Propagation of Bambusa and Dendrocalamus species by culm cuttings: Preliminary practical recommendations

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Introduction

Large stature bamboos of the genera Bambusa and Dendrocalamus are well known to be very important in the rural economy of Nepal, (Stapleton, 1982), being multipurpose species which provide constructional materials, animal fodder, fuelwood, food, and woven products for agricultural and domestic purposes, as well as baskets for transport of most commodities beyond the roadheads in the hills. They have been selected by the Community Forestry Development Project as priority species requiring particular attention, (Tystjarvi, 1981).

Planting large bamboos has in the past been severely restricted by lack of seed, lack of knowledge concerning satisfactory vegetative propagation techniques, and a complete lack of knowledge of the distribution, uses, and site requirements of Nepalese species. Considerable knowledge has been gained of the most important species including their flowering and seeding habits and also the potential for propagating them from short culm sections as well as by the traditional rhizome plus long culm section used almost exclusively in Nepal until very recently, (Stapleton, 1985a).

Short culm cuttings offer many advantages over the traditional cuttings, (Stapleton, 1985b). An average clump may provide only about five traditional cuttings each year without a severe reduction in clump vigour and productivity, while up to one or two hundred culm cuttings can be taken without affecting clump productivity or disturbing the rhizome system at all. Traditional cuttings can weigh up to 40 kg each, making transport extremely difficult. Each culm cutting weighs about half a kilogramme or less. Traditional cuttings retain certain advantages however (Stapleton and Tamrakar, 1984): nursery facilities are not required; survival is very good even under extremely arduous conditions; protection against grazing animals is much easier and establishment is potentially a little quicker.

It has been seen that seed of one very important species is available in Nepal (Stapleton 1985c), and that this species (Dendrocalamus hamiltonii) can regularly be propagated from seed. This is obviously the most economical means of raising plants and has benefits such as minimizing the chance of imminent flowering. Nevertheless the logistical problems of seed collection and supply for raising plants in widely distributed nurseries and the slow establishment of mature clumps from seedlings suggest that the advantages of culm cuttings may be considered overriding even for this species, given the practicalities of forestry implementation in Nepal.

Literature review

The literature has been reviewed by Stapleton(1985b). It is well known that bamboos vary greatly in their ability to root from culm cuttings. It has been shown that those species with abundant aerial roots on their culms and branch bases root readily while those without are very reluctant to root, (Troup 1921, McClure 1966). Beyond this basic observation very little is known as to why this is or how the reluctant species can be made

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to root. It is accepted that bamboos have received very little systematic attention (McClure 1966, Soderstrom and Calderon 1979). There is no standard way of taking cuttings, nor is there much knowledge of morphology or physiology to provide a basis for good material selection. Present fashions in research lead to studies involving application of plant growth regulating substances and tissue culturing rather than studies of more basic aspects of propagation and simple techniques. Some authors have written off the possibility of using culm cuttings altogether, (Deogun 1937, Hasan 1980). This seems a little hasty considering the well accepted present lack of basic knowledge such as how to select the best material, how to plant it, and how it should develop.

Sophisticated approaches such as tissue culturing or the use of growth regulating substances do not seem likely to provide information of practical relevance to forestry operations where facilities are basic and costs have to be minimised.

As far as simple vegetative propagation is concerned there are nevertheless many useful pieces of information in the widely dispersed literature, and McClure (1966) started to bring them together. Riviere & Riviere (1879) showed the potential of swollen branch bases for propagation because of their similarity to small—scale rhizomes with preformed roots. They also reported the need for sufficient culm material attached to the branch base. Cabanday showed in his results (1957) that single—node cuttings were more efficient than two—node cuttings or whole culms. Several authors have found that horizontal cuttings are better than upright ones, (Gupta & Pattanath 1976, Mengga 1980). McClure (1966) stressed the need for new rooted shoots to develop before success had been obtained, and showed that only inside the dormant buds is there meristematic tissue capable of achieving this. In this way bamboos differ from dicotyledonous plants which can produce roots from the ample supply of meristematic tissue widely distributed as inter-fascicular cambium. Understanding this is fundamental to successful propagation in bamboos. He also noted the need for sufficient reserves in the culms, necessitating the use of older material. Gupta and Pattanath (1976) showed April to be the best month for planting. Abeels (1962) found waterlogged conditions unsuitable. Khan (1972) found clay to be better than silty sand. In addition a few hints can be found in studies on the closely related sugarcane family (Purseglove 1972, King et al 1965), and guidance is available from the underlying principles of good propagation practice, such as timely and careful handling of good quality material and provision of an equable environment avoiding desiccation and temperature extremes.

Characteristics of Nepalese species

The large bamboos (bans) of Nepal come into the categories of both readily and reluctantly rooting species: *Dendrocalamus* species have abundant aerial roots and root readily from culm cuttings, while most *Bambusa* species have few if any aerial roots and are reluctant to produce roots from cuttings.

Investigations into propagation of Nepalese bamboos have been concentrated on those species which are considered the most important elite species. It has been seen (Stapleton, 1985a) that people need two different types of large bamboo: constructional types, and multipurpose types which provide weaving material and edible shoots. The latter requirement is covered by the elite species *Dendrocalamus hamiltonii* (choya bans) in eastern, central, and western Nepal. *Bambusa nutans* (mal bans) covers the eastern region’s constructional requirements while another *Bambusa* species (tharu bans) covers this requirement in the

central and western regions. Thus these three species alone can provide the bulk of requirements for large stature bamboos (bans) in all three regions. Mid—western and far—western species are not yet known.

As D. hamiltonii both roots readily and provides seed little time has been spent on it except for comparison with Bambusa species. Bambusa nutans (mal bans) and B. sp. (tharu bans) are very similar, both having no roots at all on the branch bases and few aerial roots on the culm above ground level. Most work has been concentrated on overcoming the reluctance of these two species to root. D. hookeri (kalo bans) is a general purpose species found in eastern Nepal. It is not as strong as Bambusa species nor as flexible as D. hamiltonii but it is widely planted. It is the construction species with the most prolific rooting, and thus the easiest to grow from culm cuttings, therefore it has also been included in trials although from the utilisational point of view it is not strictly an elite species.

Experimental results

Stapleton (1985b) gave a full description of the experimental trials of culm cuttings undertaken in Nepal.

It was seen that Dendrocalamus hookeri and D. hamiltonii produced very well rooted plants from several shoots at many nodes and that 84 percent and 70 percent of nodes respectively produced rooted plants, even under poor conditions, see fig (ii). In contrast Bambusa nutans produced rooted shoots from only 5.5 percent of nodes, see fig (i).

Bambusa nutans and B. sp. (tharu bans) were studied in more detail to find ways of improving their rooting performance. Although it was seen to be important to keep the cuttings well watered and shaded improving the environment by putting up polythene tunnels did not increase the success rate. It was seen that several other factors were limiting production of rooted plants in these species. Only the central branch gave rise to rooted shoots; shoots arising too deeply in the soil often died; only those shoots which re—orientated themselves through the horizontal rooted (see fig (1)); and several well rooted shoots died. Further investigations showed that competition from non—rooting shoots was killing these shoots.

A planting technique to overcome most of these problems has been developed for Nepalese Bambusa species, and it is being refined by further developments. A success rate of 75 per cent is now obtainable with culm cuttings of Bambusa sp. (tharu bans).

Preliminary recommendations for planting Bambusa species

1. Material selection

Only culms in their second year of growth should be used. Those still in their first year of growth do not have leafy branches and have not built up sufficient reserves of nutrients. Culms with strongly developed central branches are best. Those which have had the branches at the bottom nodes cut off to ease access to the clump will not give as many good cuttings as these nodes are ruined for propagation purposes. It is well worth using the strongest culms for cuttings despite the temptation to use only smaller, damaged or sub—standard culms which may not have any other use. From a small clump use only about five strong culms, up to a maximum of ten from a very large clump. This way quality can be maintained. Suitable culms should be identified, marked, and purchased early in the winter before the annual cutting activities remove all the best material.

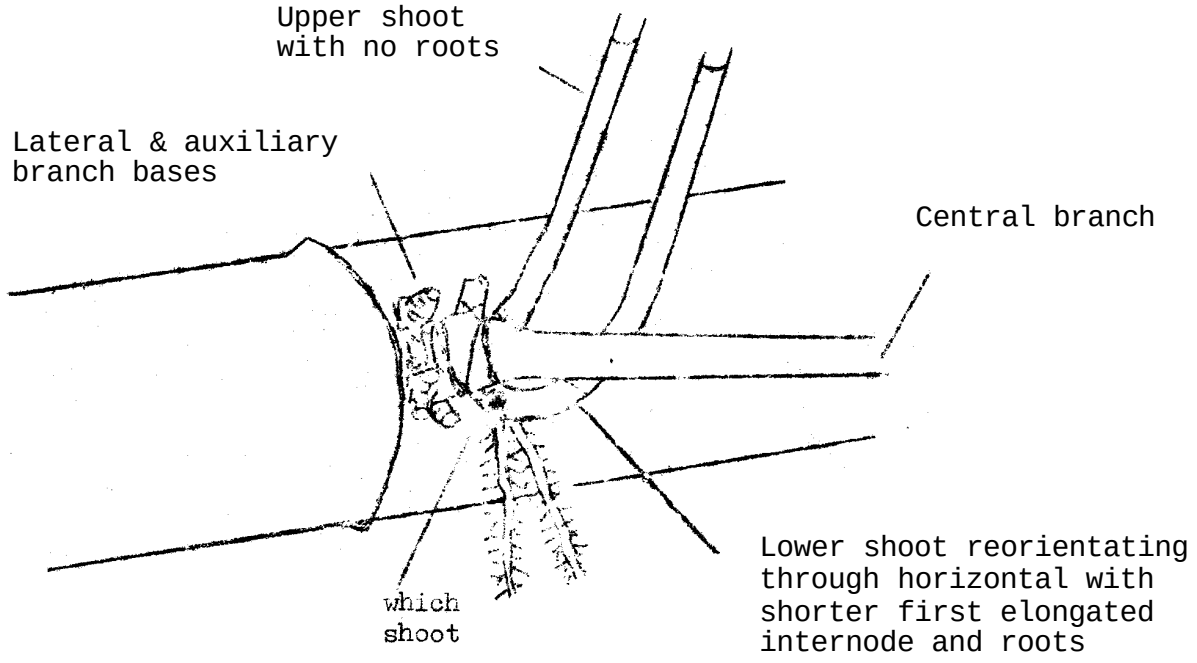


Fig. (i) Reorientating and rooting lower shoot, and non-reorientating non-rooting upper shoot from central branch base in Bambusa nutans

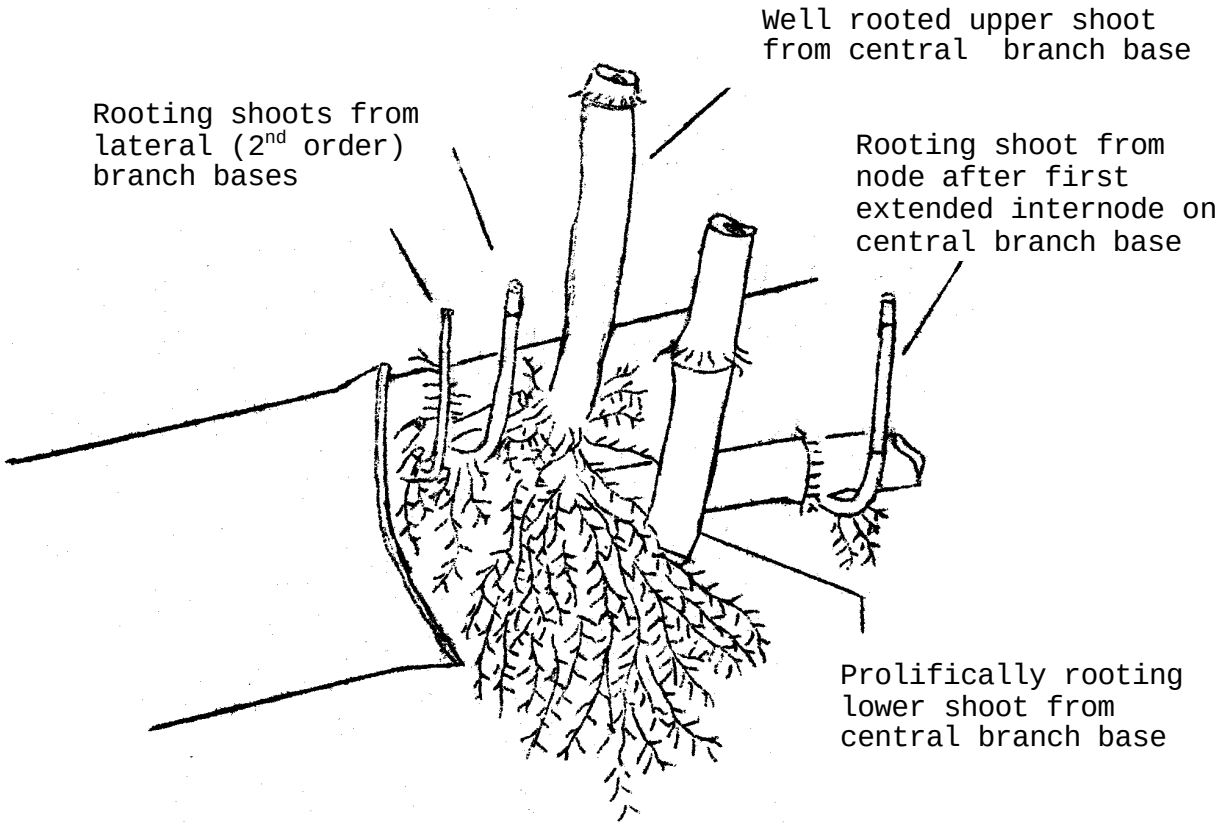


Fig. (ii) Rooting shoots from several categories of branching in Dendrocalamus hookeri

2. Time of taking cuttings

In spring the leaves and new shoots on the branches of bamboos start to grow when the temperature rises end there is enough moisture in the soil. Cuttings should be taken a while before this new growth starts (one to six weeks), when the buds are getting ready to burst. It is necessary to watch the species in an area carefully as this time varies between species and localities, although it seems consistent from year to year. Cuttings of B. nutans in Dhankuta district have been taken in mid March (start of Chaitra) and B. sp.(tharu bans) in Kathmandu in (start of Baisakh). Growth starts earlier at lower elevations.

3. Preparation of material

In order to transport the culms easily and plant them in the correct manner they should be cut midway between the nodes to give single—node cuttings. This also allows more water to enter. Material from the top of the culms where the diameter is less than 3.5 cm has been less successful and should be rejected. The central branches should be cut beyond the first elongated internode, leaving the bud visible, while other branches are trimmed back as close to the culm as possible. See fig (iii), a.

4. Transporting cuttings

It is important that the ends of the cuttings are kept wet during transportation. After loading into dokos they should be covered with wet straw or sacking or whatever is available to retain moisture and to protect the cuttings from sun and wind. A container of water should be carried with the cuttings if they are to be taken far so that they can be kept moist. They should be planted as soon as possible.

5. Preparation of beds

The coolest, dampest, shadiest part of the nursery should be used. Heavy moisture retentive soil is better than light sandy soil, but good drainage is also necessary to prevent water logging. Shades which effectively protect the beds from the drying effect of intense sunlight should be erected one metre above the bed. Bamboo mats and hessian material have been found suitable for shading as they allow a little light to penetrate. In hotter nurseries they would probably allow too much sun through.

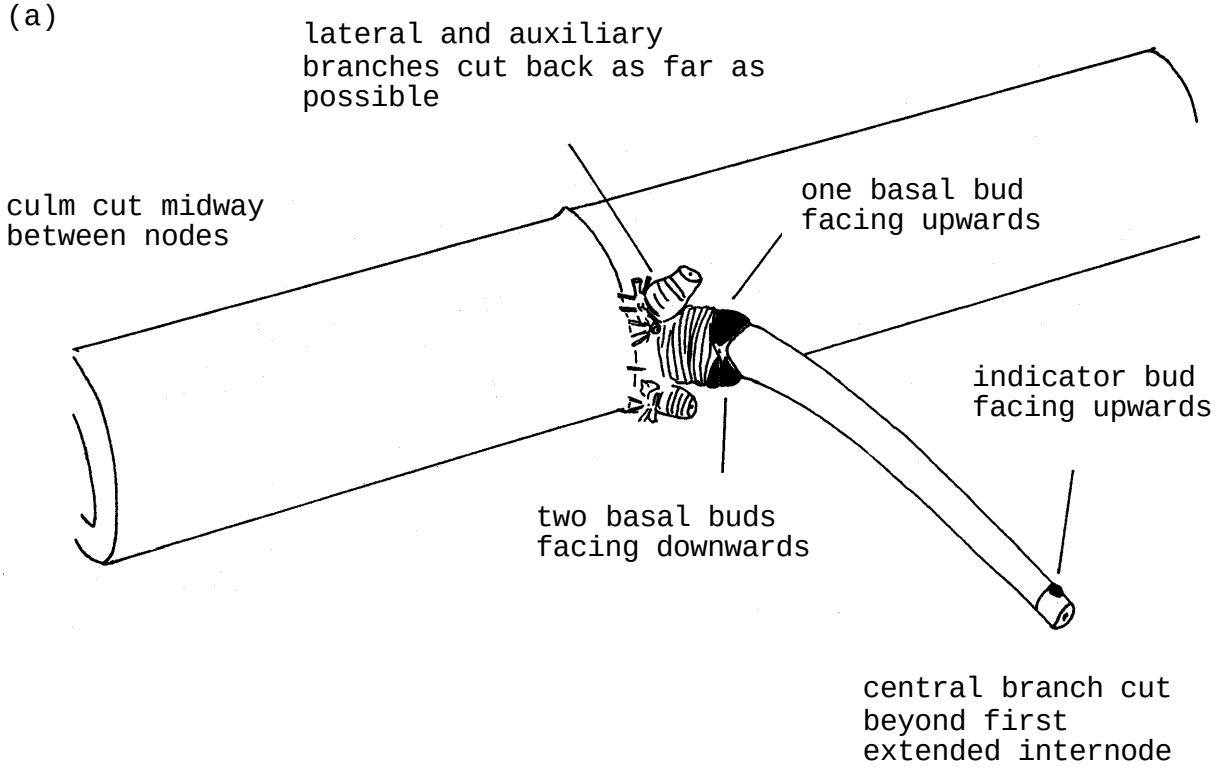
6. Planting cuttings in nursery beds

There are three important factors to take into account when planting the cuttings. Fig (iii)b shows the technique found to be successful in allowing for these factors.

Firstly the ends of the cutting must be well covered with soil. All water used by the rapidly growing shoots has to enter the cutting through these two ends. Water cannot enter the inner or outer walls of the cutting, nor the branch base, nor directly into the new shoots until they have developed their own roots. Therefore the ends must constantly be in contact with moist soil from which the large quantities of water required can be obtained.

Secondly the central branch is planted to encourage certain shoots to develop in a curving fashion so that their bases resemble the shape of full—sized rhizomes, as this has been seen to encourage root

(a)



(b)

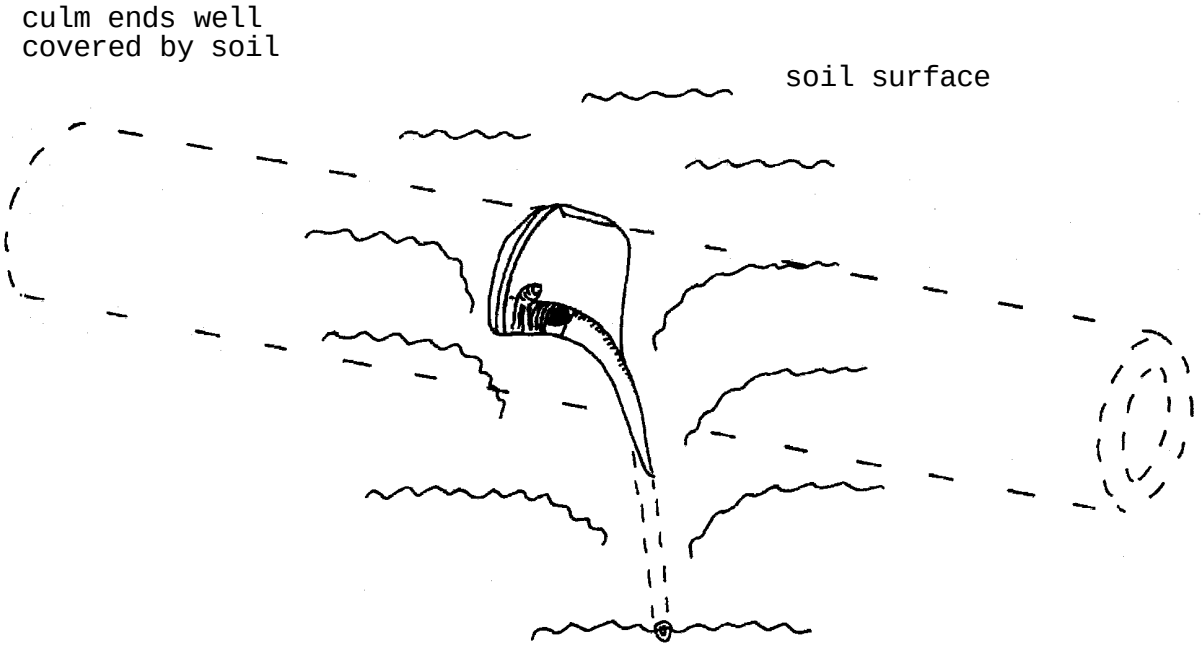


Fig. (iii) a) Prepared single-node cutting of Bambusa species
b) Planting technique with culm and branch horizontal and only branch base not covered by soil

production. With the branch horizontal shoots develop in this fashion from the buds facing downwards on the base of the branch. They initially grow downwards but quickly curve up towards the light, so that they take on the 'Umbrella—handle[1]' shape of the full—sized rhizome. If the branch is too deeply buried in the soil the shoots can die before doing so.

Thirdly the number of shoots growing straight upwards from the top of the branch base should not be more than the number developing downwards from the bottom. Shoots which grow straight upwards grow faster than those which gradually curve upwards from an initial downward orientation, and they can monopolise resources, resulting in the death of the lower shoots. As the lower shoots are more likely to root than the upper shoots this usually results in the whole cutting dying. Therefore as most branch bases have a total of three buds the cuttings should be planted with one bud facing upwards and two buds facing downwards rather than vice—versa. It is difficult to see these buds as they are covered with small sheaths. However it is easy to see the bud beyond the first extended internode. Because of the alternate insertion of buds, if this bud faces upwards there will usually be two buds at the branch base facing downwards and only one facing upwards.

Thus the three important factors which can greatly improve rooting can be easily taken into account by :—

1. Planting the cuttings with the culm section horizontal and both ends covered with soil

2. Having the central branch also horizontal with its base half—buried

3. Ensuring that the 'indicator' bud beyond the first extended internode faces upwards

7. Development and management of cuttings

The soil in which the cuttings are buried must not dry out. This means watering the beds twice a day in very hot weather. If watering or heavy rain exposes the culms they should be covered with soil again. New shoots should develop within three weeks of planting. These will grow to 1 meter or more in height and branch before roots develop from their bases during the monsoon. It does not matter if the tallest shoots emerge through the shading or bend over as they reach it. The prime function of the shading is to prevent the sun drying out the soil rather than to protect the shoots directly. In the period immediately prior to root development the cuttings will look unhealthy and branch shoots will die back. Once they have rooted however, new side shoots will grow with healthy leaves, and from September onwards strong new shoots will emerge from the ground, see fig (iv). The plants should ideally not be moved for 16—18 months until the second planting season after they were planted in the nursery, although they may be transplanted during winter if necessary. Shading from the sun is not important after the strong new shoots have emerged from the ground after the monsoon, but protection from frost may be necessary in some nurseries. The cuttings are very attractive to goats and other grazing animals, and need good protection if free grazing is practiced around or in the nursery.

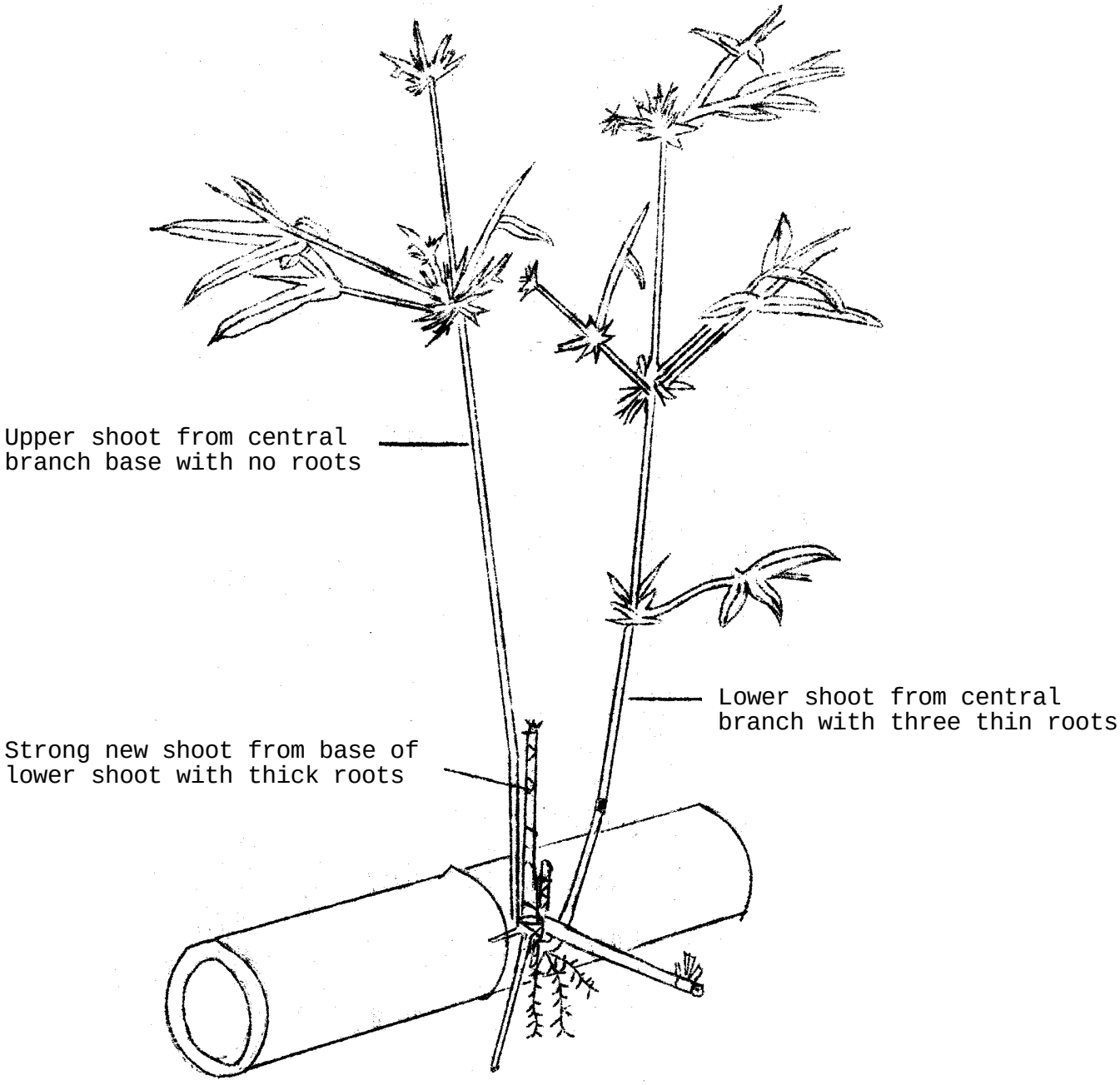


fig (iv) Successfully rooted cutting with strong new shots developing after five months

8. Planting out

To ease transport the shoots can he cut back a little, but if grazing pressure will be high it is best to keep the shoots as long as feasible. When the plants are lifted the old culm section usually breaks off easily, and the plant will often break into two well—rooted sections which can be planted separately. The root balls should be protected against desiccation, end the plants treated with more care than containerised stock. Most cuttings of Bambusa nutans taken in 1983 and planted out beside the nursery in 1984 where they could be watered in dry weather, attained heights of 6—8 meters that year, which indicates the potential of culm cuttings to establish very quickly indeed in a good site. These Bambusa species are not as demanding as other Bambusa species or Dendrocalamus species and will thrive on a poor site once they are established. On dry exposed sites it may well be necessary to under plant the bamboo or to establish it in the shade of nurse pines however, and careful handling of the planting material is even more important.

Preliminary recommendations for planting Dendrocalamus species

(for time of taking cuttings, transporting cuttings, preparation of beds, development and management, and planting out, the sections under Bambusa species apply).

1. Material selection

As with Bambusa species only second—year material should be used. Branch development varies greatly in a single culm of these species, but nearly all nodes are capable of producing rooted plants regardless of the stage of branch development. It is feasible to use culms which have no other use, such as insect—damaged or small culms as the overall root production is much greater, see fig (ii) in comparison to fig (i).

2. Preparation of material

It should be remembered that Dendrocalamus species can produce rooted shoots from several categories of branch see fig (1). Therefore none of the branches except the very smallest are cut right back. As the bud at the node after the first extended internode on the central branch will often produce a rooted shoot it should not be damaged by cutting too close to it. Culms are cut into single—node sections as in Bambusa species.

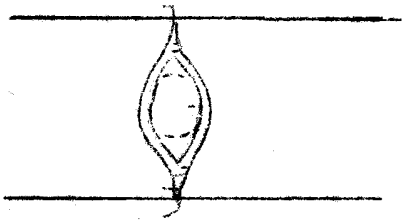
3. P1anting cuttings in the nursery

Dendrocalamus species should be planted a little deeper than Bambusa species. All dormant buds on the culm and on the central and lateral branch bases should be below the soil surface so that shoots arising from them have their basal regions in the soil. It is often not possible to put all buds at the optimum soil depth at the same time so a compromise must be made. Some buds will inevitably be too deep and their shoots will die. When small and large buds are present the small buds should be above the large buds as they are more likely to die if they cannot quickly reach the light. Several typical stages of branch development are depicted in fig (v) along with the recommended ways of planting them.

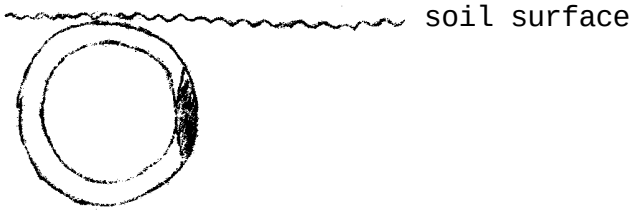
Acknowledgements

Trials of Bambusa nutans and Dendrocalamus species were undertaken at Pakhribas Agricultural Centre, Dhankuta with the kind co—operation of the managers and staff. Assistance in translation of the literature was kindly given by Mrs Isobel Crowley of UNICEF and Mme Zhang Li of ICIMOD.

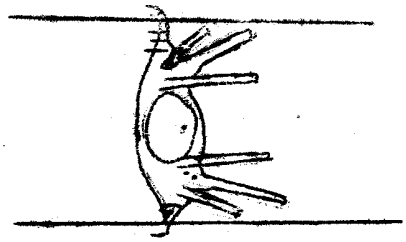
a) bud completely dormant



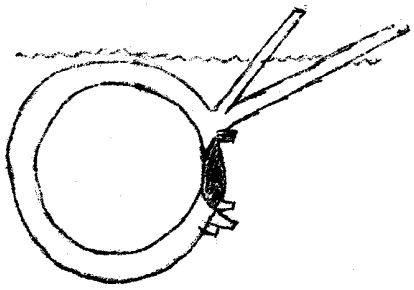
- plant with bud horizontal



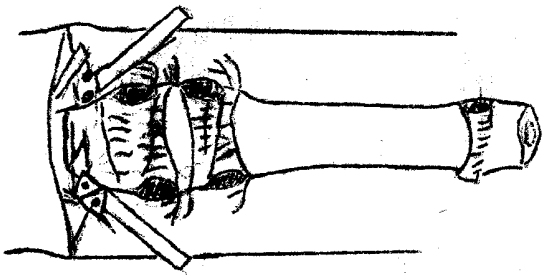
b) central branch dormant



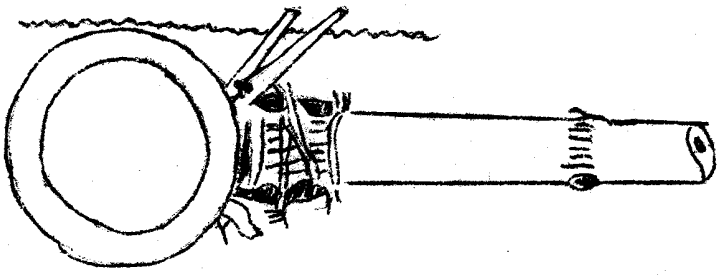
- plant with bud horizontal
  branches below bud can be cut back



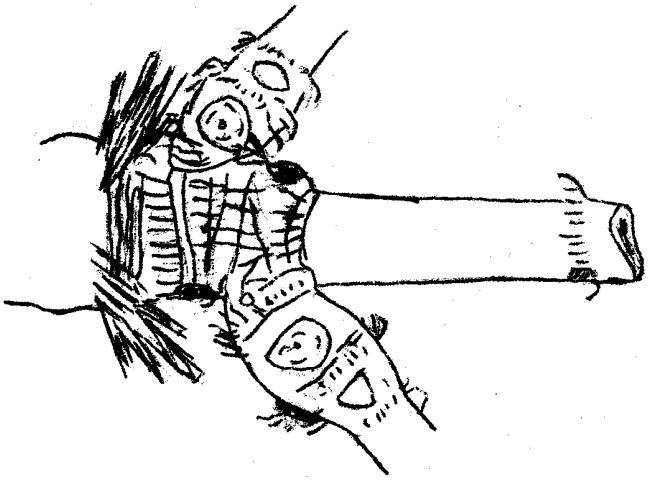
c) central branch developed with laterals



- plant with central branch horizontal and distal bud facing downwards



d) basal buds on central branch developed



- plant with central branch vertical and culm deeper in the soil

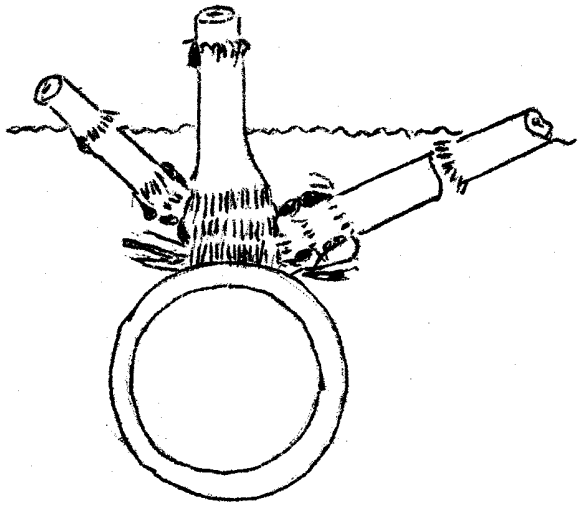


Fig. (v) Typical stages in Dendrocalamus branch development with planting techniques

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