



6

HARVESTING AND POST HARVEST MANAGEMENT

A Bamboo plantation must be carefully worked to get the desired product of good quality. After the maturity of the clump is attained, culms are harvested (cut down) every year for further use. This induces the emergence of new shoots and ensures regular and healthy culm production, resulting in a steady supply of culms and shoots for sale. After the bamboo is harvested, you must take care of the harvested bamboo during storage and transport so that a healthy and a good quality culm should reach the market and end user. The culms should also be harvested at the right age to have the best product and service life of the products. In previous lessons you have learnt about different steps and practices to be done for a bamboo plantation. Now, in this lesson you will learn about the management of culm during harvesting. You will also learn about the methods that can be used to find out the age of the culm in the bamboo clump. The precautions to be taken while storing and transportation of the harvested culms are also discussed in this lesson.



OBJECTIVES

After reading this lesson, you will be able to:

- differentiate the age of harvesting according to the use;
- harvest bamboo carefully in congested clumps and at right age;
- follow good harvesting practices for good yield of bamboo;
- ensure proper storage of the harvested culms till they reach the market.



6.1 HARVESTING

Harvesting of bamboo for commercial purpose can begin from the third year of establishing a plantation. However, the clump will mature and yield culms of full physical dimensions only after the fourth year.

The age of the harvested culm depends on the purpose or the use:

- For non-structural applications like basket and various other artifacts making and those that do not require much physical and mechanical strength, 2–3-year-old culms from a mature clump may be harvested.
- For most purposes, however, culms should be harvested when they are 4 years old.
- Culms that are more than 5 years old begin to turn brittle (easily breakable) and weak, and then die. Therefore, culms over 5 years should not be retained in a commercial plantation.

The best time of the year to harvest culms is the post-monsoon (after rains) season. It may also be extended through the winter. This is because it is the period of dormancy, during which culms tend to have lower starch content. They are therefore less susceptible to borers, termites and other pests.

Clumps should not be harvested in the growing season, which is usually during the monsoon months. Harvesting in this period can damage young and emerging shoots and retard the future growth of the clump.

6.1.1 Uses of Culms of Different Maturities

As you know that the bamboo culms can be used for a variety of purposes. Each of these uses has its own requirements of strength and other characters. So culms can be harvested at different ages to put them at different uses. Some of them are discussed below:

For pulping	2–3-year-old bamboo is preferred. Bamboo over 5 years old are not desirable for this purpose.
For applications where mechanical strength is not required	In craft and for mat-making, 2–3-year-old culms may be used. At this age, they are flexible enough to be easily woven
For board-making and for structural applications	Only 4-year-old bamboo should be used. A 4 year old bamboo culm has the highest strength.



6.1.2 Strength and Other Properties of Culms

The culms have varied characters like mechanical strength, moisture content, starch content etc. at different ages (Fig 6.1). The main traits are discussed below:

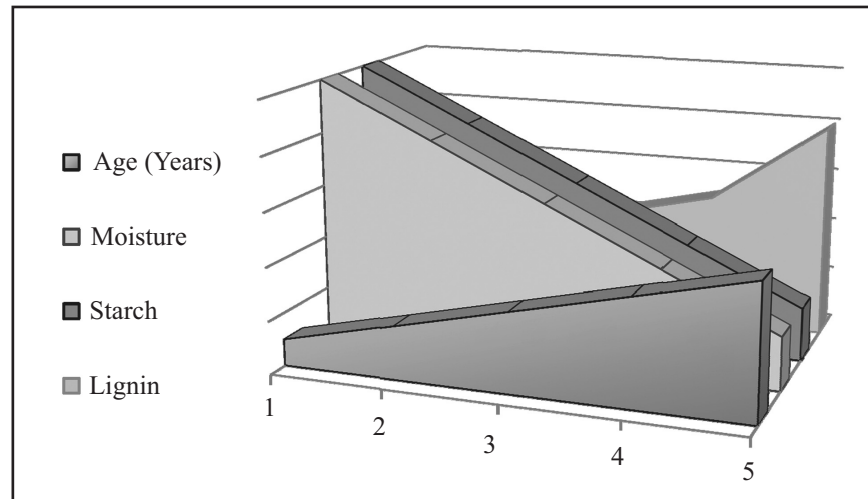


Fig. 6.1: Culm properties

- Culms below one year of age have a very high moisture content and shrivel up after harvesting.
- Young bamboo culms have a high starch content that makes them exposed to borers and termites when harvested and used. The process of lignifications is also incomplete in young culms, leading to poor strength and mechanical properties.
- As the culm grows older, the starch content reduces and the lignin content is enhanced which contributes to the hardness of the culm.
- Culms therefore increase in strength and other properties as they grow older.
- A bamboo culm is strongest in its fourth and fifth years.
- After this it becomes gradually brittle and weak, until it dies in its seventh or eighth year.

6.2 HARVESTING CONGESTED CLUMPS

A bamboo clump can get crowded for many reasons. A major reason could be that the clump has not been worked or harvested for a year or two. This is often true for bamboo growing in some forestlands. There the harvesting or working may take place in rotational cycles of once in 4 years or at even greater intervals. This,



however, should not be in case of an intensively and regularly managed bamboo plantation.

Some bamboo species, like *Bambusa bambos*, *Bambusa balcooa* and *Dendrocalamus strictus*, tend to have closely spaced culms in the clump. In such cases the chances of clump congestion are relatively higher. Further, *Bambusa bambos* tends to have thorny branches and this makes working the clump more difficult. In such situations, it may be necessary to adopt different techniques of harvesting like the ‘tunnel’ or ‘horse-shoe’ system of extraction/harvesting.

<p>The Tunnel System of Harvesting</p>	<p>This system provides entry to the inside of a bamboo clump. The main outline of this system is as follows:</p> <ul style="list-style-type: none"> ● Two tunnels are created through the centre of the clump, effectively dividing it into four sections. The tunnels provide access to the inside of the clump and allow easy working. ● Culms of adequate maturity are then selected and extracted from each section. ● It is also useful to remove weak and stunted culms from the periphery of the clump, retaining only the healthy ones.
<p>The Horse-shoe System of Harvesting</p>	<p>This is another method of harvesting that can be done in the bamboo plantation.</p> <ul style="list-style-type: none"> ● The clump is worked in a horse-shoe pattern, or in an inverted V, by making an opening opposite the part which is most dense. ● All the old, dry and rotten culms are extracted, leaving only 1-year-old, vigorously growing culms. Also, an appropriate number of evenly spaced and healthy older culms are also retained.

Although these methods of extraction involve high initial costs and may result in removal of some mature and immature culms, they prevent crowding and provide space for proper growth of shoots and culms. They also ensure easy working of the clump in subsequent years.

6.3 MATURITY MARKING OF BAMBOO CULMS

As you are now aware, bamboo culms vary in their strength and other properties with age. It is therefore important to know the age of the culm while harvesting.



Only when they are harvested at the right time, will the culm have appropriate strength which is important for its use in products and applications. This can be done through a simple Maturity Marking System (MMS).

6.3.1 Identifying Culm Maturity

Under field conditions, it is not easy to recognize the age of a bamboo culm, especially since culms in a mature clump tend to have similar girth, length and nodal structure. People familiar with bamboo cultivation can distinguish bamboo of different ages in a clump. However, the accuracy of such distinction is dependent on the skill and experience of the person. It is not always reliable. Therefore, there is a need to implement independent systems of maturity identification. These systems provide a basis for harvesting and help to ensure out-turn of good-quality and mature bamboo.

6.3.2 Maturity Marking System (MMS)

Maturity marking systems are used and encouraged in several parts of the world. Such systems ensure that bamboo of the desired maturity is harvested.

In some countries, the year of culm emergence is engraved or written on the bamboo culm. This is an inexpensive and easy method. Engraving may damage the culm wall. Also the numerals tend to fade over time and get blurred.

Another system uses multiple color bands, with one band added every year. Thus, a 2 year old bamboo will have 2 bands, and a 4 year-old bamboo will have 4 bands. This is a laborious process, however, because every bamboo in the clump and in the plantation has to be marked every year. It is particularly unmanageable in the case of bamboo culms in the middle of a clump, which are difficult to get to.

The simplest and most effective system, described below, is a single color band marking system.

Single Color Band Maturity Marking System

(Developed by K.S. Sethi, Forest Department, Government of Tripura, 2003)

This is a maturity marking system that can dependably be used to mark the age of bamboo culms. The main feature of this system is placement of a colored band painted on the culm in the year in which it emerges (Fig 6.2). Five colors are used, one for each year of a 5-year cycle. Culms that are 6 years old should not be retained in the clump, as they become weak and brittle and can be expected to die within a year or so.



Fig. 6.2: Coloured painted on culm

Marking is to be done after the culm attains its full height, that is, after it has stopped growing. The indication of the stoppage of further dimensional growth (length) is when branches begin to appear, normally first in the upper portion of the culm. The colors, and the years (an example) in which they are to be used could be as follows (Fig 6.3).

Color type	Shoot Emergence Year		
Red	2005	2010	2015
Yellow	2006	2011	2016
Blue	2007	2012	2017
White	2008	2013	2018
Black	2009	2014	2019

Fig. 6.3: Color marking example for 3 bamboo cultivation cycles

- The culm sheath should be detached from the culm before beginning to paint.
- The color band should be 3 inches thick (7–8 cm). They should be placed at chest height and in the inter-nodal portion of the culm.
- The color bands should be placed clearly. Care should be taken not to let the paint drip down the culm.



Notes

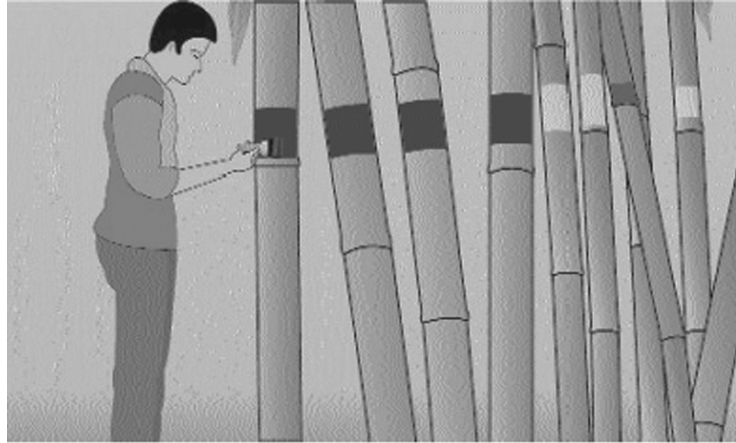


Fig 6.4: Single color band maturity marking system



INTEXT QUESTIONS 6.1

1. Fill in the blanks
 - (a) Harvesting of bamboo for commercial purpose can begin from year of growth.
 - (b) is the best season for harvesting bamboo.
 - (c) and system of harvesting are used for harvesting culms in densely clumped bamboo.
 - (d) Culms of more than 5 years are
 - (e) is the system used for ensuring right age of bamboo while harvesting.

6.4 GOOD HARVESTING PRACTICES

There are certain things that you must keep in mind while harvesting the bamboo culm. They can be summarized as follows:

- The number of harvested mature culms should not normally exceed the number of healthy shoots that sprouted and grew into young culms in the previous year.
- Aborted, stunted (short) and diseased shoots should be removed from the clump as soon as they are identified.



- The clump should be visually examined and the culms to be harvested should be selected before beginning cutting operations.
- Adherence to a maturity marking system will facilitate selection. There are various systems like writing or engraving year in which culm emerged. Another system use adding different colored band on bamboo every year so by seeing the number of bands, age of culm can be ascertained.
- Branches extending from the lower nodes of the selected culms should be removed. This makes cutting and extraction easier.
- The culm should be harvested at least one, preferably two nodes, above the ground. This reduces the risk of injuring the rhizome.
- The culm should be cut with a slanted cut. This ensures that rainwater, debris and twigs do not collect in the uncut portion above the last remaining node and do not become a breeding ground for fungus, parasites and insects.
- Twigs and remnants of branches should be removed from the area surrounding the clump.
- The felled culms should not be dragged along the ground to the collection or stacking point. This may injure or scratch their epidermal layer, lowering their value.

6.5 STACKING AND STORAGE

Stacking and storage of the harvested bamboo are essential features in the bamboo plantation management. Harvested bamboo may often have to be used immediately for many reasons like:

- to bulk a quantity for supply in the market,
- to hold supplies till a better price is obtained,
- to carry out preservation and treatment activities.

Therefore, they have to be stacked and stored for a period of time at or near the plantation. Certain factors must be taken care to avoid the degradation of culm quality or loss of culm during storage.

Immediately after harvesting and throughout the storage period, culms should be stacked vertically rather than horizontally. Horizontal stacking puts pressure on culms at the bottom of the pile and can injure, deform or break culms. Vertical stacking of green bamboo is better, because a larger surface area is exposed. This facilitates uniform and quicker drying.



Notes

If possible, the stacking area should have a permanent (*pucca*) floor. In case of temporary or imperfect (*kutchra*) floor or soil where the culm come in contact with the ground, they become exposed to borers and termites. There are other less expensive options like using polythene sheets and tarpaulin on the floor. A covered, or at least shaded, area is recommended for storage, to protect the bamboo from direct sunlight and rain. Exposure to rain will lead to re-absorption of moisture and delay the drying process. Exposure to sunlight may cause rapid drying, resulting in splits and cracks.

6.6 TREATMENT AND PRESERVATION

The four long years of your hard work need to result in getting satisfactory monetary returns, while storing the culms for the apt time.

Towards this you will need to apply traditional and chemical ways to achieve this. We will now see what traditional means can be adopted at the plantation level at a very low cost. This treatment process permits better prices for the raw material to industries or processors since the bamboo can remain unaffected with pests and diseases. However, large scale plantations may need to adopt chemical means.

These treatments methods go together with good harvest and storage practices. So, the process may be seen as in this process figure (Fig 6.5).

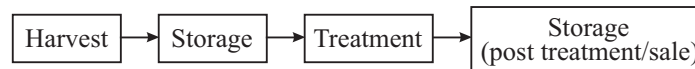


Fig. 6.5: Post-harvest process

After or before the ‘storage (post treatment/sale)’ is the marketing step. The basic storage practices have been discussed in the earlier section. Traditional (non-chemical) treatment is seen as applicable to both green bamboos and dry bamboos. The main aim of these different systems is to basically lower the sugar and starch content so that insects and pests find the treated bamboos less tasty. Control of pests and diseases can be achieved through these low-cost means:

1. **Timing the harvest** such that the sugar content is at the lowest – harvest in the cold season after rains is preferred (ideally between August to December).
2. After harvest or cutting down the bamboo culm, the sugar content can be lowered by keeping **standing the**



Fig. 6.6: Standing the bamboo poles



harvested culms after leaning against trees or a supporting framework. This period enables the sugars to be used by the remaining living cells.

3. **Washing/leaching** away the bamboo is another way in which the sugar/starch content of plant sap is lowered. Plantations near rivers often use the flowing water to leach them away while transporting them through flowing water.



Fig. 6.7: Leaching the bamboo poles

4. **Soaking in a water tank** is useful for plantations away from flowing water. For a proper soaking the bamboos are made tight with the help of an iron frame and the duration taken here is 4 to 12 weeks.



Fig. 6.8: Soaking bamboo in a water tank

5. **Heating the bamboo poles** over a fire or placing burning coals is another method (after coating oil on green round poles). Quick drying of the outer layers and partial burning aids in lowering the starches and sugars which results in a steady bamboo. However, it must be noted that all the surfaces are changed continually. This is also currently used in making bent round poles straight.

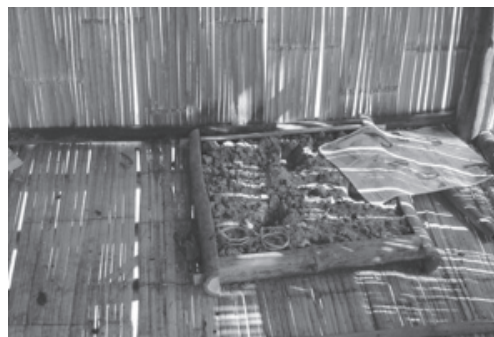


Fig. 6.9: Heating the bamboo poles

6. **For control of pests and diseases of bamboo used outdoors:** Coatings like tar, lime wash, and tar sprinkled with sand, are used for house construction (esp. in Indonesia) to prevent damage to poles in contact with soil. These are needed to be used also at all open surfaces (cuts, exposed internodes, abrasions) to be completely successful.

There is nowadays a dyeing (coloring) system to identify treated bamboos and this can become an avenue for fetching higher prices. Chemical treatment is done through Boric acid-Borax etc.



6.7 REGULATORY MECHANISM

The Govt. of India amended the Indian Forest Act, 1927, in November 2017 by grouping bamboo as a grass, and not as a tree. It is believed that the change would enable poorer communities to legally cultivate, harvest and trade bamboo across state boundaries.

6.8 GRADING AND SIZING

Once the bamboos are harvested, they are graded on the basis of certain characters. This grading is very important to feed different bamboo industries with right raw material. During grading the geometric, physical and mechanical properties for bamboo originating from a source region are assessed with the aim of developing reliable selection criteria. Some of the criteria used for grading are:

Internodal distance	Usually the diameter and wall thickness are defined at hollow region of bamboo culm between two nodes i.e. internodes.
Mechanical property	It is a measurable property of bamboo associated with both culm geometry and bamboo material properties. It describes the behavior of the culm under the effects of applied load or stress.
Moisture content	Amount of water content in culms are very important property. Portion of culm weight consisting of water is expressed as percentage of oven-dry weight
Physical properties	The measureable property of bamboo that describes its behavior in response to external influences other than stress or strain are the physical properties. It is generally used in reference to density, moisture content, etc.



INTEXT QUESTIONS 6.2

1. Fill in the blanks
 - (a) is done after harvest to improve the sale price and while storing the culms for the apt time.

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- (b) The basic aim of treatment and preservation is to lower the
and
- (c) Pests and diseases can be controlled through these traditional methods:
- (i)
- (ii)
- (iii)
- (iv)
- (v)
- (d) and are used for treating bamboo poles used in house construction.
- (e) is done with Boric acid-Borax and others



Notes



WHAT YOU HAVE LEARNT

Let us summarize and list the main points we have learnt through this lesson:

- Bamboo culm should be harvested from second to fourth year.
- Age of harvesting depends on the purpose or use of the culm.
- Properties and strength of the culm depends on the age.
- Harvesting of crowded clumps can be done using various strategies like Tunnel System of Harvesting or Horse-shoe System of Harvesting.
- A maturity marker system (MMS) can be adopted to ascertain that the culm of right age is harvested.
- There are many MMS which are used. It can be by engraving the year or by colour coding the year.
- The culm should be cut at least one node above the ground.
- The cut should be slant to avoid infection with pathogens and infestation with pests.
- The harvested bamboo should not be stored horizontally but vertically.
- They could be stored on *pucca* floor to prevent them from pests and diseases.
- The drying of the culms must be slow and uniform to avoid splits and cracks in the culms.



Notes

- There are traditional and chemical methods to preserve and treat harvested bamboo.
- The main aim of these preservation and treatment methods is to reduce the sugar and starch levels.
- The traditional methods are: 1. Timing the harvest, 2. Standing the harvested culms, 3. Washing / leaching the culms, 4. Soaking in a water tank, 5. Heating the bamboo poles.
- Tar, Lime wash etc. are used to treat bamboo poles for house construction where they may come in contact with the ground or soil.

**TERMINAL EXERCISE**

1. Why should bamboo be harvested in the post-monsoon and not during monsoon period?
2. What are the problems met during harvesting of bamboo in a clump?
3. What are the strategies adopted to overcome the problems met during harvesting?
4. List any five major good harvest practices in bamboo.
5. Explain why the culm should be cut obliquely during harvesting?
6. Why is vertical fencing of bamboo better during storage period?
7. Why is Maturity Marking System important in bamboo plantation? What are the different methods adopted for this?
8. Why do we do preservation and treatment of bamboo poles?
9. What is the main aim of this preservation and treatment process?
10. What traditional methods are used for doing the preservation and treatment?

**ANSWERS TO INTEXT QUESTIONS****6.1**

1. (a) Third (b) Post monsoon
(c) Horse shoe, tunnel (d) Weak / brittle
(e) Maturity Marking System (MMS)



6.2

1. (a) Treatment and preservation (b) Sugars and starches
- (c) (i) Timing the bamboo harvest
- (ii) Sanding the harvested culms
- (iii) Washing and leaching
- (iv) Soaking in a water tank
- (v) Heating the bamboo poles
- (d) Tar, lime wash etc.
- (e) Chemical treatment

Key Learning Outcomes

- Harvesting bamboo at right age following good harvesting practices.
- Preserve and treat the culms for improving their storage life and getting a better quality price.