

Bamboo cultivation: Opportunities and value addition for sustainable livelihoods

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Since 2017, the deregulation of bamboo harvesting and transport in India has promoted large-scale bamboo cultivation on private farmlands. Bamboo is a highly versatile agroforestry species widely used in agriculture, horticulture, dryland farming, and rural households, generating significant rural employment. National demand for bamboo is rising, with added importance in biofuel production and as an eco-friendly alternative to plastics. It grows well in light soils, reduces soil erosion, and supports soil and water conservation, making it vital for climate resilience and sustainable land management.

Keywords: Agroforestry, Value addition, Sustainable livelihood

INDIA is the world's second-largest producer of bamboo. Since 2017, the Government of India and especially in Maharashtra have excluded bamboo from the category of forest trees, thereby removing restrictions on its harvesting and transportation. This change has encouraged large-scale bamboo cultivation on private farmlands in Maharashtra. Among agroforestry tree species, bamboo stands out as the most versatile for its utility in preparation of agricultural implements, field fencing, and animal shelters. Furthermore, in rural households, it is widely used for crafting daily utility items, toys, grain storage structures, and more. Such applications generate employment opportunities for local communities through cultivation, processing, and marketing.

In Vidarbha's agroforestry systems, species such as *Bambusa katan*, *B. vulagris*, *B. stalky*, *B. polymorpha*, *B. balcooa*, *B. tulda*, and *B. olivieri* are cultivated. Around 7 lakh hectares of land are devoted to fruit orchards such as oranges, mangoes, amla, and guava, along with vegetable crops, where bamboo

is used for staking and supporting plants. It also plays a vital role in storing and transporting fruits. A major share of India's bamboo harvest is supplied to paper mills as raw material. In 2020, the demand for bamboo and bamboo-based products in India reached about 20 million tonnes, with projections suggesting a rise to 23–24 million tonnes by 2024–25.

Cultivation practices in bamboo

Site and soil selection: Bamboo grows well in a wide range of soils, from light to medium-textured soils, with good drainage. Slightly acidic to neutral pH (5.5–7.5) is ideal. Most species perform well under tropical and subtropical climates with annual rainfall of 1,000–2,500 mm.

Selection of species: The selection of species mostly depends on two factors i.e. purpose of use and agro-climatic conditions of the region. Common cultivated species include *Dendrocalamus strictus*, *Bambusa bambos*, *B. balcooa*, *B. tulda*, and *D. asper* for timber, pulp, construction, and energy purposes.

Planting material and propagation: Bamboo is propagated

using offsets, culm cuttings, branch cuttings, or tissue-cultured plantlets.

Land preparation and planting: Pits (60 cm × 60 cm × 60 cm) are prepared and filled with topsoil mixed with FYM or compost. Spacing generally ranges from 5 m × 5 m to 7 m × 7 m, depending on species and management intensity. Planting is mostly done during the monsoon.

Nutrient management: Nitrogen is especially important during early growth stages. Fertiliser dose of 100:40:125 g per clump should be maintained during early stage of establishment.

Irrigation and moisture conservation: Bamboo has drought tolerant capacity but scheduled irrigation improves growth. Mulching and water conservation measures also enhance soil moisture retention.

Intercultural operations: Weeding, mulching and removal of weak or dead culms help maintain clump health. Protection from grazing and fire is essential during early stages.

Harvesting and clump management: Regular cultivation

and harvesting should be carried out annually in bamboo plantations, as this encourages the sprouting of new shoots and ensures a steady supply of bamboo for sale. For commercial use, harvesting commences in the third year after planting, but clumps generally reach maturity by the fourth year, enabling consistent and continuous bamboo production.

Rules for bamboo cutting

- Bamboo should not be harvested during its active growth phase, i.e. from mid-June to mid-September. The most suitable period for harvesting is between November and February.
- Immature bamboo must not be cut; clumps with fewer than 10 culms are considered immature.
- Priority should be given to removing half-broken, crooked, or dried culms first.
- For every young and tender shoot, at least two mature culms should be left in the clump to provide support.
- During the monsoon, bamboo uses large amounts of nutrients to develop new rhizomes, resulting in a high sugar content in the culms. Harvesting at this stage increases susceptibility to borers and fungal infections.
- Care must be taken to avoid exposing or damaging the root system.
- Mature culms retained in the clump should be cut in a way that ensures proper spacing within the clump.
- A specialised saw should be used for felling bamboo.
- After harvesting, all leftover debris should be cleared from the clump to reduce the risk of pest infestation and fire hazards.

Management of bamboo groves after harvesting

In bamboo plantations, the typical clump structure follows a ratio of 3:3:3:1 for the first, second, third, and fourth-year culms, respectively. However, in plantations focused on culm (cob) production, clump management practices differ.

- The number of mature culms

harvested should never exceed the number of healthy new shoots in the clump, as these shoots develop into bamboo in the following year.

- Any weak, stunted, or diseased shoots should be removed promptly once identified.
- Before harvesting begins, a thorough inspection of the clump is necessary to determine which culms should be cut.
- Marking mature culms beforehand speeds up the selection process, and pruning the lower branches from selected bamboo makes cutting and removal easier.
- Culms should be cut at least one, preferably two, nodes above the ground to minimise the risk of damaging the rhizome.
- A slanted cut is recommended to prevent rainwater, debris, and thorns from collecting on the remaining stump.

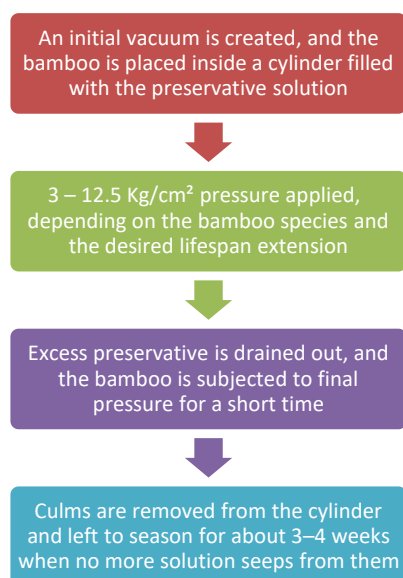
Processing of newly harvested bamboo

When bamboo is intended for outdoor or ground use, it can be treated for solar protection through different methods: soaking in hot water for about 2 h, immersing in an open tank for 4–6 h, or fumigation for 1 h.

Table 1. Treatment methods and their effectiveness

Treatment method	Absorption (kg/m ³) (Creosote + Fuel oil 50:50)	Bamboo lifespan (years)
Hot water immersion	16–32	2–5
Open tank immersion	48–96	10–15
Pressure process	48–128	10–20

Since bamboo is prone to cracking during drying, large amounts of chemical preservatives can be absorbed using open tank or pressure treatments. However, this method also has drawbacks, such as the difficulty of removing excess preservatives and the associated higher costs. Despite these limitations, bamboo lifespan can be extended up to 10–20 years with open tank or pressure treatment



Compression process of bamboo treatment

processes.

Processing of green and wet bamboo: Unlike wood, bamboo lacks concentric growth rings spreading outward from the center. Both the inner and outer cell layers of bamboo are shielded by tough protective tissues, which, in dried bamboo, restrict water absorption during processing or pressure treatments.

The structural arrangement of fibres and inner tissues gives bamboo its refractive properties, encouraging exploration of alternative methods beyond traditional pressure treatment. The dense, rigid skin of dried bamboo makes it difficult for chemical preservatives to penetrate. In contrast, living bamboo has more fluid cells, where nutrient movement occurs through interflow. This property is advantageous in processing freshly harvested (green) bamboo, as it allows for internal nutrient exchange and better treatment outcomes.

Assembling process: This method is one of the simplest and most effective techniques for preserving freshly cut or green round bamboo. In this process, bamboo that is three to four years old is submerged in a chemical preservative solution, allowing sufficient absorption to reach the required depth. Since the method requires only basic tools and minimal technical expertise, it can be applied widely for various bamboo



Assembling method of bamboo processing

processing needs.

However, careful attention must be given to key factors such as the choice of preservative, its concentration in the solution, and the length of immersion. When bamboo is intended for ground use, it should remain immersed in the preservative solution for about five to six weeks. As a result, this preservation method, while effective, is relatively time-consuming.

Protective methods of bamboo handicrafts:

Bamboo based handicrafts are highly vulnerable to insect infestations, which can lead to rapid deterioration and cause major losses to the handicraft industry. To prevent this, chemical preservation is essential. Boric acid and borax are commonly used since they are safe for humans and pose no health hazards, making them suitable even for items used to store food. A 5% solution in a 2.5:2.5 ratio is typically applied. Additionally, a 2% solution of sodium pentachlorophenate (NaPCP) has proven effective in controlling insect attacks. This aqueous solution can be applied directly to finished bamboo products, generally three times at 24 h intervals. The following precautions should be taken when using chemical preservatives.

- Always wear protective gear i.e. gloves, boots, helmet, and goggles.
- Store chemicals safely and follow manufacturer instructions.
- Spray in the wind's direction.
- Wash or shower after work and change clothes regularly.
- Keep chemicals and containers away from children; bury empty containers safely.
- Prevent sediment buildup in solutions.

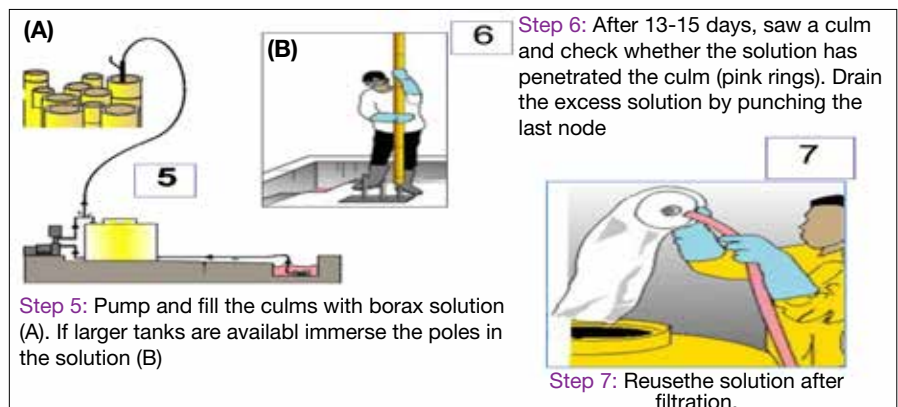
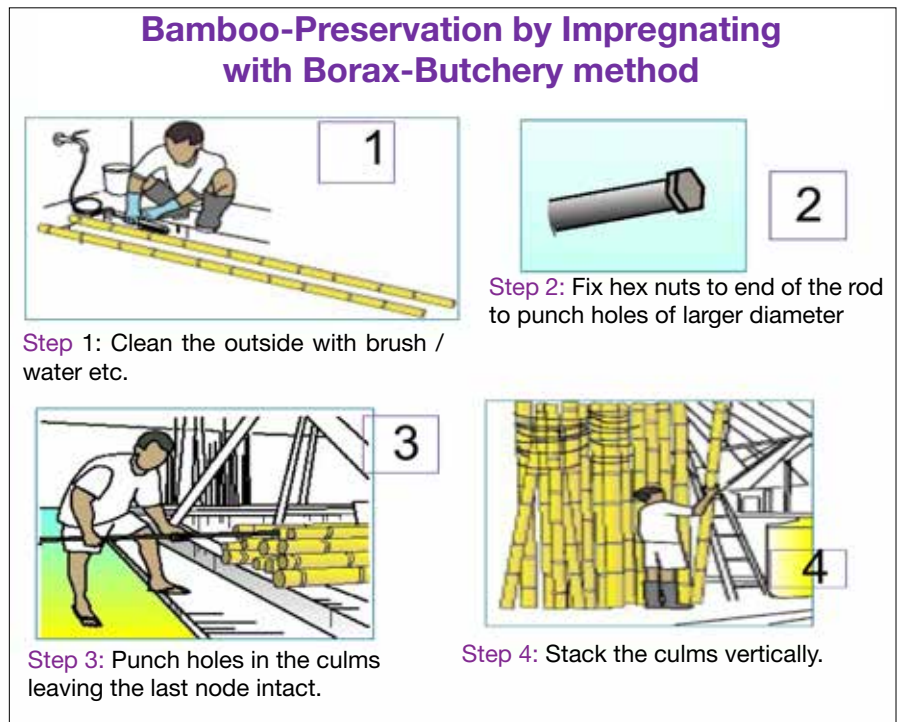
- Do not move treated bamboo until dripping stops.
- Store water-treated bamboo [Copper, chromium, arsenic (CCA)/ Copper, chromium, boron (CCB)] under cover until fully dry.
- Dispose leftover solutions by evaporating water and bury residues in inert soil.
- Discard chemicals only in

designated underground or dumping sites.

- Never burn or release CCA-treated bamboo into water bodies.
- Ensure all workers receive proper training, safety gear, and information.

Bamboo wastage and its derivatives

Bamboo wastage refers to the unused or discarded by-products generated during bamboo cultivation, harvesting, processing, and utilisation. It mainly includes tops, branches, leaves, nodes, split residues, sawdust, shavings, rejected culms, and additional waste from bamboo-based industries such as paper, furniture, incense sticks, and handicrafts. However, bamboo wastage has high potential



Source: bambooman.com.au/infos/treating-process-of-bamboo

value and can be effectively utilised for bioenergy (pellets, briquettes, charcoal, biofuel), compost and biochar production, particle boards and composites, mulching and soil amendment, and paper and pulp recovery.

Bamboo charcoal: It is a carbon-rich material produced by the pyrolysis of bamboo under limited or no oxygen conditions. It is an eco-friendly, renewable product with wide agricultural, environmental, and industrial applications. It has a highly porous structure and large surface area, leading to excellent adsorption capacity. It is widely used for soil improvement, as it enhances soil structure, water-holding capacity, nutrient retention, and microbial activity, while also helping to immobilise heavy metals and reduce soil acidity. In agriculture and horticulture, bamboo charcoal/biochar improves crop productivity and long-term soil health. Environmentally, bamboo charcoal acts as a carbon sink, contributing to climate change mitigation by storing stable carbon in soils for long periods. It is also used in water and air purification, odour control, and as an eco-friendly alternative to activated carbon.

Bamboo pellets: These are solid biofuel produced by compressing processed bamboo biomass such as culms, branches, leaves, and bamboo processing residues into dense, uniform pellets. Bamboo pellets have high bulk density, good mechanical strength, and high calorific value, making them suitable for domestic heating, industrial boilers, gasifiers, and power generation. Compared to loose bamboo residues, pelletisation improves handling, storage, and transportation efficiency while ensuring uniform combustion. Also bamboo pellets are carbon-neutral, as the CO₂ released during combustion is offset by carbon sequestration during bamboo growth.

Bamboo compost: It is an organic soil amendment produced by decomposing bamboo residues such as leaves, tender branches, culm shavings, and processing waste through controlled composting. It

offers an effective way to recycle bamboo wastage into a valuable input for sustainable agriculture. Bamboo compost is rich in organic carbon and contributes to improved soil structure, aeration, water-holding capacity, and microbial activity. It enhances soil fertility, improves nutrient availability, and supports long-term soil health, particularly in degraded and light soils. In addition, it reduces waste accumulation, lowers reliance on chemical fertilisers, and promotes carbon sequestration, which aligns with circular economy and climate-smart agriculture practices.

Value-added uses of bamboo

Bamboo is a lightweight yet strong and durable material. Because of its natural flexibility, it is widely used in construction. Its structural strength and physical properties give it clear advantages over many other building materials. The unique hollow form and longitudinally aligned fibre design of bamboo makes it more efficient and lighter than bulkier materials like wood. While most materials are efficient in only one or two directions, bamboo

provides strength across multiple directions.

It serves diverse purposes, from traditional crafts such as basketry to industrial uses including roofing, panels, tiles, and wall cladding. In tropical regions, bamboo plays a vital role in daily life, offering shelter, fuel, employment, and income.

Bamboo and paper: Paper can be produced from bamboo fibres, resulting in a strong and durable product. Bleached bamboo pulp is used for offset printing paper, typing paper, and high-quality cultural papers, while unbleached bamboo pulp is commonly used in packaging paper.

Fuel (Coal): Bamboo can be converted into energy through gasification, which produces methane gas along with bamboo-based charcoal. Since both fuels are generated together, the process is highly efficient and profitable. Bamboo charcoal, in particular, serves as a clean, solid fuel comparable to conventional coal.

Bamboo pellets: Bamboo pellets are compact, cylindrical bio-products made by densifying



1 (Bamboo temple)



2 (Bamboo wall panel)



3 (Bamboo in house construction)



4 (Bamboo charcoal)



5 (Bamboo handicraft)



6 (Bamboo support for dragon fruit)



7 (Bamboo stocks)



8 (Bamboo shoots)



9 (Bamboo food preparation)

Value-added uses and products of bamboo

Source: Image No. 8 and 9 are taken from Book 'Management of Bamboo Clump' published by PDKV, Akola

processed bamboo biomass under high pressure. Due to their high lignin content, bamboo pellets exhibit good mechanical strength and durability without the need for external binders.

Furniture and handicrafts: Its low cost and versatility make it ideal for daily-use items like mats, stools, baskets, traps, and decorative goods. Beyond these, bamboo is also fashioned into artistic and lifestyle products such as torans, lamps, rakhis, jewelry, toothbrushes, pens, nameplates, and ornamental crafts.

Construction: Bamboo has long been valued as a building material for scaffolding, bridges, homes, and structural components. Its strength-to-weight ratio is comparable to wood, with mechanical strength similar to strong softwoods or even hardwoods, making it reliable for high-load applications, reinforcement, fencing, etc.

Musical instruments: Traditional instruments like flutes, trumpets, xylophones, and drums are often made from bamboo.

Traditional medicine: Bamboo has medicinal value, offering antioxidant, anti-inflammatory, liver-protective, and neuroprotective properties. Its leaves are traditionally used to treat ailments such as diabetes, atherosclerosis, and neurological disorders.

Food (Shoots): Tender bamboo shoots are nutritious, low in calories, and rich in fibre (one cup contains about 13 calories). They enhance meals with both flavour and health benefits. Additionally, bamboo leaves are brewed into a green tea with wellness-promoting properties.

Fodder: Bamboo leaves contain 1–3% nitrogen on a dry weight basis, which corresponds to about 6–19% protein, making them comparable to other grass-based animal feeds. In some regions, such as Australia, bamboo leaves are even used as a natural fertiliser for agricultural fields.

Bamboo compost: Bamboo compost is an organic soil amendment rich in organic carbon and beneficial microorganisms.

It improves soil structure, water-holding capacity, and nutrient availability. Its use supports sustainable waste management in bamboo-based agroforestry systems while enhancing soil fertility and long-term soil health.

SUMMARY

Bamboo thrives well in lighter soils owing to its specialised root system and helps in maintaining soil fertility. Converting raw bamboo culms into higher-value products and services (furniture, panels, engineered product charcoal, textiles, processed food, handicrafts, building components, biochar, activated carbon, etc.) involves processing, treatment, design, branding and market linkages. This helps to increase the shelf life, fetch good price and market reach of bamboo products which, in turn, helps in getting employment, higher income and rural development.

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