. Given bamboo's unique structure being hollow, fibrous and lightweight specialized joinery methods must be used rather than traditional wood techniques. From simple interlocking joints to pole and stick fittings, these methods ensure the product's strength and enhance the artisan's creative flexibility. Understanding and applying appropriate joinery not only improves the structural integrity of bamboo products but also showcases the craftsmanship and design innovation possible with this sustainable material.

Finishing Process of Bamboo Products

After the completion of bamboo product making, it must be finished with various tools to prepare the product for market delivery. Various materials such as sandpapers, adhesives and varnishes and tools such as sanding machines and buffing machines are used to remove unevenness and create a smooth finish.

1. Buffing machine in use for smoothening surfaces.
2. Sanding machine in use for cleaner lines and edges.
3. Drilling machine in use for final product making.

Fig. 3.46: Steps involved in finishing of bamboo products

- **Gap filling:** The process of bamboo product making is completed by applying PVA adhesives (adhesive mixed with water to prevent the fibres from splitting. Considerably big gaps can be filled with a dough of PVA adhesives and bamboo dust.

- **Polishing:** Varnish or resin is applied to the final products for shine and lustre. 2-3 coats of resin can be applied to retain the consistency of the fluid. After the first coat, it must be let to dry completely before applying the second coat of resin. A third coat also can be applied

similar to the previous coat. A third coat also can be applied similar to the previous coat.

- **Finishing:** Finishing plays a vital role in making the bamboo products ready for the market. Finished products can gather better prices and acceptability from customers. Thus, this stage determines the possibility of bamboo penetrating into the market space of a sustainable world.

Activities

Activity: Take an existing bamboo product from the nearby market and improve its finish by using relevant tools.

Materials Required

1. Sandpaper
2. Adhesives
3. Varnish

Procedure

1. Take a product from nearby market
2. Observe the finishing changes has to be made
3. Use relevant finishing technique and tool
4. Finish the product

Check Your Progress

A. Fill in the Blanks

1. _____ is the process of joining two or more pieces of bamboo to create strong and stable products.
2. In pole and stick joinery, a _____ is made in the bamboo pole to insert the stick securely with adhesive.
3. _____ and buffing machines are used to remove unevenness and create a smooth surface on bamboo products.
4. Gaps in bamboo products can be filled using a mixture of PVA adhesive and _____.
5. To enhance shine and protect bamboo products, 2–3 coats of _____ or resin are applied during the polishing process.

B. Short Answer Questions

1. What tools are commonly used in the finishing process of bamboo products?
2. Describe the "end to end joinery at 90 degrees" technique.

C. Long Answer Questions

1. Explain the different joinery techniques used in bamboo product making and their importance in ensuring the durability of the products.
2. Describe the process of finishing bamboo products, including the steps and materials used to prepare them for market delivery.

Session - 5
Design & Development of Bamboo Products

This session focuses on the design and development of bamboo-based products, emphasizing the material's required and commercial applications. The process of creating bamboo products involves a harmonious blend of traditional craftsmanship and modern design principles. From utility products to lifestyle accessories, bamboo offers endless possibilities for innovation. Understanding the characteristics of bamboo such as strength, flexibility and aesthetic appeal is essential for effective product development.

In this session, we will explore the stages of designing bamboo products, including material selection, conceptualization, sample and final production also its variations. This exploration not only highlights the functional and artistic value of bamboo but also promotes sustainable practices in design and manufacturing.

Here, bamboo products are categorised into different categories like home décor, kitchen ware, jewellery, utility products and some other products on the basis of its diversification. we have already discussed various techniques for making bamboo products, we will now apply those techniques to create products in this session.

A) HOME DÉCOR

Bamboo is being utilized in home décor more and more because of its natural aesthetic appeal, strength and versatility. From lighting fixtures to room dividers, it adds warmth and sophistication to interior design.

1. PLANT ORGANISER

A bamboo plant organiser is a decorative and functional item made primarily from bamboo or bamboo slivers that helps arrange, support or display potted plants in an organized and aesthetically pleasing way. There are many uses of a bamboo plant organiser like plant display it showcases multiple plants in an attractive way, often at different heights, space management which helps to maximize small spaces like balconies, windowsills, or apartment corners by stacking or organizing plants vertically, creating a plant pot cover using big bamboo slivers is a beautiful way to give your plant pots a natural look while using sustainable materials. Here's a complete step-by-step guide, including materials and process.

Tools & Materials Used

- Mature bamboo culms (for big slivers)

- Natural adhesive or wood glue
- Plant pot (to size the cover accordingly)
- Optional: Jute rope for binding or decoration
- Handsaw or machete (to cut bamboo)
- Knife or chisel (to split bamboo into wide slivers)
- Sandpaper (to smooth edges)
- Measuring tape
- Brush (for applying finish)

Product Making

Step 1. Splitting

After choosing treated and processed whole bamboo, remove the nodes and split the culm longitudinally according to your requirement using hand splitter/Splitting machine/Hand saw. Size can be differed accordingly

Step 2. Slivers Making

Convert Split into thin slivers (according to requirement) using desired tool. To make slivers smoothen use a knife or slivering machine to make slivers even and flexible according to your product.

Step 3. Create the Base Platform

Take bamboo slivers and arrange it into a flat square. Then reinforce the border with thicker bamboo slivers (strips). Also, trim excess slivers and sand the surface smooth.

Step 4. Build the Frame

Now use thicker bamboo sticks to make vertical supports (like legs in chair). Attach legs to the four corners of the base using glue or nails, make sure it should be fix properly.

Step 5. Construct Side Panels

Use bamboo slivers to create four panels according to the design and need then, align slivers side by side vertically or horizontally (optional) with the help of nails or glue to support edge sticks for firmness.

Step 6. Attach Slivers

Attach the wide side panels or bamboo slivers vertically or horizontally (accordingly) around the pot with the help of glue or nails and bind them to a base. Ensure slivers are evenly spaced.

Step 7. Finishing

At last sand the entire box, whole surface including joints and edges once again by sand paper or by buffing machine. Make sure there are no splinters or sharp corners on the product, then apply varnish or lacquer for protection or waterproofing and subtle finish. Let it dry completely before use. Test stability and balance of the bamboo plant organiser. Now place plant pots or baskets inside.

Fig. 3.47: Plant organiser

2. KEY HOLDER

A key holder is a small item used to keep keys organized and in one place. It can be a hook, box, or board usually hung on a wall near the door. They come in different shapes, colours and designs to match the home decor. Some key holders also have labels or small shelves for extra storage.

Tools & Materials Used

- Dried bamboo culm
- Metal hooks
- Bamboo cutter or hand saw
- Sandpaper for smooth finishing
- Hand drill or manual awl
- Measuring tape and pencil

- Screwdriver or pliers
- Clear varnish– For protective finishing
- Adhesive – For fixing decorative elements.

Product Making

Step 1. Splitting

After choosing treated and processed whole bamboo, remove the nodes and split the culm longitudinally according to your requirement using hand splitter/Splitting machine/Hand saw.

Step 2: Half-Cut the Bambo0

- Place the bamboo piece securely on a flat surface. Use a fine-toothed saw to carefully split the bamboo piece longitudinally into two equal halves.
- One half will be used as the main body of the key holder. Smooth the edges using sandpaper to avoid splinters.

Step 3: Surface Smoothing

- Rub the outer and inner surfaces of the bamboo using medium-grit (100–120) sandpaper.
- Follow up with fine-grit (220 or higher) sandpaper to achieve a smooth and clean finish. Make sure all corners and edges are rounded slightly for a finished look.

Step 4: Mark and Install Hooks

- Use a pencil and ruler to mark evenly spaced points along the curved surface for hook placement.
- Drill small pilot holes at the marked points using a hand drill.
- Twist metal hooks into the holes gently and ensure they are fixed tightly. Typically, 5–6 hooks are ideal for a medium-sized key holder.

Step 5: Add Hanging Support

- Drill a small hole on each flat end of the bamboo base for inserting eye screws.
- Attach eye screws securely and tie a strong jute rope, wire or thread between them for wall hanging.
- Ensure the rope is tight enough to keep the key holder level when mounted.

Step 6: Decoration and Finishing

- Apply natural polish or clear varnish using a brush or cloth to enhance the bamboo's look.
- For a decorative finish, paint designs such as tribal art, floral motifs or geometric patterns using acrylic paints.
- Allow sufficient drying time between coats.

Fig. 3.48: Key holder

Variations of Key Holder

This is a bamboo key holder made from hard bamboo, but many other types of key holders are also made in a similar way. It can be made from the bamboo slivers also. Here are some common variations like combines key hooks with letter holders, phone shelves or storage trays, a closed cabinet-style holder with doors, based on aesthetics and customization: key holder can be design and develop with different combination of design elements like carved art, printed patterns or decorative items, also Laser-etched with names, quotes or artwork. It means you can also engrave bamboo key holders according to the need and design.

Fig. 3.49: Variation of key holder

3. WALL HANGING

Wall hangings can be made from a variety of materials such as bamboo, fabric, paper, wool, beads, metal, or even recycled items. They come in many forms like paintings, embroidered cloth, macramé, paper crafts, or traditional designs made with natural materials.

Bamboo wall hangings are crafted using parts like bamboo sticks, slivers and thin strips. Techniques such as weaving, tying and assembling are used to create artistic and traditional designs. These natural wall hangings add a rustic and eco-friendly touch to home décor.

In this chapter, you will learn about how to make wall hanging using bamboo mat

Tools & Material Used

- Processed and Treated Bamboo
- Cutting Tools like Hand saw and Knife or chisel
- Wire Nail
- Slivering machine or Bamboo Splitter
- Sandpaper
- Varnish and brush
- Plywood back support
- Acrylic paints or fabric paints
- Strong adhesive (Wood glue, or hot glue)
- Metal hook or string
- Painted figures or scenes – made from: Cardboard or handmade paper and thin plywood

Product Making

Step 1. Splitting

After choosing treated and processed whole bamboo, remove the nodes and split the culm longitudinally according to your requirement using hand splitter/Splitting machine/Hand saw.

Step 2. Slivers Making

Convert Split into thin slivers (according to requirement) using desired tool. To make slivers smoothen use a knife or slivering machine to make slivers even and flexible according to your product.

Step 3. Making the Mat

Now, these slivers are woven using either a handloom or a power loom. You can also procure these woven bamboo slivers, commonly known as bamboo mats. You can cut into the according to the desired size.

Step 4. Prepare the Bamboo Slivers

- To create frame from bamboo, cut broad sliver of one inch, then cut into the 02 long horizontal slivers and 02 short vertical slivers according to the design of the frame.
- Then Smooth all rough edges with sandpaper.

Step 5. Making the Frame

Arrange all 04 slivers around the edges of the bamboo mat to form a rectangular frame, placing the ends together at the corners. Ensure the angles are aligned properly, then fix the slivers in place using strong adhesive or small nails.

Step 6. Creating the Painted Figures

- On thin wood, MDF board, or cardboard, draw a pattern of your choice.
- Use acrylic or poster paints to paint these figures. Outline details with black paint for a sharp look.
- Once dry, cut out each figure carefully using a precision cutter.
- Optionally, coat the figures with a thin layer of varnish for protection and shine.

Step 7. Pasting the Figures

- Decide on the composition – spacing and positioning of each figure.
- Apply strong glue to the back of each cutout and gently press it onto the bamboo mat.
- Hold in place until it is glued properly.
- Allow to dry thoroughly.

Step 8. Final Touches

- You may add additional painted details directly on the mat (e.g., flowers, ground texture as seen in the image).
- Once fully dry, attach a small hook or jute string to the back for hanging.
- Optionally, paste a cardboard or plywood sheet at the back for rigidity.

Fig. 3.50: Wall Hanging

Variation of Wall Hanging

This is a wall hanging made from a bamboo mat, but many other types of wall hangings are also made in a similar way. In following wall hanging, a painting is done on bamboo mat. Just like this, a hook or string is attached at the top so it can be easily hung on the wall. These wall hangings are a nice way to show art and decorate rooms. They come in many styles, colours and designs and are fun to make and look at.

Fig. 3.51: Variation of Wall Hanging

4. LAMP

Lamps provide light for reading, studying, working and also help create a warm and pleasant atmosphere in a room. There are different types of lamps such as table lamps, floor lamps, wall lamps and ceiling lamps. Each type has its own use depending on where and how we want to light up an area. Lamps can be made from materials like bamboo, metal, wood, glass, clay, or plastic and they come in many shapes, sizes and designs.

Bamboo lamps are made using different parts of the bamboo plant like hollow stems, thin strips and slivers. Techniques such as cutting, carving, weaving and shaping are used to create beautiful and natural-looking lamp designs.

Tools & Material Used

- Processed and Treated Bamboo
- Natural Adhesive or Wood Glue
- Cutting Tools like Hand saw and Knife or chisel
- Slivering machine or Bamboo Splitter
- Sandpaper
- Decorative Net/Cloth
- Decorative Laces
- Tassels
- Varnish and brush

Product Making

Step 1. Splitting

After choosing treated and processed whole bamboo, remove the nodes and split the culm longitudinally according to your requirement using hand splitter/Splitting machine/Hand saw.

Step 2. Slivers Making

Convert Split into thin slivers (according to requirement) using desired tool. To make slivers smoothen use a knife or slivering machine to make slivers even and flexible according to your product.

Step 3. Making the Mat

Now, these slivers are woven using either a handloom or a power loom. You can also procure these woven bamboo slivers, commonly known as bamboo mats. You can cut into the according to the desired size.

Step 4. Prepare the Bamboo Slivers

To create frame from bamboo, cut broad sliver of one inch, then cut into the 06 long slivers and 03 short slivers according to the design. Then Smooth any rough edges with sandpaper.

Step 5. Making the Frame

- Arrange the 2 long bamboo sticks in a pyramid shape – like a triangle that meets at the top.
- Attach the shorter bamboo pieces at the bottom to make a triangular base.
- Use glue to fix the bamboo pieces together. Hold until dry or use clips to keep them in place.

Step 6. Add the Mat & Fabric Panels

- Measure and cut triangular bamboo mat and fabric pieces to fit each side of the bamboo frame.
- Apply glue along the edges of the fabric and carefully stick each panel to the bamboo frame.
- Let the bamboo mat and fabric dry completely.
- After drying paste the colourful lace or decorative material on joint of the fabric and bamboo mat.

Step 7. Decorate the Bottom Edges

- Take your lace, ribbon, or fabric border.
- Stick it neatly around the bottom edge of the lamp using glue. This covers the bamboo joints and gives a beautiful finish.
- Attach the tassels in the corners of the lamp.

Step 8. Add a String to Hang

- Tie a strong thread or yarn to the top point where the bamboo sticks meet.
- Make a loop or knot for hanging on a hook or ceiling.
- **Optional: Add Lighting** if you want this to work as a lamp, place a battery-operated LED light inside.You can hang the LED with thread or stick it to the top inner part of the frame.

Step 9. Final Touches

- Once all parts are fixed, paint your lamp with Varnish. Let it dry before using it.

Fig. 3.52: Lamp

B) KITCHENWARE

Bamboo kitchenware is environmentally friendly, long-lasting and naturally antimicrobial. It provides a safe and fashionable substitute for plastic and metal utensils for daily use.

1. TRAY

A bamboo tray is a flat or shallow container made primarily from bamboo slivers, strips, or sheets, often woven or framed, used for carrying, serving, or organizing items. It's a traditional and eco-friendly product valued for its light weight, strength and sustainability. Common uses of bamboo trays are serving tray like used to serve tea, snacks, or meals. Decorative display like holds candles, potpourri or ornaments as a home décor item.

Storage/Organizer like used to organize stationery, toiletries, jewellery or keys. Here's a step-by-step process for making a bamboo tray using bamboo slivers (thin strips of bamboo) a common handmade product in bamboo craft:

Tools & Material Used

- Processed and Treated Bamboo
- Natural Adhesive or Wood Glue
- Cutting Tools like Hand saw and Knife or chisel
- Sliver Maker or Bamboo Splitter

- Sandpaper or Sanding Block
- Hammer and Small Nails/Clamps
- Brushes or Cloth
- Wood Varnish or Clear Lacquer

Product Making

Step 1. Splitting

After choosing treated and processed whole bamboo, remove the nodes and split the culm longitudinally according to your requirement using hand splitter/Splitting machine/Hand saw.

Step 2. Slivers Making

Convert Split into thin slivers (according to requirement) using desired tool. To make slivers smoothen use a knife or slivering machine to make slivers even and flexible according to your product.

Step 3. Making the Tray Base

- To make rectangular base, take two long slivers parallel (horizontally) to each other and take two small bamboo slivers and attach it on the both end side of parallel bamboo with the help of nails or glue.
- Make sure the rectangular base should be tight and fix.
- Lay rectangular base slivers flat, now begin by attaching more slivers in the middle of the rectangular base. Or interlacing horizontal and vertical slivers in a criss-cross or desired pattern.
- Make sure the distance of each bamboo slivers should be same.

Step 4. Making the Frame

- To create frame from bamboo, cut two broad slivers into a rectangle shape (according to the tray design or need).
- Attach the rectangular base part to the frame vertically by glue to fix the base into the frame.

Step 5. Finishing

- After fixing all the required slivers trim extra slivers from the edges, then smooth edges and corners with sandpaper or a sanding machine. Sand the full surface for a smooth finish.
- Apply a finish such as varnish, touch wood or lacquer (for glossy look and protection). Let it dry completely.

Step 6. Final Touches:

After finishing the product inspect the finished product for any defects. Then add optional features like handles, decorative lacing or paint accordingly. At last package the tray carefully to avoid breakage.

Fig. 3.53: Tray

Bamboo trays can be made from different types, here is a variation of bamboo tray, each suited for different purposes and aesthetics. You can change different shapes, different types of weaving on bamboo trays and also compartments according to your design.

Fig. 3.54: Variation of Tray

2. BAMBOO CUP

A bamboo cup is a type of drinking cup made from bamboo, a fast-growing, renewable natural resource. These cups are often used as a sustainable alternative to plastic, ceramic, or glass cups. Bamboo Cups used for drinking beverages like coffee, tea, water, smoothies, etc. Some bamboo cups are made with melamine resin as a binder, which is not biodegradable and may release harmful substances at high temperatures. For the most sustainable option, look for 100% natural bamboo or certified food-safe products.

Tools and Materials Used

- Small bamboo ring or strip

- Wood-safe adhesive
- Thick bamboo piece
- Wood polish or natural oil
- Food-safe waterproof coating
- Hacksaw or fine-tooth saw
- Sandpaper (medium and fine)
- Drill or chisel (for hollowing and shaping)
- Measuring tape or ruler
- Pencil/marker for marking
- Varnish brush or soft cloth
- Small heating pot or spoon (for melting sealing wax if needed)

Product Making

Step 1: Select and Cut the Bamboo

After choosing treated and processed whole bamboo, remove the nodes and split the culm longitudinally according to your requirement using hand splitter/Splitting machine/Hand saw. Ensure that the bottom includes a natural node to act as the sealed base of the cup.

Step 2: Smooth the Edges

Use medium and fine sandpaper to smooth the top rim and outer surface of the bamboo. This ensures the edges are even, safe to touch and visually appealing.

Step 3: Hollow and Clean the Inner Surface

If the interior contains any partitions or nodes, carefully remove them using a chisel or drill. Smooth the inside with fine sandpaper to prevent splinters and allow for easy cleaning.

Step 4: Create and Attach the Handle

Cut a curved strip from a thinner bamboo piece to form the handle. Sand it to ensure smoothness. Attach it to the side of the cup using strong wood-safe adhesive. Alternatively, the ends of the handle can be inserted into small drilled holes for stronger attachment. Let it dry completely.

Step 5: Waterproofing the Interior (for Functional Use)

If you want to make the bamboo cup suitable for holding liquids like water, tea, or juice, you must waterproof the inner surface.

- Use a **food-safe sealant** such as **melted beeswax, edible lacquer, or natural resin**.
- Gently heat the sealing material and pour or spread a thin layer inside the cup.
- Tilt and rotate the cup so that the sealant evenly coats the entire inner surface.
- Allow it to cool and harden completely before use.

This step is essential to prevent leakage and ensure safe usage for beverages.

Step 6: Final Sanding and Outer Finishing

Once the cup is dry and the handle is fixed, sand the full outer surface again. Apply a layer of wood polish or natural oil to enhance the bamboo's natural shine and to protect it from moisture and damage.

Step 7: Dry and Inspect

Let the entire cup dry thoroughly. Inspect the sealant inside (if applied), handle grip and overall balance. The cup is now ready for use either as a functional drinkware item or a decorative utility piece.

Fig. 3.55: Cup

This is a bamboo cup made from a hard bamboo, but many other types of cups are also made in a similar way. Here are some common variations of bamboo cups, based on design, usage and material combination like you can change its shapes according to your design, including different lid, grips and colours. You can add different prints, patterns or artwork. It can also be made with the combination of steel and other material you want.

Fig. 3.56: Variation of Cup

C) JEWELLERY

Bamboo jewellery blends the traditional with contemporary design. It's light, eco-friendly and an eco-friendly fashion option that is increasing in popularity globally.

1. EARING

A bamboo earring is a type of jewellery made from bamboo, a natural, sustainable and lightweight material. These earrings are often handcrafted and reflect eco-friendly fashion and traditional craftsmanship. Extremely lightweight, making them comfortable to wear.

To make these bamboo coil earrings, we will use traditional techniques from bamboo craft. Here's a detailed breakdown of the materials required and the step-by-step process to make earrings like the ones in your image.

Tools & Materials Used

- Thin bamboo strips (1–2 mm width, uniform thickness, flexible and well-polished)
- Scissors or cutter
- Sandpaper (fine grit)
- Glue (any strong craft adhesive)
- Earring hooks (golden or matching colour)

- Jump rings (small metal rings to connect components)
- Round-nose pliers
- Needle or small awl (for making holes)
- Clear varnish or lacquer (optional, for finishing)
- Thread or thin wire (optional, for additional binding)

Product Making

Step 1. Splitting

After choosing treated and processed whole bamboo, remove the nodes and split the culm longitudinally according to your requirement using hand splitter/Splitting machine/Hand saw. Soak in warm water for 5–10 minutes if needed to make strips more flexible.

Step 2: Create Bamboo Coils

- Start rolling the bamboo strip into a tight coil (like a spiral). Gradually increase the diameter as you roll — each loop should be slightly larger than the last.
- Apply a small amount of glue between layers to secure them in place.
- Keep rolling until you achieve the desired size (like in the image — around 6–8 concentric circles). Press the end firmly and hold until the glue sets.

Step 3: Make the Top Knot/Loop

Use a short strip of bamboo to make the decorative knot or loop at the top. This part adds design and also provides a base for attaching the hook. Tie the knot and glue the ends to secure it.

Step 4: Assemble the Earring

- Use a needle or awl to carefully make a hole at the top of the coil or knot.
- Attach a jump ring through the hole using pliers and connect the earring hook to the jump ring.

Step 5: Finishing Touch

- Apply a clear varnish or lacquer to protect the bamboo and give it a shiny finish. Let it dry completely before using.

Fig. 3.57: Earrings

2. NECKLACE

A bamboo necklace is a type of eco-friendly jewellery made primarily using bamboo, a fast-growing, sustainable plant. These necklaces are often handcrafted and are popular for their light weight, natural aesthetic and cultural value. Making a bamboo necklace using quilling techniques is a beautiful blend of traditional bamboo craft and paper quilling-style design. In this method, thin bamboo strips are rolled and shaped similarly to how paper is used in quilling.

Tools & Materials Used

- Thin bamboo strips (0.5–2 mm wide, flexible, well-polished)
- Scissors or craft knife
- Sandpaper (fine grit)
- Craft glue
- Needle or awl (for piercing holes)
- Clear varnish or lacquer (for finishing)
- Jewellery thread or cord (cotton, silk, or nylon)
- Jump rings and clasps
- Chain or thread for the necklace base
- Beads (optional – wooden, glass, or bamboo)
- Pliers (round-nose, for opening/closing jump rings)
- Quilling tool (optional, can also be rolled by hand)

Product Making

Step 1. Splitting

After choosing treated and processed whole bamboo, remove the nodes and split the culm longitudinally according to your requirement using hand splitter/Splitting machine/Hand saw. Soak in warm water for 5–10 minutes if needed to make strips more flexible.

Step 2: Create Bamboo Quills

- Using a quilling tool or fingers, roll the bamboo strip tightly into a coil.
- For a pendant, use longer strips to make a larger central coil.
- You can create multiple coils of different sizes to layer them creatively.
- Glue the end of the strip to secure the coil.
- Optionally, press coils into shapes: teardrop, leaf, heart, etc.

Step 3: Design the Necklace Pieces

- Combine small and large coils to form a pendant design.
- Use multiple small coils to make beads or decorative elements.
- Allow all pieces to dry fully.

Step 4: Add Finishing Touch

- Apply a coat of clear varnish or lacquer for shine and durability.
- Let it dry thoroughly (preferably overnight).

Step 5: Assemble the Necklace

- Use a needle or awl to pierce small holes in the pendant and coils if needed.
- Attach jump rings to the pendant or coil elements.
- String the pieces onto a cord or chain, alternating with optional beads.
- Attach clasp hooks to the ends of the necklace for fastening.

Optional Creative Variations

- Dye the bamboo strips before coiling for colourful designs.
- Add bamboo beads or fabric elements for a tribal look.
- Use burnt bamboo effect (gently charring edges) for texture and contrast.

Fig. 3.58: Quilling Necklace

D) UTILITY PRODUCTS

Bamboo utility products are practical items used in our daily lives. These include things like baskets, trays, storage boxes, hangers, dustbins, organizers, pen stands and even laundry hampers. They are designed to make everyday tasks easier and more organised. Bamboo is naturally strong, lightweight and eco-friendly, which makes it perfect for creating such useful household items. Many artisans blend traditional techniques with modern designs to create durable and attractive utility products that suit both rural and urban lifestyles. These products are not just functional—they also add a touch of natural beauty to homes and workplaces.

1. BAMBOO PEN STAND BY SOLID BAMBOO

Bamboo is one of the most versatile and sustainable natural resources available to us. Known for its rapid growth, strength and biodegradability, bamboo has been used for centuries in a variety of applications—from construction and furniture to kitchenware and decorative crafts. In recent years, it has gained renewed attention as an eco-friendly alternative to plastic and other non-renewable materials. Creating a bamboo pen stand is not just a craft; it is an expression of creativity rooted in environmental responsibility. By using bamboo, artisans and learners contribute to reducing plastic consumption and embracing a greener lifestyle. This simple yet functional item used to store pens, pencils and other stationery can reflect both utility and artistry.

Beyond its practical use on office desks or study tables, a bamboo pen stand can serve as a thoughtful handmade gift, a decorative item, or a project piece in educational settings that integrate subjects like environmental science, design thinking and craft education. In essence, a bamboo pen stand symbolizes more than just a stationery holder—it is a small but meaningful step toward a more eco-conscious world, where creativity and sustainability go hand in hand.

Tools & Materials Used

- Dried bamboo culm
- Cutting Machine (or Bamboo Cutter)
- Sandpaper
- Hand drill or electric drill
- Pencil and measuring tape
- Ruler or scale – For alignment and design layout.
- Acrylic paints– For artistic decoration.
- Clear varnish, wood polish– For sealing and protecting bamboo.
- Paintbrushes or sponge – For painting and varnishing.

- Jute rope, coloured thread or fabric pieces – For outer wrapping (optional).
- Adhesive or hot glue)

Product Making

Step 1. Splitting

After choosing treated and processed whole bamboo, remove the nodes and split the culm longitudinally according to your requirement using hand splitter/Splitting machine/Hand saw.

Step 2: Cut the Bamboo

- Use a measuring tape and pencil to mark the height (about 5 to 6 inches). Hold the bamboo firmly and cut it straight using a cutting machine.
- If the bamboo is open at the bottom you can cut a thin bamboo disc from another piece and glue it using adhesive to close the base.

Step 3: Smooth the Surface

- Use medium-grit sandpaper to rub the outer surface and remove the rough natural layer. Then use fine-grit sandpaper to make the surface smooth and polished.
- Carefully sand the top edge to remove any splinters and ensure it's safe to handle.

Step 4: Hollow Bamboo Pen Stand

- The bamboo itself is hollow inside, which makes it ideal for use as a single compartment to store pens, pencils or brushes. There's no need to drill any holes for this simple design.
- Just clean the inside of the bamboo with a cloth to remove any dust.
- This creates a basic, functional pen stand with a natural or Raw look.

Step 5: Decoration and Finishing

- Apply varnish with a brush or sponge.
- Let it dry for a few hours between coats. Apply 1–2 coats for a shiny and protective finish.
- Painted Finish Lightly sketch your design with a pencil. Use acrylic paints to decorate:

Step 6: Final Touch

- Let the pen stand dry completely in a clean, dust-free space.
- Once dry, clean the inside and check by placing pens or pencils.
- Eco-friendly bamboo pen stand is now ready to use.

Fig. 3.59: Pen stand

2. UTILITY BOX

A bamboo utility box is a storage container or box made from bamboo. These boxes are often used in homes and offices for organizing various items. They come in different shapes, sizes and designs. Also, may have compartments, lids or handles depending on the use. Bamboo utility boxes are sometimes used as sustainable packaging for gifts, food items or eco-conscious product lines. Their natural aesthetic makes them suitable for interior decoration, especially in minimalist or eco-friendly themes.

Benefits of Bamboo Utility Boxes

- Eco-Friendly: Bamboo is a renewable resource.
- Durable: Strong and long-lasting.
- Lightweight: Easy to move and handle.
- Aesthetic: Natural look that complements many interior styles.
- Low Maintenance: Easy to clean with a damp cloth.

Here's a full guide on making a simple utility box from bamboo slivers a practical container for holding small household or office items.

Tools & Materials Used

- Mature bamboo (for slivers and base)
- Bamboo slivers (wide and thin, 2-3 mm thick, 1-2 cm wide)
- Base material: flat bamboo sheet

- Adhesive: Wood glue or natural glue
- Optional: Jute rope or binding strips for reinforcement
- Knife or bamboo splitter (to make slivers)
- Saw (to cut bamboo)
- Sandpaper (for smoothing edges)
- Measuring tape or ruler
- Brush (for applying finish)
- Drill/nails (if using a fixed base)
- Varnish or clear lacquer for waterproofing

Product Making

Step 1. Splitting

After choosing treated and processed whole bamboo, remove the nodes and split the culm longitudinally according to your requirement using hand splitter/Splitting machine/Hand saw.

Step 2. Slivers Making

Convert Split into thin slivers (according to requirement) using desired tool. To make slivers smoothen use a knife or slivering machine to make slivers even and flexible according to your product.

Step 3. Prepare the Base

Cut a square or rectangular/square piece (e.g., 6x6 inches) from: flat bamboo board or thick woven bamboo mat (for a lightweight box). Or make base from thin bamboo slivers by putting it into flat square and arrange side by side with the help of glue.

Step 4. Construct the Sides

Take 4 slivers (for each side) and attach upright around the base with the help of glue or small nails to fix slivers to the base edges. Clamp in place until the adhesive sets. Align horizontally other slivers around these uprights to build up the sides.

Step 5. Add a Lid

Make a lid using the same material and process as the base. Attach with a piece of cloth as a hinge or leave as a loose cover.

Step 6. Sand and Finishing

Smooth all corners and joints with sandpaper. Apply varnish for protection and a polished look. Let it dry fully before using.

Fig. 3.60: Utility box

There are several variations of a bamboo utility box, considering different uses, designs and added features. You can made different utility box by using ideas based on different purpose. Make utility box by different shapes, compartments, sliding lid, weaving design, paintings, different patterns and different forms of bamboo or carvings, attach leather handle, magnetic closures, layers that can be detached and strap for carrying according to your need and design.

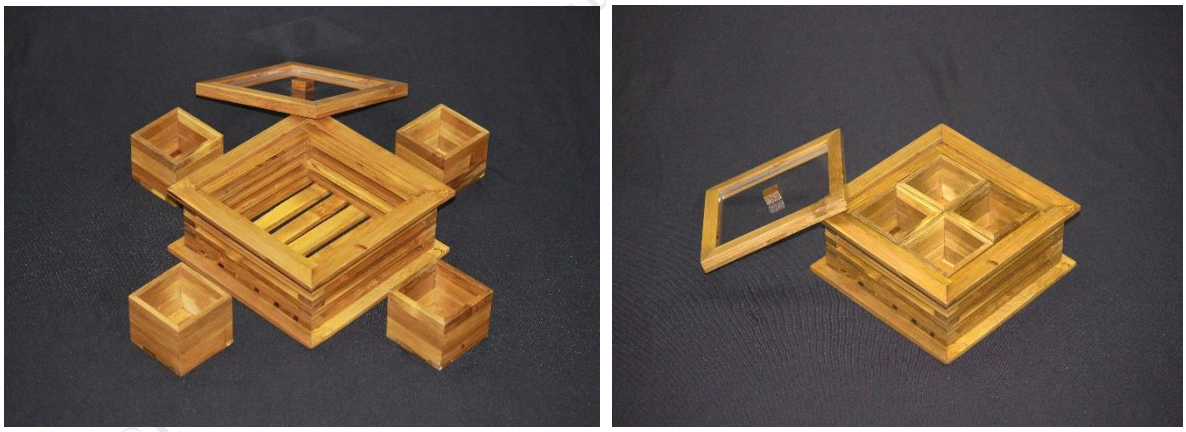


Fig. 3.61: Variation of Utility box

3. MOBILE STAND

A bamboo mobile stand is a holder or support structure made from bamboo, designed to hold a mobile phone upright in a stable position. It allows for hands-free use of your phone while working, studying, video calling, watching videos, or reading. Because it's made of natural bamboo, it's both eco-friendly and aesthetically pleasing, often used as a sustainable alternative to plastic or metal stands. This product is a handcrafted bamboo mobile stand, designed to hold a mobile phone at a convenient viewing angle. Below is the step-by-step process to make a similar bamboo mobile stand.

Tools & Materials used

- Flat bamboo slivers
- A circular bamboo ring or bent bamboo piece
- Glue (wood glue or hot glue)
- Sandpaper
- Cutter or fine saw
- Varnish or polish (optional)

Product Making

Step 1. Splitting

After choosing treated and processed whole bamboo, remove the nodes and split the culm longitudinally according to your requirement using hand splitter/Splitting machine/Hand saw.

Step 2. Slivers Making

Convert Split into thin slivers (according to requirement) using desired tool. To make slivers smoothen use a knife or slivering machine to make slivers even and flexible according to your product.

Step 3. Prepare the Base

Cut a rectangular bamboo slivers for the base. Frame the edges by gluing thin bamboo slivers around three sides (left, right and bottom) to create a shallow tray where the phone rests.

Step 4. Create the Stand Support

- Use a semi-circular or full ring piece of bamboo to act as the vertical support and cut a bamboo ring into a curve and fix it with glue.
- Attach the curved support to the base with glue. Let it dry and ensure its firmly standing.

Step 5. Make the Mobile Holding Panel

- Take slivers and glue bamboo slivers piece together to form a flat rectangular board.
- Cut the edges of the corners to give a clean, angled look as in the image and sand the edges for smoothness with the help of sandpaper.

Step 6. Fix the Panel to the Stand

Attach the panel to the top of the curved bamboo support at an angle that allows the phone to rest and be easily viewable (typically around 60–70°). Ensure the glue is strong and let it dry completely.

Step 7. Final Touches

- Sand all surfaces to remove any splinters or roughness. Then apply a coat of varnish for durability and a finished look.
- Test with a mobile phone to ensure the angle and support are functional.

Fig. 3.62: Mobile Stand

4. BAMBOO BASKET

Basket making is an ancient art performed all over India. Bamboo baskets are resistant, light and environmentally friendly. These baskets are prepared by weaving thin bamboo slivers in varying patterns to create a variety of shapes and sizes. Some uses of bamboo baskets are as mentioned below.

- **Bamboo Baskets** (Storage, fruit baskets, laundry bins, etc.)
- **Handicrafts** (Wall decor, furniture, lampshades, trays, etc.)
- **Utility Items** (Mats, pen holders, coasters, etc.)

Tools & Materials Used

- Bamboo poles: Chosen on the basis of flexibility and thickness.
- Bamboo slivers: Narrow, flat slivers produced by cutting bamboo.
- Knife: To cut bamboo into slivers.
- Water: To wet bamboo and render it pliable.
- Dyes or paints (optional): For colouring.
- Rope or thread (optional: For ornamentation or sewing.

1. Types of Basketry Weaving (Weaving of Slivers)

Prior to the creation of a basket, one should be aware of the fundamental weaving techniques employed in basketry. These techniques determine the strength, design and appearance of the basket.

a. Coiling

- Here, a bundle of bamboo slivers is coiled in a spiral shape.
- Each coil is sewn to the other with fine slivers.

b. Twining

- Two pliable slivers are twisted over vertical slivers.
- This imparts strength and flexibility to the basket.

c. Plaiting (Weaving)

- Thin slivers are woven over and under one another at right angles.
- This is the most common technique employed in bamboo basketry.

d. Wicker Weaving

- Thicker bamboo rods are employed as the foundation and thin slivers are woven upon them.
- It is employed in strong and big baskets.

Product Making

Step 1: Bamboo Selection

- Select mature bamboo that is flexible and hard.
- It must be treated and crack-free.

Step 2: Preparation of Slivers

- Cut the bamboo into short pieces.
- Shred it into thin strands with a knife.
- Submerge the strands in water to soften and loosen them.

- Slivers can be dyes in multiple colours using chemical or traditional dyeing process.

Step 3: Creating the Base

- Begin with sliver weaving in a crisscross manner to create the base.
- Employ 4 to 6 strands and interweave them tightly.

Step 4: Weaving the Sides

- Sliver upward from the base to create the walls of the basket.
- Begin to weave horizontally with slivers employing plaiting or twining.
- Keep the weave close and even.

Step 5: Shaping the Basket

- As you work your way up, shape the basket gently.
- You can shape it round, oval, or square depending on its intended use.
- You can use different weaving patterns and techniques based on the product design you want to create, as discussed in the previous session.

Step 6: Finishing the Rim

- When you've reached the desired height, fold slivers vertically in.
- Tuck them inside the weave or tie with thread to complete rim.

Step 7: Drying and Polishing

- Polish it using varnish if necessary. Allow the basket to dry in the shade.

Fig. 3.63: Different types of Basketry weaving

E) OTHER PRODUCTS

1. BAMBOO FLUTE

The most widely used bamboo for flute construction is Bambusa tulda, or Indian timber bamboo or Bengal bamboo. Nevertheless, the best bamboo for flute construction usually possesses the following traits:

- Straight and cylindrical internodes
- Thin walls but sturdy structure
- Smooth inner surface
- Few nodes or small node swellings
- Aged and naturally dried

Fig. 3.64: Bambusa tulda majorly used species to make flutes

Making of a bamboo flute from Bambusa tulda requires deliberate choice, drying, measurement, tuning and finishing. Below is step-by-step detailing of the age-old yet successful method:

Tools & Materials Used

- Mature bamboo (tulda species)
- Base material: flat bamboo sheet
- Adhesive: Wood glue or natural glue
- Sandpaper (for smoothing edges)
- Measuring tape or ruler
- Brush (for applying finish)
- Drill
- Varnish or clear lacquer for waterproofing

Product making

Step 1. Bamboo Choice

- Prefer Bambusa tulda species for best result
- Internodes must be long, straight and free of cracks or blemishes.
- Diameter varies with the type of flute (bansuri, bass flute, etc.).

Step 2. Cutting and Drying

- Cut the bamboo slightly longer than the desired flute.
- Dry naturally for 3–6 months, or oven dry slowly to prevent cracking.
- Insect-proof by treating with borax and boric acid solution.

Step 3. Cleaning and Preparation

- Remove inner diaphragm (node walls) with a rod or sandpaper.
- Sand the interior lightly for smooth air flow.
- Sand the outside surface and optionally polish with fine sandpaper.

Step 4. Marking and Drilling

- Mark embouchure hole (blowing hole) and finger holes with a scale or tuner.
- Drill embouchure hole first with small bit, widening carefully afterward.
- Drill 6 or 7 finger holes (depending on type of flute), checking for spacing with tuner.

Step 5. Tuning

- Play and refine hole size or location to get correct pitch.
- Match each note with a scale (e.g., C major) using digital tuner.
- This step requires patience and small adjustments.

Step 6. Finishing

- Put on light wax or linseed oil to protect and provide sheen.
- Add decorative thread binding optionally near the ends.
- Inspect play to guarantee tone quality, smooth airflow and tuning.

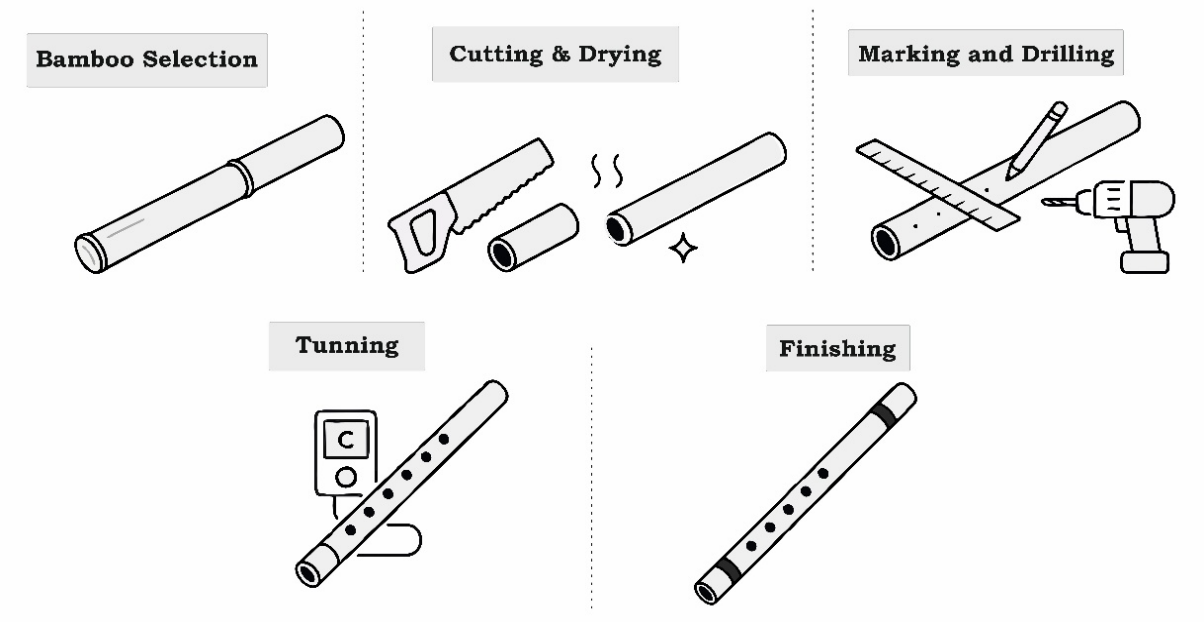


Fig. 3.65: Process of making flute from bamboo

2. AGARBATTI STAND

A bamboo agarbatti stand is a holder or stand made from bamboo that is designed to hold agarbatti (incense sticks) while they burn. It typically serves both a functional and decorative purpose. It is used for holding the agarbatti upright or at an angle, collects ash from the burning incense to keep the area clean, provides stability to prevent the stick from falling over.

Benefits of bamboo agarbatti stands are: eco-friendly alternative to plastic or metal holders, lightweight and portable and adds a natural aesthetic to spiritual or meditation spaces.

Tools & Materials Used

- Bamboo internode (2–3 inches)
- Bamboo flat base
- Saw or fine-toothed cutter
- Sandpaper
- Drill or hand tool
- Adhesive (wood glue/eco-bond)
- Polish or natural oil

Product Making

Step 1. Splitting

- After choosing treated and processed whole bamboo, remove the nodes and split the culm longitudinally according to your requirement using hand splitter/Splitting machine/Hand saw.

Step 2. Select and Cut Bamboo Internode

- Choose a mature bamboo internode section (2–3 inches in diameter and length).
- Cut a 3-inch cylindrical piece using a fine-toothed saw.
- Ensure the section has closed nodes at both ends, or one closed end for better form.

Step 3. Split the Internode

- Carefully cut the internode section lengthwise into two equal halves.
- You should now have two concave semi-cylindrical halves.

Step 4. Join the Halves to Form a Tent Shape

- Flip one half over and join both halves at the edges to form a tent-like shape (as seen in your photo).
- Glue the halves together securely using wood glue or an eco-friendly adhesive.
- Hold them in place with light pressure or tape until fully dry.

Step 5. Drill Incense Stick Holes

- Once the structure is stable, drill small holes (2–3 mm wide) on one side of the tent-like structure.
- Ensure holes are at an inclined angle so the incense sticks rest pointing upward and ash can fall downward.

Step 6. Prepare the Bamboo Base

- Cut a flat bamboo slice or a thin bamboo board slightly larger than the tent structure.
- Smoothen the edges with sandpaper.

Step 7. Attach Structure to Base

- Apply glue to the bottom edges of the joined bamboo tent.
- Stick it to the centre of the bamboo base and press down firmly.
- Let it dry for a few hours.

Step 8. Final Finishing

- Smoothen all rough surfaces using fine sandpaper.
- Apply a natural polish, beeswax, or linseed oil for a subtle shine and protection.
- Allow to dry before use.
- The holes serve as incense stick holders.
- The base collects falling ash, keeping the area clean.
- It combines aesthetic appeal with natural material sustainability.

Fig. 3.66: Agarbatti Stand

3. APPLIQUE BIRD

The Appliqué Bamboo Bird is a decorative handmade item crafted using thin bamboo slivers and supporting materials. This traditional craft technique involves shaping and layering bamboo components over a base structure to form artistic representations of birds. The method combines flexibility of bamboo splits, filler materials and precise detailing with adhesives, creating a visually rich and eco-friendly craft piece. Commonly used for home décor, gifting and craft exhibitions, this appliqué bird showcases the artisan's skill in weaving, modelling and assembling natural materials into a lifelike figure.

Tools & Materials Used

- Treated Bamboo Culms
- Bamboo Slivers/Splits
- Wire (Binding Wire or Soft Craft Wire)
- Thermocol / Cotton / Residual Bamboo Fibres
- PVA Adhesive

- Eyes (Plastic or Glass) Can be changed according to your desired product
- Coated Rice Grains/ M-Seal or Epoxy Resin
- Wood Varnish / Resin Polish
- Cutting Tools (Knife, Chisel)
- Sandpaper
- Clamps / Binding String
- Brushes or Cloth

Product Making

Step 1: Base Structure Formation

- Create the base framework of the bird using wire, themacol,, wood etc. according to your convince and availability. You may use any other shape and form your base if you wish to make any other shape like animal, fruit, etc shape will work as an armature.
- Shape the form (neck, wings, tail, body curve) by bending and joining splits with wire.
- Ensure a firm structure by interlocking and tightening joints.

Step 2: Adding Filler Material

- If you are using wire armature insert thermocol, cotton, hay, or bamboo fibres inside the structure to give volume and contour.
- Fill carefully to avoid bulging or imbalance.

Step 3: Layering

- Prepare or collect thin bamboo slivers/pieces accoding to your desired shape.
- Paste the slivers onto the surface of the bird's structure using Adhesive.
- Cover evenly to define the bird's outer shape.

Step 4: Detailing

- Paste finely cut bamboo shapes for wings, beak, feathers, or tail.
- Attach coated rice grains decoratively on the neck or body.
- Use grains for eyes or fix plastic eyes to enhance realism.

Step 5: Feet and Support

- Form the bird's feet using wire, covered and shaped using M-seal or epoxy.
- Attach them firmly to the body structure.

Step 6: Finishing

- Inspect the product for gaps or unfinished areas.
- Apply wood varnish or resin polish using a brush for a smooth, shiny and protective finish.

There is no fixed or rigid process for creating bamboo appliqué products. While the basic steps and materials provide a framework, students are encouraged to explore their creativity by experimenting with different shapes, sizes and structures. The beauty of appliqué work lies in its flexibility and artistic freedom.

Fig. 3.67: Creative use bamboo root to display applique work

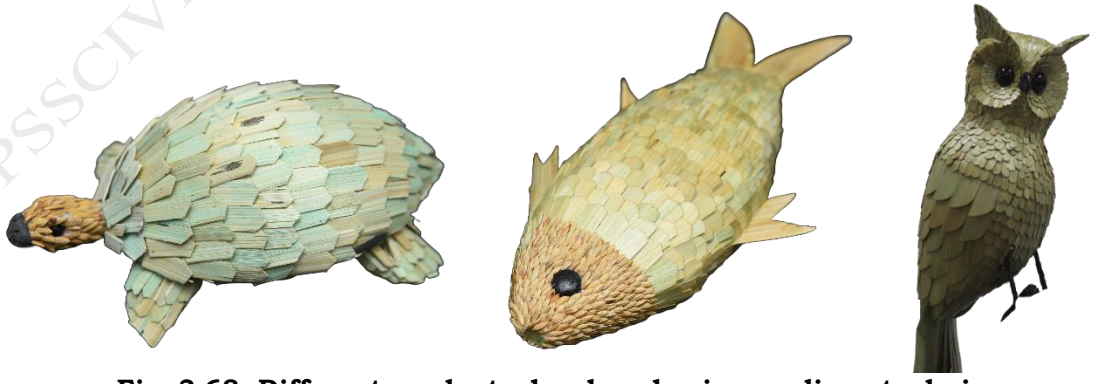


Fig. 3.68: Different products developed using applique technique

There are no limitations on the type or combination of supportive materials used artisans can incorporate any sustainable or locally available elements to

enhance form and detail. This open-ended approach not only nurtures innovation and personal expression but also helps keep the traditional craft dynamic and evolving with time.

Bamboo Roots Sculpture

Bamboo roots, known for their organic strength and aesthetic irregularity, offer immense potential for artistic expression. While most bamboo crafts typically use the **culm (stem),** the **roots (underground rhizomes)** are equally valuable due to their naturally twisted and textured forms. These roots can be carved, sculpted, or engraved by artisans to create a wide range of handcrafted items.

Different Products Made from Bamboo Roots

- Jewellery
- Sculptures
- Animal figurines
- Abstract art pieces
- Toys
- Cultural showpieces
- Functional products such as toothbrushes, cutlery, and more
- Unutilized bamboo roots are a valuable resource and can be repurposed into new creative items.

Tools & Materials Used

- Bamboo roots
- Handsaw or hacksaw (for cutting)
- Chisel set (for shaping)
- Sandpaper or sanding machine
- Drill (for holes or joining parts)
- Wood file and carving tools
- Wood varnish or lacquer
- Brushes or spray guns
- Paint (optional, for colored designs)

Note: The required tools and materials may vary depending on the design and product. Artisans are encouraged to explore creative variations.

Product Making

1. **Collection & Selection**: Carefully dig out bamboo roots during or after harvesting. Select roots with natural curves, textures, or interesting shapes.
2. **Cleaning**: Wash thoroughly to remove soil, mold, and fibrous outer matter. Bark may be peeled off as needed.
3. **Drying**: Sun-dry or shade-dry the roots for several days (1–2 weeks depending on climate) to remove moisture and prevent cracking.
4. **Cutting & Shaping** : Use saws to remove unwanted parts. Carve or shape based on the design. Preserve natural curves for aesthetic value.
5. **Smoothing**: Use files and sandpaper to smooth surfaces. Some textures can be retained for a rustic appearance.
6. **Drilling & Joining (if required)**: Drill holes for assembly or hardware fittings. Parts can be joined with nails, screws, or adhesives.
7. **Finishing**: Inspect for cracks or rough areas. Polish or apply varnish to highlight the root's natural grain and color.

Fig. 3.69: Sculptures made up of bamboo roots

Each bamboo root is unique, resulting in one-of-a-kind handmade products. Techniques, tools, or materials may be modified based on individual creativity.

Bamboo Leaves Crafting

Bamboo leaves are long, narrow, green foliage found on bamboo branches. Soft, flexible, and biodegradable, they offer eco-friendly and traditional applications in bamboo crafts.

Common Bamboo Leaf Products

- Jewellery
- Decorative wall art
- Baskets
- Mats
- Home decor and utility items

Crafting with bamboo leaves ensures holistic utilization of the bamboo plant, promoting zero waste.

Tools & Materials Used

- Fresh or dried bamboo leaves (as per design)
- Needle and thread (for stitching or binding)
- Twine or thin wire (for structural support)
- Glue or resin (optional, for stiffness or preservation)
- Scissors (for cutting or shaping)

Product Making

1. **Selection of Bamboo Leaves:** Begin by selecting fresh or dried bamboo leaves based on the nature of your product. Fresh leaves are suitable for items requiring flexibility, while dried leaves work well for more rigid structures. Ensure that the leaves are clean, undamaged, and free from mold or pests. The size, color, and texture of the leaves may also influence your selection depending on the product design.
2. **Cleaning and Conditioning:** Gently wash the selected leaves with clean water to remove any dust, dirt, or residue. After cleaning, allow the leaves to air-dry in a shaded area to retain their natural color. If you are using dried leaves, you can briefly soak or steam them to restore flexibility, which makes them easier to fold, weave, or shape.
3. **Design Planning:** Plan the product you wish to create whether it's jewelry, a decorative piece, or a functional item. Visualize or sketch your design to understand the structure and components required. You may also sort the leaves according to size and shape at this stage to help with uniformity and symmetry in your final piece.
4. **Cutting and Shaping:** Trim the leaves to the desired shape using scissors/craft knives/. Depending on your design, the leaves can be cut into strips, patterns, or shapes like petals or panels. Precision and careful handling are essential, especially for detailed or small-scale work.
5. **Forming and Weaving:** Use various techniques such as folding, braiding, rolling, or weaving to build the form of your product. Bamboo

leaves are versatile and can be shaped into different structures. Secure the shapes using thread, twine, or thin wire as needed to maintain the form and stability of the product.

6. **Assembly and Attachment:** Join different components of the product using suitable methods. You may stitch parts together with a needle and thread, bind them using twine, or use glue or resin for extra strength and durability. Ensure all parts are properly aligned and securely attached.
7. **Drying and Setting:** Once the product is assembled, place it in a shaded, well-ventilated area to dry thoroughly. This step is important, especially if adhesives or coatings have been used, as it ensures that the product sets properly and retains its intended shape.
8. **Finishing Touching and Varnishing:** Examine the final product for any loose edges or imperfections. Smooth any rough areas and add embellishments if desired such as beads, paint, natural dyes, or protective coatings like varnish. These finishing elements enhance both the appearance and longevity of the product

Fig. 3.70: Different products made up of bamboo leaves

Note: Tools and materials may vary depending on the type of product created. There are no fixed rules or limitations when working with bamboo roots or leaves. Artisans and students are encouraged to explore, innovate, and express their creativity freely while respecting the natural beauty of the material.

Activities

Activity: Pick a product category and create a mood board showing all different kind of bamboo products related to the chosen categories. Following are the categories to choose from:
Following are the categories to choose from:

- Home Decor
- Kitchenware

- Jewellery
- Utility Products
- Miscellaneous (furniture, planters, etc.)

Materials Required

- Chart paper (A3/A2 size)
- Printed images of bamboo products (home décor, kitchenware, accessories, etc.)
- Natural material swatches (optional): bamboo mat pieces, jute, cotton, cane
- Scissors and paper cutter
- Glue stick
- Double-sided tape
- Ruler and pencil
- Decorative elements (optional): buttons, twine, beads,

Procedure

1. **Choose a Category**

   Select one focus area: Home Décor, Kitchenware, Accessories, Jewellery, Utility, or Miscellaneous.

2. **Collect Visuals**

   Gather images, textures, colours, sketches and keywords related to bamboo and your chosen category (from magazines, internet, or your own drawings).

3. **Select a Base**

   Use chart paper for a physical board or Canva/PowerPoint for a digital board.

4. **Arrange Elements**

   Place your visuals in a creative layout—group similar ideas, balance colours and keep the theme clear.

5. **Add Text**

   Include short captions, keywords, or notes to explain your ideas and inspirations.

6. **Final Touches**

   Decorate or refine your board—add borders, highlight key elements and ensure everything is neatly placed.

7. **Present Your Mood Board**

Briefly explain your concept, chosen elements and how they connect to bamboo product design.

Check Your Progress

A. Fill in the Blanks

1. A bamboo _____ is used to display or support potted plants in an organized and aesthetic manner.
2. The bamboo _____ is a sustainable and artistic way to keep keys organized at home or in the office.
3. Bamboo wall hangings often use techniques such as _____, tying and assembling.
4. A bamboo _____ is made from slivers or strips and is commonly used for serving or organizing items.
5. The natural hollow structure of bamboo makes it ideal for making items like a bamboo _____.

B. Short Answer Questions

1. What are the different types of bamboo plant organisers and how do they help in space management?
2. Mention two uses of a bamboo tray and the basic material used in its making.

C. Long Answer Questions

1. Explain the process, materials used and benefits of creating a bamboo key holder. How does it contribute to sustainable living?
2. Describe the various types of bamboo wall hangings and the techniques involved in their making. How do they enhance interior décor?

Module 4	Green Products, Market and Consumerism

Module Overview

Bamboo handicrafts are experiencing a resurgence as contemporary designs merge tradition with modern aesthetics. Influenced by design movements like modernism, minimalism and Art Deco, these designs highlight modularity, material combinations and naturalist elements. With the support of digital tools and fabrication techniques, bamboo products are evolving and becoming more refined and sustainable. As eco-conscious consumerism grows, bamboo has emerged as a key material in the global market, driven by sustainable practices and green marketing, contributing to rural employment and economic growth in regions like India.

Learning Outcomes
After completing this module, you will be able to: • Explain emerging trends in bamboo handicraft • Identify and analyze the different aspects related to market of bamboo crafts and products. Role of national and international government organizations and initiatives in promoting the bamboo handicraft industry • Identify and explain the key SDGs and their targets, analyze and apply green design principles in sustainable practices of eco-friendly bamboo products
Module Structure
Session 1: Emerging Trends in Bamboo Handicrafts
Session 2: Bamboo Market and Consumers
Session 3: Sustainable Development Goals – 2030

Session – 1
Emerging Trends in Bamboo Handicraft

Contemporary bamboo designs embody current trends by integrating modernist, minimalist, and Art Deco influences. They emphasize modularity, innovative material combinations, and naturalistic elements that celebrate the beauty of imperfection. The use of digital design tools, along with advanced fabrication techniques like CNC machining, 3D printing, and laser cutting, further elevates the creativity and precision in bamboo product development.

Movement	Elements	Sample Products
Modernism	• Use of a neutral colour • Use of Clean lines • Use of uncluttered design • A mix of texture and materials • Use of organic geometry	
Minimalism	• Use of monochromatic colours • Use of simple form • Dominance of basic geometric forms • Elements without decoration • Repetitions of structures • Vacant space	
Art deco	• Express sinuous form • Feature luxurious and shiny materials • Use of bold and vibrant colours • Integration of technological advancements revealing machine age	

Table no. 4.1: Table Showcasing elements of modernism, minimalism and Art Deco

Contemporary Styles

Contemporary bamboo products reflect current design trends and are perpetually evolving. This style is firmly anchored in the present and adapts to resonate with prevailing aesthetics. It draws inspiration from a range of design movements, including modernism, minimalism and Art Deco, while maintaining a balanced approach that does not overly prioritize any one influence. Here are some characteristics of contemporary design:

- **Combination of materials:** Contemporary bamboo design often features a mix of two or more natural materials, creating subtle variations in shade or tone as well as stark contrasts in texture.

Fig. 4.1: Combination of bamboo with different materials

- **Modularity:** Contemporary bamboo products use modular design as an alternative to the traditional weaving method of 2D to 3D to avoid the challenges of industrialization and difficulty in translating into products.

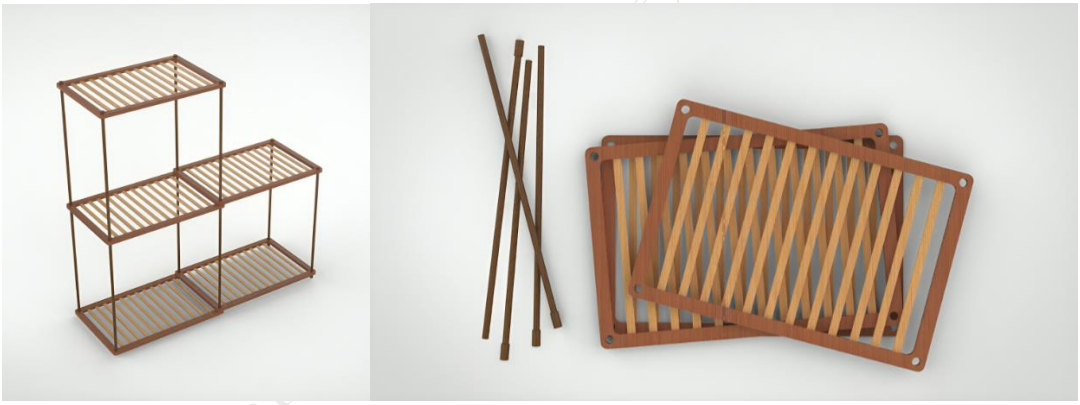


Fig. 4.2: Modularity

- **Naturalist design:** Contemporary bamboo products often embody the philosophy of naturalist design, which mimics nature and emphasizes the use of natural materials, warm elements, natural textures, contrasts and the beauty of imperfection.

Fig. 4.3: Naturalist design of bamboo eyewear

- **High-tech features:** Contemporary craft design uses new natural composite materials (a mix of natural fibre and natural or biodegradable resin) and cutting-edge technology to manufacture different products.

Fig. 4.4: High-tech features

- **Sweeping curves:** Contemporary bamboo products often incorporate sweeping curves to display dominance with flow.

Fig. 4.5: Sweeping curves

Online marketplace

As the number of innovations and emerging brands continues to rise, brand exposure becomes crucial for business success. In addition, the growing trend of digitalization and the evolving shopping culture make online marketplaces an excellent platform for businesses to connect with their customers and satisfy their needs. Building a brand in an online marketplace can create international opportunities by showcasing products to a global audience. This strategy is especially relevant for craft businesses, such as those that specialize in bamboo products.

An **online marketplace** is a platform that connects sellers and buyers to trade products or services. These electronic marketplaces or multiple-vendor e-commerce stores enable sellers to register and sell everything from

individual items to larger quantities, in different financial terms such as cash on delivery or pay on delivery. In this setting, consumer transactions are processed by registered sellers and then products are delivered.

There are different types of online marketplaces, such as:

- **Business-to-business marketplaces (B2B):** In business-to-business marketplaces, the buying and selling of products and services occur exclusively between businesses.
- **Business-to-consumer marketplaces (B2C):** Business-to-consumer marketplaces are those, where the buying and selling of products and services occur exclusively between business-to-consumer.
- **Consumer-to-consumer (C2C):** Consumer-to-consumer platforms allow transactions and exchanges between customers for new or old products.
- **Direct-to-consumer marketplaces (D2C):** Direct-to-consumer (DTC) marketplaces facilitate a direct transactional relationship between brands and consumers to sell products or services directly to their end-users enabling highly personalized customer experiences.
- **Hyperlocal marketplaces:** Hyperlocal marketplaces are business models that connect customers with local vendors within a specific geographical area.
- **Peer-to-peer marketplaces (P2P):** A peer-to-peer marketplace is an online platform that facilitates bringing together buyers and sellers to communicate for offline products and services.

Many craftsmen or intermediaries sell bamboo products on social media platforms, such as Facebook, Instagram, TikTok, Pinterest, WhatsApp and Google. However, there are several dedicated platforms where craft items like bamboo products are sold, which fall in the category of online marketplaces mentioned above. The following are a few:

Digital Design Tools

In the digital era of computer-aided design (CAD), there are numerous digital design tools available. While many of these tools cater to the general design market, only a select few are truly adaptable and beneficial for designing specifically with and for bamboo product design. Below are some options that are frequently utilized in the bamboo design process:

There are several digital tools available today that make 3D modeling easier and more creative. One such tool is free and user-friendly, helping users quickly build 3D models. Over time, many useful features and add-ons have been added to it, making it suitable for designing projects of various sizes and styles. Some of the latest tools help in creating smooth, natural shapes, which are especially useful for designing with materials like bamboo.

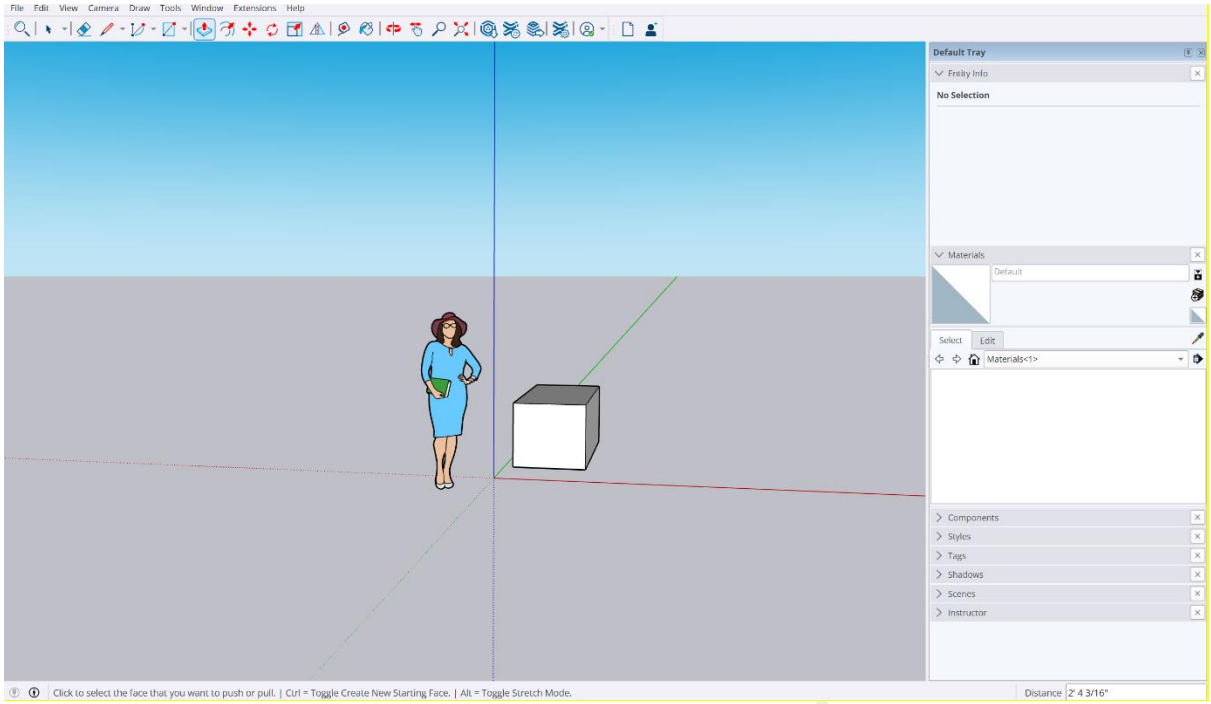


Fig. 4.6: User interface of 3D design software

Another advanced tool allows users to create very detailed 3D models, similar to shaping objects with clay. It comes with a special library of textures, including woven patterns, which are ideal for modeling bamboo-based products in a realistic way.

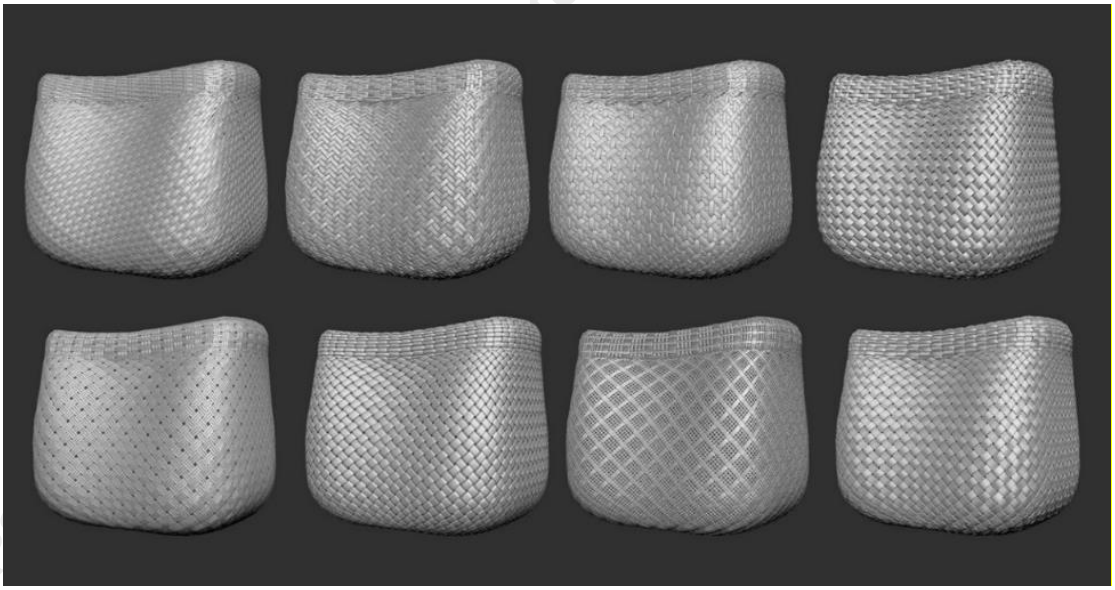


Fig. 4.7: Achievable sample textures for bamboo products using design software

There is also a high-level design tool known for handling complex and curved shapes. It is excellent for making detailed parts, creative forms, and building structures that are difficult to design with simpler programs. This tool is especially powerful when working on bamboo designs that require flowing, organic surfaces and detailed connections.

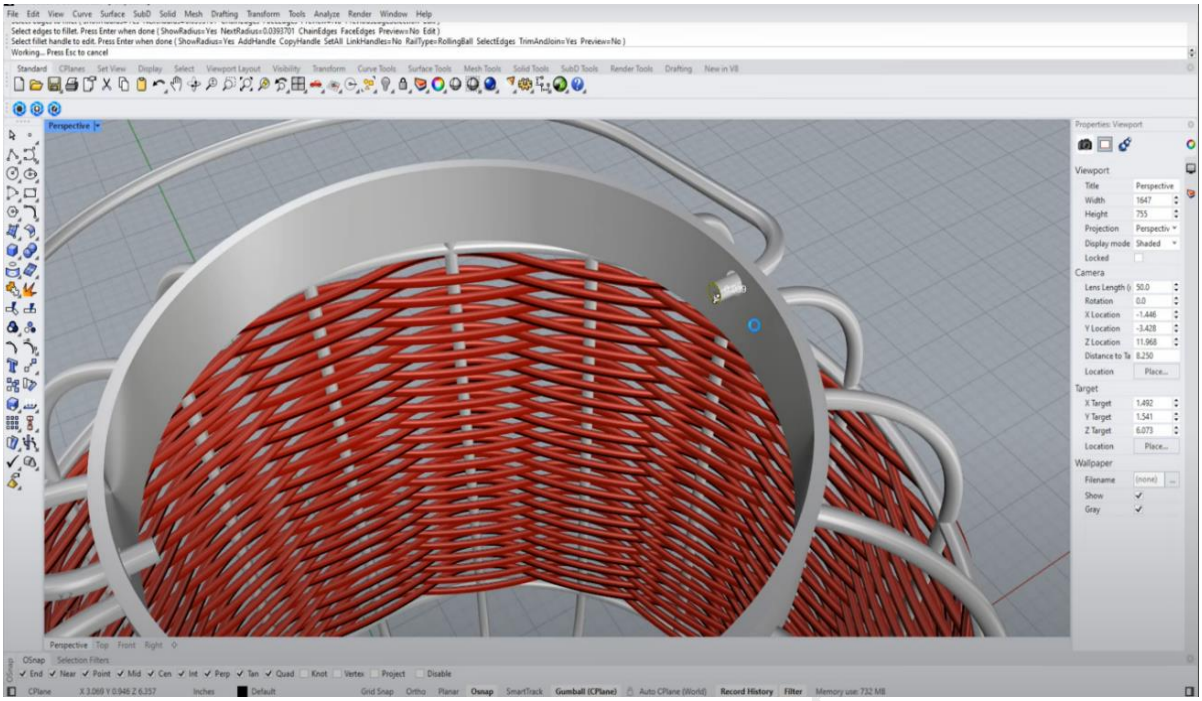


Fig. 4.8: Bamboo product modelling in 3D design software

Advance Machinery

Digital fabrication is a design and manufacturing process in which digital design data directly influences additive or subtractive manufacturing equipment to create parts of various geometries. Digital design data typically originates from CAD (computer-aided design) or vector-based graphic tools (e.g., Corel Draw, Adobe Illustrator) and is then transferred to CAM (computer-aided manufacturing) software to manage machine operations. The following are the common digital fabrication techniques:

1. Computer Numerical Control (CNC) Machining: CNC machining is a subtractive manufacturing process that involves removing material from a solid workpiece through drilling, cutting, grinding and boring techniques. Tools are operated via CNC in this process. There are two primary methods for material removal in CNC machining: one involves a fixed component with a rotating tool (milling), while the other features a stationary tool with a rotating workpiece (lathe).

CNC milling or a router is mainly used in the case of bamboo machining. A typical CNC router is shown in the Figure. CNC mills or routers are equipped with proprietary software that translates 2D vector drawings or 3D models into G-code. This alphanumeric format represents specific functions for the CNC machine, allowing it to interpret and execute the necessary operations. Typically, CNC machine beds offer substantial working areas with dimensions of about 1300 x 2500 x 200-300 mm.

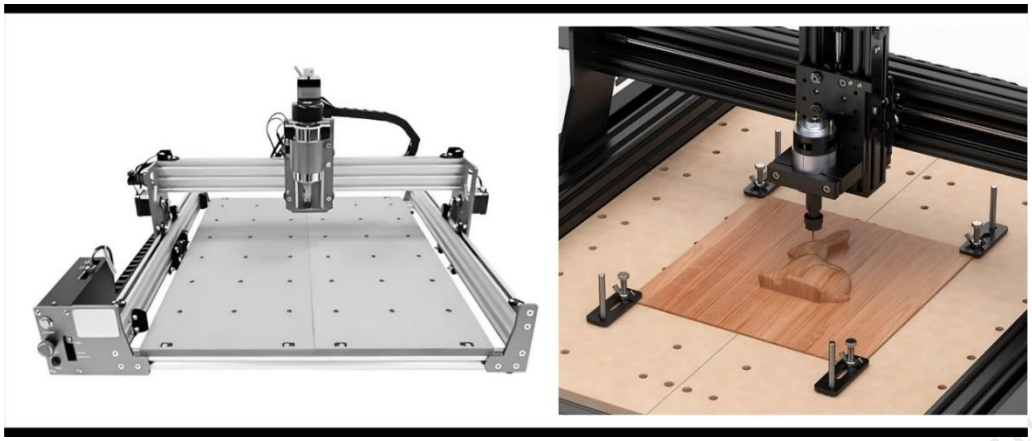


Fig. 4.9: CNC router

Following are a few products that are produced with CNC routers:

- Bamboo enclosure for electronic products, such as enclosure speakers, calculators and keyboards
- Bamboo kitchen products, such as cutting mats and trays
- Bamboo office stationery, such as a pencil stand and pencil box
- Bamboo gift items, such as mementoes and awards

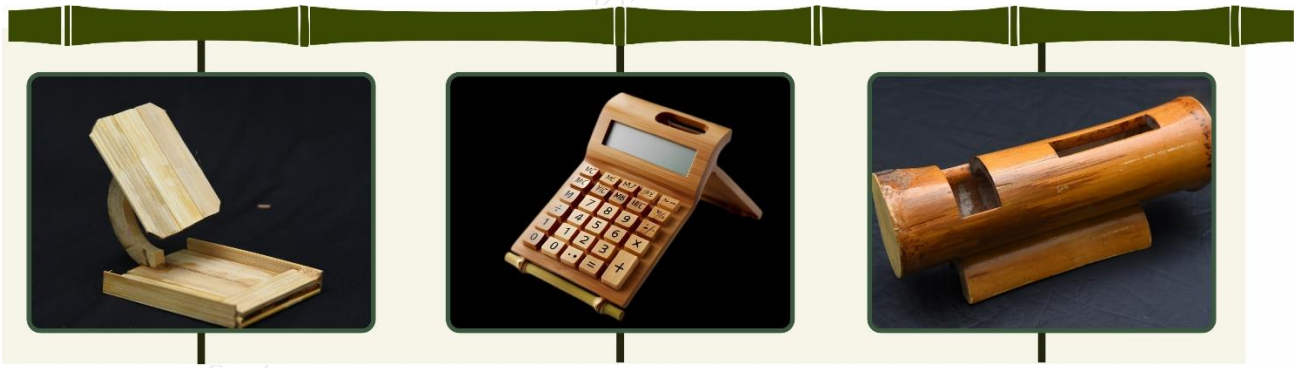


Fig. 4.10: Bamboo-based electronic products

Fig. 4.11: Bamboo office stationeries and bamboo kitchen products

Fig. 4.12: Bamboo gift items

2. 3D Printing: 3D printing is an additive manufacturing process to construct a three-dimensional object from a three-dimensional digital model made using CAD software. Out of many 3D printing technologies, only Fused Deposition Modelling (FDM) printers can print bamboo and polylactic acid (PLA) composite. A typical 3D printing workflow is shown below, where the following steps are involved:

1. Generation of a three-dimension model using CAD software

2. Generation of stereolithography (.stl file), which is a file format required for slicing

3. Slicing 3D model into thin layers using slicing software. In the slicing process, 3D CAD models are transformed into G-code, which is a collection of instructions that are compatible with 3D printers

4. 3D printing by depositing bamboo and polylactic acid (PLA) composite filament layer by layer

5. Post-processing of 3D printed parts by removing supports, polishing and coating with paints (Note: Oil-based paints are not preferred for painting PLA-based 3D printed parts, instead acrylic or enamel paints are preferred for painting PLA-based 3D printed parts)

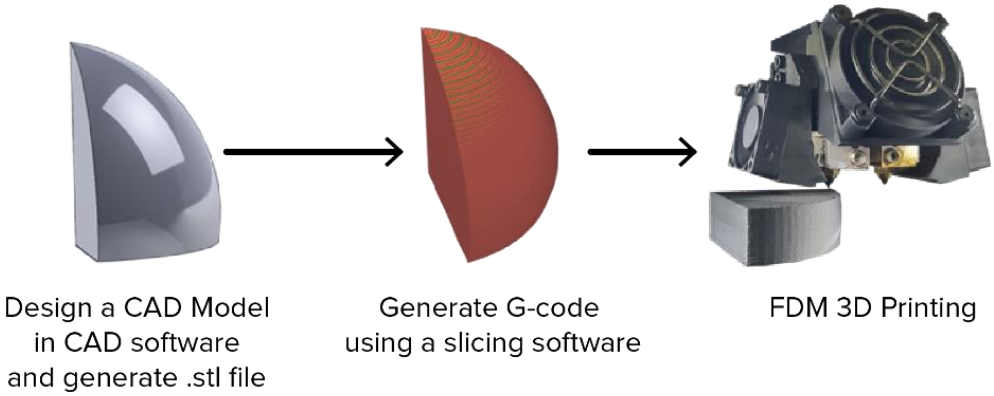


Fig. 4.13: 3D printing workflow

The following are some possible applications of 3D printing with bamboo and polylactic acid (PLA) composite:

Fig. 4.14: Toys, figurines or other playful products printed by 3D Printer

Fig. 4.15: Home Décor Item printed by 3D Printer

Apart from the above, other items made with laminated bamboo also can be made with 3D printing. However, size is a constraint.

3. Laser Cutting: Laser cutters utilize a laser to vaporize material to engrave or cut through a diverse array of materials with remarkable precision. They are cost-effective, efficient and user-friendly tools for engraving and cutting thin, flat sheets of laminated bamboo, making them ideal for prototypes and mechanical and structural components. Typically, laser cutters come equipped with driver software that translates 2D vector drawings to G-code for the laser head to follow the path.

Fig. 4.16: Did you know

The advantage of laser cutting over a CNC router is its cost-effectiveness. However, the quality and depth of the cut are limitations. A laser cutter with a power range of 40 to 150 watts is typically effective for cutting bamboo laminate up to ¼ inch (6mm) thick. In contrast, high-power industrial laser cutters that exceed 400 watts can handle bamboo laminate up to 1 inch (25mm) thick; however, achieving this may necessitate multiple passes depending on the laminate's density. Also, burn marks during laser cutting degrade the quality for commercialization.

Following are a few products that are produced with laser cutting machines:

- Bamboo personalised items, such as visiting cards and nameplates

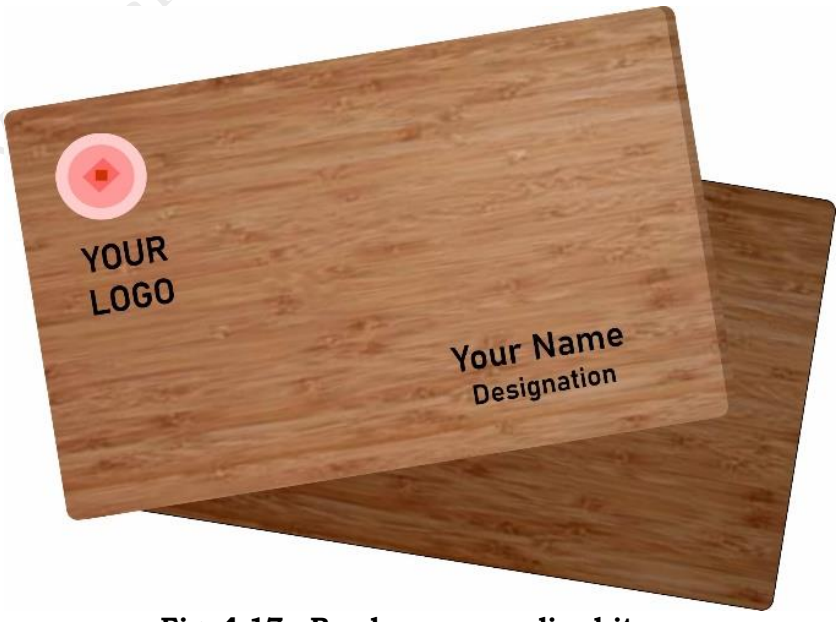


Fig. 4.17: Bamboo personalised items

Fig. 4.18: Bamboo room dividers

Fig. 4.19: Bamboo trophy design

Activities

Activity: Design a trophy or memento and make it with bamboo (size limit: L x B x H = 6 inch x 4 inch x 10 inch)

Materials Required

1. 2 feet bamboo pole
2. Saw, knife, hammer, chisel, planer, sandpaper, adhesive, varnish
3. Sketch pad or chart paper, pencil, eraser and rulers

Procedure

1. Sketch the concept on the sketch pad or a chart paper
2. Define the dimension
3. Decide whether to make it with split or solid bamboo
4. Mark dimensions on bamboo
5. Cut according to the dimensions decided using a saw

6. Arrange bamboo according to the design
7. Join bamboo parts by applying the different joining techniques and applying adhesives
8. Finish the product using sandpaper
9. Apply varnish for final finishing
10. Showcase the trophy or memento and discuss

Optional: Use a planer to make flat surfaces and a chisel to make grooves

Check Your Progress

A. Fill in the Blanks

1. Contemporary bamboo designs often incorporate influences from _____, minimalism and Art Deco to create aesthetically appealing products.
2. The use of digital fabrication techniques such as CNC machining, _____ and laser cutting has enhanced the precision and efficiency of bamboo product manufacturing.
3. In modular bamboo design, parts are created to fit together like building blocks, offering an alternative to the traditional _____ weaving method.
4. In online marketplaces, _____ platforms allow local vendors to connect with customers in specific geographical areas.

B. Short Answer Questions

1. What are some key design movements that influence contemporary bamboo products?
2. How does CNC machining help in the production of bamboo products?
3. What are the advantages of laser cutting over CNC machining of bamboo?
4. Explain naturalist design characteristics in reference to contemporary bamboo products with an example.

C. Long Answer Questions

1. Explain the role of digital design tools like SketchUp, ZBrush and Rhinoceros 3D in the design of bamboo products.
2. Discuss the benefits and challenges of using digital fabrication techniques like CNC machining, 3D printing and laser cutting for bamboo product manufacturing.

Session – 2
Bamboo Market and Consumers

Bamboo is not a plant it is a vital resource that sustains the environment, economy and lives of people. Globally and particularly in India, bamboo has been referred to as "green gold" since it is environmentally friendly, quick to grow and can be utilized to produce numerous valuable items.

In this session, you will understand how the bamboo business is expanding in India and globally. Individuals are becoming more cautious towards the environment and many prefer to purchase products that are natural, safe and sustainable. This has boosted the demand for bamboo products such as furniture, bags, crafts, straws and even clothing.

The Indian government is also assisting bamboo farmers and artisans through initiatives such as the National Bamboo Mission, which assists in growing bamboo, producing products and marketing them in markets. Global organizations such as INBAR, UNDP and WBO are also encouraging bamboo by assisting artisans, financing projects and conserving the environment.

This session will also enlighten you about green consumerism—a trend where individuals opt for products that are nature-friendly. You'll discover how various generations (such as Gen Z and Millennials) are embracing eco-friendly products and how companies are transforming themselves to cater to this demand.

At the end of this session, you will understand how bamboo is assisting people and the planet and how national and global initiatives are creating a better future through bamboo.

Market and Consumerism

Market is defined as the means by which the display and exchange of goods and services take place as a result of interaction between buyers and sellers. Marketing is the process of getting the right products to the right people at the right time and place. Consumerism is the protection or promotion of the interests of consumers. It is the study of the marketplace, including how to regulate it, interact with it and how to match consumers with trustworthy information and products to improve their well-being and quality of life.

The future of markets and consumerism lies in promoting sustainability, ethical practices and environmental responsibility. As consumer awareness grows, markets are shifting toward offering eco-friendly, durable and ethically produced goods. Consumers play a key role by choosing products that are better for the planet, which in turn drives demand for greener alternatives. With support from governments, businesses and consumers, future markets

can become more sustainable, fostering economic growth while protecting the environment for future generations.

One way to support sustainable markets and consumerism is by using eco-friendly materials like bamboo, cane, cork, straw bales, hemp, biomass and other rapidly renewable resources. These materials grow quickly and can be replenished without harming the environment. They are strong, versatile and can be used to make furniture, packaging, textiles and everyday products. By choosing items made from these materials, consumers reduce the demand for non-renewable resources like plastic and hardwood. This shift encourages businesses to adopt greener production methods, leading to less waste and a lower carbon footprint. Promoting the use of sustainable materials is a key step toward a healthier planet and a more responsible market system.

Market Trends

The current market is increasingly shaped by consumer demand for sustainability, ethical practices and transparency. People are becoming more conscious of the environmental and social impact of their purchases, leading to a growing preference for eco-friendly, recyclable and ethically sourced products. This shift has encouraged companies to adopt sustainable production methods, reduce waste and incorporate circular economy principles. Technology and e-commerce platforms have made it easier for consumers to access sustainable products and compare brands based on their environmental impact. As a result, businesses that prioritize sustainability are gaining a competitive edge in today's market.

Sustainability and ethical marketing are becoming essential for businesses looking to build trust and long-term loyalty with consumers. Ethical marketing focuses on honest advertising, fair labour practices and the responsible sourcing of materials. Brands are now promoting their commitment to sustainability by highlighting eco-friendly certifications, transparent supply chains and community impact initiatives. The promotion of products as environmentally friendly is called Green Marketing.

It has become a key strategy for attracting conscious consumers. However, companies must avoid "greenwashing," where misleading claims about sustainability are made. Consumers are increasingly able to spot false claims, thanks to tools and certifications that verify ethical practices. By being transparent and genuinely committed to sustainability, businesses can build stronger relationships with their customers while contributing to a healthier planet.

Market Economy

The bamboo market in India is experiencing steady growth, driven by increasing demand for eco-friendly products, government initiatives and rising global interest in sustainable materials. As of 2023, the Indian bamboo market was valued at approximately USD 314.67 million and is projected to

grow at a compound annual growth rate (CAGR) of 5.82% from 2025 to 2029. This growth is fuelled by the rising use of bamboo in sectors like construction, furniture, handicrafts, textiles and paper production.
The government is actively promoting bamboo cultivation through the National Bamboo Mission, which aims to boost production, enhance post-harvest management and support bamboo-based enterprises. This initiative also improves access to markets. With government subsidies and encouragement of private cultivation, bamboo product production has increased. Popular products include construction materials, furniture, handicrafts, kitchenware and paper with modern processing techniques expanding their applications.

The future of India's bamboo market looks promising with an increased focus on self-reliance (Aatmanirbhar Bharat) and sustainable development creating rural employment and reducing imports.

Identifying Consumer

Eco-conscious consumers are individuals who prioritize sustainability, ethical production and environmental well-being in their purchasing decisions. Generational studies reveal that these consumers are spread across all age groups but are particularly prominent among Millennials (born 1981–1996) and Generation Z (born 1997–2012). Each generation's approach to sustainability is Influenced by its unique experiences, values and access to information.

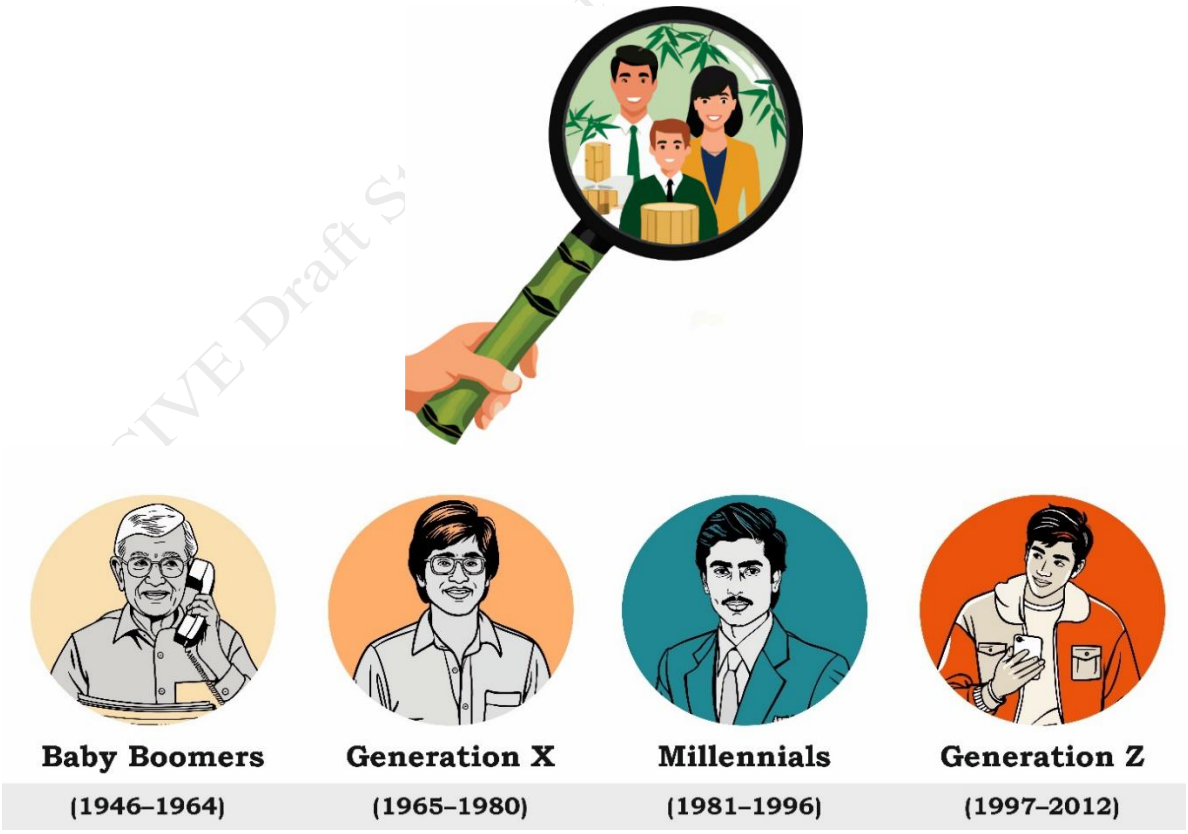


Fig. 4.20: Generations of different era

1. **Generation Z (Born 1997–2012):** Generation Z is often regarded as the most eco-conscious generation. They have grown up during a time of heightened awareness of climate change and environmental crises. Digital natives use social media to advocate for sustainability and hold brands accountable for their environmental impact. Studies show that 62% of Gen Z prefer to buy from sustainable brands and they are more willing to pay a premium for eco-friendly products. Their purchasing decisions are heavily influenced by transparency, ethical supply chains and corporate social responsibility.
2. **Millennials (Born 1981–1996):** Millennials are another major driver of the sustainability movement. As the largest group in the workforce, they have significant purchasing power. This generation prioritizes experiences and wellness, leading them to support brands that promote sustainable practices and healthy living. Millennials seek out eco-friendly fashion, sustainable home products and clean beauty items. Research indicates that 75% of Millennials are willing to change their consumption habits to reduce environmental impact and they actively support brands with a strong sustainability message.
3. **Generation X (Born 1965–1980):** Generation X plays a more balanced role in eco-conscious consumerism. While they value sustainability, their purchasing decisions are often driven by quality, practicality and long-term value. Many Gen X consumers have embraced sustainable living, especially in areas like home improvement, energy-efficient appliances and sustainable food choices. Their focus tends to be on making responsible, long-term investments in products with durability and reduced waste.
4. **Baby Boomers (Born 1946–1964):** While Baby Boomers are generally less engaged with eco-conscious consumerism compared to younger generations, their influence should not be underestimated. This generation is known for valuing quality and reliability. Eco-friendly home products, health-related goods and sustainable gardening tools are popular among Boomers. With more disposable income, Baby Boomers are willing to invest in solar panels, electric vehicles and sustainable home improvements that offer financial returns in the long term.

How Businesses Identify Eco-Conscious Consumers

1. **Surveys and Market Research**: Businesses conduct generational studies to understand consumer priorities, such as willingness to pay for sustainability and brand loyalty.
2. **Purchase History and Data Analytics**: E-commerce platforms track purchase data to segment eco-conscious buyers and target them with personalized product recommendations.
3. **Social Media Listening**: By monitoring sustainability-related discussions on platforms like Instagram, TikTok and Twitter, brands

can identify which generations are most vocal and influential in promoting eco-friendly products.

4. **Certifications and Labels**: Brands that highlight certifications like "Fair Trade," "Organic," and "B Corp" attract attention from eco-conscious consumers, especially among Gen Z and Millennials.

By understanding generational differences in sustainability values, brands can tailor marketing strategies to meet the needs of specific age groups. Gen Z and Millennials demand transparency, social impact and environmental accountability while Gen X and Boomers prioritize practicality, durability and quality. This insight allows businesses to design products, messages and marketing campaigns that align with each generation's preferences.

Green Consumerism

Green consumerism, a growing trend focused on sustainability and environmental responsibility, has found strong alignment with the bamboo industry. Bamboo, often referred to as "green gold," is a highly renewable resource that grows quickly, requires minimal water and absorbs more carbon dioxide compared to other plants.

These qualities make bamboo an ideal choice for eco-conscious consumers looking to reduce their environmental impact. As part of green consumerism, bamboo is increasingly used in products ranging from construction materials to home décor, textiles and personal care items, offering an environmentally friendly alternative to traditional, more resource-heavy materials like timber, plastic and cotton.

The demand for bamboo products is rising among Millennials and Generation Z, who prioritize sustainable and ethically sourced options. Bamboo is popular in eco-friendly clothing, flooring and reusable items like straws and toothbrushes due to its low ecological footprint, biodegradability and absence of harmful chemicals. Companies in the bamboo industry are highlighting these environmental benefits and adopting responsible practices, aligning with the values of green consumerism, where consumers choose products for their functionality and positive environmental impact.

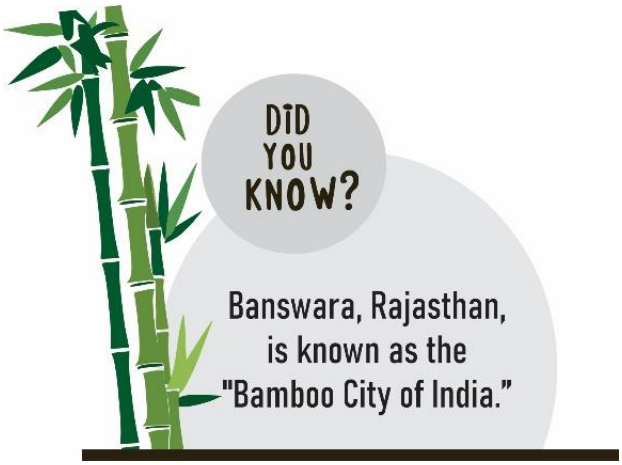


Fig. 4.21: Did you know

In India, where bamboo is abundant, this trend is being supported by both government initiatives and private enterprises. The National Bamboo Mission aims to promote bamboo cultivation and its industrial applications, which is helping to meet the growing demand for

bamboo products while creating rural employment. The shift towards bamboo products in the Indian market is also an example of how green consumerism can help reduce reliance on non-renewable resources and provide sustainable alternatives that support both environmental and economic growth.

This rise in green consumerism around bamboo products signifies a broader shift toward eco-conscious purchasing habits, which is encouraging the development of sustainable industries globally.

Role of National and International Organizations and Initiatives in Promoting the Bamboo Handicraft Industry

International Organizations and Programs

International Bamboo and Rattan Organisation (INBAR)

INBAR is a global organization dedicated to promoting the use of bamboo and rattan for sustainable development. It supports eco-friendly innovations and helps artisans exchange knowledge through international conferences. INBAR also works with governments to create policies that encourage the global bamboo trade. As a result of its efforts, India now exports bamboo products to over 50 countries, boosting the visibility and market potential of Indian artisans.

Fig. 4.22: Logo of INBAR

United Nations Development Program (UNDP)

The UNDP uses bamboo-based projects to reduce poverty and promote sustainability. It focuses on training women artisans in bamboo crafts, funding small businesses that produce bamboo furniture and decor and encouraging the use of bamboo to replace single-use plastics. For instance, bamboo straws and cutlery are gaining popularity in Southeast Asia, reducing plastic pollution and supporting local economies.

Fig. 4.23: Logo of UNDP

World Bamboo Organization (WBO)

WBO works to increase global awareness of bamboo's potential in industry, culture and environmental conservation. It organizes events such as World Bamboo Day to celebrate artisans and promote innovative industrial uses of bamboo. This initiative highlights bamboo as a valuable resource in addressing modern challenges sustainably.

Fig. 4.24: Logo of WPO

National Organizations and Initiatives

National Bamboo Mission (NBM)

The National Bamboo Mission (NBM) is a key initiative by the Government of India designed to leverage bamboo as a versatile and sustainable resource. Introduced under the National Mission for Sustainable Agriculture (NMSA) by the Ministry of Agriculture and Farmers' Welfare, the mission aims to foster the comprehensive development of the bamboo sector. This initiative is poised to enhance rural livelihoods, boost industrial growth and promote environmental sustainability.

Fig. 4.25: Logo of NBM Mission

Overview of National Bamboo Mission (NBM)

Aspect	Details
Evolution	1. Launched in 2006-07 as a Centrally Sponsored Scheme. 2. Integrated with the Mission for Integrated Development of Horticulture (MIDH) in 2014-15. 3. Renamed as NABM with state-specific strategies.
Key Objectives	1. Increase bamboo plantations in non-forest areas. 2. Improve post-harvest management. 3. Promote product development and industrial growth. 4. Build skills and awareness.
Benefits	1. **Economic Empowerment:** Sustainable income for farmers and artisans. 2. **Environmental Conservation:** Supports reforestation and carbon sequestration.

	3. **Industrial Development:** Encourages processing units and value-added products. 4. **Rural Development:** Addresses unemployment and poverty in rural areas.
Key States Focused	Assam, Arunachal Pradesh, Madhya Pradesh, Maharashtra, Chhattisgarh, Odisha, Karnataka, Uttarakhand, Bihar, Jharkhand andhra Pradesh, Telangana, Gujarat, Tamil Nadu and Kerala.

Khadi and Village Industries Commission (KVIC)

KVIC is reviving traditional bamboo crafts and supporting rural artisans with financial and technical aid. Key Activities of KVIC include skill development programs to enhance craftsmanship. It also helps in providing modern tools like laser cutters and sanders.
Marketing support through Khadi outlets and exhibitions is done to support the bamboo artisans.

Fig. 4.26: Logo of KVIC Commission

Tribal Cooperative Marketing Development Federation of India (TRIFED)

TRIFED empowers tribal artisans and connects them to mainstream markets. It undertakes many activities such as organizing exhibitions like Aadi Mahotsav to showcase tribal bamboo crafts. It has launched e-commerce platforms to expand its market reach. TRIFED is collaborating with design institutes for innovative bamboo product development. For example, Bamboo jewellery from Nagaland is gaining popularity in metropolitan cities, improving artisan visibility and earnings.

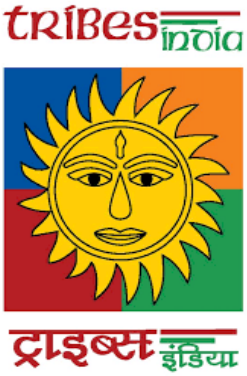


Fig. 4.27: Logo of TRIFED

Bamboo and Cane Development Institute (BCDI), Agartala

The main objective of BCDI is to promote bamboo and cane craftsmanship through research, training and technological advancements. Key Contributions include the development of new designs for bamboo handicrafts, training programs to upgrade artisans' skills and collaboration with the Office of Development Commissioner (Handicrafts) for large-scale promotion.

Fig. 4.28: Logo of BCDI Agartala

State-Specific Initiatives

1. **Tripura Bamboo Mission (TBM):** Promoting bamboo-based livelihoods and entrepreneurial ventures.
2. **North East Cane and Bamboo Development Council (NECBDC):** Focused on cane and bamboo technological advancements, supported by UNIDO projects.
3. **Madhya Pradesh State Bamboo Mission (MPSBM):** Dedicated to creating a sustainable bamboo economy and supporting entrepreneurs.

Other Foundations

- **Dutch Bamboo Foundation:** Focuses on research and innovation in sustainable bamboo applications, helping to find new ways to use this versatile material.
- **American Bamboo Society:** Promotes bamboo education and advocacy in North America, raising awareness of its economic and ecological benefits.

The bamboo handicraft industry is growing due to strong support from national and international organizations. By preserving traditional crafts and adopting modern techniques, artisans are expanding their markets and contributing to global sustainability. Bamboo holds immense potential to revolutionize sustainable development and livelihood enhancement.

Activities

Activity: Visit any organisation (Government or private)/Workshop/Unit related to bamboo and document their work in a report.

Materials Required

1. Chart paper or large sheets
2. Sketch pens, pencils and markers
3. Colour pencils or watercolours
4. Printed images of tools (e.g., sandpaper, buffing machine) and bamboo products
5. Glue and scissors (for cutting and pasting visuals)
6. Rulers and erasers

Procedure

1. Introduce the Topic
2. Divide the report into multiple sections and sub-sections

3. Fill the sections and sub-sections with relevant information and images
4. Add Descriptions and Annotations for all the images and table
5. Review and refine the report
6. Present and discuss

Check Your Progress

A. Fill in the blanks

1. Bamboo is known for its _____ growth rate, making it an eco-friendly material for various products.
2. The global market for bamboo-based products is growing due to its _____ and sustainable nature.
3. In India, bamboo plays a significant role in _____ development, providing income opportunities for rural artisans and farmers.
4. One of the main environmental benefits of bamboo is its ability to _____ large amounts of carbon dioxide, contributing to climate change mitigation.
5. Bamboo products are increasingly being used in the _____ industry, including handicrafts, furniture and construction materials.

B. Long Answer Questions

1. Explain the significance of bamboo in sustainable development and how its utilization contributes to environmental and economic benefits.
2. Discuss the different state, national and international organizations promoting bamboo.

C. Short Answer Questions

1. What are the key environmental benefits of using bamboo?
2. How does bamboo contribute to rural development in India?
3. Name two roles of the National Bamboo Mission in promoting bamboo handicrafts.
4. If you were part of INBAR, what policies would you suggest to encourage more countries to adopt bamboo handicrafts?

Session – 3
Sustainable Development Goals – 2030

Sustainable Development Goals (SDGs) are a global initiative by the United Nations to create a fair, healthy and sustainable world by 2030. With 17 goals, they address critical issues like poverty, hunger, inequality, climate change and environmental protection, ensuring no one is left behind. These goals aim to balance human well-being and planetary health by promoting sustainable practices worldwide.

Green Design, or sustainable design, complements SDGs by focusing on eco-friendly products and processes. Bamboo, a prime example, is celebrated for its rapid growth, minimal environmental impact and versatility in creating biodegradable, durable alternatives to plastic and wood.

This session highlights the significance of SDGs and the role of green design in achieving a sustainable future through conscious choices and innovation.

Introduction to Sustainable Development Goals (SDGs) – 2030 and their Targets

Have you ever thought about what makes the world a better place for everyone? On earth presently, lives are under threat, be it humans, animals, birds, rivers, land, all living creatures and even the temperature, which is rising rapidly, is a major threat to the existence of lives.

During the past few decades, man has exploited resources and nature, which impacted badly and now it is resulting in threats to the existence of lives. People from all around the world came together and created a plan to improve life on Earth.

This plan is called the Sustainable Development Goals (SDGs) and it was made to make the world a fairer, healthier and happier place for all by the year 2030.

There are 17 SDGs that focus on different important areas, like ending poverty, protecting the environment and making sure everyone has the chance to live a good life.

Sustainable Development Goals (SDGs)

The SDGs are a set of goals created by the United Nations in 2015 to help guide countries to work together for a better world by 2030. These goals aim ~~is~~ to solve problems like poverty, hunger, inequality and climate change. The idea behind the SDGs is to make sure that everyone has the chance to live a good life without harming the planet.

Importance of SDGs

The SDGs are important because they provide a clear path to a future where everyone has what they need to live well and the environment is protected. These goals are a way to ensure that no one is left behind—whether it's providing food for the hungry, making sure all kids get to go to school, or acting to protect the planet from climate change.

Reasons to develop goals

a. Ending Poverty and Reducing Inequality
b. Fighting Hunger and Ensuring Food for All
c. Protecting the Environment
d. Promoting Good Health and Education
e. Ensuring Clean Water, Sanitation and Energy for All
f. Building Sustainable Cities and Communities
g. Promoting Peace and Justice
h. Creating a Better Future for All

Fig. 4.29: 17 Sustainable development goals

Source: https://www.un.org/sustainabledevelopment/news/communications-material/#FAQ

There are 17 goals in total and each one has specific targets to be achieved by 2030.

Goal 1: No Poverty - This goal aims to end poverty everywhere. Poverty means not having enough money to meet basic needs like food, shelter and education. This goal ensures that everyone has access to resources and opportunities to improve their lives.

Goal 2: Zero Hunger - Hunger is when people don't have enough food to eat. Goal 2 is about ending hunger and ensuring that everyone, especially children, has enough nutritious food. It also focuses on improving farming methods to grow more food in a sustainable way.

Goal 3: Good Health and Well-being - Good health is the foundation for a happy life. Goal 3 focuses on ensuring everyone has access to healthcare and living in a healthy environment. It aims to reduce illnesses and promote healthy living for people of all ages.

Goal 4: Quality Education - Education is important for everyone. This goal ensures that all children, no matter where they live, can go to school and learn the skills they need to succeed in life. It also aims to improve the quality of education worldwide, ensuring that everyone has equal access to learning opportunities.

Goal 5: Gender Equality - This goal is about giving equal rights and opportunities to both girls and boys, women and men. Goal 5 focuses on ending discrimination, ensuring that women and girls have the same chances as men and boys in education, work and decision-making.

Goal 6: Clean Water and Sanitation - Water is essential for life. Goal 6 is about making sure everyone has access to clean water and proper sanitation, like clean toilets and safe waste disposal. It also focuses on protecting water sources from pollution and ensuring they are available for future generations.

Goal 8: Decent Work and Economic Growth - Goal 8 promotes jobs and opportunities for everyone. It aims to create safe and productive jobs, ensure fair wages and protect workers' rights. It also focuses on growing the economy in ways that benefit all people, not just a few.

Goal 9: Industry, Innovation and Infrastructure - This goal is about building strong infrastructure like roads, bridges and the internet and promoting innovation and new technologies. It ensures that industry and technology grow in a way that helps people, supports the environment and improves everyone's lives.

Goal 10: Reduced Inequalities - Inequality happens when some people have more opportunities or resources than others. Goal 10 focuses on reducing the gap between rich and poor and making sure everyone has equal chances, no matter where they are born, what gender they are, or how much money they have.

Goal 11: Sustainable Cities and Communities - Many people live in cities and communities and this goal is about making sure they are safe, healthy and sustainable. It includes building better public transportation, affordable housing and protecting cultural and natural heritage in cities.

Goal 12: Responsible Consumption and Production - Goal 12 encourages everyone to use resources wisely. This means reducing waste, recycling and making products in ways that are good for the environment. It aims to make sure we don't take more from the Earth than we need and we protect resources for future generations.

Goal 14: Life below Water - Goal 14 focuses on protecting the oceans, seas and marine life. Oceans provide food, regulate climate and support marine animals. This goal aims to stop overfishing, reduce ocean pollution and protect marine habitats like coral reefs.

Goal 15: Life on Land - Forests, animals and plants are essential for life on Earth. Goal 15 is about protecting the land and the animals that live on it. It aims to stop deforestation, protect wildlife and restore ecosystems that have been damaged.

Goal 16: Peace, Justice and Strong Institutions - This goal is about promoting peaceful and fair societies. It focuses on reducing violence, ensuring access to justice and building strong, accountable governments that protect human rights.

Goal 17: Partnerships for the Goals - No country can achieve the SDGs on its own. Goal 17 encourages countries to work together and share knowledge, resources and technologies. It focuses on building partnerships between governments, businesses and communities to achieve the SDGs faster and more effectively.
How goals can be achieve?

The SDGs can be reached if countries, communities and individuals all work together.

Here are some ways as an individual can help contribute to these goals:

- Reduce waste: By recycling and reusing materials, we can reduce pollution and can save resources
- Save water and energy: Turning off the tap while brushing your teeth or using less electricity can help conserve resources.
- Be kind to others: Helping people in need, sharing with friends and treating everyone equally are ways to support goals like ending poverty and
- Plant trees and clean up: Planting trees and keeping your surroundings clean can protect the environment and help fight climate change.

The Sustainable Development Goals are all about making the world a better place by 2030. Each goal is important and together, they form a roadmap for helping people live better lives while taking care of our planet.

Green Design

Green design**,** also known as sustainable design, is the process of creating products, buildings and systems in a way that reduces their impact on the environment. It focuses on using eco-friendly materials and methods that help reduce pollution, conserve energy and minimize waste.

Let's take an example. A plastic toothbrush manufacturing company generates a lot of pollution during the manufacturing process and the end products after use harm soil because of polyurethane, which is not bio-degradable. These plastic end products harm the environment badly because they are non-biodegradable and create landfill debris, whereas the bamboo toothbrush and other utility item manufacturing processes do not contain any chemicals that harm the environment and the end products are also biodegradable.

Green design includes:

1. **Using renewable materials**: This involves using materials that come from nature and can be replenished, like bamboo, recycled plastic, or sustainable wood.
2. **Energy-efficient design**: Green buildings or products are designed to use less energy. This can include using energy-efficient appliances, solar panels, or natural light to reduce electricity use.
3. **Reducing waste**: Green design aims to minimize waste by recycling, reusing materials, or creating products that last longer.
4. **Water conservation**: In buildings, green design includes features that save water, like low-flow faucets or rainwater collection systems.
5. **Healthy environments**: Green design promotes using materials and products that don't release harmful chemicals into the air or water, creating healthier living spaces for people.

In short, green design is about making things in a way that is good for the planet and helps us live sustainably by using resources wisely and minimizing harm to the environment.

Eco-friendly aspects of bamboo

Bamboo is considered an eco-friendly material because it has several properties that make it a sustainable and environmentally friendly choice. Let's first understand its lifecycle which will prove it sustainable:

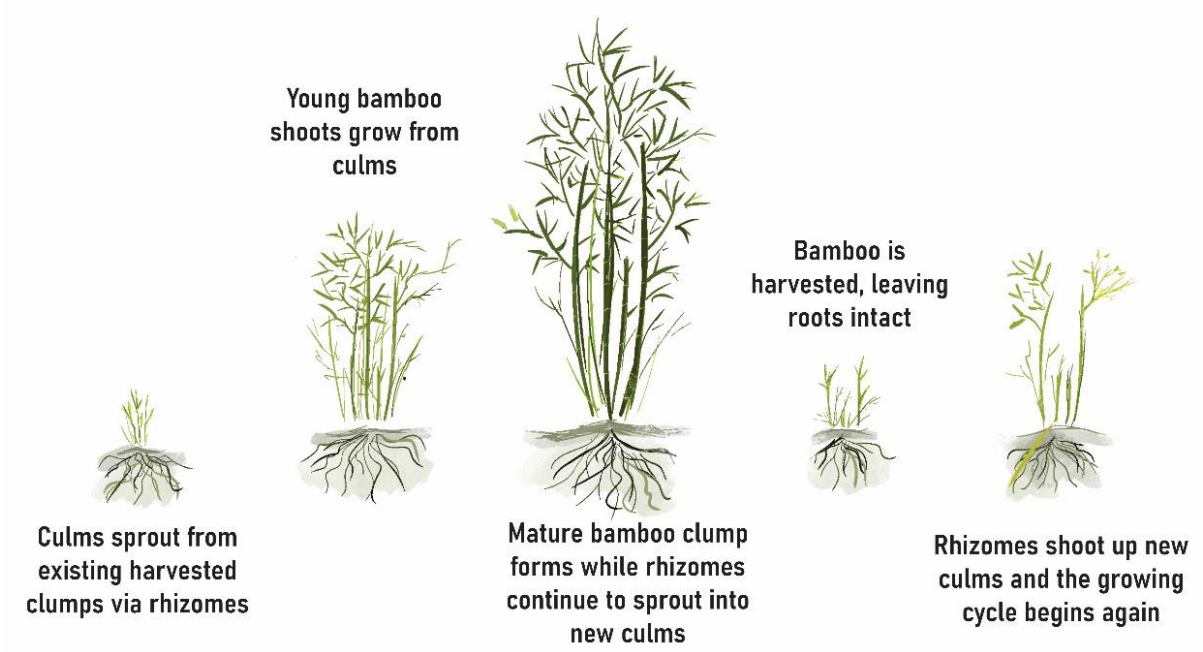


Fig. 4.30: Life cycle of bamboo

1. **Fast Growth**: Bamboo is one of the fastest-growing plants on Earth. Some species can grow up to 3 feet (1 meter) per day! This rapid growth makes bamboo a highly renewable resource, as it can be harvested frequently without depleting natural supplies. Generally, farmers begin harvesting after one year to 5 years when it reaches maximum heights. After harvesting, the root system remains intact to produce new shoots.
2. **Minimal Water Usage**: Bamboo requires very little water to grow compared to other crops like cotton. It also doesn't need chemical fertilizers or pesticides, which reduces its environmental impact.
3. **Carbon Absorption**: Bamboo absorbs large amounts of carbon dioxide from the atmosphere, helping reduce greenhouse gases. In fact, bamboo can absorb up to 35% more CO2 than an equivalent stand of trees, making it excellent for fighting climate change.
4. **Soil Health**: Bamboo has a deep root system that helps prevent soil erosion and improves soil health. The roots remain in place even after harvesting, allowing the plant to regrow while maintaining the integrity of the soil.
5. **Biodegradable**: Bamboo is a natural material that breaks down easily in the environment without releasing harmful chemicals. This makes it an eco-friendly option compared to plastic, which takes hundreds of years to decompose.
6. **Durable and Strong**: Despite being lightweight, bamboo is incredibly strong and durable, which makes it a sustainable alternative to wood for construction, furniture and other products.

Eco-Friendly Products Made from Bamboo

Bamboo is used to create a wide range of eco-friendly products that replace less sustainable materials like plastic and wood. Here are some popular bamboo products:

1. **Bamboo Toothbrushes**: These are a great alternative to plastic toothbrushes. The handle is made from bamboo, which is biodegradable, unlike plastic.
2. **Bamboo Straws**: Reusable bamboo straws are a sustainable alternative to single-use plastic straws. They are washable, durable and compostable. These straws are made from natural, food-grade bamboo and are safe to consume after use. Straws with a large opening are designed for thicker beverages like smoothies and lassi, while those with a small opening suit lighter drinks such as water, juices and soft drinks.
3. **Bamboo Clothing**: Bamboo fibres can be turned into soft, breathable and comfortable fabric for clothing, towels and bed linens. Bamboo fabric is often naturally antibacterial and moisture-wicking.
4. **Bamboo Paper Products**: Bamboo is used to make eco-friendly paper products like toilet paper, paper towels and tissues. Bamboo paper is a more sustainable option because it regrows much faster than trees.
5. **Bamboo Utensils**: Reusable bamboo cutlery, plates and bowls are popular for picnics, camping, or daily use. They are durable, lightweight and biodegradable.
6. **Bamboo Furniture**: Bamboo is used to make sustainable furniture such as chairs, tables and beds. It's as strong as hardwood but grows much faster, making it a more sustainable option.
7. **Bamboo Flooring**: Bamboo flooring is an eco-friendly alternative to traditional hardwood floors. It's strong, long-lasting and comes from a renewable resource.
8. **Bamboo Charcoal**: Bamboo charcoal is used in air purifiers, deodorizers and water filters. It's effective at absorbing toxins, odours and moisture from the air and water.
9. **Bamboo Packaging**: Many companies are starting to use bamboo-based packaging to reduce the use of plastic. This can include food containers, packaging wraps, boxes, lids, covers and even bottle caps.
10. **Bamboo toys/show pieces**: Reusable bamboo toys and show pieces are in trend now a days. Like- bamboo lamp shades, mats and toys. They are durable, lightweight and economical.
11. **Edible Bamboo Products**: Bamboo is not only appreciated for its strength and adaptability in crafts but also for its new uses in the food industry. Some parts of the bamboo plant are traditionally used in local cuisine and are now being used in various modern foodstuffs. These foods are processed using safe processes and are controlled under food

safety laws, like those dictated by the Food Safety and Standards Authority of India (FSSAI). What is crucial to mention is that only certain bamboo species and plant parts are safe for edible use and should be treated properly before being utilized as food ingredients.

Fig. 4.31: Different eco-friendly products made up of bamboo

Choosing bamboo products helps reduce the demand for plastic, conserves natural resources and supports a healthier environment. Bamboo's sustainability and versatility make it a powerful solution for everyday products that have a lower impact on the planet.

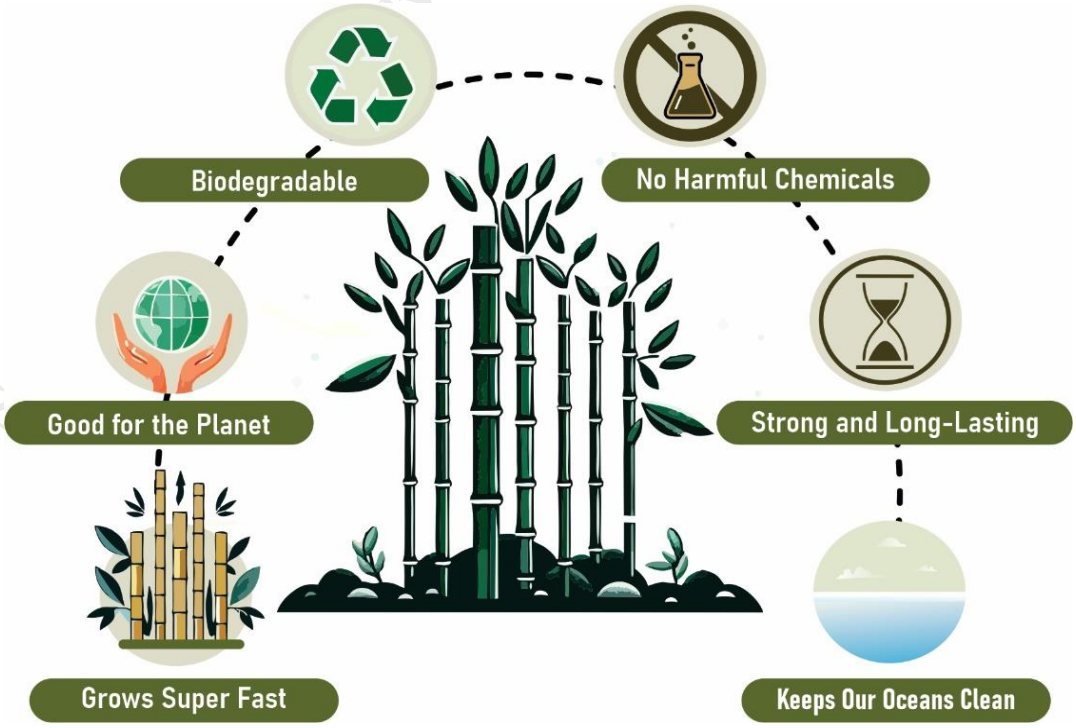


Fig. 4.32: Different qualities of bamboo

1. **Bamboo Grows Superfast:** Bamboo is one of the fastest-growing plants in the world! It can grow really tall in just a few days. This means we can use it without worrying about running out and it grows back quickly.
2. **Good for the Planet:** Bamboo helps keep our planet healthy. It absorbs carbon dioxide (a harmful gas) and produces oxygen (the air we breathe), which is great for fighting climate change.
3. **No Harmful Chemicals:** Bamboo doesn't need pesticides or fertilizers to grow, which means it's natural and doesn't harm the soil or water.
4. **Biodegradable:** When bamboo products are no longer needed, they break down easily in nature. Unlike plastic, which stays in the environment for a long time, bamboo disappears without causing pollution.
5. **Strong and Long-Lasting:** Even though bamboo is lightweight, it's very strong and can be used to make all kinds of things like furniture, clothes and even toys that last a long time.
6. **Keeps Our Oceans Clean:** By using bamboo products like straws or toothbrushes instead of plastic ones, we help reduce the amount of plastic waste that ends up in the oceans, protecting sea animals.

Activities

Activity: Create a chart Comparing bamboo products with other utility products made of plastic or metal in terms of sustainability. It should have a minimum of 8 points.

Materials Required

1. **Chart Paper/Poster Board** – Large enough to accommodate comparisons
2. **Markers/Pens** – Different colours for clarity and emphasis
3. **Ruler** – To draw straight lines for the table format
4. **Printed Images/Icons** (Optional) – Pictures of bamboo products and their plastic or metal counterparts
5. **Research Notes/Printouts** – Information on bamboo, plastic and metal products' sustainability (like biodegradability, strength, etc.)
6. **Glue/Sticky Notes** (Optional) – To attach pictures or key facts

Procedure

1. Draw the Structure of the Chart:
2. Title and Introduction:
3. Fill in the Chart (8 Comparison Points):
4. Add Visuals:

5. Review and Final Touches:
6. Present Your Chart

Check Your Progress

A. Fill in the blanks

1. Bamboo is considered a highly sustainable material because it grows at a much faster rate than most trees with some species growing up to _____ feet per day.
2. Unlike plastic, bamboo products are biodegradable and decompose in _____ years, whereas plastic can take hundreds of years to break down.
3. Plastic production results in a significant amount of carbon emissions, while bamboo absorbs and stores _____ times more carbon than trees of the same size.
4. Bamboo requires less _____ compared to plastic or metal products, making it a more water-efficient material for production.
5. In terms of health, plastic products may release harmful chemicals like BPA, while bamboo is considered safe as it does not contain any _____ or toxic substances.

B. Short Answer Questions

1. How does bamboo contribute to reducing carbon emissions compared to plastic or metal products?
2. What are the benefits of using bamboo products over plastic in terms of environmental impact?

C. Long Answer Questions

1. Explain the lifecycle of bamboo and how it makes bamboo a sustainable and eco-friendly material.
2. Discuss the importance of Green Design and how it aligns with the Sustainable Development Goals (SDGs) in promoting environmental sustainability.

Module 5 Work Area, Tools and Machines

Module Overview

In bamboo craftsmanship, the work area and the tools you use play a very important role in how well and safely you can work. This unit will guide you on how to create a safe, clean and efficient work environment. You will learn how to take care of your tools and materials so they last longer and help you work better. Safety is a key part of this unit—you will understand how to avoid accidents and keep your workplace neat and well-organized. This unit also focuses on how to store bamboo properly to protect it from insects and moisture and how to manage bamboo waste in eco-friendly ways. The three sessions in this unit will help you build habits of safety, care and responsibility in the workplace.

Learning Outcomes
After completing this module, you will be able to: • Explain Maintenance of Tools & Work Area Safety • Describe safe storage of material and waste management • Analyze use of tools and material according to work flow standards
Module Structure
Session 1: Maintenance of Tools, Materials and Work Area Safety
Session 2: Safe Storage of Material and Waste Management
Session 3: Tools and Material According to Work Flow Standards

Session – 1
Maintenance of Tool, Materials and Work Area Safety

Maintaining tools in good condition is the first step towards ensuring a smooth production process. Without it, materials cannot move smoothly, which can have a detrimental impact on the production process as a whole.

Handling of tools requires a methodical approach to managing equipment, from planning to packaging, distribution and storage. To put it simply, it is a

collection of techniques for organizing and managing material flows for efficient production. There are multiple steps involved:

- **Planning**: In order to manage space and maintain safety warehouse managers make plans to guarantee the proper level of storage and protection of tools.
- **Packaging:** They also guarantee that items are appropriately wrapped and safeguarded throughout storage and internal transportation.
- **Handling:** After that, they attest to the importance of moving items with care from one location to another.
- **Storage**: After that, managers plan and arrange the secure and orderly storage of items.
- **Contro**l: Lastly, they keep an eye on and oversee the movement of tools from the warehouse to the designated area of production.

The last step in the chain of production in any handicraft unit is managing waste. The procedures and activities necessary to manage leftover material waste from its creation to its ultimate disposal are referred to as waste management or waste disposal. This covers waste collection, transportation, treatment and disposal as well as the oversight and control of the waste management procedure and the laws, technologies and financial systems pertaining to waste.

Work Area Management

Housekeeping is not all about sparkling walls and floors. A clean workplace is a healthy and safe environment for employees. If the workplace is unclean or hazardous, employees can fall ill or become injured. To prevent accidents and illness, adopt these basic rules in cleaning:

1. Dry and Clean Floors

Dry floors are critical to avoid slipping accidents. Various floor cleaners exist in the market to cater to different situations. For heavy-footed areas, alkaline cleaners are usually suitable because of their strong cleaning action. In the case of work environments that have a tendency towards rust, acidic cleaners can be more suitable.

But care should be taken to select cleaning products, as certain products contain abrasive chemicals that might not be suitable for certain settings. For example, in textile industries, acidic cleaning products must be avoided, as they might ruin the fabric.

To further keep floors dry and clean, substances like mats, carpets, or rubber rolls can be utilized. Although these supplements enhance floor safety and cleanliness, they can be more expensive in terms of initial setup because

vacuum cleaners or specific equipment may be required for frequent maintenance.

Fig. 5.1: Using Mop on Floor

2. Kill Germs and Infections

Germs such as bacteria and viruses are easily spread. Kill them with disinfectants and maintain a healthy workplace. We all witnessed during the COVID-19 pandemic how deadly viruses can be.

Fig. 5.2: Applying disinfectants on work area

3. Clean the Air

- Dust and small particles in the air may hurt your health.
- Good ventilation prevents air from becoming dirty and lessens illness.
- If cutting or grinding is part of your work, air cleaning is extremely crucial.
- Clean your HVAC system frequently to prevent mould and bacteria.

- Use HEPA filter vacuum cleaners to get rid of fine dust.

Maintain humidity between 30% and 50%. You can use:

- A dehumidifier if air is too dry.
- A humidifier if the air is too dry and dusty.

Fig. 5.3: Air Filtration

4. Keep Proper Lighting

Do not keep your lights dirty or it will reduce this effectiveness. Good light is important for working with concentration. Also, stairways and aisles should always have clear visibility by lights to preventing accidents.

- Filthy lights lower brightness.
- Clean light fixtures and bulbs frequently.
- Ensure stairs and pathways are properly lighted to prevent accidents.

Fig. 5.4: Light Bulbs

5. Employ Eco-friendly Products

- Utilize environment-friendly cleaners.
- Toxic chemicals can harm the environment.
- The use of green products keeps our Earth safe.

Fig. 5.5: Eco-friendly Cleaning

6. Utilize Proper Dust Bins

Classify your dust bins in terms of wastage you generate in your working place. You may have different dust bins for wet and dry trash. If your waste products contain paper, glass, plastic, or metal then you may have the same number of dust bins so recycling them would be convenient and effective.

Fig. 5.6: Bin Types

Advantages of Keeping Workplace Clean

A clean and well-kept workplace provides numerous advantages:

- Saves time and effort in dealing with materials.
- Less slipping and falling accidents.
- Less likelihood of fire.
- Workers remain healthier with fewer respiratory issues.

- Tools and materials are readily available.
- Tools and machines are simpler to clean and maintain.
- Cleaner environments improve worker morale and mood.
- Improved utilization of available space.
- Fewer damages to tools and property.
- Increased productivity of workers.

Handling Materials & Tools

The predominant raw material used in carrying out bamboo work is bamboo work is poles. Bamboo work is carried out by both handheld tools and smaller machines to produce artistic and innovative products. Beautiful items can be made from bamboo, keeping in mind the safety measures in order to protect the health and wellbeing of the workers as well as the environment at large. Thus it is important to keep a check on safety hazards related to bamboo work

Other equipment and tools used in processing and making bamboo products are mostly the ones used in woodworking. Like wood cutting, bamboo also requires specific equipment for cutting and splitting as per the bamboo grains. Wrong cutting may lead to reduced strength. That is why sometimes artisans prefer to use local, handmade household tools.

Tool lifespan can be ensured by using, maintaining and storing them properly. Furthermore, preserving the integrity of bamboo logs through proper handling and storage of the tools can reduce waste and ultimately save money.

Therefore, putting a high priority on tool safety is critical to averting mishaps and fostering a safety-conscious working culture. Usage of right gear, maintaining proper handling of tools helps in minimizing accidents and reducing hazards at workplace.

Following proper safety measures in bamboo work units guarantees a safe and productive workplace. This is even applicable to household production methods applied in traditional home units in bamboo industry.

Major benefits of using the right tools can be broadly classified under safety, efficiency and financial savings.

- **Security:** By ensuring that the equipment is suited for its intended purpose, installed correctly and routinely examined, the right tools can aid in the prevention of injuries.
- **Efficiency**: By enabling workers to concentrate on their work without having to find inventive ways to make do with what they have, the correct tools can increase efficiency.

- **Cost effective**: With the correct tools, you can safeguard the bottom line of business and save money.
- **Competition:** Proper tools help in maintaining market standards of products thus not letting competition get edge over business .Wen the task takes longer to complete, using the incorrect equipment can be costly and time-consuming.

Maintenance of tools

In order to maintain efficiency of work and protect the user from any safety lapse it is important to maintain the tools and equipment in good working condition. Long life and smooth functioning of tools can be maintained by proper servicing and storing of tools and equipment. Also, preserving the bamboo through proper handling and warehousing can help reduce damage and wastage. Thus, prioritizing the safety of bamboo workers and tools is an important factor in avoiding accidents and promoting a safe working culture. Proper procedures must be developed and followed to keep a check on health and safety hazards.

A mandatory checklist for safety, storage and tool maintenance should be made in every unit. Proper care must be taken while storing the raw material. Designated space should allocated for storage with proper marking for each of the items. The area should be well-lit and easily accessible. Proper ventilation with no moisture should be there; otherwise, bamboo will catch fungus and moulds.

The tools and equipment should be cleaned and serviced from time to time to keep them in good working condition.

The following factors must be considered while choosing the tools

1. **Safety Gear:** When using tools, wear safety gear, like safety glasses, to protect eyes from dust, debris and shavings. While lifting heavy objects, a lifting belt and gloves must be worn.

Fig. 5.7: Safety Gear

2. **Quality:** The tools' quality is also crucial. One should always go for tools manufactured from high-quality materials like chrome vanadium steel, which have a reputation for longevity and corrosion resistance. Effective grip and warranty cover also contribute to the value addition of the tool selection.

Fig. 5.8: Quality

3. **Proper use:** Be informed about proper safety procedures before using power tools. Improper use can cause injuries that require immediate medical care. Understanding the proper use of tools is critical, especially when dealing with power tools. Without adequate knowledge or training, improper handling can result in serious injuries that require immediate medical attention. Therefore, it is advisable to learn safety procedures and operational guidelines before using any tool.

Fig. 5.9: Proper use

4. **Tool Storage:** Tool storage is also a critical consideration. Having sharp or heavy tools in your pockets is unsafe, as they can drop or hurt you when you move or bend. Tools must be stored in their respective toolboxes, wall mounts, or belts for easy access and organization.

Fig. 5.10: Tool storage

5. **Work Area:** Keep your work area clean and tidy to avoid trip hazards. Maintaining a **clean and tidy work area** also contributes to a safer working environment. A cluttered workspace increases the risk of tripping and makes it difficult to find tools quickly. Ensuring that the area is free of unnecessary objects and keeping the floor dry and clear is a good practice.

Fig. 5.11: Work area

6. **Disposal: disposal of worn-out or damaged tools** should be done responsibly. Using faulty tools not only compromises safety but also affects the quality of work. Regular inspection and timely replacement of tools help maintain high standards and prevent accidents.

Fig. 5.12: Disposal

Consequences of improper tool and material maintenance:

1. **Damage to Bamboo:** If dull or improper tools are used, bamboo may split or break.
2. **Breakage:** Using the wrong equipment might cause bamboo slits and slivers to break, risking the structural integrality of the product.
3. **Uneven structure:** Using the wrong tools might cause the weave to have to joineries have unequal tension and compression which will give the product an uneven structural design.
4. **Bad Fit:** Parts made with appropriate tools may fit incorrectly, causing the product to be unsteady or poorly made.

5. **Diminished Sturdiness:** Using the wrong tools might result in weak and improver joints and connections, which shortens the product lifespan and eventually causes it to collapse.
6. **Finishing Problems:** Using the wrong finishing instruments may lead to time lags and high cost. Incorrect tools often require additional time to fix errors or rework damaged parts, extending the crafting process. Extra materials and repairs due to incorrect tools can lead to increased production costs.
7. **Risk of Safety:** Using improper or poorly maintained tools can lead to injuries such as cuts or abrasions.
8. **Health Hazards:** Bamboo dust and splinters from incorrect handling can cause respiratory issues or skin irritation.

The maintenance of tools and equipment is important to avoid safety hazards due to accidents and work getting affected as a result of tools not functioning properly.
Maintenance can be of three types Minor, medium and major maintenance and repairs. Proper maintenance requires steps that broadly cover three things: regular cleaning, oiling and sharpening of tools.

There should be a mandatory maintenance checklist covering below points:

Fig: 5.13: Maintenance of tools

1. **Upkeep/cleaning of instruments:** The tools should be properly cleaned at regular intervals. This will help in maintaining the longevity of equipment and efficiency while carrying out production.
2. **Regular oiling and sharpening of equipment:** Tools should be lubricated as required. Oiling and sharpening must be carried out from time to time to maintain the smooth functioning of equipment.
3. **Safe and secure storage space:** Designated spaces should be allocated for the storage of tools and equipment. The area should be well-lit and clean. Accessibility should be easy to avoid mishaps during handling of tools. All the tools and equipment should have identification marks and allocated areas should be labeled accordingly for easy recognition.
4. **Regular Checking and inspection of tools and equipment:** Proper checklist should be made to inspect the tools at timely intervals. This will ensure that the tools are in working condition when needed and will also increase the life of the equipment.
5. **Proper care and safety precautions must be followed:** Proper care must be taken while handling tools to ensure that handler does not get injured while dealing with the tools. This requires proper storage conditions for tools and necessary safety gear for the workers like gloves, kits etc. Frequent examination of tools should be done.
6. **Usage of Appropriate Tools for the Task:** In order to reduce wastage and avoid injury it is important that right set of tools are used. The workers should be trained to use the tools according to the tests that can be performed using specific tool.
7. **Training and manuals on equipment handling:** Necessary manuals containing instructions on handling tools and training to carry out these instructions should be undertaken from time to time. This will lead to proper work skills and improved production at the work unit. Proper know-how of the equipment will also help in proper care of equipment.
8. **Scheduled Maintenance on a Regular Basis:** This will ensure repairs are done on time if needed and the equipment is ready for production when needed. Any worn-out parts can be replaced on time to protect the rest of the equipment from becoming nonfunctional.
9. **High-quality equipment should be used:** Both efficiency and neatness in production are maintained when the equipment is of good quality and supports the worker in properly converting the raw material.

Methods of cleaning the tools

In order to maintain the tools in good and safe working condition they should be properly clean. A detailed checklist of tasks should be followed on regular basis:

Following are the main points of tool cleaning checklist:

1. **Oiling:** Apply a thin layer of vegetable or mineral oil to bamboo tools to protect them from moisture, steam or any other wear and tear. Painting a brush or cloth can be used to coat the tool then wipe off any excess oil with a clean cloth.
2. **Scheduled Inspections:** Regularly inspect the tools to check and rule out any wear and tear and repair any damage as soon as possible.
3. **Avoid soaking:** Prolonged submersion in water can cause rusting in tools; hence the tools should not be kept in moisture or water for a long time.
4. **Proper storage:** Store tools in a toolbox or designated storage space and use climate-controlled storage to minimize the impact of environmental factors.

Activities

Activity: Visit a handicraft or bamboo industry and prepare a report on different types of tools and materials used for finishing and packing and write about the maintenance and cleaning methods used.

Materials Required

1. Register/File
2. Pens and pencils
3. Eraser
4. Ruler

Procedure

1. Visit a handicraft or Bamboo industry.
2. Study the tools and materials used for finishing and packing and its cleaning and maintenance methods.
3. Prepare a report and submit the same.

Check Your Progress

A. Fill in the Blanks

1. The primary raw material used in bamboo work is _____.
2. Proper tool storage should be done in a well-lit and _____ area.
3. Regular _____ and sharpening are important for the smooth functioning of tools.
4. To prevent rusting, tools should be thoroughly _____ after washing.

5. Using the wrong tools may lead to _____ and breakage of bamboo, compromising the quality of the product.

B. Short Answer Questions

1. What is the importance of tool maintenance in bamboo work?
2. What safety gear should be worn while handling bamboo working tools?

C. Long Answer Questions

1. Describe the various steps involved in tool handling and how they contribute to the smooth production process.
2. Explain the methods of cleaning bamboo working tools and why regular maintenance is crucial for ensuring their longevity and efficiency.

Session – 2
Safe Storage of Material and Waste Management

Bamboo is vulnerable to insects like aphids, mealy bugs, borers, termites, the powder post beetle and fungus. However, bamboo can be stored following treatment methods such as leaching method, smoking method, lime washing, open tank method, Boucherie method, butt treatment and vacuum pressure treatment. Bamboo can be infested even after treatment if proper storing techniques are not followed. Thus, bamboo storage is an important pre-manufacturing processing aspect to be considered.

Post-manufacturing processes of bamboo generate a lot of fibres and dust of various grain sizes. Thus, effective waste management is equally vital for bamboo manufacturing units to follow sustainable practices and generate revenue from upcycling waste.

Bamboo storing techniques

The following are the techniques to store treated bamboo for extended shelf life:

1. Horizontal Storing

It is recommended that treated bamboo be kept horizontally in a warehouse or another location that is shielded from direct sunlight and moisture. Good ventilation and air movement are essential in storage or warehouses to prevent excessive moisture, which can lead to mould growth on bamboo. Each stack should not be higher than 30 cm to allow good airflow around the stack.

Fig: 5.14: Horizontal storing of bamboo

2. Vertical Storing

Overly soaked bamboo should be stored vertically for two to three days before being stored horizontally, which will allow the extra water inside the bamboo to drain and dry completely. Vertically stacked bamboo dries twice as quickly as bamboo piled horizontally. While species with thinner wall sections are dried in the sun for two to three days, species with thicker wall sections are left in the sun for a week.

Fig. 5.15: Vertical storing of bamboo

While adopting any of the storing techniques, the following precautionary steps should be followed:

1. **Moisture Control:** Bamboo must be stored in a well-ventilated space, ideally beneath a high roof to avoid fungus. Bamboo culms must be covered with a thin canvas sheet to protect them from moisture change.
2. **Contact to Ground**: To prevent moisture absorption, bamboo poles must be stacked horizontally or vertically at least 30 cm distance from the ground.
3. **Pest Control:** It is critical to treat the storage area for insects and small animals such as lizards, rats and insects. Typically, methyl bromide is used to treat such conditions.
4. **Infected Bamboo:** Remove infected bamboo culms from storage to avoid transmission of fungus and diseases.
5. **Sorting:** Bamboo poles must be stored according to varying diameters and sizes to facilitate ease of selection of bamboo.
6. **Identification Marking:** Bamboo poles must be categorised according to species for ease of identification and marked using different identifiers.

Waste Management

When bamboo items are no longer needed, it's critical to properly dispose of them. They ought to be completely compostable or biodegradable and shouldn't go to landfills. Bamboo waste can be disposed of in several ways, such as composting, utilizing it as fuel, or recycling it into different goods.

Waste management strategies

1. **Composting:** Products made of bamboo should be broken down into smaller fragments and can be combined with compost. The bamboo fragment will decompose and enrich compost with nutrients over time, strengthening its structure.
2. **Repurposing:** Bamboo waste and offcuts can be repurposed by regional craftspeople to make small crafted goods like jewellery and toys and smaller consumer products such as toothbrushes, cutlery, etc. The unutilized bamboo plant roots can be used for making new craft items.
3. **Fuelling:** Waste bamboo can be used to make briquettes and charcoal, or it can be used in gasification to create producer gas, which is a combustible gas.

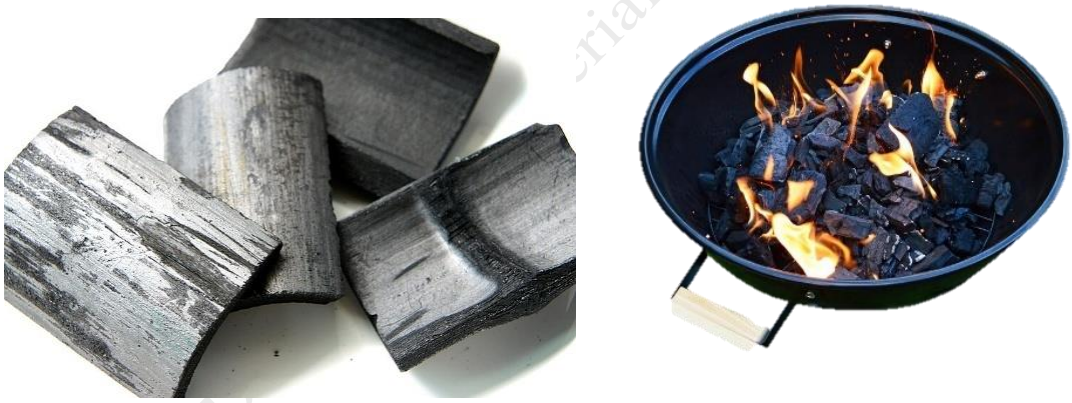


Fig. 5.16: Fuelling

4. **Recycle:** Bamboo dust, a by-product generated during the cutting, shaping and processing of bamboo, can be effectively recycled into various useful products. Instead of being discarded, this fine residue is collected and repurposed to create items such as incense sticks (agarbatti), handmade or industrial paper and bamboo-based textiles.

   Additionally, bamboo dust is commonly used in the production of particle boards and composite materials, where it is mixed with adhesives or other additives to form strong, eco-friendly alternatives to traditional wood products. Recycling bamboo dust not only reduces waste but also contributes to sustainable and efficient use of bamboo resources.

Fig. 5.17: Bamboo particle boards

Bamboo Leaves: Bamboo leaves are used to create a variety of products such as home décor, jewellery and utility items, ensuring that every part of the bamboo plant is repurposed effectively.

Activities

Activity: Visit any bamboo cluster, shop or industry to collect a maximum of 500 gm of bamboo waste (dust, chips, nodes, roots, shavings or cut offs) and make a utility product out of waste. Make a brief report on the process of making useful products out of waste.

Materials Required

1. Register/File
2. Pencil, eraser and ruler
3. Bamboo waste
4. Other hand tools as required according to the design
5. Adhesives and varnish

Procedure

1. Visit any bamboo cluster, shop or industry
2. collect a maximum of 500 gm of bamboo waste (dust, chips, nodes, roots, shavings or cut offs)
3. Sketch a new design out of bamboo waste
4. Execute the design using different hand tools
5. Make a report and submit the same

Check Your Progress

A. Fill in the blank

1. To avoid mould growth, bamboo should be stored in a _____ and well-ventilated area protected from moisture and sunlight.

2. In vertical storing, bamboo dries faster because water inside the culms _____ more effectively.
3. During storage, bamboo must be kept at least _____ centimetres above ground level to avoid moisture absorption.
4. _____ is a method of reusing bamboo waste to make new products like jewellery, toys and cutlery.
5. Bamboo dust can be recycled into eco-friendly products like incense sticks, paper, textiles and _____ boards.

B. Short Answer Questions

1. Why is sorting bamboo poles important in the storing process?
2. Name different products made of recycled bamboo waste.
3. Explain the relevance of ground contact in bamboo storage.

C. Long Answer Questions

1. Describe the different bamboo storing methods with sketches.
2. Explain various bamboo waste management strategies.

Session – 3
Tools and Material According to Workflow Standards

The proper use of tools and materials is essential in ensuring the efficiency, safety and quality of production activities. Selecting the correct tools tailored to the specific requirements of each task not only helps maintain industry standards but also minimizes the risk of accidents and mishaps in the workplace. It is important to equip workers with the appropriate tools for the job, as this not only enhances productivity but also safeguards their well-being. Specialized knowledge and training are key when using tools, as many require particular skill sets and techniques to maximize their effectiveness. Ensuring that tools are in optimal working condition is also critical, as poorly maintained or incorrect tools can lead to damage, inefficiency and safety hazards. This makes proper tool usage and maintenance vital for achieving high-quality outcomes and a safe working environment.

Use of correct tools and material

Careful selection of tools that match the unique requirements of each assignment is crucial. The correct tools also maintain industry standards, make the workplace safer and guard against mishaps and injuries.

Equipping workers with the right tools for the job not only protects their safety but also boosts output and efficiency. Training and skill development go hand in hand with using the appropriate tools because many tools demand specialized knowledge and usage approaches. Making the time to acquire the proper tool usage skills can greatly increase your competence and proficiency.

Consequences of poorly maintained tools and equipment deployed in production activity

Damage to Bamboo

- **Splitting and Cracking:** Bamboo can split or crack if dull or inappropriate tools are used, compromising the basket's structural integrity.
- **Breakage:** Incorrect tools can cause bamboo strips to break, leading to gaps and weakened parts in the basket.

Inconsistent Weaving

- **Uneven Structure:** Using incorrect tools can lead to uneven tension in the weave, resulting in a structurally inconsistent basket.
- **Poor Fit:** Tools that are not designed for bamboo can result in poorly fitting parts, making the basket unstable or poorly constructed.

Reduced Durability

- **Weak Joints:** Improper tools can lead to weak joints and connections, reducing the basket's lifespan and causing it to fall apart over time.
- **Finish Issues:** Inappropriate finishing tools can result in a poor finish, leaving the basket vulnerable to environmental damage and wear.

Increased Labour and Time

- **More Time:** Incorrect tools often require additional time to fix errors or rework damaged parts, extending the crafting process.
- **Higher Costs:** Extra materials and repairs due to incorrect tools can lead to increased production costs.

Safety Risks

- **Injury:** Using improper or poorly maintained tools can lead to injuries such as cuts or abrasions.
- **Health Hazards:** Bamboo dust and splinters from incorrect handling can cause respiratory issues or skin irritation

Introduction to Running Maintenance

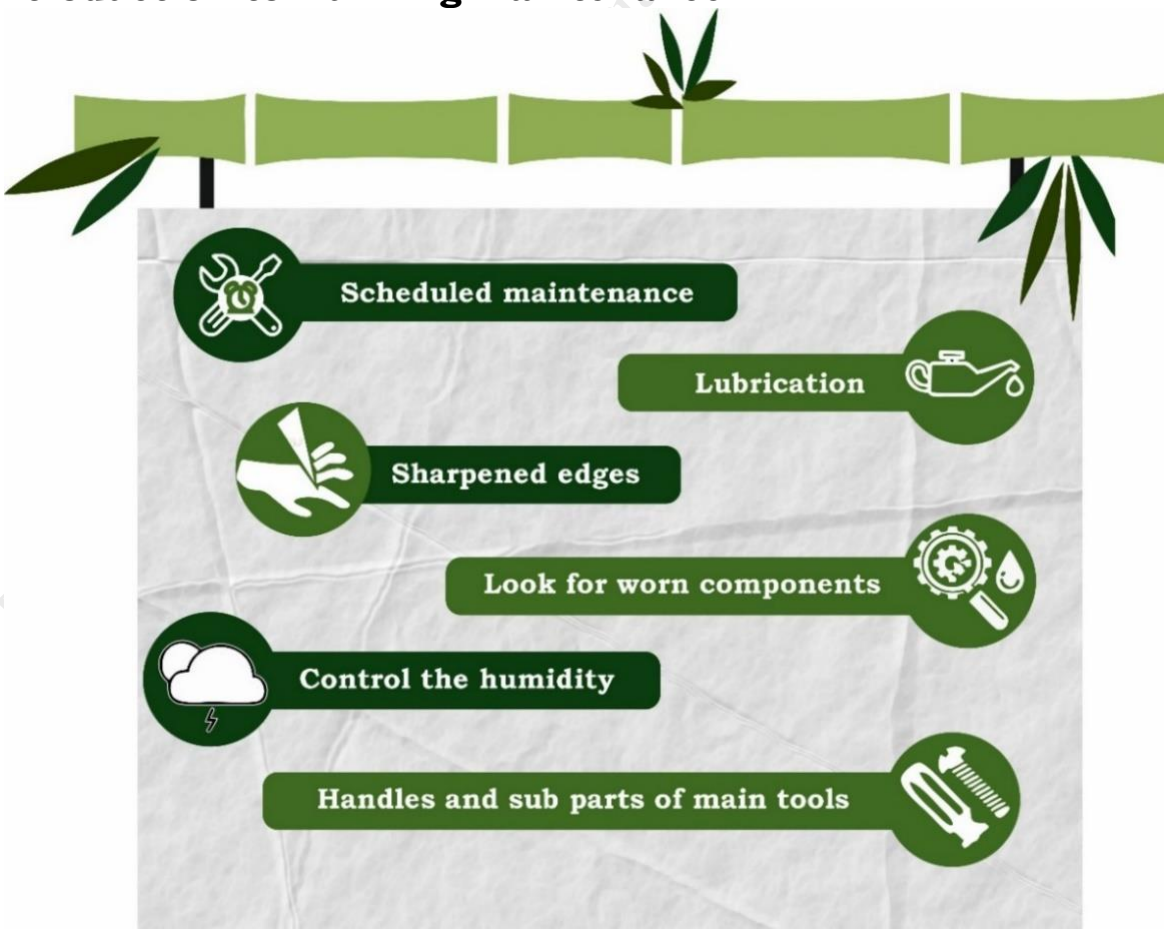


Fig. 5.18: Running maintenance

Scheduled maintenance: Make a schedule for maintaining, cleaning and checking your tools. This contributes to the maintenance of tools, extending their lifespan and improving worker safety and productivity.

1. **Lubrication:** A crucial preventive maintenance procedure that keeps instruments performing at their best is lubrication.
2. **Sharpened edges:** Blades, including cold saw and bi-metal saw blades, need to be sharpened for maximum effectiveness.
3. **Look for worn components:** Check tools on a regular basis for wear, fluid leaks, excessive clearances and other indications of degradation or damage.
4. **Control the humidity:** Bamboo might change shape when stored in humid spaces. Humidity swings can be tolerated to some extent, but continuous humidity can cause problems.
5. **Handles and sub parts of main tools**: Clean and condition wooden handles to prevent decay and splinters. Check and tighten loose handles to ensure a secure grip. Other tips for maintaining semi industrial and automatic tools include Cooling down heated tools, Calibrating tools, replacing worn parts and Taking care of batteries.

The proper application and care of tools and materials are central to accomplishing efficiency, safety and quality in bamboo craft manufacturing. Choosing the right tools for a particular task not only guarantees the durability and accuracy of the end product but also minimizes the possibility of accidents in the workplace. Additionally, regular maintenance procedures like sharpening, greasing and inspections enable tools to last longer and provide constant performance. By following standard operating procedures and providing workers with the requisite training, craftsmen can enhance productivity substantially without compromising on safety and quality standards.

Activities

Activity: Visit any bamboo cluster and study their workflow systems and prepare a report on the same.

Materials Required

1. Stopwatch/Timer
2. Pens and pencils
3. Eraser
4. Notebook
5. Standard Workflow guide

Procedure

1. Visit any bamboo cluster. Present participants with a bamboo craft project that involves multiple steps, such as making a simple basket.
2. Provide a stopwatch or timer to measure the time taken to complete the project.
3. Ask participants to follow the standard workflow guide while completing the project.
4. Compare the time taken to the standard time in the guide and assess whether participants adhered to the workflow standards.
5. Discuss any deviations or improvements in efficiency and quality achieved during the exercise.

Check Your Progress

A. Fill in the Blanks

1. Correct tool selection is essential for maintaining industry standards, ensuring safety and preventing _____ and injuries.
2. Using the appropriate tools boosts productivity and protects workers from _____ hazards.
3. Improper tools can lead to _____ in the weaving process, resulting in structural issues with the bamboo product.
4. Scheduled maintenance, including regular cleaning and checking, contributes to the _____ of tools and ensures worker safety.
5. A crucial preventive maintenance procedure that keeps tools in optimal condition is _____.

B. Long Answer Questions

1. How does the careful selection of tools contribute to the safety and efficiency of bamboo craftwork?
2. What are the consequences of using poorly maintained tools in bamboo production?

C. Short Answer Questions

1. Why is regular maintenance, including lubrication and sharpening, important for tools used in bamboo crafting?
2. How can improper tools affect the durability and quality of bamboo products?

Module 6 Health, Hazards and Safety Measures at Workplace

Module Overview

Workplace safety and wellness measures enhance the workers' quality of life. It also helps maintain effective safety laws, incentivizing businesses and employees to safeguard one another's financial stability and well-being. Maintaining everyone's safety and productivity requires regular monitoring of work and cooperation from all team members.

There are various reasons for safeguarding workers' health and well-being. Semi-skilled craft people mostly handle bamboo craft units; hence, it becomes extremely important to maintain and follow proper safety guidelines.

Reasons to maintain safety norms in bamboo units:

1. **Avoid Disease, Injury and Death:** Business leaders must prioritize preventing illness and harm. Employees should be trained to recognize the specific hazards of disease or injury that may arise in any workplace.
2. **Decrease in Hazards leads to Increased Productivity:** Safeguarding coworkers also helps to reduce workplace hazards. This reduction can minimize both the direct costs of pay and the indirect costs associated with lost productivity.
3. **Handle Liability and Public Relations:** Effective safety initiatives can help attract artisans and enhance the perception of the workplace in terms of a sense of security. Craft people are more likely to remain with a company when they feel protected and appreciated.

Learning Outcomes
After completing this module, you will be able to: • List and analyze potential hazards & safety measures at workplace • Describe health, safety, and security at workplace • Explain environmental management procedures, security details, potential accidents and emergencies
Module Structure
Session 1: Hazards and Safety Measures
Session 2: Safety at Bamboo Craft Unit
Session 3: Environmental Management Procedures and Emergency Response

Session – 1
Hazards and Safety Measures

Every item, circumstance, or activity that has the potential to injure workers—including bodily hurt, illness, or health damage—is considered a "hazard" at the bamboo craft unit, which could arise from factors like people, equipment, materials and the environment. Organizations need to prioritize the safety of their employees by focusing on both training and equipment maintenance. Employees should receive comprehensive training to identify potential hazards and properly utilize safety equipment, ensuring they are aware of the risks and equipped to prevent them. Concurrently, the equipment used in the workplace must undergo regular inspections and maintenance to prevent malfunctions and ensure it remains safe for user operation. By addressing both employee awareness and equipment safety, companies can create a safer work environment for everyone involved. Seven major categories of workplace hazards can occur in a bamboo work unit:

Types of potential hazards

Fig. 6.1: Types of hazard

a) **Mechanical hazards:** Because bamboo is a sharp material, artisans must handle it carefully to prevent mishaps like cuts, punctures and other mechanical hazards. Cutting risks from sharp edges on bamboo splits, incorrectly sharpened blades that can cause a backlash and inadequate protection on cutting blades are among the mechanical risks unique to bamboo machine tools. Furthermore, bamboo fibres can wrap around moving shafts and entanglement problems can occur when loose clothes or hair becomes stuck in rotating sections. While impact dangers exist because bamboo splinters may be ejected during cutting and incorrect feeding mechanisms may cause uncontrolled

movement of bamboo pieces, crushing hazards may arise from poorly designed clamping devices that apply excessive pressure or fail during processing. Installing guards on moving parts, routinely maintaining and sharpening cutting blades, feeding bamboo into machines safely with push sticks, donning the proper personal protective equipment (PPE), educating operators on safe practices and routinely checking and maintaining all machine parts for proper operation are all crucial safety precautions to reduce these risks.

b) **Biological hazards:** Bamboo experiences fungal growth due to humidity. Thus, it is advised to wear masks, eye protection and gloves to avoid contamination of eyes, lungs and skin by fungal exposure. If there are incidents involving blood from cuts and lacerations, the infected materials or tools must be well-sanitised before being used again.

c) **Chemical hazards:** The main chemical risk associated with using bamboo machines is silica dust exposure from cutting and sanding bamboo. Because of its high silica concentration, breathing in this dust can be detrimental to the respiratory system. Other possible chemical risks include coming into contact with glues, coatings and processing-related chemical treatments. Volatile Organic Compounds (VOCs), such as formaldehyde or benzene, which can irritate the skin and respiratory system, may be present in these materials. Ensuring enough ventilation is crucial to reducing dust exposure and mitigating these chemical dangers. When cutting or sanding bamboo, always wear the proper respiratory protection. To minimize skin contact with chemicals, wear personal protective equipment (PPE), including gloves, safety glasses and protective clothes. Additionally, selecting low-VOC coatings and wearing N95 masks while working with chemicals are essential components of safe operations.

d) **Ergonomic hazards:** Bamboo craftsmen encounter various ergonomic hazards due to awkward postures and repetitive tasks involved in craft work, which can contribute to musculoskeletal disorders. Prolonged periods of sitting or squatting on the floor with a bent back and neck are common, along with persistent pain and limitations in mobility, dexterity and overall functioning that can decrease work efficiency. Additional ergonomic hazards include force exertion—related to the amount lifted, pushed, or pulled—task repetition, vibration exposure, contact stress, sustained exertion and exposure to cold temperatures. To reduce these ergonomic hazards, it is essential to enhance the layout and operation of equipment, improve lighting conditions, implement better noise control measures, optimize workstation design and height, refine task and workplace design and improve techniques for lifting, pushing and pulling.

e) **Electrical hazards:** Machine tools are the main source of electrical risks in bamboo crafts, which can involve problems like broken

equipment, overloaded circuits and exposed electrical components. Overloaded circuits—caused by utilizing too many high-wattage devices on a single circuit—can overheat wiring, potentially resulting in fires and damaged equipment provides risks because their conductors may get electrified, raising the risk of electrocution. Burns and shocks can occur from exposed electrical components, such as open power distribution units or damaged insulation. Injuries from spark, which occurs when electricity jumps between circuits, electric shock from contact with live parts, fires from defective equipment and explosions from inappropriate electrical apparatus are further risks. Regular checks must be conducted to identify open wires, defective socket, loose connections and faulty tools and equipment to mitigate such hazards.

f) **Physical hazards:** Physical Hazards refer to tangible elements within the workplace that have the potential to cause injury to individuals. These hazards encompass slips, trips and falls that can occur from wet or slippery surfaces, uneven floors and obstructions. Such situations may lead to injuries, such as fractures, sprains, or head injuries. Additional potential dangers include hand injuries and fatigue caused by machine vibrations, as well as risks associated with falling bamboo or machine components impacting the feet while handling large bamboo materials. Cleaning and lighting walkways, prompt cleaning of spills, decluttering spaces by organising tools in proper places and stacking bamboo according to sizes and smaller sections are essential steps to avoid these hazards.

g) **Psychological hazards:** Psychological hazards impacting bamboo artisans encompass various social and organizational factors related to work that can influence mental health. Psychological hazards include work-related stress, instances of bullying in the workplace and insufficient social support. Excessive workloads, uncertainty regarding job security, extended working hours and a lack of control over tasks can lead to stress, anxiety, or depression. Experiences of harassment or intimidation in the workplace can severely affect mental well-being, while feelings of isolation and poor communication from colleagues or supervisors can create a detrimental work atmosphere. To tackle psychological risks associated with extended work stress, it is important to follow the regulations concerning weekly work hours specified in the Factories Act of 1948, as well as to reduce overtime where possible. Addressing workplace bullying in a positive way and ensuring that management supports those impacted are essential actions. Moreover, creating a feeling of job security during tough times is important for enhancing the overall mental health of artisans

Keeping work area free from hazards

Here are a few strategies for removing dangers from a work area:

Fig: 6.2: Hazards free work area

1. **Personal Protective Equipment (PPE):** Hard hats, safety glasses, aprons and protective boots are examples of Personal Protective Equipment (PPE), which is an essential first line of defence against potential dangers. Employers are responsible for making sure staff members receive the necessary PPE training.

2. **Determine and evaluate dangers:** An essential component of any successful safety program is a proactive approach to detecting and evaluating hazards.

3. **Report dangerous conditions:** Employees should report dangerous conditions and should be aware of those.

4. **Safe work practices**: These can help against burns, falls, chemical exposure, fires and more.

5. **Teach workers about workplace safety:** Employers are in charge of educating and training staff members about hazards at the craft unit.

6. **Housekeeping:** Keeping your workspace neat and orderly will assist reduce the risk of fire hazards, trips and falls and slips and falls.

7. **Signage:** Establish a culture of safety by employing signage and offering prizes for safe behaviour.
8. **Conduct equipment inspections:** These can contribute to maintaining a safe working environment.
9. **Take stretch breaks:** Throughout the day, taking stretch breaks can help keep staff members safe.

Activities

Activity: Collect the data and make a report on potential risk and hazards of industry.

Material Required

1. Practical File
2. Coloured pens and pencils
3. Ruler
4. Eraser
5. Pictures of different hazards in an industry

Procedure

1. Search and collect the data and pictures of different types of hazards of an industry.
2. Place the pictures in the practical file and label the same.
3. Write the description and make a report.

Check Your Progress

A. Fill in the blank

1. A hazard is anything that has the potential to induce harm or other adverse effects and it refers to a potential source of _____ or damage.
2. Bamboo units are mostly handled by _____ artisans, making it extremely important to follow proper safety guidelines.
3. One of the common _____ in bamboo units is exposure to chemicals during pesticide treatment.
4. Effective safety initiatives can help _____ the workplace and attract top personnel.
5. _____ risks can result in negative outcomes such as stress or burnout, which can lead to workers making mistakes.

B. Long Answer Questions

1. Explain the importance of maintaining health, safety and security in the workplace, especially in bamboo work units. Discuss the various types of hazards and the measures that should be taken to mitigate them.
2. Describe the different categories of workplace hazards that can occur in a bamboo work unit. How do these hazards affect the workers' health and productivity? Provide examples for each category.

C. Short Answer Questions

1. What are some common mishaps that can occur in a bamboo unit and why is it essential to follow safety guidelines?
2. Define the term "hazard" and explain the difference between a hazard and a risk in the context of workplace safety.

Session – 2
Safety at Bamboo Craft Unit

Maintaining health, safety and security at the workplace is crucial for protecting employees and ensuring smooth operations. Adhering to safety protocols, such as using personal protective equipment (PPE), conducting emergency drills and ensuring ergonomic workspaces, minimizes risks. Inclusivity for gender and persons with disabilities (PwDs) fosters a supportive work environment. Risk management through regular assessments, updated risk registers and stakeholder reviews helps mitigate potential workplace hazards, ensuring a secure and efficient craft space for all. The following are the compliances that must be taken care of in an organised bamboo craft unit.

Complying with Health & Safety instructions

Failure to follow good health and safety practices can result in accidents, incidents and ill health. This can have a significant impact on the business, the craft people and the craft quality.

Fig. 6.3: Complying health & safety

1. **Objective:** A safe and healthy environment for all participants and staff must be ensured.
2. **Emergency Protocols:** Clear demarcation of emergency exits must be ensured for better accessibility during an accident. A well-stocked first aid kit must be kept on-site and staff must be trained in basic first aid

and emergency procedures. Fire extinguishers must be installed, regularly checked and fire safety drills must be conducted periodically.

3. **Personal Protective Equipment (PPE):** Use of appropriate PPE such as gloves, masks and safety goggles must be provided and enforced.
4. **Tool Safety:** Training on the proper use of all tools and machinery must be given and a system for reporting and addressing any safety hazards or equipment malfunctions must be implemented.
5. **Workspace Ergonomics:** Arrangements of workstations must be promoted for appropriate posture and to minimize strain. Ergonomic tools, furniture and workstations must be provided as far as possible.

Complying with gender and persons with disabilities (PwDs) related instructions

Creating an inclusive and respectful work environment is essential in the bamboo craft industry. Whether in a bamboo cluster, a self-help group, or a professional craft enterprise, it's important to ensure that both gender equity and the needs of persons with disabilities (PwDs) are considered and respected.

Considering gender inclusivity

Bamboo clusters or self-help groups maintain a good balance of gender ratio predominantly. However, new craft businesses or existing craft enterprises intending to be organised must have a balance of gender ratio and inclusive environment. Work distribution must be done according to gender disposition to make a favourable work environment. The health issues of women and girls must be considered while making work schedules.

Considering PwDs

Not all disabilities can be accommodated in a bamboo craft workspace. However, under special circumstances, while accommodating PwDs, efforts should be made to make a conducive environment for them. For example, emergency response for hearing impairment should be made using light or haptics.

Promoting inclusivity isn't just about compliance it's about building stronger, more respectful and more productive teams. Whether ensuring gender equality or accommodating persons with disabilities, small changes in planning, communication and environment can lead to a more collaborative and ethical workspace.

Monitoring potential risks at the workplace

Assessment and evaluation of possible hazards that might affect the goals and operations of the company must be identified to mitigate them. Potential

sources of injury or loss in the workplace must be determined by looking for and evaluating potential dangers. Possible risks and the possibility of harm to workers, property, or the environment must be determined. This is known as risk assessment.

1. **Risk assessment:** Potential risks in the workflow and supply chain of businesses must be discussed frequently within employees of the enterprise. Plans must be made to lessen the impact of any unfavourable event and identify risks before they materialize by using a risk assessment matrix.
2. **Risk registry and verification:** A risk register must be maintained in the workplace, which must be updated frequently. Ascertain whether they remain at ease with the risk profile.
3. **Informative on boarding:** For new businesses, artisans and employees must be informed about the potential risks involved in the workplace during onboarding. The risk factors must be daily reminders in the form of visuals in the workspace.
4. **Outside audit:** An audit by a third party can be conducted to check the status of safety and risk in the company to comply with the Occupational Safety, Health and Working Conditions Code, 2020.

Fig. 6.4: Points to monitor potential risk

Safety Guidelines

Broadly the following safety guidelines can be used when handling bamboo working tools and equipment:

1) Instructions and material handling manual: Instructions and directions provided by the manufacturer must be read to get familiar with the features, functions and safety precautions of the tools before using them.
2) Proper working gear: Appropriate clothes and wherever required protective equipment (PPE) that is appropriate for the task, such as dust masks, gloves, safety glasses and ear protection should be worn.

3) Neat and clear work area: Well-maintained work area is important to work freely.
4) Proper storage of tools not in use: Tools that are not in use should be stored appropriately. This will help to avoid accidents.
5) Proper usage of tools and equipment: Training and instruction manuals should be provided to all workers to help them understand proper handling and functioning of all the tools.

Fig. 6.5: Safety in bamboo workshop

The following are the specifics of the PPE to be used:

Gloves: Three different kinds of gloves are predominantly used:

Cotton gloves: Cotton gloves are used as a cost-effective and practical form of personal protective equipment (PPE). They are used for a variety of tasks, including general work, quality control and handling moderately hot objects. Cotton gloves are useful mainly while working with machine tools for bamboo processing. Some cotton styles come with PVC dots to provide the wearer with increased gripping power and increased abrasion resistance.

Fig. 6.6: Cotton gloves

Leather gloves: Leather gloves are used mainly to protect hands from cuts, abrasions, punctures and heat. While bamboo heat bending or steam bending, leather gloves should be used.

Fig. 6.7: Leather gloves

Rubber gloves: Rubber gloves can be unsupported (rubber only) or supported (rubber coating of textile glove). Rubber gloves are useful in bamboo craft, specifically handling chemicals while treating bamboo, handling varnishes during finishing work, cleaning and maintaining hand tools and greasing and oiling machine tools.

Fig. 6.8: Rubber gloves

Safety glasses: Safety glasses protect eyes from injury by bamboo splinters, chemical splashes and bamboo dust. It must be ensured that the eyes are covered from all sides.

Fig. 6.9: Safety glasses

Apron: Industrial aprons are used primarily to protect workers' clothing from stains, spills, dust, chemicals, heat, sharp objects and other potential hazards depending on the work environment. Made out of thick fabric, it acts as a barrier to keep clothes clean and maintain personal safety while working.

Fig. 6.10: Apron

Safety boots: Industrial safety boots are used to protect workers' feet from potential injuries caused by falling objects, sharp materials, heavy machinery, slippery surfaces and other hazards present in industrial workplaces.

Fig. 6.11: Safety boots

Mask: Industrial N95 masks are used to protect workers from inhaling harmful airborne particles in various industrial settings, as they provide a high level of filtration, effectively blocking at least 95% of airborne particles, including dust, fumes, mists and certain hazardous chemicals, which can be detrimental to respiratory health when inhaled.

Fig. 6.12: Mask

Earmuff or earplug: Earmuffs or ear plugs are required in bamboo craft space to protect workers from noise-induced hearing loss caused by exposure to loud machinery like the knot removal machine, the bamboo split planer machine and the power saw.

Fig. 6.13: Earmuff or earplug

Activities

Activity: Create an informative and visually engaging poster on workplace safety in a bamboo craft unit.

Materials Required

1. Chart paper or A3 sheets
2. Printed or hand-drawn images of PPE, safety equipment and workplace hazards
3. Coloured markers, sketch pens, glue and scissors
4. Safety guidelines (for reference)

Procedure

1. Divide the poster into sections: PPE, Emergency Protocols, Tool Safety, Ergonomics and Risk Assessment.
2. Draw or paste images of safety equipment and precautions in each section.
3. Write short, clear descriptions of each safety measure.
4. Highlight key safety instructions using bold colours.
5. Ensure the poster is visually appealing and easy to understand.
6. Present the poster to the class, explaining each safety measure.
7. Display the posters in the classroom or workshop area for awareness.

Check Your Progress

A. Fill in the blanks

1. Failure to follow good health and safety practices can result in accidents, incidents and _____ health.
2. To ensure safety in the workplace, it's important to clearly mark _____ exits and ensure they are accessible.
3. Personal Protective Equipment (PPE) includes items such as _____, masks and safety goggles.
4. To prevent moisture absorption, bamboo poles must be stacked at least _____ cm above the ground.
5. Waste bamboo can be used to make briquettes and charcoal or utilized in gasification to create _____ gas.

B. Short Answer Questions

1. What are some of the key elements of emergency protocols that should be implemented in a workplace?
2. What is a risk assessment matrix and how does it help in managing workplace hazards?

C. Long Answer Questions

1. Explain the importance of complying with health and safety instructions in the workplace. How can failure to follow these practices affect the business and its employees?
2. Discuss the role of gender sensitivity in the workplace and the inclusion of people with disabilities (PwDs) in programs and initiatives. How can organizations create a more inclusive environment?

Session – 3
Environmental Management Procedures and Emergency Response

Environmental Management Procedures help businesses and craft-based industries adopt sustainable practices that reduce environmental harm. The Environmental Management System (EMS) provides a structured approach to identifying environmental issues, planning solutions and improving sustainability efforts. Additionally, emergency response training ensures safety in the workplace by preparing artisans for potential hazards such as electrical shocks, fires and injuries. This session will cover key EMS procedures, emergency preparedness measures and first-aid responses to accidents in bamboo craft spaces.

Environmental Management System

Chemical waste disposal – In order to reduce industrial pollution, discharge points – the end of the pipe – have received a lot of attention up until recently. Pollution control was addressed separately and as an afterthought to the main production activity. Since the intended outcomes from this method have not been achieved, the focus has now changed from pollution control to the Environmental Management System (EMS). The Environmental Management System has started a new phase in the reduction of pollution from industry. A number of environmental management standards are included in ISO 14000. The most significant in the series, ISO 14001, was published towards the end of 1996. Industry can detect related environmental issues with ISO 14001, cut pollutants and gradually enhance environmental performance. Another name for ISO 14001 is the Environmental Management System (EMS).

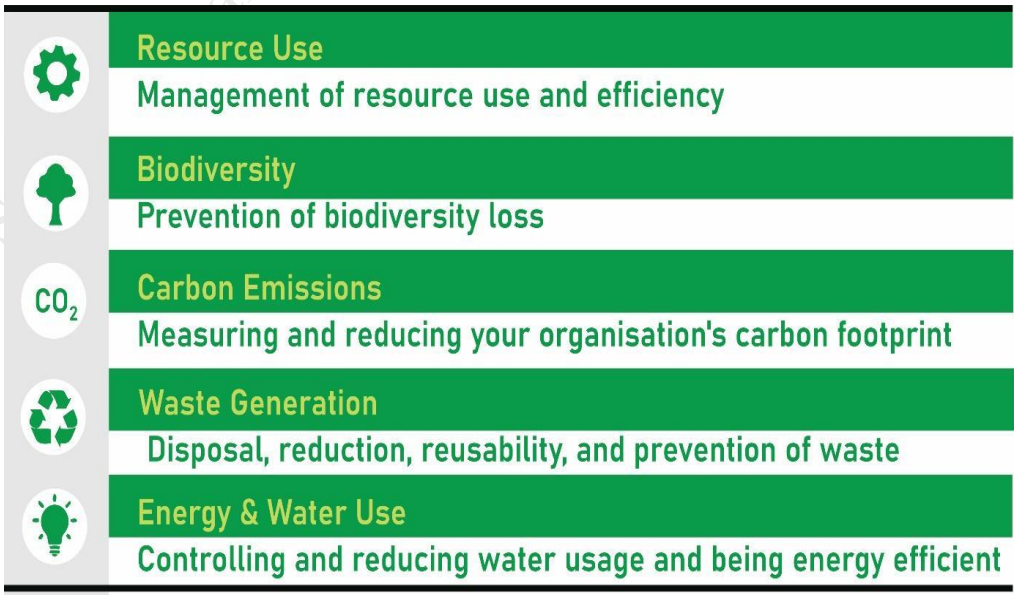


Fig. 6.14: Environmental management system

EMS serves as a tool for problem identification and solving and depending on the needs and goals of an organization or business, it can be implemented in a variety of ways. It offers a structure that enables a company to reduce the negative environmental effects of its operations. The following procedures can identify EMS:

A. Planning

The planning phase of an Environmental Management System (EMS) involves three main steps:

(i) The organization or business identifies how its activities, products, or services affect the environment, both positively and negatively.

(ii) It checks the laws and regulations it must follow to stay compliant.

(iii) The enterprise sets clear goals and action plans to reduce harm to the environment and improve sustainability.

The focus is on identifying the most important environmental issues and taking steps to manage them effectively.

B. Action

For an unorganized sector involving craftsmanship, a clear structure, well-defined roles and proper skills are important for success. Training helps artisans to improve their craft and understand better ways to work sustainably.

Support from management or local leaders ensures they have the right tools and materials. Proper record-keeping and guidelines help maintain quality and consistency in their work. Safe working practices and waste management are necessary to protect both workers and the environment. Emergency plans should be in place to handle accidents. Regular training and updates can help artisans grow while keeping their work eco-friendly.

C. Review

For businesses with craftspeople, having a system to check and improve their work is important. There should be a way to monitor their environmental impact and ensure they follow sustainable practices. If any issues arise, steps should be taken to correct them. Proper records of daily work should be maintained to track progress and avoid losses.

Regular reviews by skilled professionals or local leaders can help improve craftsmanship and eco-friendly practices. Periodic audits and checks ensure that artisans meet quality standards while protecting the environment, leading to better work conditions and long-term sustainability.

Certification Bodies

There are several certification bodies accredited from other countries operating in India.

- Bureau of Indian Standard (BIS) Det Norske (DNV)
- Lloyd's Register Quality Assurance (LRQA)
- International Certifications Limited (ICL)
- KPMG Quality Register
- Bureau Veritas Quality International (BVQI)
- TUV India Private Limited
- Quality Assurance Services
- AJA EQS Certification Services Pvt. Ltd.
- Standardization, Testing & Quality Certification (STQC)

Here are some ways bamboo can be used to support environmental management

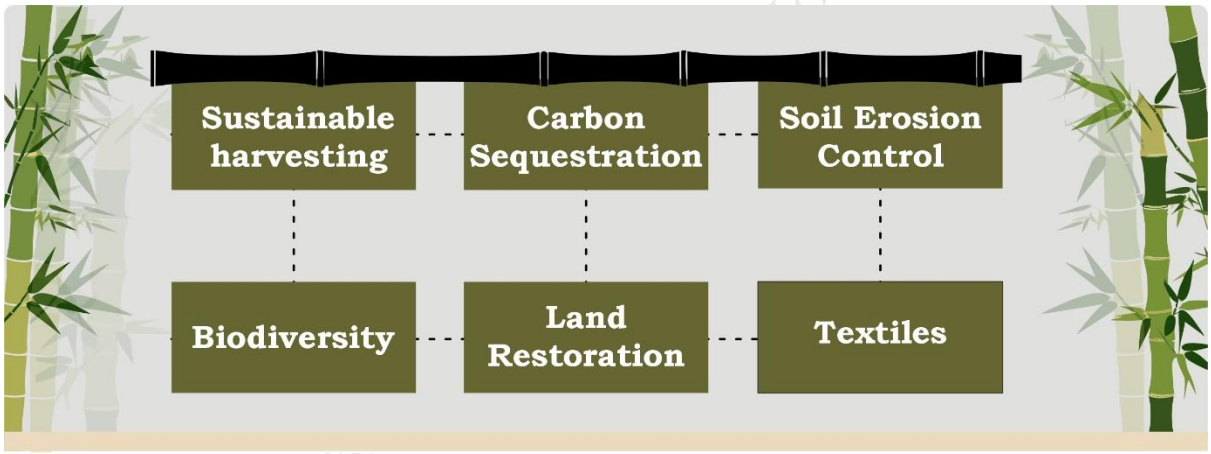


Fig. 6.15: Ways to support environmental management system

1. **Sustainable harvesting:** Bamboo can be sustainably harvested because it can regenerate quickly from its root system, unlike trees that need to be replanted.
2. **Carbon sequestration:** Bamboo plantations can help reduce greenhouse gas emissions by sequestering carbon. Bamboo can absorb about 3.73 cubic meters of carbon dioxide per day, which is equivalent to the emissions from about two cars.
3. **Soil erosion control:** Bamboo roots can help prevent soil erosion and sedimentation in water bodies.
4. **Biodiversity:** Bamboo can support biodiversity by providing habitats for various species.
5. **Land restoration:** Bamboo can help restore degraded land and promote sustainable land use.

6. **Textiles:** Bamboo can be used to make antibacterial and UV-absorbing clothing.

Under EMS programs in India, bamboo has been planted on severely degraded land – the result of an intensive brick-making industry. In 20 years, the water table had risen by 10 meters (m) and agricultural crops and tree species had been incorporated into a landscape of bamboo. Due to its success, the project has expanded to cover 100,000 ha of degraded land in 600 villages, benefiting more than one million people economically and socially.

Emergency Response and Training

Emergency response training in a craft workplace refers to providing craft people in a craft-based industry with the knowledge and skills needed to safely respond to potential emergencies like fires, chemical spills, accidents, or medical emergencies, including knowing evacuation procedures, using safety equipment and understanding their designated roles in an emergency.

No matter how big or little, emergencies and disasters can occur anywhere. Thus, employees at bamboo craft places must be trained to know and prepare for what to do in the event of an emergency by enrolling them in an emergency response training course. The following are a few basic knowledge for emergency preparedness and response procedures:

Emergency due to electric shock

In a bamboo craft space where power tools and machine tools are used to process bamboo, may encounter any of the following situations:

- Experiencing mild or heavy shocks upon contact
- Unusual generation of heat
- Arcing, sparking, or emission of smoke from the machine tools or power boards

Craft people in bamboo craft space can be protected against the dangers of electricity in a number of ways, such as by grounding, guarding, insulation and electrical protection equipment. Craft people can greatly lower electrical dangers by taking some simple precautions:

- Regular inspection of the wiring of all equipment must be done prior to each use. Damaged or frayed electrical cords must be replaced immediately.
- All employees must be aware of the location and operation of shut-off switches and/or circuit breaker panels so that they can act during an emergency due to electricity.
- Use of extension cords must be minimized. Extension cords must only be used for short durations of temporary tasks.
- Multi-plug adapters having circuit breakers or fuses only be used.

- Electrical wires should not be exposed and are positioned behind shields.
- Water or liquid chemical spills should be avoided around electrical equipment to reduce the risk.

The following are the key emergency response steps in case of an electric shock:

- Before approaching the victim, the rescuer should ensure his or her own safety and check if the power source can be safely turned off or if the victim can be moved away using a plastic, wood or any non-conductive object. Wet or metal objects should never be used to move a person in contact with electricity.
- If possible, turn off the electricity at the main switch or circuit breaker.
- Once the victim is clear of the electrical source, check if they are conscious and breathing.
- If the victim is not breathing, begin CPR immediately.

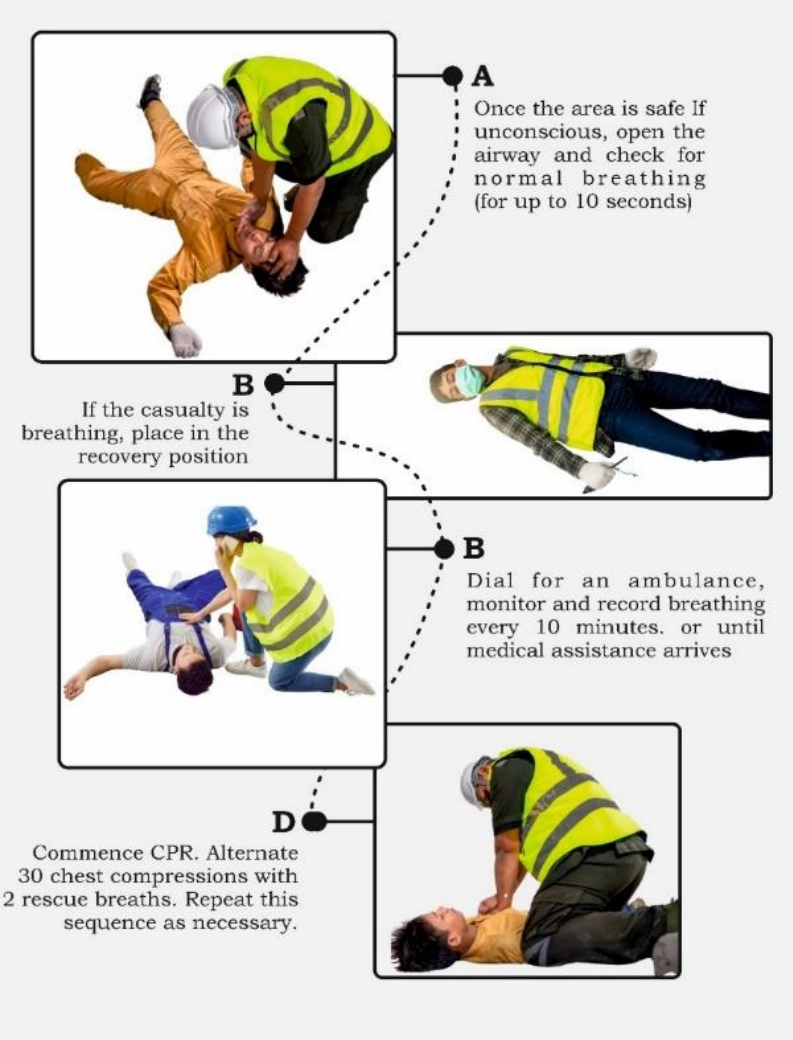


Fig. 6.16: Electric shock emergency resuscitation

- If the victim has burn marks from the electrical shock, cool the area with running water for 20 minutes and cover it with a clean, dry cloth.
- For severe injury or if the rescuer is not confident about what to do, emergency medical services should be called immediately.

Emergency due to factory fire

In a bamboo craft space, fire can be due to the following sources:

- Fire used for bamboo treatment and processing

- Electrical fires due to faulty electrical outlets

As bamboo is a flammable material, any bamboo craft unit should be prepared to protect against the dangers of fire. The following are the precautionary steps to ensure fire safety.

- Fire extinguishers should be placed in strategic locations and readily accessible. The validity of the fire extinguishers should be checked regularly and properly maintained.
- Fire exits and evacuation routes must be marked clearly with green colour and directional arrows. Fire exit signs must be designed to be visible in dim light or dark environments and also with photoluminescent material.
- Posters on the fire safety instructions, i.e. 'RACE' and 'PASS' and a list of post-emergency contact numbers, must be displayed in various places.
- All employees must be trained on fire safety procedures, including the proper use of fire extinguishers, evacuation routes, alarm systems and emergency contact numbers.

Fig. 6.17: Fire instructions

The following are the key emergency response steps in case of a fire emergency:

- **R** - All the occupants must be **removed** from the space.

- **A** - The fire alarm must be **activated** immediately to alert all people in the facility and call 101 to report the fire. The local fire services must be contacted and provided detailed information about the location and potential hazards.
- **C** – After removing all the occupants, the fire should be **confined** by turning off the ventilation systems to prevent it from spreading.
- **E** - Trained individuals should attempt to **extinguish** the fire using the nearest fire extinguisher following the acronym PASS (Pull, Aim, Squeeze, Sweep).

First aid should be provided to injured people and coordinated with emergency medical services if necessary.

Potential accidents and response to those scenarios

Cuts and wounds

The following are the cuts and wounds that are caused while working with bamboo and bamboo processing machine tools:

- Abrasions or minor lacerations
- Deep cuts or puncture wounds
- Wounds that bleed heavily or won't stop bleeding
- Wounds with visible foreign objects
- Boils due to repeated rubbing against the tool handle

Fig. 6.18: Different cuts and wounds

A significant number of injuries and their underlying causes are, in fact, predictable and preventable through organised and strategic preparedness measures. The following are a few preparedness measures to deal with an accident in a bamboo craft place:

- Appropriate personal protective equipment must be worn to avoid abrasions or minor lacerations.
- Safety precautions must be followed to avoid cuts or puncture wounds.
- To avoid boils. Well-fitted gloves with cushions for hands are required to reduce friction. Further, comfortable and non-slip handles are desired.
- A first aid kit with essential items like antibiotic ointment, sterile gauze pads, antiseptic wipes, adhesive bandages of various sizes, disposable gloves, tweezers and a pair of clean scissors should be kept in readily accessible locations.

Accidents are often viewed as unforeseen events or "acts of God" and are thus believed to be unavoidable. During an emergency with cuts and wounds, the following immediate steps are to be followed:

- Debris of any kind has to be removed using sterilized tweezers.
- Gently rinse the wound with clean running water or saline solution.
- It is recommended to gently rinse the wound with clean running water or saline solution.
- Bleeding has to be stopped by applying pressure with thoroughly washed hands.
- Put a thin layer of antibiotic cream on the cleaned wound.
- A sterile bandage or clean dressing must be applied to the wound.
- For deep cuts, puncture wounds or wounds that bleed heavily, the casualty must be taken to the nearest primary health care or the hospital.

Accidents due to bamboo splinters

- A "bamboo splinter" refers to a thin, sharp sliver of bamboo. Depending on the speed and size, bamboo splinters can penetrate various parts of the body:
- Bamboo splinters can penetrate the fornix area of the eyes and cause discomfort
- Bamboo splinters can deeply penetrate the corneal stroma which can lead to blurred vision
- Bamboo splinters can be lodged in muscle tissue and can easily cause infection.

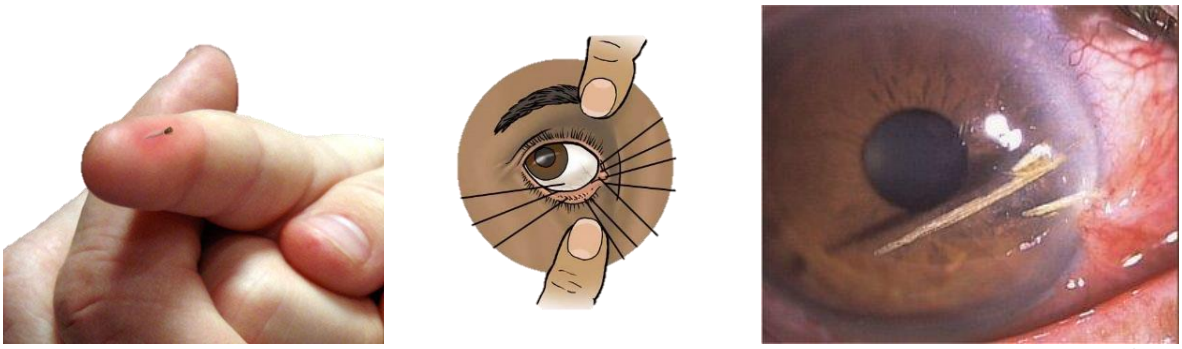


Fig. 6.19: Injuries due to bamboo splinters

The following are a few preparedness measures to avoid an accident due to the bamboo splinters:

- Appropriate personal protective equipment must be worn.
- Nitrile-coated gloves must be used while sanding and polishing.
- Safety goggles must be worn to protect eyes from splinters.

In case of accidents due to splinters, the following are the steps to be followed to remove splinters:

Splinters embedded under the skin

- After washing hands and the area around the splinter with soap and warm water, the splinter must be removed with a sterilized tweezer and a needle by pulling slowly and gently at the same angle the splinter went in.
- In case of unavailability of a tweezer and needle, a piece of adhesive tape can be applied over the area and peeled off to pull out the splinter.
- In case the splinter is not visible enough to remove, a thick paste of 1 tablespoon of baking soda and 1 tablespoon of water must be applied around the site of the splinter by covering it with a bandage for 24 hours. The splinter will pop out so that it can be removed by a tweezer and needle.

Fig. 6.20: Did you know

Banana peel or potato peel also can be applied in place of a soda-water mix to remove splinter.

Splinters lodged in the eyes

- Small splinters in the fornix area of the eyes can be removed with a cotton swab.
- Flushing eyes can remove invisible splinters with water.
- For severe conditions like penetration of splinters in the cornea, the casualty must be taken to the nearest primary health care or the hospital.

Fig. 6.21: Splinters lodged in the eyes

Accidents due to fall of bamboo pole

If a bamboo pole falls on the feet or hits the legs, depending on the size and weight of the pole, it can cause the following injuries:

- **Bruising:** This is the most frequent result, particularly with a smaller bamboo pole or a less intense impact.
- **Bone fractures:** A strong enough impact may lead to fractures in the foot, affecting areas such as the toes, metatarsals, or even the heel.
- **Crush injuries:** If a heavy bamboo pole lands directly on the foot, it can lead to considerable crushing damage to both the soft tissues and bones.
- **Lacerations**: If the bamboo pole has sharp edges, it could cut the skin and cause open wounds.

To prevent injuries from falling bamboo poles on feet or legs, the following are the primary safety considerations:

- Steel-toed safety shoes must be worn to protect the toes from impact injuries.
- Regular inspection of safety shoes is advised and damaged footwear must be replaced.

- Bamboo poles must be stacked securely on shelves, ensuring they are stacked properly and not overloaded. The recommended width and height of a stack are 1.5 m and 2.0 m respectively. The minimum distance between two stacks shall be 800 mm. The height of each stack should not exceed 300 mm. A typical stacking system is shown in Figure 6.21

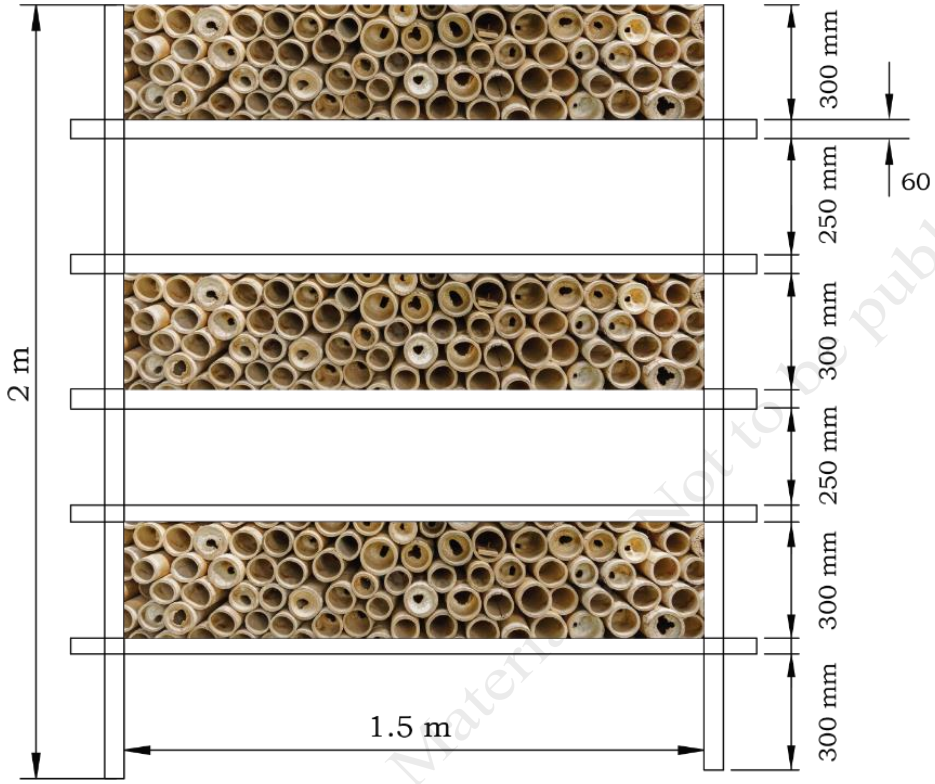


Fig. 6.22: Bamboo pole stacking system

The following are the emergency response steps, if there is any accident due to the fall of bamboo poles on the feet or hits the legs:

- For minor lacerations, cover the wound with a bandage or gauze pad after applying antibacterial ointment to the rinsed wound.
- For moderate injury and pain ice packs must be applied immediately to the affected area to reduce swelling and pain. To subside swelling and pain, medicine must be taken in consultation with the doctor.
- For immediate signs of serious injury like severe pain, visible deformity, or inability to bear weight, the accident victim must be taken to the nearest primary health care or hospital.

Crushed finger

A crushed finger constitutes a type of injury characterized by trauma to the finger, which can occur when it is subjected to forceful impact, jamming, or compression within bamboo processing machinery. Clinically, the symptoms of this injury may include localized pain, swelling, bruising and, in certain cases, the absence of sensory perception.

The following preventive measures may prevent crushed finger injury:

- A pinch point caution sign should be displayed to warn people of a potential hazard where moving parts of a machine can pinch or crush fingers or other body parts.
- Safety guards, guiding slots and stoppers should be provided on machinery to protect hands and fingers.
- All the craftsmen must be trained to use hand tools and machine tools securely to avoid accidental pinching.
- Appropriate gloves must be used to ensure safety.
- Proper lockout procedures must be followed during servicing machinery to avoid unanticipated start-up and avoid accidents.

Fig. 6.23: Caution

Despite all, if there are any incidents of crushed fingers, the following are the emergency response steps:

- Rings should be removed from the affected finger immediately before swelling.
- Open cuts should be gently cleaned with soap and water and a sterile bandage should be applied.
- To minimize swelling, the hand should be kept raised above heart level.
- Ice packs should be applied to the injured finger for 10 to 20 minutes at a time, multiple times a day.
- If there are visible deformities in the finger, blood under the fingernail, substantial bleeding that doesn't stop, deep cuts or loss of sensation in the finger, the injured person must be taken to the nearest primary health care or hospital.

Safety mock drill

A safety mock drill is a practice exercise that helps people prepare for emergencies. Safety mock drills should be conducted in craft spaces for the following reasons:

To create a culture of safety

- To ensure everyone knows their roles and responsibilities
- To understand emergency protocols
- To respond quickly and effectively to threats
- To review and evaluate emergency preparedness plans

Adhering to legal requirements regarding the frequency and type of drills conducted is essential to ensure compliance with all relevant regulations. Maintaining detailed records of these drills is crucial for accountability and evaluation purposes. Additionally, obtaining any necessary certifications or approvals from regulatory bodies helps ensure that all safety protocols are met and upheld effectively. The Directorate of Industrial Safety and Health (DISH) can be contacted to conduct mock drills to assess preparedness for industrial accidents.

Activities

Activity: Prepare a detailed report on Security & Emergency Management

Materials Required

1. Practical File
2. Coloured pens and pencils
3. Ruler
4. Eraser

Procedure

1. Visit a craft cluster.
2. Prepare a questionnaire.
3. Interview people trained for Security and emergency services.
4. Document it and prepare a detailed report of the same.

Check Your Progress

A. Fill in the blanks

1. An effective Environmental Management System (EMS) helps bamboo artisans reduce _____ impact and comply with legal regulations.
2. During emergencies like fires or gas leaks, bamboo artisans should follow a predefined _____ plan to ensure safety and reduce panic.
3. Bamboo workshops must store flammable materials like varnish or adhesives in a _____-ventilated area away from heat sources.
4. The _____ procedure involves identifying, reporting and taking corrective action after any environmental accident.

5. The concept of "_____ Responsibility" encourages artisans to adopt sustainable practices and prevent environmental damage.

B. Long Answer Questions

1. Explain the key phases of the Environmental Management System (EMS) as outlined in ISO 14001 and discuss how they contribute to continuous environmental improvement in an organization.
2. Describe the importance of emergency preparedness and response in the context of environmental management and outline the steps an organization should take to mitigate potential environmental impacts during an emergency.

C. Short Answer Questions

1. What is the primary purpose of the PDCA cycle in the EMS framework?
2. Name two common potential accidents in the manufacturing industry and explain one preventive measure for each.

Glossary

A

- **Anatomy**: The structural components or physical makeup of bamboo.
- **Applique**: A technique of decorating objects by attaching pieces of fabric or material.
- **Arborescent**: Tree-like in growth or appearance.
- **Artisanry**: The skill and craftsmanship of creating handmade items.

B

- **Bambusoideae**: The botanical subfamily of grasses to which bamboo belongs.
- **Boucherie Method**: A bamboo preservation method where preservatives are forced through the length of fresh bamboo using pressure.
- **Borosilicate Solution**: A chemical solution used in bamboo preservation to enhance resistance against pests.

C

- **Caryopsis**: A type of dry fruit that forms in some bamboo species.
- **Culm**: The hollow, woody stem of bamboo, used in crafting and construction.
- **Culmsheath**: A protective casing at each node of bamboo that shields young shoots.

D

- **Decentralized System**: A production model where resources and manufacturing are spread across smaller, localized units.
- **Density**: The compactness of bamboo material, influencing strength and durability.
- **Diffusion**: The movement of chemicals through bamboo during preservation processes.

E

- **Eco-Design**: Designing products with environmental sustainability in focus.
- **Elasticity**: Bamboo's ability to regain its shape after deformation.
- **End Applications**: Final uses or purposes of treated bamboo, such as furniture or construction.

F

- **Famine Food**: Bamboo shoots used as an emergency food source.
- **Flexibility**: Bamboo's ability to bend without breaking, essential for crafting.

G

- **Green Gold**: A term symbolizing bamboo's economic and environmental value.
- **Guild**: Historical associations of craftsmen or merchants with similar skills.

H

- **Handloom**: A manual weaving technique using a non-electric loom.
- **Hydrolysis**: A chemical reaction involving water, used in bamboo treatment.

I

- **Internode**: The hollow section between two nodes on a bamboo culm.
- **Inflorescence**: The arrangement of flowers on bamboo.

L

- **Leaching**: A traditional method of soaking bamboo in water to remove starches.
- **Lacquering**: Applying a protective finish to bamboo for durability and aesthetics.

M

- **Mechanical Properties**: Characteristics like strength and flexibility that determine bamboo's usability.
- **Modulus of Elasticity**: A measure of bamboo's deformation under stress.

N

- **Node**: A joint on a bamboo culm where leaves or branches emerge.

P

- **Pachymorph**: A clumping type of bamboo rhizome.
- **Perennial**: A plant that lives for multiple years, like bamboo.
- **Preservative Penetration**: The depth to which chemicals enter bamboo during treatment.

R

- **Rhizome**: The underground stem of bamboo that supports its growth and spread.
- **Running Rhizome**: A horizontally spreading rhizome type producing distant bamboo shoots.

S

- **Sap Replacement**: Replacing natural sap in bamboo with preservatives during treatment.

- **Splits**: Thin sections of bamboo culms for weaving or construction.
- **Starch Content**: Natural sugars in bamboo that attract pests and require removal for durability.

T

- **Tensile Strength**: Bamboo's capacity to resist pulling forces.
- **Transpiration**: The process by which water moves through bamboo vessels, aiding treatment.

V

- **Vascular Bundle**: Groups of cells in bamboo that conduct water and nutrients.

W

- **Wax Coating**: A natural layer on bamboo culms that can interfere with chemical treatments.

Answer Key

Unit 1

Session 1

Fill in the blanks

1. Traditional
2. 35
3. 50
4. National Bamboo Mission
5. 85

Session 2

Fill in the blanks

1. Poaceae
2. Reliable Information
3. Renewable
4. Bamboo Farming
5. Improvements

Session 3

Fill in the blanks

1. Skillfully
2. Hand-Eye
3. Quality Assurance
4. Analytical
5. Safety

Unit 2

Session 1

Fill in the blanks

1. Grass
2. 125
3. Kashmir
4. Rhizomes
5. Tensile

Session 2

Fill in the blanks

1. Tulda
2. Melocanna Baccifera
3. Bambusa Arundinacea
4. Dendrocalamus Strictus
5. Bambusa Vulgaris

Session 3

Fill in the blanks

1. Degradation
2. Leaching
3. Long-lasting
4. Fungal
5. Butt Treatment

Session 4

Fill in the blanks

1. Durability
2. Slivers
3. Splits
4. Absorbent
5. Charcoal

Unit 3

Session 1

Fill in the blanks

1. Calipers
2. Hand Splitter
3. Four-Side Planer
4. Node Removing Machine
5. Carpenter's Vice / C Clamp / Multi Vise Tool

Session 2

Fill in the blanks

1. Dyeing

2. Mordant
3. Roots
4. Dried
5. Weaving

Session 3

Fill in the blanks

1. Drilling
2. Interlock
3. Hole
4. Bamboo dust
5. Varnish

Session 4

Fill in the blanks

1. Joinery
2. Hole
3. Sanding machines
4. Bamboo dust
5. Varnish

Session 5

Fill in the blanks

1. Plant organiser
2. Key holder
3. Weaving
4. Tray
5. Cup

Unit 4

Session 1

Fill in the blanks

1. Modernism
2. 3D printing
3. 2D to 3D
4. Hyperlocal

Session 2

Fill in the blanks

1. Rapid
2. Eco-Friendly
3. Rural
4. Sequester
5. Manufacturing

Session 3

Fill in the blanks

1. 3 feet
2. 3-5 years
3. 35
4. Water
5. Chemicals

Unit 5

Session 1

Fill in the blanks

1. Bamboo Poles
2. Clean
3. Oiling
4. Dried
5. Damage

Session 2

Fill in the blanks

1. Dry
2. Drains
3. 30
4. Repurposing
5. Particle

Session 3

Fill in the blanks

1. Mishaps
2. Safety

3. Inconsistent
4. Longevity
5. Lubrication

Unit 6

Session 1

Fill in the blanks

1. Injury
2. Semi-skilled or marginal
3. Mishaps
4. Enhance
5. Psychological

Session 2

Fill in the blanks

1. Ill
2. Emergency
3. Gloves
4. 30
5. Producer

Session 3

Fill in the blanks

1. Environmental
2. Evacuation
3. Well
4. Incident reporting
5.Personal

List of Credits

Tarunay Singh : 1.2, 1.6, 2.15, 2.16, 2.17, 2.18, 2.19, 2.20, 2.21, 2.22, 2.23, 2.24, 2.25, 2.26, 2.27, 2.31(a), 2.31(b), 2.32, 2.33, 2.34, 2.35, 2.36, 2.37, 3.3, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.11, 3.12, 3.13, 3.29, 3.30, 3.31, 3.32, 3.33, 3.35, 3.36, 3.37, 3.38, 3.39, 3.40, 3.41, 3.42, 3.43, 3.44, 3.45, 3.53, 3.61, 3.62, 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 4.13, 4.14, 4.15, 4.16, 4,17, 4.18, 4.19, 4.20, 4.21, 4.22, 4.23, 4.24, 4.25, 4.26, 4.27, 4.28, 4.29, 4.30, 4.31, 4.32, 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10, 5.11, 5.12, 5.13, 5.14, 5.17, 5.18, 5.19, 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8, 6.9, 6.10, 6.11, 6.12, 6.13, 6.14, 6.15, 6.16, 6.17, 6.18, 6.19, 6.20, 6.21, 6.22

Prachi Verma : 1.1, 1.3, 1.4, 1.5, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10, 2.11, 2.12(a & b), 2.13, 2.14, 2.28, 2.29, 2.30, 2.38, 2.39(a & b), 3.1, 3.2, 3.4, 3.14, 3.15, 3.16, 3.17, 3.18, 3.19, 3.20, 3.21, 3.22, 3.23, 3.24, 3.25, 3.26, 3.27 (a & b), 3.28, 3.34, 3.46, 3.47, 3.48, 3.49, 3.51, 3.52, 3.54, 3.55, 3.56, 3.57, 3.60, 3.61, 3.62, 3.63, 3.64, 3.65, 4.33, 5.15, 5.16, 6.23 and Design Palette

Raghuveer Singh : 3.47, 3.50, 3.58, 3.59, 3.63, 3.64

Ashish Kathane : Typing, Layout and Composing

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