

*BamCraft – Crafting a Green Future: Bamboo
in the curio and souvenir industry of Kenya*

Bamboo Training Manual 1: Bamboo Harvesting and Preservation

Funded by:



Government of Japan

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United Nations Industrial
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1 THE BAMBOO PLANT

Every type of bamboo product that is manufactured with a view towards quality and durability makes use of raw materials with distinct physical and mechanical properties. Making the best use of bamboo requires a little understanding about the biology of the plant. Some general observations on the growth of bamboo are therefore noteworthy.

BAMBOO IS A NOT A TREE

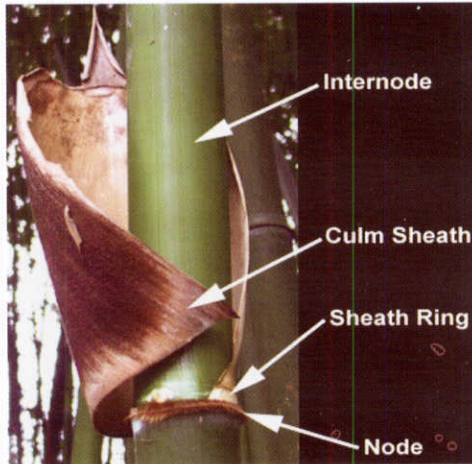
The most common bamboos are timber species which resemble trees in some ways. However, bamboos are not trees. Bamboo is a member of the grass family. There are over 1200 species of bamboo, many of which are tree-like timber varieties, while many others are herbaceous and resemble shrubby plants of the grass family.

All bamboos – including large tree-like species -- share the biological features of grasses, most notably their jointed stems. Nodes that are apparent in bamboo poles or culms are characteristic features throughout the plant, including the underground rhizomes and the branches.

When a bamboo seed germinates or when a young bamboo plantlet is cultivated, the rhizomes develop and generate new shoots that emerge from the soil. Each young shoot develops into a “culm” or pole by elongating vertically towards its

maximum height. Bamboo culms are the aerial parts of the bamboo plant which develop and grow from the underground rhizome system.

Internodes are the separate sections of the culm. A node is the connecting ring of on each section of the culm that separates one internode from another. Nodes are present in rhizomes and new shoots of the bamboo plant. The internodes of new culms are protected by sheaths that are attached to rings at the nodes. Sheaths fall off as the culm grows and develop branches.



The process of vertical growth of culms is fully completed in one growing season, and lasts between 3 to 6 months depending on the species. Unlike trees, individual bamboo culms do not grow diametrically or become thicker over time. The diameter of the bamboo culm remains unchanged throughout its lifespan.

Each year, with the progressive growth and development of the rhizome system, larger shoots will emerge from the soil. Usually within 4 to 5 years, the emerging shoots will attain the maximum size and diameter typical of the species, and the clump will include several new culms with a large diameter. In subsequent years, the diameter and size of new culms will not increase. It is at this stage in time when it can be said that the clump or grove has reached maturity.

LIFESPAN OF CULMS AND OF THE BAMBOO PLANT

The life of a standing bamboo culm is about 10 years, but this figure may be more or less depending on the species. Individual culms undergo a gradual process of development. As a culm matures, it becomes harder and acquires the properties of timber. With the passage of years, the standing culm gradually loses its strength and eventually dies.

The maturity and lifespan of individual culms should not be confused with the maturity and lifetime of the bamboo plant. This biological feature of bamboo is important. The bamboo plant is sustained by its rhizome system. When old culms die, the bamboo plant will continue to live on, and generate new culms. The natural lifespan of the bamboo plant is usually more than 50 years for many species, and over a hundred years for many others.







2 MATERIAL PROPERTIES OF BAMBOO CULMS

The material properties of the bamboo culm develop and change year after year. Knowledge of the material properties of bamboo, particularly in relation to the age and parts of the culm, is essential for selecting raw materials for bamboo products.

NEW CULMS: New culms (i.e. younger than 1 year old) are soft and their moisture content is high. Their fibers are tender and they lack the sturdiness of older culms.

LIGNIFICATION: As a culm ages, it undergoes a lignification process, which involves the thickening of plant cell walls through the deposition of lignin, making the bamboo harder and more woody.

MATURITY: The 'mature age' of a bamboo culm can be defined as the point in time when the culm has ripened and reached the vital peak of its development in terms of its specific biological, chemical, and mechanical properties. The culms of many small bamboo species are fully mature when they are 2 years old. The culms of mid to large timber bamboos generally mature when they are 3-4 years old. This is the case with *Yushania alpina*, the indigineous highland species of Kenya.

DETERIORATION: In the years following maturity, the bamboo culm gradually becomes old and weak. Culms that are not harvested will eventually dry out, die, and decompose. As a general rule, the vitality, quality, and strength of culms deteriorate substantially 3 years after they reach their peak of maturity.

PROPERTIES ALONG THE LENGTH OF THE CULM

The properties of the culm differ in varying degrees along its length. In particular, the fibers of the lower part of the bamboo culm are generally more tender, flexible, and pliable compared to fibers in the higher section or tip.

The base and middle sections of the culm are closer to the roots and rhizomes which supply food and energy to the whole plant. Moisture and nutrition follows an upward path along the cells of the culm, diverting throughout the branches and foliage, and extending towards the tip of the culm. Accordingly, there is greater moisture in the cells and fibers of the lower and middle culm sections, than in the upper sections. The upper portion and tip of the culm receives direct sunlight and more heat in comparison to the lower portion, which is shaded by the canopy of foliage. This component of solar radiation also contributes to the properties of fibers at various levels of a culm's height.





3

SELECTION AND HARVESTING OF BAMBOO CULMS

The selection of bamboo raw materials is very important for making high quality products. Culm size, age, and the growing environment of bamboos are the main criteria for selecting raw materials.

PROPERTIES FOR SPECIFIC APPLICATIONS

The raw material required depends greatly on the intended application and desired characteristics of the product that will be manufactured. For instance:

- New culms (i.e., younger than 1 year old), which have very soft and flexible fibers, can be used as finishing strips for weaving and for making bamboo fiber for crochet weaving.
- Fibers from 1 year old culms, which are quite tender, are the best materials for plain woven products such as mats.
- For plain bamboo weaving, the base and middle portion of the culms are ideal materials, since they have more tender fibers than upper section of the culm.

- 3 to 4 year old culms are ideal for bamboo furniture making.

DETERMINING THE AGE OF BAMBOO CULMS

Identifying the age of bamboo culms is an essential skill in the raw material selection. There are two practical methods to identify the age of culms.

Colour of the Culm

Identifying the age of bamboo culms by their colour is possible with new and young culms, but is increasingly difficult for older culms. One year old culms generally have a distinctive sheen, which is typical for green, yellow, and black bamboo varieties. Bamboos with green culms generally have a dark green colour when they are 1 year old, but as the culms age, their colour gradually fades and becomes murky. For most species, it is difficult to distinguish 2 and 3 year old culms by their colour. Differences in soil and climatic conditions can have a significant impact on the appearance of the same species in different locations. In effect, ascertaining the age of culms by means of colour is not a very reliable method unless

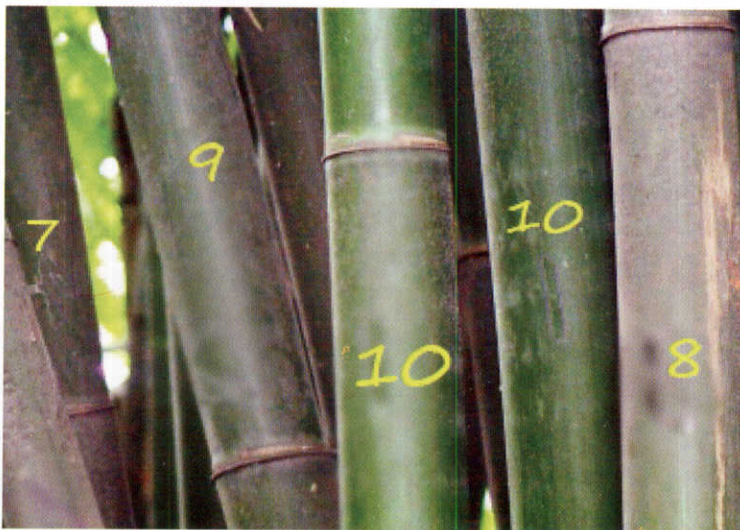


The photo shows 1,2,3 and 4 year old culms. Note that the older culms are less shiny but they are most suitable for making furniture.

one has carefully observed the pattern of colour changes of culms of a species, year after year, in a specific environment or location. At best, observing the colour of culms can provide clues to estimate whether the culm is young, mature, old, but such assessments may be off the mark by several years. As a rule, when culms are needed for furniture making or for construction, select the culms that are not shiny or which do not have the most attractive outer surface.

Marking Culms

The difficulty of determining the age of culms has led to the implementation of a very reliable method which involves marking each new culm. The method is laborious since it involves inspection of an entire plantation or forest and marking each new culm with code indicating the year of emergence. For example, the new culms that emerged in year 2011 can be marked with “11” using indelible ink or paint. Culms that emerge in 2012 can be marked with “12”,



The photo shows marked culms that emerged in 2007, 2008, 2009 and 2010.

and so on for subsequent years. The markings simplify harvesting culms by their age.

HARVESTING

As mentioned above, each bamboo application requires materials with specific characteristics which are related to the age of the culm and to the part of the culm.

Selection of Culms

Before harvesting, it is very important to select the culms suitable to the intended application.

For bamboo weaving, 1 year old culms should be selected. The thickness of the culm wall of the species is important because it will determine the number of layers and strips that can be obtained from a culm. On the other hand, if the culm is too strong, it will be difficult to strip the bamboo. It is therefore important to select the species for harvesting very carefully.

For making bamboo furniture, select culms that are mature (3-4 years old). The choice of species for furniture making is very important because the culms walls should have a minimum diameter of 3 cm with culm walls of at least 5 mm. The diameter of the culm and the thickness of the culm walls may be larger, depending on the type of furniture. As a rule, very small and thin culms are not suitable for furniture making. If the culms are too thin, the material will not have the strength to support weight, as required by the type of furniture. Medium to large bamboo species are suitable for making furniture. In Kenya and other parts of Eastern Africa, *Yushania alpina* is used for making furniture.

When to Harvest?

The time of harvesting is very important. Bamboos grow during the rainy season. During the season of growth, the culms have very high moisture content and also a high starch content which provides nutrients to the plant and supports its growth and expansion. Bamboo poles should therefore never be harvested during the rainy or growing season. They should be harvested during the dry season. In other words, bamboo culms should be harvested at the time of the year when the moisture content and starch content of the culms is lowest. The period of harvesting varies from location to location. The climate in each region varies depending on

its latitude, so it is important to be aware of climatic patterns of the specific region. In many areas, for example, along equatorial zones, there are short and long rainy seasons, and each bamboo species behaves differently according to the climatic patterns. As a rule, only harvest the culms during the driest periods of the year.

Culms should be harvested selectively, according to the requirements of the product and industry. The culms should be cut between the first and second node, or around 15 to 20 cm above the ground.

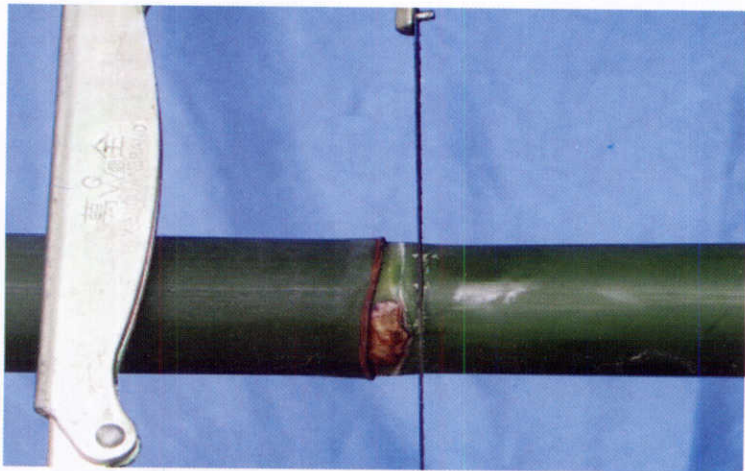
After cutting down bamboo culms, they will have to be carried to a nearby area where initial post harvest treatment can begin.

Removal of Branches

The first step after harvesting is to remove all the branches of the culm. Branches should be cautiously removed in order to avoid scrapping the epidermis and damaging the culm.

Cutting the culm into sections

To cut the bamboo culms into sections, place the saw about 1 cm away from the node and cut parallel to the node. A straight cross section cut will enable one to see the actual thickness of the culm wall. Once the culm is stripped of its branches and foliage, the culm should be cut into sections in order to facilitate transport to the area where processing will take place.





4 **BAMBOO PRESERVATION TREATMENT**

Why preserve bamboo?

Bamboo is a fast growing source of timber with a multitude of uses. Furniture and house construction are common applications. However, bamboo culms are rich in starch content and are very susceptible to biological degradation. This is a factor that curtails the value and wider application of bamboo.

The perishability of bamboo therefore needs to be addressed to elevate its status as a structural material that can substitute wood for durable applications.

The purpose of preservation is to remove the nourishment that attracts insects and other pests that feed on bamboo. The lifetime of bamboo that is not preserved is about 2 years. When bamboo is well preserved it can last for over 20 years.

TECHNICAL NOTES

Bamboo, in its natural state, is not a durable material. It is easily attacked by insects and fungi due to the presence of starch and sugar in the culms. Preservation treatment is essential to enhance durability of culms during storage and of finished products. Preservation makes the difference between traditional uses — where bamboo was dubbed as the poor man's timber— and modern bamboo applications.

When treated with chemicals, borers and termites will not eat bamboo. Former generations unknowingly used hazardous chemicals and many illnesses have been traced to wood preservatives. Treatment must not be toxic to people; it just has to stop the borers and termites, which love to feed on bamboo culms.

Villagers and artisans in many parts of the world have traditionally used some natural methods of preserving bamboo. Although such traditional methods provide some resistance to insect and fungal attack on freshly cut culms, they do not ensure long-term durability and are not recommended for bamboo that will be used for commercial products.

Non-Chemical Methods

Some traditional/non-chemical methods of treating bamboo include:

Culm curing: The culms are cut, but left in place in a vertical position with branches intact for up to 4 months. The evaporation in the leaves reduces the moisture content and leads to the fermentation of starches in the culm. The threat of beetle attack is reduced, but attack by termites is not diminished, and fungal attack and rotting are still possible.

Leaching in Water: Freshly cut bamboo is stored in rivers or streams for 3-4 months to leach out starch. The method takes a long time and provides no guarantee of long-term durability.

Smoking: Freshly cut bamboo are placed in closed chambers under a fireplace and smoked. The smoke produces toxic agents and heat that destroy starch in bamboo, thus making

them less palatable to insects and pests. The process also blackens the culms, but the heat usually causes the culms to crack.

White washing: Bamboo culms are painted with slaked lime to reduce moisture absorption. This prolongs durability, but the threat of termites remains.

All of the above methods are too slow for commercial use, and their effectiveness is unpredictable.

Chemical Methods

Many chemicals are used as a preservative for wood, and some have also been used for treating bamboo. The three major chemicals used for preserving timber are Creosote, Pentachlorophenol (PCP) and Chromated Copper Arsenate (CCA). These chemicals are usually applied to wood using pressure systems. Creosote and PCP are not soluble in water, so for treatment they are usually dissolved or diluted in a petroleum-based solvent such as light oil. The oil acts as a carrier to help the preservative penetrate a spaced stack of timber when it is heated and pressurized in a large steel cylinder. CCA, on the other hand, is a combination of inorganic salts dissolved in water and forced into the wood. CCA has been applied to bamboo using a Boucherie process that makes use of an air pump to inject the chemicals into the culms.

These chemicals combine well with wood, resulting in little or no loss on subsequent contact with humidity, rain and groundwater. However, they are toxic and hazardous to people!

Phosphate based insecticides that are used in the agricultural industry are known for their allergenic potential, while creosote is carcinogenic. So far, the only petrochemical agents that are more or less acceptable are the pyrethrin based insecticides like Permethrin and Deltamethrin. These products are among the most popular and widely used insecticides in the world. They are used for protecting wood products and by many bamboo furniture industries in Asia. All these agents are applied with turpentine or kerosene, and have a foul odor. They are not recommended for products that will be used indoors.

There is a much cleaner and even cheaper solution, which has been regarded as an eco-friendly wood preservation agent in Europe for over a generation, namely, borax.

What is Borax?

Borax is an important boron compound, which occurs naturally as a mineral deposit produced by the repeated evaporation of seasonal lakes. The most commercially important deposits are found in Turkey, Southwestern United States, Chile, Tibet and Romania. It is usually a white powder consisting of soft colorless crystals that dissolve easily in water. It has many industrial applications, and works as a fire retardant, as an antifungal agent, and as an insecticide.

Availability of Borax

Borax is available in granulated or powder form as Boric Acid and Borax Oxide.

In Kenya, a 25 kg sack of Boric Acid powder costs about Ksh 9,000 (2011 price in Nairobi), or approximately Ksh 360 per kg. Borax Oxide costs approximately the same amount.

Borax Solution for preserving Bamboo

- Preservation of bamboo is achieved using a 5% Borax solution, which is pH neutral.
- The pH neutral solution is made using equal amounts of Boric Acid (2.5%) and Borax Oxide (2.5%), both in powder form, and dissolving them in warm water.
- The concentration of both chemical agents dissolved in water is 50kg per M³ (i.e. 5kg per 100 L of water)

Effective Duration

The borax solution remains active for 1 to 2 months.

Output

1000 liters of borax solution will require one 25 kg sack of Boric Acid and one 25 kg sack of Borax Oxide. This can be used to preserve over a hundred or more bamboo culms, depending on their size.

Maintenance

When used several times in a trough, the borax solution will become murky and may produce foul smells. This can be remedied by adding algae control products that are used for maintaining swimming pools.

Safety Precautions

The 5% borax solution is pH neutral and is not hazardous or harmful to the skin. Nonetheless, long-term contact should be avoided.

- Workers preparing the solution are advised to wear rubber gloves, nose masks and goggles.
- Care should be taken to avoid getting their clothes soaked with the solution; it is recommended to wear protective clothing when working with chemicals.
- Never drink the solution!
- If the mixture comes into contact with the eyes, wash immediately with water.

WARNING:

- **Avoid making higher concentrations of Borax solution than recommended herein.**
- **Borax concentrations above 5% are hazardous!**

How Borax Works

Borax treatment works by immersing the solution into the bamboo, or alternatively by submerging the bamboo into the solution. For the solution to act on the whole culm, the diaphragms of the nodes need to be perforated so that the solution fills the inner part of the culm.

Through a process of osmosis, the borax solution gradually penetrates the inner and outer tissues of the culm. But this osmotic diffusion process only works when the cell walls of the culm are still alive and active. Dry bamboo will not take up boron molecules; dry bamboo will absorb the water but the boron will remain on the surface and not permeate through the cell tissues that have dried out. It is therefore useless to

attempt treatment of dry culms. Borax treatment only works when the bamboo is still green. Freshly felled bamboo takes up boron faster than one or two month old poles.

The practical formula for diffusion under normal tropical temperature of 20 to 30°C involves using a 5 % borax solution (which is pH neutral) for at least 1 week.

Regulating the Concentration of the Solution

Higher concentrations of borax will leave a white powder on the surface of bamboo. This indicates sometimes that the boron concentration is becoming too high and that there is insufficient water in the mixture. This effect is natural since the poles suck up the water quicker than the borax, thereby increasing the concentration of the solution. This should be avoided to avoid wasting the chemicals and controlling costs. It can be countered by adding water to the mixture. However, the best way to control the concentration is with electric resistances. There are commercial measuring devices available that will indicate the targeted 4 to 6 % solution at an allowable range between 12.000 and 16.000 Micro Siemens. If you want to use self-made testers, just calibrate by measuring the electric resistance of 50 grams of borax oxide/boric acid in one liter of water.

PROPOSED METHODS OF PRESERVATION

Although there are various ways of preserving bamboo, they are not used widely by artisans due to lack of know-how and the absence of treatment facilities. Some methods are however simple, efficient, and cost effective. Two effective and closely related methods are:

- (1) Vertical soak diffusion
- (2) Horizontal dip diffusion.

Both methods make use of 5% Borax solution as a preservative agent.

To successfully preserve bamboo, it is essential to stress the following points:

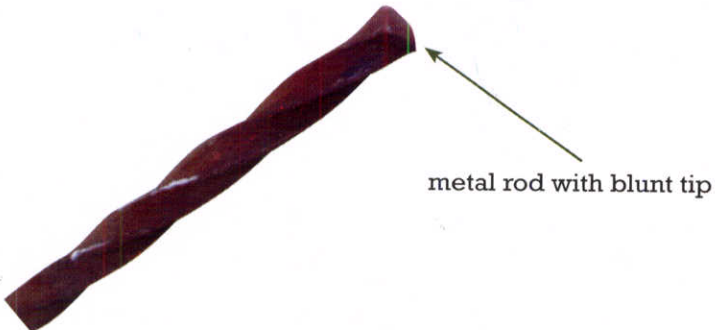
- Culms that are to be preserved should be newly felled, and should not be more than two weeks old.
- Borax treatment only works when bamboo is still green.
- Dry bamboo will not absorb the chemical preservation agents!
- Chemical preservation requires that the diaphragms at each node be perforated in order to allow the chemical agent to penetrate the inner tissues of the culm.

The procedures for preserving bamboo are described and illustrated in the following pages.

PREPARATION OF BAMBOO CULMS FOR TREATMENT:

Tools & Materials:

- 100 litre Metal Drum
- Boric Acid
- Borax Oxide
- Fire Wood
- Matchbox
- Rag
- Candle wax / candle
- Metal rod (Y-10)
- Watering can
- Scrapping Knife
- Nose masks
- Rubber gloves
- Goggles



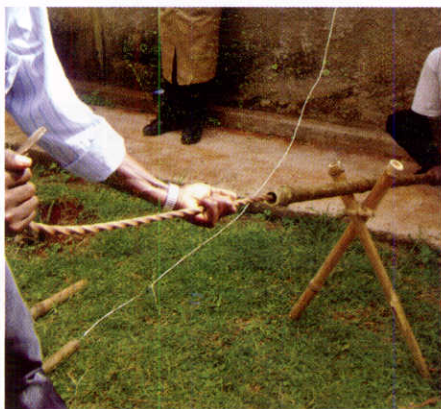
Cut the Culms to Required size:

- The standard commercial size of Bamboo culms is six (6) metres in length.
- Such long culms are useful for construction purposes.
- You can also use culms that are shorter (2 , 3 or 4 metres) depending on the application.



Perforation of Diaphragms:

- Perforation of the diaphragm is done by either punching with a long metal rod or drilling.
- The metal rod should have a blunt tip; do not sharpen it since it may get stuck in the nodes, making the penetration of nodes very difficult.

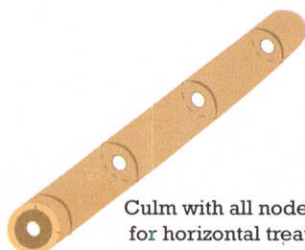


NOTE:

- The way that you punch the nodes will depend on the type of preservation treatment that is used.
- For vertical soak diffusion treatment, you punch all nodes except the bottom node.
- For horizontal dip diffusion treatment, you should perforate all nodes.



Culm with all nodes except bottom perforated for vertical treatment



Culm with all nodes perforated for horizontal treatment

VERTICAL SOAK DIFFUSION TREATMENT:

- Vertical Soak Diffusion is a method, where all the nodes except the last one are penetrated with a long iron rod.
- Bamboo culms are vertically positioned in a drum or container, and borax solution preservative is poured in to them.

Ratio of Borax and Boric Acid to Water

- The recommended preservation agent is 5% borax solution. This is made using borax oxide and boric acid (in powder form) that is dissolved in hot water.
- The ratio of the chemicals is shown below:

Borax (kg)	Boric Acid (kg)	5% borax + Boric acid (kg)	Water (Litres)
1.25	1.25	2.5	50
2.5	2.5	5	100
5	5	10	200

- 200 ltrs Oil barrel to be used for the preparation of the solution



STEP 1

- Use a 55gallon (200ltrs) oil barrel for preparing the solution.
- Elevate the barrel about 20cm from the ground using concrete stones or blocks.
- Ensure the barrel is level and stable to avoid tipping
- Prepare a fire under the elevated barrel filled with water to heat the barrel.



STEP 2

- Dissolve 5kg borax oxide and 5kg boric acid in 200ltr barrel.(10kg in 200ltrs makes a 5% Borax solution).
- While water is heating in the barrel, stir continuously until Borax is dissolved.





STEP 3

- For vertical treatment, you have to identify if the poles have borer holes.



- Use candle wax to seal the hole.
- This will prevent leakage during treatment.



STEP 4

- Before treatment the culms should be properly cleaned.
- All dirt should be removed using water and a rag or plastic brush.

STEP 5

- Place the culms to be treated vertically in empty oil barrels. The culms should rest against a rail support.
- Fill the poles with borax solution (max. 30° celsius, otherwise any wax seals will dissolve).
- Leave the poles in a vertical position for 8 - 10 days.



STEP 6

- After 8 - 10 days, remove the poles and punch the diaphragm of bottom node to release and recover the solution in another oil barrel.
- You can re-use this solution several times.
- Leftovers can be mixed with saw dust and used for mulching.



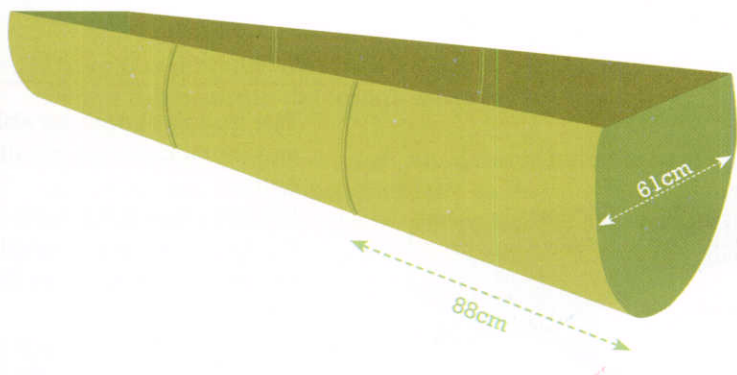
HORIZONTAL DIP DIFFUSION TREATMENT:

Horizontal Dip Diffusion is a method whereby all the nodes are penetrated with a long iron rod. The bamboo culms are then dipped in a trough filled with borax solution.

It is advisable to use troughs that are made from steel barrels or a concrete pool for a slower cold method.

Troughs can be custom made according to the required length. They are made by cutting openings along the lengths of the barrels, removing the base of the barrels except the first and last one, and welding all the barrels together. Each barrel has a length of 88cm and a diameter of 61cm. The capacity of each barrel is 200 litres. Each barrel segment of the trough will have a liquid capacity of 100 litres. Details are shown in the table below.

Number of Barrels	Trough length (cm)	Liquid Capacity (Ltrs)
2	$2 \times 88 = 176$	200
3	$3 \times 88 = 264$	300
4	$4 \times 88 = 352$	400
5	$5 \times 88 = 440$	500
6	$6 \times 88 = 528$	600
7	$7 \times 88 = 616$	700



STEP 1

- Use a 55gallon (200ltrs) oil barrel for preparing the solution.
- Elevate the barrel about 20cm from the ground using concrete stones or blocks.
- Ensure the barrel is level and stable to avoid tipping.
- Prepare a fire under the elevated barrel filled with water to heat the barrel.



STEP 2

- Dissolve 5kg borax oxide and 5kg boric acid in 200ltr barrel. 10kg in 200ltrs makes a 5% Borax solution.
- While water is heating in the barrel, stir continuously until Borax is dissolved.



STEP 3



- The trough should be able to accommodate the length of culms.
- If preserving 2.5m long culms for furniture, use a trough made with a minimum of three barrels.
- There are three options on using this method that are equally effective but which differ in terms of productivity:

Option 1: Fast Method (Hot):

- Using this method up to four loads per day are possible.
- Fill the trough with 5% borax solution.
- Start a fire underneath the trough to heat the solution.
- Feed the fire so that the temperature of the solution is maintained at 70° - 80° C
- Place the culms in the trough when the solution is heated
- Place concrete blocks on top of bamboo poles so that they are totally submerged in the solution.
- Boiling time for thin walled culms is at least 1.5 hours
- For thick walled culms the time required is 2-3 hours.
- Refill with the pre-prepared borax solution as needed.

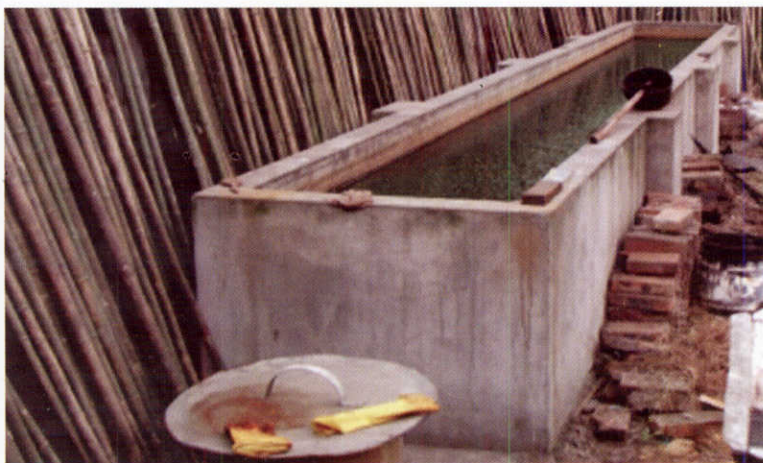


Option 2: Slow Method: (Hot and Cooling down)

- Using this method two loads are possible per day.
- Start a fire beneath the trough and heat up to a temperature of 80° C.
- Place the culms in the trough when the solution is heated.
- Allow the fire to fade out gradually so that the poles are soaking in the warm solution that is gradually cooling down for three or four hours.
- The process will take six hours per load.

Option 3: Cold Method

- For this method, either a metal trough or concrete pool may be used.
- Fill the trough or pool with 5% borax solution.
- Place the perforated culms in the pool for at least seven days.
- Make sure the culms are totally submerged. Use blocks or heavy stones if necessary.
- After seven days remove the culms and drain out the solution into the trough or pool.
- The solution can be used several times.
- If necessary refill the pool with borax solution before reloading.
- Using this method one load of bamboo can be preserved every week (7 days).





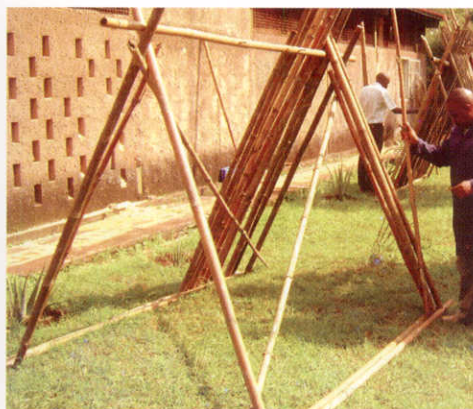






DRYING:

- Set up an A- Frame to support treated culms for drying.
- Choose a shady location with good air circulation.



- Use diagonal braces to support the A-frame so that it does not fall over under a heavy load.



- Use broken or unusable culms to elevate the drying culms from the ground.
- Never dry the culms under direct sunlight.
- If there is direct sunlight, the culms should be rotated several times a day.
- The drying process should be slow otherwise the culms will crack.
- Withdraw from the A-frame after 3 - 4 weeks.
- Store the poles in a dry area.

STORAGE:



- Store the poles in a well ventilated shelter, never in a closed area.
- Pile the poles in stacks of different diameters.
- Categorise between base and middle stem.
- Stack them with distance splits to allow air flow.



- After three (3) months you can assume 20% humidity in the bamboo.
- Sort and classify the preserved culms according to size, diameter and quality.
- You can pile them now without spacers but 20cm off the ground.
- The best way of storing treated bamboo culms is in horizontal racks.

NOTES:

