

# **Field Manual for Propagation of bamboo in North East India**

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## FOREWORD

North East India is known for its rich biodiversity - Flora and Fauna. Arunachal Pradesh including Sikkim is particularly recognised as one of the "Biodiversity Hot Spots" in the world. An important and dominant component of the flora is bamboo. There are 90 bamboo species in the region spread over almost all the vegetational types. This particular group of plants which is referred to as "poor man" timber has cast profound influence on the life and lore of the people of this region.

Bamboo is a versatile multipurpose forest produce that has immense potential in the industrial and domestic applications. In spite of the economic importance of bamboo there has not been serious attempt in promoting bamboo based industries that has the potential to transform economy of the people of the northeastern region. With the recent Supreme Court intervention there has been shift from mainly timber based economy to that of non timber forest produce. Thus, bamboo products are gaining importance. In this regard the efforts of the UNDP in promoting the bamboo sector through the Ministry of Textiles, Handloom and Handicraft, Govt. of India is indeed timely and praiseworthy.

In Arunachal Pradesh State Forest Research Institute, Itanagar under the Department of Environment and Forests, has been working on conservation of bamboo and its propagation aspects to cater to the needs of the people of the state. Based on their research finding it has been possible to standardise protocols for the propagation of bamboo which is very essential in catering to the needs of the department as well as local farmers for raising bamboo in the available land in the state. I am sure that this field manual for propagation of bamboo will certainly help in imparting the technical knowledge to all those involved in raising bamboo plantation and help in uplifting the economy of the rural poor.

Date: Itanagar  
Place : 26-12-2002.

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Principal Chief Conservator of Forests,  
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# PREFACE

North East India has rich bamboo culture. The different tribes inhabiting the region heavily depend on bamboos for various domestic and agricultural purposes. Their handicrafts using bamboo has gained popularity both nationally and internationally. These products are made of specific bamboos usually cultivated by the people. In recent times bamboos have been identified as a valuable industrial raw material substituting wood products and having potential for augmenting the economy. Their utility as edible shoots are also being exploited for setting up of industrial ventures. All these will warrant for extensive plantation ventures, which will in-turn require adequate planting stocks of quality bamboos.

Bamboo being monocarpic that is dying after flowering and flowers only after specific intervals of 30-100 years propagation through seed is not always possible. Alternative methods of vegetative propagation using modern techniques are to be adopted for successful raising of nursery and plantation. The State Forest Research Institute has been experimenting with various techniques of bamboo propagation and has standardized some of these, which could be applied to the field. There is a need to take this information to the field staff and farmers who are interested in bamboo sector. Accordingly, this bulletin has been prepared to serve the purpose of extension material.

It is earnestly hoped that the users will find it useful. The authors seek suggestion for improvement of the publication.

We also take this opportunity to thank the Development Commissioner (Handicrafts), Ministry of Textiles, Govt. of India for the financial support under the UNDP Cane and Bamboo project. The field staff of SFRI Field Research Station at Chessa has extended valuable help in the field which is also acknowledged.

Authors

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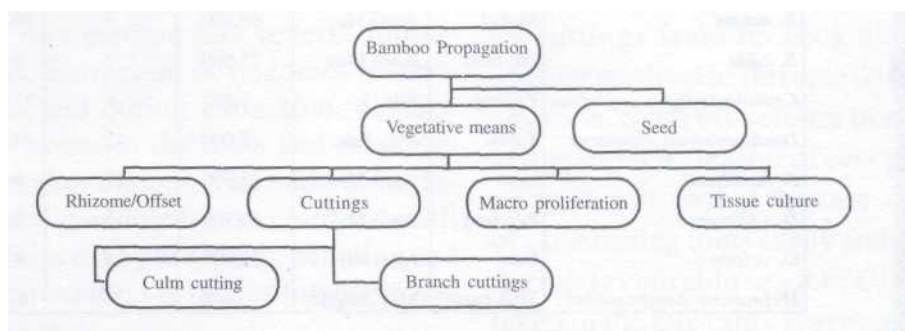
# BAMBOO PROPAGATION

## methods for North East India

Introduction:

**B**amboos are important group of plants, which have become inseparable part of the culture and day to day life of the people particularly those living in the rural areas of N.E. region of India. In India their representation is much more in this region and form abundant resource base for viable industries. Bamboo has an advantage of being a very renewable resource and can be repeatedly harvested thus forming sustainable source of raw material. In recent years there has been increase in demand world over for bamboo and cane products. This has resulted in higher rates of extraction leading to depletion in wild habitats. So, also there is a need for large scale plantations to meet the demand. This can also be a good source of income for the farmers. Bamboo can be propagated by the following methods.

Conventional methods of propagation of bamboo are based on seeds and vegetative methods. Availability of seed is limited to certain specific period only as bamboos flower once in life time only. Most of the bamboos flower in long Cycles ranging from 10-over 60 years depending upon species. Usually the cyclic flowering is gregarious and after flowering the entire flowered population of bamboo dies. The huge quantity of seeds produced are either washed away in hill slopes during rains, or eaten by rodents (rats). The remaining seeds fallen in ideal conditions germinate to seedlings for regeneration. Seeds formed after gregarious flowering can be collected and cleaned. The cleaned seeds can be stored for 6 months or even more than a year through special storage techniques like controlled moisture, low temperature etc. Apart from gregari-



ous flowering bamboos are also seen to flower sporadically in one or two clumps here and there. This is a regular feature in *Dendrocalamus hamiltonii* (Kako). Such flowering will help in getting seeds for nursery trials. The viability of bamboo seeds is lost gradually. Hence it is advisable to sow the seeds soon after collection. Sowing is done in mother beds with overhead shade, either broad casting or in lines. A thin layer of soil is used to cover the seeds and regularly watered. Seeds will germinate in 3-7 days and will continue upto 15-25 days (Banik 1987). Seed size varies from species to species. Seeds of *Dendrocalamus hamiltonii* and *B. bambos* are like those of wheat while *Schizostachyum fuchsianum* has bigger size than that of a pea nut. *Melocanna baccifera* has seeds as large as small apple.

Table 1: Showing flowering and seeding intervals of important species of bamboos in North East India

Species	Common Name	Seed year in intervals of	Flowering nature
<i>Bambusa arundinacea</i>	Kanta bans	30 - 34	Gregarious, sporadic
<i>B. balcooa</i>	Bhaluka bans	40 + 5	Sporadic
<i>B. longispiculata</i>		20+5	Sporadic, gregarious
<i>B. polymorpha</i>	Betwa bans	35-60	Gregarious, sporadic
<i>B. tulda</i>	Jati bans	30-60	Sporadic, gregarious
<i>B. vulgaris</i>	Bans	80 + 8	Rarely, poor seeding
<i>Dendrocalamus hamiltonii</i>	Kako	30	Gregarious, sporadic
<i>D. strictus</i>	Lathi bans	20-65	Gregarious, sporadic
<i>Melocanna baccifera</i>	Muli bans	30-45	Gregarious, sporadic
<i>Phyllostachys bambusoides</i>	Apatani	60 - > 100	(not observed so far at Ziro)

Table 2: Seed and germination characteristics of selected species of bamboos.

Species	Common Name	Fruiting time	Seeds per Kg	Viability* in months	Germination	
					Period	Percent
<i>Arundinaria falcata</i>	Ringal	May-June	—	6	15-55	50
<i>Bambusa arundinacea</i>	Kanta bans	April-may	90,000	6	12-30	55
<i>B. nutans</i>	Mokal	April-May	60,000	3	10-30	80
<i>B. tulda</i>	Jati bans	April-May	25,600	3	9-30	92
<i>Cephalostachyum capitatum</i>	Payong	July	1,885	6	31-90	25
<i>Dendrocalamus giganteus</i>	Tabou	May-June	17,000	12	10-30	70
<i>D. hamiltonii</i>	kako	April-May	38,500	12	8-28	60
<i>D. sikkimensis</i>	Pugriang	April-May	16,700	13	9-31	55
<i>D. strictus</i>	Bans	June-July	32,000	24	8-26	75
<i>Melocanna bambusoides</i>	Muli bans	May-August	6-8	1/2	6-14	80

\*Bamboo seeds are generally short viable and period given here is under proper storage conditions.

Seedlings can be transplanted when they are at three leaf stage to poly-pots. The transplanted seedlings are to be kept in partial shade initially for a month and then to open beds. Except for rainy season they need to be watered regularly. Seedlings are to be shifted after 3 months locally to avoid root penetration. 6 months to 1 year old seedlings can be used for plantation purpose.

### **Propagation through Vegetative Methods:**

Although large quantity of seeds are produced during gregarious flowering but they remain viable for one to six months. Further, seeding cycle of important bamboo species is very long and varies from 20 to > 100 years.


As most of the time seeds are not available, bamboos can be propagated vegetatively. Various methods of vegetative propagation like off-set and rhizome planting, branch and culm cuttings, marcotting and layering are commonly used for different bamboos. Among these, rhizome or off-set planting is most commonly used but this method has several limitations. Extraction of rhizomes is laborious and during extraction, damage may occur to the roots and rhizomes of mother clumps. The number of rhizomes available from a clump is small and since they are bulky, handling and transportation is labour intensive and expensive.

### **Propagation through Off-set planting:**

Vegetative propagation by rhizome or off-set is an age old method and has been used extensively in the region. Though it is traditional and perhaps most commonly used method of propagation of bamboos, this is practicable only in cultivating a few clumps particularly in small and accessible area. Availability of propagules in large number by this method is somewhat limited. It is best if offsets are planted just before the rainy season. In general, success of off-set planting in thin walled bamboo species is relatively poor and vary greatly from species to species. Bamboo species with large diameter culms requires larger rhizomes for planting. The use of rhizome for propagating bamboo has been limited mostly to non-clump forming (monopodial) species.

Off- set from 1-2 year old culms are cut at about 1.0 - 1.5 m height (3 to 5 nodes bearing viable branch buds), that is excavated along with a portion of rhizome with its root system. The rhizome must be separated by cuttings from its neck carefully causing minimal to rhizome during excavation. Such off sets are best taken and planted in season of rest prior to rainy season, so that they are capable of establishing roots easily and growth during favourable season. Off- sets taken in the late rainy season after the





new growth has started, usually fails to establish. Off-sets should be transplanted immediately after the extraction from mother clump and kept in moist gunny bag during transport. In field, preferably the top of culm should be covered with polythene bag and cavity filled with water to prevent drying. Alternatively people also practice covering the cut end using soil - cow dung mix. In case of prolonged dry weather daily watering may be required in new plantations.

However to meet the larger demands of planting stock more effective techniques which can result in mass seedlings production need to be adapted. Some of these modern techniques are culm cutting, branch cutting, layering, macro-proliferation and tissue culture. There is also lot of variation in each of these techniques. In this manual propagation through macro-proliferation, culm cutting and branch cutting are dealt along with brief reference to layering and marcotting.

### **Propagation through Macro-proliferation:**

This method is generally practiced in small seedlings usually raised through seeds. The multiplication of a bamboo seedling by rhizome separation leading to smaller sized planting material is known as macro-proliferation. Through this technique 5-9 month old seedlings of

*B. bambos*, *B. tulda*, *D.hamiltonii* etc, are multiplied 3-5 times. Every year this can be repeated.

When the bamboo seedling show rhizome development in 30-40 days it also produces culms. Seedlings with 4-5 culms are taken out from the bed. Then the soil is removed by washing or shaking. Each culm with a piece of rhizome and roots are carefully separated using sharp knife or secateur and planted in separate poly-pots as seedlings. Under proper nursery conditions these will further produce culms and the process can be repeated thus perennially making a good stock of plantable seedlings.

### **Propagation through culm cutting:**

Vegetative propagation using culm or stem segments is a viable alternative and has several advantages over other methods. The success and survival are higher (40 to 80%) than offset method. The method involves treatment of culm cuttings with growth regulating chemicals for inducing root formation. The method has been tested for most species of economically important bamboo and has been reported successful. Large scale multiplication of superior varieties is possible through this method. When out planted, plants raised from cuttings develop to culms much faster than seedlings. The practical steps involved in propagation of bamboo through culm cuttings are as follows:-

## Preparation of Nursery beds

1. Prepare raised nursery beds of 10 m x 1.2 m by deep ploughing/digging and fill with a mixture of soil, sand and fully decomposed FYM in 2:1:1 ratio.
2. One week prior to planting, drench the nursery beds separately with the insecticide, Aldrin and the fungicide, Bevistin to prevent termite and fungal attack. For each bed, use 40 liters of 0.015% (a.i). Aldrin prepared by adding 0.5 ml of Aldrex 30EC per liter of water and 30 liter of 0.05% (a.i) prepared by adding 1 g of Bevistin 50 WP per liter of water. During non-availability of Aldrin other insecticides like Chloropyrophos (Dursban) @ 2 ml per liter or Endosulphan - 35 EC @ 2 ml per liter can be applied by spraying 40 liter solution on each bed.

## Collection of bamboos and preparation of cuttings

1. Extract 2 to 3 years old culms from healthy clumps of bamboos by cutting them at the ground level or just above the first node.
2. Remove the tender top thin part of culm bearing leaves (shoot) and trim the side branches as shown in (fig. 1). Take care not to injure the axillary buds on nodes while re-

moving leaves and side branches.

3. Transport the culms to the nursery site as quickly as possible. Maximum care should be taken to prevent drying. This can be done either by wrapping the cut end in moist gunny bags or embedding in boxes containing moist saw dust.
4. Prepare two or three noded cuttings (cutting with 2-3 nodes leaving 5-7 cm on either side of nodes) using preferably a hacksaw or a sharp knife (dao). For thin walled bamboos use of hacksaw is advised to avoid splitting of the cut ends (fig. 2a).
5. Make an opening (about 2 cm in length and 1 cm in width) or drill two holes (about 7 mm diameter) in the centre of internode. Care should be taken while making hole that axillary buds or branches on both the nodes must lie in lateral plane to the ground (fig. 2b).

## Treatment of cuttings for root induction

1. Dissolve 20 g Boric Acid in half-liter water. Pour this solution to a clean container and add water to make up 100 liters. Mix the solution thoroughly by stirring. The final concentration of boric acid will be 200 mg/liters of water or equiva-

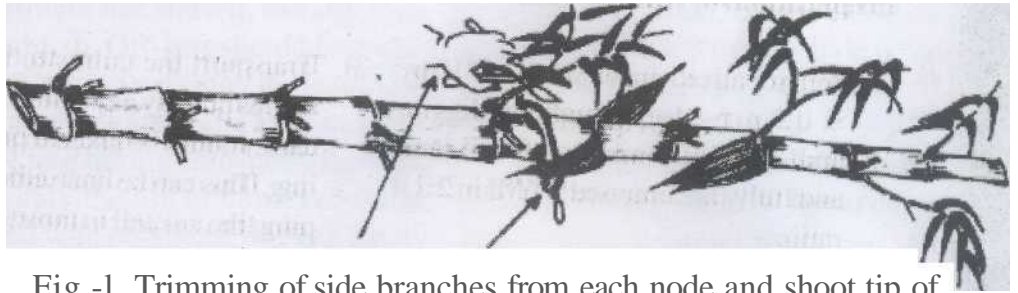
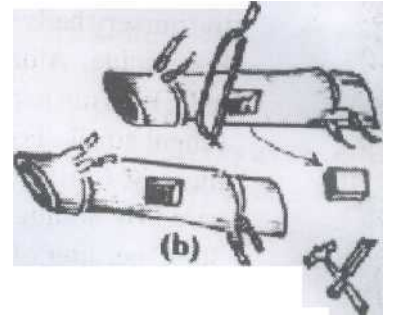


Fig.-1. Trimming of side branches from each node and shoot tip of bamboo culm.



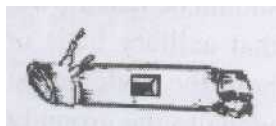
(a)



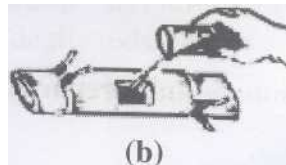
(b)

Fig.-2. (a) Making culm cutting using hack-saw.

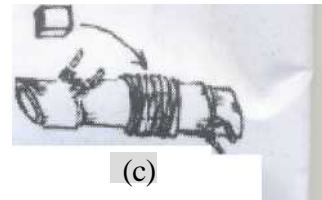
(b) Making an opening (whole) in the centre of internode of culm cutting (note the bamboo block or chip removed using hack-saw and chisel).



(a)



(b)



(c)

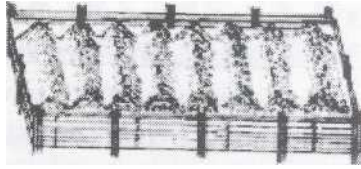
Fig.-3. Treatment of cuttings and closing of the whole of culm cavity.

(a) Bamboo culm with cavity opened.

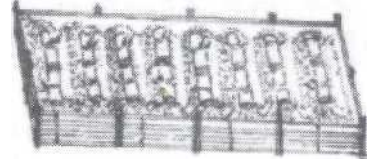
(b) Solution being poured into the cavity.

(c) Closing operation (note the removed chip replaced and tied up with polythene strip after sealing the cavity).



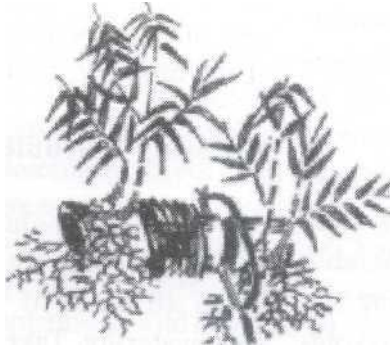


(a)



(b)

Fig.-4.(a) Bed with furrows prepared for planting.  
(b) Treated cuttings planted in bed.



(a)



(b)

Fig.-4.(a) Well rooted and sprouted cuttings being separated using  
hack-saw.  
(b) Propagule transplanted in polybag.

lent to 200 ppm (part per million). This solution is sufficient to treat 1000 cuttings.

2. Pour about 100 ml of the solution to the culm cavity. To avoid spillage, use wash bottle or funnel to pour the solution through the drilled holes. (fig. 3b)
3. Close the hole by melted wax or by wrapping and tying with a polythene strip ( 6 cm width X 60 cm length). Ensure that the polythene wrapping is tight so that solution does not leak out (fig. 3c). Keep the cuttings horizontally with the opening facing upwards.
4. After extraction, culm cuttings should be treated with Boric acid as quickly as possible (preferably the same day). If the planting site is far away and there is unavoidable delay for planting, the treated cuttings can be preserved up to three days by keeping in moist sawdust.

### **Planting of cuttings**

1. Make 10 to 16 cm deep furrows at a distance of 40 to 50 cm apart across the nursery beds (fig. 4a). Depth and distance of furrows can be decreased or increased depending on the diameter of culm cuttings.

2. Place the cuttings in furrows horizontally across the nursery beds in such a way that the hole/opening facing upward or buds placed laterally (fig. 4b). About 50-60 cuttings may be conveniently planted on a raised nursery bed of 10 m X 1.0 m size. Cover the cuttings with a 2-3 cm layer of soil.

### **Nursery management - Shade**

Nursery beds must be provided with a layer of mulch i.e. thatch or dry grass/straw to conserve the moisture and protect the cuttings from direct sunlight, which may be removed at the onset or monsoon.

### **Watering schedule**

The beds should be watered regularly in the morning and evening with 30 to 40 liters of water per bed at each watering. Take due care to avoid over watering and water logging.

### **Fungicidal treatment**

Treat the sprouts after one month with 0.01% a.i. (active ingredient) of Bevistin to avoid fungal attack.

### **Manuring**

If soil is poor and find necessary, fully decomposed farm yard manure may be applied to increase the vigour of the sprouts. This can be applied

when sprouting is completed, other wise shoots emerging from soil may get damaged during application.

### **Transplanting**

Sprouting can be noticed within 15 days and root development takes about 1 to 2 months. Rhizome development and new shoot emergence takes 3 - 4 months. Rooted cuttings can be excavated after flooding of beds and loosening the soil. Plants are transplanted to the field during June-July (after about 4 - 6 months). Those cuttings sprouted and rooted from both nodes, can be separated by cutting carefully at the middle of the culm cutting (internode) to get two plantlets (fig. 5 a & b).

If there is need to transport the plants to long distance, then excavated plants should be transplanted in large size (30 X 30 cm) polybags. These are to be watered twice daily and kept in shade for initial five days. When plants are established properly in bags, they can be transported or shifted to open beds.

### **Precautions**

Avoid collection of culms from the clumps, which are likely to flower in near future because new clumps developed from such cuttings will also flower and perish along with the mother clump. The year in which the clumps are likely to flower can be found out by checking the previous flowering record

from the area and the flowering cycle of the species.

Propagation during the spring and rainy season i.e. March to October gives better results in comparison of winter season for almost all species of bamboos. During winter season the sprouting and rooting rate are very poor due to unfavourable climatic conditions as well as due to low content of carbohydrates and hormones in the bamboo culms.

### **Propagation through Branch cutting method:**

Thick walled bamboo species like *Bambusa balcooa* (Bhaluka), *B. bambos*, *B. vulgaris*, *B. wamin*, *Dendrocalamus hamiltonii*, *D. asper* etc. produces stout branches often with basal nodes of branches with root primordia. These branches are cut and carefully extracted from 1-3 year old culm. 3-4 noded cuttings are prepared from such branches and planted in to propagation beds obliquely vertical. The cut portion above is sealed with molten wax. A treatment of rooting hormone like IB A, NAA or some commercial preparation will give better results. Cuttings can also be best propagated in mist chamber. The cuttings are buried at least 7-10 cm below in sand bed in mist chamber. The sprouting and rooting will take place in 1-4 month time and can be transplanted to poly-pots kept in shade beds initially and then these seedlings can be stocked in open beds. These seedlings are ready for plant-

ing in 6 months to 1 year time. Though not so commonly practiced this is a more economical and effective method of propagation.

### **Propagation through layering and Marcotting:**

There are three types of layering procedures i.e. ground or simple layering, air - layering or marcotting and stump layering. In ground layering, a 1 year old culm is pruned without injury to dormant buds and half buried under well prepared soil media in such a way that the buds along each side of the culm are in lateral position (fig. 6b). Marcotting involves bending of one year old culm so that all the nodes come within easy reach of the worker. The branches of the nodes are pruned to about 2.5 to 4 cm from node in such a

manner that dormant buds are not damaged or injured. An admixture of garden soil, leaf mould and rootex, Rootone or any other commercial rooting hormone preparation is placed around each node and longitudinally wrapped with coconut fiber or water hyacinth roots. This is then securely tied at both ends. Successfully rooted nodes are separated from the stem to become a new plant with its own roots and planted in field (fig. 6a).

Rooting whether aerial or ground can also be induced in some bamboo species by detasseling of shoot top and removing the newly emerging culms from the clump. About 28% success has been reported by both air and ground layering in bamboos mainly in mid culm zone, but it varies from species to species. April and May are best period of the year for such layering works.



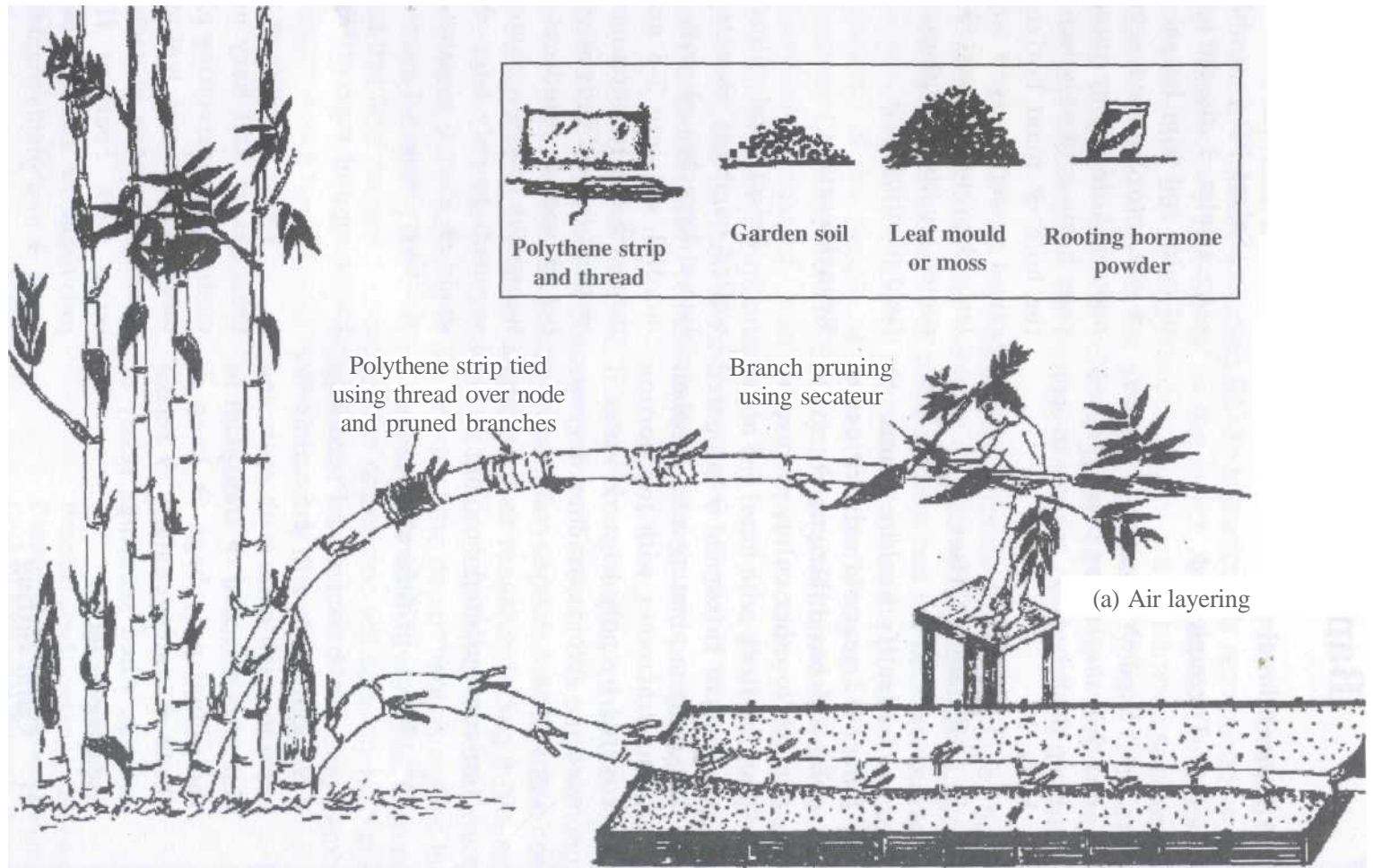


Fig.-6. Air layering (marcotting) and ground layering of bamboo culms for rooting.

(b) Ground layering



# Bamboo propagation at a glance

## Conventional:

### 1) Through seed.

Seed → Sowing in Nursery bed → Transplanting to polybags → Keep shade beds → transfer to open beds →

### 2) Rhizome/Offset.

Identify healthy culms → Select 1-2 year old culm → extent culm with basal rhizome → avoid damage to other culms → prepare planting stock with basal 3-5 nodes and rooted rhizomes → prepared large pits in planting sites → plant offsets/rhizomes with top portion covered by poly bags → water if needed. Avoid extraction in growing season.

## Non-conventional :

### 3) Macroproliferation :

Raise seed raised seedlings 5-9 month old with 4-5 culms → separate each culm with roots and rhizomes attached → transplant to individual poly bags → keep in shade → water regularly → repeat process when seedlings ready or use for plantation.

### 4) Culm cutting :

Select 1-2 year old culm → extract culm → discard top portion of culm and trim lateral branches → cut into 2 noded segments → make a hold in the internode → pour boric acid solution → cover the hole → plant horizontally in raised nursery beds → water regularly → protect sprouts → separate rooted seedlings → plants ready for field planting.

### Branch cutting :

Select good culms of thick walled bamboos → extract basal lateral branches → with root primordial, cut into 2-3 noded segments → dip in hormone solution → plant in sand beds in mist chamber → seal exposed cut ends → transplant rooted sprouted branch segments to poly bags → keep in shade → after 6 months ready for planting.

### Layering and marcotting :

1 year old culm → prune the branches → half bury under soil media. For marcotting place mixture of garden soil, leaf mould and rooting hormone at each node → wrap with coconut fibre and polythene → rooted nodes separated → new plants planted in field.

**SOME SELECTED BAMBOOS HAVING INDUSTRIAL APPLICATION AND THEIR USES:**

Species	Uses
<i>Bambusa balcooa</i>	Building construction, Agarbathi sticks, edible shoots.
<i>Bambusa bambos</i>	Building construction, ladder, tent pole, making baskets, mats, agricultural implements.
<i>Bambusa nutans</i>	Construction, pulp, basketry, handicrafts.
<i>Bambusa pallida</i>	Construction, mats, basketry, edible shoots.
<i>Bambusa teres</i>	Baskets, mats, agarbathi sticks, foodgrain containers.
<i>Bambusa tulda</i>	Construction, pulp, basketry, mats, toys, handicrafts.
<i>Gigantochloa macrostachya</i>	Construction, pulp, basketry, mats, toys, handicrafts.
<i>Melocanna baccifera</i>	Construction, pulp, basketry, mats, toys, handicrafts, walling, foodgrain containers.
<i>Phyllostachys bambusoides</i>	Construction, mats, walling, splits, edible.

**BAMBOO SPECIES FOR PLANTING IN DIFFERENT ALTITUDES****Low altitude (Tropical conditions) below 1000m MSL**

<i>Bambusa balcooa</i> ( Baluka)	Clump forming
<i>Bambusa bambos</i> (Kata bans)	Clump forming
<i>Bambusa nutans</i> ( Mokal)	Clump forming
<i>Bambusa pallida</i> ( Bijuli)	Clump forming
<i>Bambusa teres</i> ( Paora)	Clump forming
<i>Bambusa tulda</i> ( Jati)	Clump forming
<i>Gigantochloa macrostachya</i> (Tekserah)	Clump forming
<i>Melocanna baccifera</i> ( Muli)	Non clump forming

**High altitudes above 1000m MSL**

<i>Bambusa nutans</i> ( Mokal)	Clump forming
<i>Bambusa tulda</i> ( Jati)	Clump forming
<i>Phyllostachys bambusoides</i> ( Apatani bans )	Non clump forming