Propagation

In general, seed is the best source of planting material for large scale plantations. Multiplication of bamboo by seed is the most common method, but many of the bamboo flower and seed after a long period. Again, after flowering most of the bamboos die. Therefore, the possibilities of raising bamboo plantations from seed have been very limited and difficult, and vegetative method of multiplication is only the solution.

Propagation from Seeds:

The seeds are sown in germination beds in September/October. Germination takes from 10 to 20 days. When seedlings are about three months old, they are picked out in to polythene bags of size 20x10 cm filled with well-powdered local soil mixed with manure. The bags are regularly watered and the polybags are kept under partial shade (75% shade provided by agro shade nets) and irrigated daily. Seedlings are ready for planting during July next. Pits of about (30x30x30) cm are dug out at a spacing of (5x5)m for planting the seedlings. After planting necessary watering and weeding are done.

Vegetative Multiplication:

Due to its long term flowering interval the bamboo seedlings are unavailable in every year and this is the major impediment in raising large-scale plantations of bamboo. Several methods of vegetative propagation of bamboos have been tried. The age, nature and location of a bamboo propagule are important for better success. The various methods of vegetative propagation tried in bamboos are briefly described below:

Rhizome Planting:-

This is the most common propagation method of bamboo. The bulky rhizomes of bamboos are dug out in the rainy season and planted in the field. Dabral (1950) described it as “the best method” of propagating bamboo. The use of rhizomes for propagating bamboo has been limited to non-clump forming species. Of course, there are some problems in this method, these are: -

meagre development of roots,
decay of rhizomes and
slowness of rhizome buds to break dormancy.

Offset Planting:-

The term “offset” is described for bamboo propagules each composed of the lower part of a single culm with the rhizome axis basal to it. Generally 1 or 2 year old offsets give better results, while propagules consisting of material 3 years or more in age give progressively poorer results. Propagation of bamboos by offset planting is a very common method in the villages of Assam.

Both age of the offsets and their collection time have significant effect on their survival and growth after field plantation (Banik, 1991 a). It is generally found that

success is higher when collected and planted in the month of late March or April, though it may extend upto 1st part of July. Two nodes of the culm with rhizome are sufficient for survival of offset and the offset with more nodes of the culm may give poorer results.

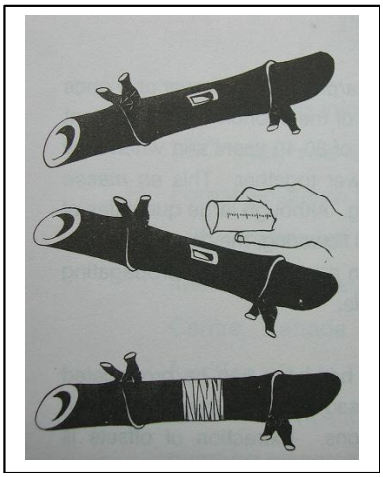
Offset of *Bambusa bambos*

Culm or Stem Cutting:-

Propagation of bamboo through culm or stem segments is known as culm cutting or stem cutting technique. Generally culm segment of bamboos of 1 or 2 - 3 nodes bearing healthy buds or branches used for propagation. For this technique I.5-2 year old culms were selected from healthy mother clumps. The selected culms were felled during February-March. The thin walled top one-third portion was discarded. Rest of the culms was made into either single noded or two noded cuttings depending on the experiment.

Such cuttings are usually set upright or at an angle or horizontally, with at least 1 node well covered. April is the best month for this type of planting and one year culm gives best result. Treatment of culm cuttings with growth regulating substances for inducing root formation is generally done. Large-scale multiplication is possible by this method. When out planted, plants raised from cuttings develop to clumps much faster than seedlings. Hence this method is most useful.

A cutting first develops leafy axis from the nodal bud(s) within 1-2 weeks of planting. Rooting from cuttings usually takes place after 2-4 months and cuttings which fails to develop roots die. Appearance of new shoots (culms) from the rooted material indicates that rhizome has formed in the cuttings and the cuttings that fail to develop rhizomes ultimately die. The use of auxins may be helpful in root development. IAA (Indole Acetic Acid, Seethalakshmi *et al*,



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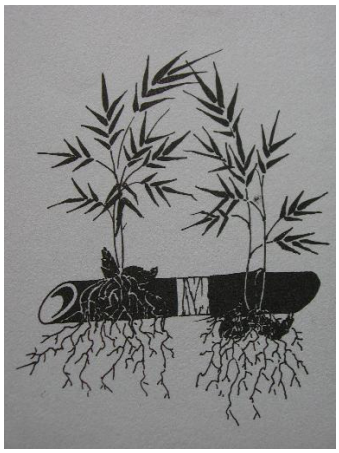

B

Fig: A, B: Culm cutting technique

1983); (Indole Acetic Acid, Seethalakshmi *et al*, 1983); Boric acid, NAA (Naphthalene Acetic Acid, Surendran *et al*, 1983) give better sprouting and rooting in two-noded cuttings. The internodal cavity is filled with measured quantity of growth regulator through a chiseled hole in the internode which is later bandaged with a polythene tape. The base of the planting stock may be immersed in plant growth regulator for 24 hours before being planted (Uchimura, 1977).

Branch cutting:-

In thick walled bamboo species having prominent primary branches, branch cutting is the ideal planting material. Its small size and the fact that many branches can be extracted without damaging the mother clump make it the propagating material of future. Discard the top portion

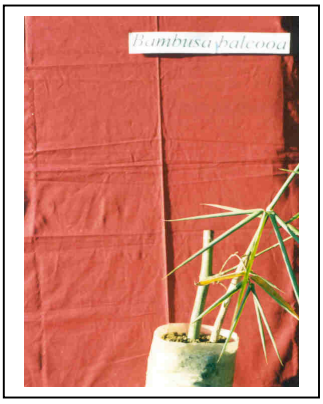

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Fig.: Stages of branch cutting

leaving two nodes and the basal swell. Then dip the cuttings in hormonal solution (IBA solution of 200 ppm) for 24 hours. Seal the cut ends with wax to prevent desiccation. Dip the cuttings in Bavistin (0.1%) solution just before planting. Plant the cuttings vertically either in polybags or raised beds in such a way that the rhizomatous swelling

and one node remain below the soil surface. The polybags were kept under partial shade (75% shade provided by agro shade nets) and irrigated daily. The successfully rooted and rhizomed cuttings were out planted in the next rainy season.

Propagation Using Whole Culm:

Vegetative propagation using whole culms is carried out in two ways:

The culms are given an undercut at the base, bent down wards and their tips are buried in the soil. The branches on the culms are cut off. After a few weeks, roots and shoots develop at the buried nodes. The internodal segments are than separated and each segment produces new plants.

A whole young culm may be cut at the base, and buried 15-20 cm deep in the soil after removing its main branches. The top and a few secondary branches are left exposed above the ground. New roots and shoots develop at the buried nodes after a few weeks. The internodes are then separated .after about 6-8 months.

Kurz (1876) described this method as “by taking whole halms (Culms) with in the ground.” Pathak (1899) tried propagation of *Dendrocalamus stictus* using 3-5 years old cuttings. Although sprouting was good in the initial stages, the cuttings failed to establish during summer. 2-year old culms of *D. strictus* and *B. tulda* produced more propagules than 1 year old culms. Of course this method is not useful for all bamboos.

Macroproliferation (Seedling Multiplication):-

In order to increase planting stock before transfer to the field, macroproliferation is practised. A bamboo seedling, at the age of 30-40 days, produces new culms and start developing rhizome. At four to five months period, these plantlets develop five to six culms (tillers). These tillers may be separated into as many units with a small piece of rhizome and roots. In order to avoid/minimise casualities the seedlings, after separation, should be kept in shade, watered regularly few days and then brought to the nursery beds. These propagules attain the size of field plantable saplings within four months, or they can be further multiplied through macroproliferation. Banik (1985) reported that five to nine months old seedlings of *B. tulda* can be multiplied 3-5 times in number through this technique. The survival rate of these multiplied seedlings is within 90-100. By this technology a large number of identified planting stocks can be made available. Advantages of this method are that once seedlings of a bamboo species are available the process can be continued atleast for a number of years. It is easy to handle and transport the proliferated seedlings (Banik, 1985; Tewari, 1992) as they are small in size due to continuous rhizome separation. Banik (1985), however, suggested that the seedling multiplication in this way should not be continued for a very long time. The advantages of this method are that once seedlings of a bamboo are available, the process can be continued at least for a number of years. Proliferated seedlings remain small in size due to continuous separation of rhizomes, thereby making it easy to handle and transport them. (Banik 1987, Tewari1992).

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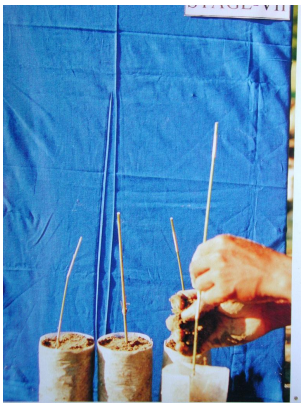

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Fig.: Stages of Macroproliferation

Standardization of basal media:-

In *Bambusa tulda* the media containing two parts of soil, one part sand and one part FYM is the best for root and shoot induction. The media composition helped in producing more number of vigorous shoots.

Rooting media standardization:-

In *Dendrocalamus hamiltonii* treatment with 200 ppm Naphthalene acetic acid (NAA) was found to be the best with 78% success. The cuttings with rhizomatic swelling and two branch nodes are the best for propagation of *Bambusa balcooa. Bambusa balcooa* when treated with Coumarin, NAA or a mixture of Coumarin and IAA gave the highest percentage of rooting and survival after transplanting in the field (Seethalakshmi *et al*. 1983).

In the second experiment significant difference was observed among the four levels of the first factor (culm portion) for all the observed parameters viz., number of roots, maximum root length, number of shoots, shoot height and collar diameter. Similarly significant difference was observed among the ten levels of the second factor

(hormone) for parameters of collar diameter, number of roots and maximum root length. Cuttings with rhizomatic swelling and two nodes (P_1) treated with 200 ppm IBA (H_3) gave highest percent (66.7 %) rooting and rhizome formation as compared to 33.3 % in control.

None of the cuttings without rhizomatic swelling survived. They remained in green condition for 2-5 months and afterwards perished.

Standard dose of fertilizer:-

The results of several experiments conducted in South and South East Asia have shown increased productivity with yearly manuring and fertilization. Three things need to be taken into consideration while fertilizing the clumps:

Method of application
Kind and dosage of fertilizer
Fertilization time

There are several methods of fertilizer application like broadcasting, in furrows around the clump, foliage dressing and stump fertilization. Fertilizer application efficiency is high when it is applied in furrows around the clump. The efficiency is also good in stump application, where it is absorbed through the inner wall of the internodal cavity. Organic manures should, also be placed in furrows around the clump.

Both the organic and the chemical fertilizers should be used widely. Nitrogen is the most important, followed by P and K. 50 Kg N/ha (109 Kg Urea/ha) is the recommended dose. If the soil lack in P and K, 50 Kg P2O5/ha (313 kg SSP/ha) and 25 Kg K2O/ha (43 Kg MOP/ha) is recommended. The proportion of N: P: K should be 2:2:1.

The period of shoot bud differentiation is the suitable time for fertilization. It may be carried out along with the soil working before the emergence of new culms.

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Flowering Symptoms and Changes

In India, bamboo resources are used in various sectors such as handicrafts, industries, construction, agricultural uses etc. There are extensive programmes initiated all over India to popularise bamboo as farm crop and promote bamboo planting in private and community lands in addition to the plantation programmes implemented under various schemes by State Forest Departments. Non availability of bamboo seeds is the major problem in the bamboo resource development. It is due to peculiar nature of flowering of bamboos.

Flowering behaviour of bamboo is of three types viz.-annual or continuous flowering, gregarious or periodic flowering and sporadic or irregular flowering. Unfortunately most of the commercial bamboos belong to the gregarious flowering group. Moreover, it is seen that most of the bamboo culm die after flowering or seed setting. The flowering interval of periodic flowering bamboos varies from three to one hundred and twenty years. The exact physiological mechanism of bamboo flowering is not yet known precisely. Different evolutionary hypothesis are put forward to explain the bamboo flowering. But these are remaining controversial.

Based on the experience of practicing foresters, some indications to predict the occurrence of flowering in *D. strictus* has been reported. They are i) the branches tend to be stunted and bushy, ii) production of new shoots stop, iii) colour of the stem become dull and freshness disappear and iv) in several cases yellow / whitish vertical streaks develop on the stem. Flowering of bamboo can be controlled by tending, soil mounting, applying fertilizers etc. So far, none of them are successful.

During flowering chemical changes occur in bamboos. Some chemical substance like carbohydrate, reducing sugars etc. increase during flowering. On the contrary, substances like α-cellulose, hemi-cellulose and moisture content always reduce during flowering. No change occur in lignin profile during flowering but during post flowering 40% increase is found with very little partition to seeds. High lignin contact has been suspected as one of the factor causing death of flowered bamboo.

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Bamboo Diseases and Management

The productive potential of bamboo stands in most of the bamboo growing countries in Asia is affected by various biotic and abiotic factors. A large number of diseases have been reported in bamboo from different countries in Asia. About 170 species of bamboos belonging to 26 genera are found affected by various diseases and disorders. A total of 440 fungi, three bacteria, two viruses, one bacterium like organism have been reported to be associated with these diseases and disorders. Only a few diseases are identified as serious one, affecting culm production as well as stand productivity. Diseases which are recognized as potentially serious include: culm blight caused by *Sarocladium oryzae* in village groves in Bangladesh and in the coastal belts of Orissa state, India; rot of emerging and growing culms caused by *Fusarium* spp.; witches-broom caused by *Balansia* spp. In China, India, Japan and Taiwan-China; little leaf diseases caused by phytoplasma in the dry tracts of Southern India; culm mosaic caused by bamboo mosaic virus in Taiwan- china; and culm rust caused by *Stereostratum corticioides* and top blight of Phyllostachys spp.caused by Ceratospaeria phyllostachydis in China.

In bamboo nurseries, 13 diseases have been recorded from India, the Philippines and Thailand. Among the nursery diseases, web blight caused by *Rhizoctonia solani* is a potentially serious disease that is widespread. *Dasturella divina*, which causes leaf rust, and *Exserohilum* spp. and *Bipolaris* spp., which cause foliage infection, are the other major diseases.

Culm blight, culm rust, top blight and culm mosaic are spreading fast in bamboo stands in different countries, and new out breaks are common , adversely affecting bamboo industries as well as the rural economy as a whole. Diseases management measures in practice in these countries have relied mainly on silvicultural measures and to a lesser extent on prophylactic treatment. However, etiology and epidemiology of these diseases are little investigated and control measures often prove inefficient. Hence, a concerted effort is required to develop appropriate measures to check further spread of the diseases in stands as well as to safeguard against the inadvertent introduction of the diseases to new areas. Most nursery diseases can usually be controlled by good nursery management practices or prophylactic fungicidal application.

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