An improvised vegetative propagation technique for self-incompatible bamboos

In recent years, there has been a heavy demand for bamboo planting stocks impelled by the significant thrust in the bamboo sector. Non-availability of sufficient quantity of saplings is a major problem. The International Network for Bamboo and Rattan (INBAR) has recognized 20 important bamboos and has accorded them a high priority status for international action[1]. This list includes six species that do not set seeds. Studies carried out on the widely cultivated golden bamboo, *Bambusa vulgaris*, have shown that lack of fruit set is a cumulative effect of factors such as high pollen sterility, absence of natural pollination, inhibition of pollen tubes in the stigma tissue, etc.[2]. Self-incompatibility due to similar factors could be the reason for the lack of seed set in other species also. As seeds and seedlings are not available, such species are being propagated vegetatively. Several methods of vegetative propagation using offsets, culm and branch cuttings, layers, macroproliferation of seedlings, tissue culture, etc. are being practised[3–5]. However, to suit the requirements of farmers and NGOs low cost, easier and improvised techniques are urgently needed. Clump division[3] or offset planting is the traditional method of bamboo propagation. The propagules in this method are the offsets[6] – each composed of the lower part of 1–2-year-old culm cut at a height of 60–75 cm having 3–5 nodes with a portion of the rhizome at the base. These are planted directly into the field. In the cutting method, culm cuttings or branch cuttings of desirable sizes are planted in polybags or nursery beds to raise saplings. The difficulties in the above methods are: (i) the offsets are bulky, heavy and hence difficult to transport, (ii) the number of offsets that can be extracted from established clumps are limited and therefore large-scale plantation is not possible, (iii) digging out of offsets and their transportation are labour intensive and expensive, (iv) continued extraction of offsets and cuttings often cause damage to the parent clumps. Tissue culture propagation requires laboratory facilities, expensive chemicals, etc. Macroproliferation[7] is a simpler and effective procedure of vegetative propagation recommended when bamboo seedlings are available. In this method, the tillers (individual thin culms along with rhizome) of a proliferated seedling are separated (by rhizome division) and planted as individual propagules. New tillers will arise from these propagules in a few weeks. When they reach a 3–5 tiller stage, they are again subjected to tiller separation and planting. By repeating the process, a large number of saplings can be made. This technique was proved successful by later workers[4,8–10] and was further improved at the Tropical Botanic Garden and Research Institute (TBGRI), Kerala by the introduction of the mist technique[11]. If such a method could be adopted for non-seed setting bamboos, their propagation would become easier. Here we describe a technique by which a large number of easy to carry saplings can be produced throughout the year.

The essential prerequisite for macroproliferation method is the availability of a few seedlings to start with. However, as there is no possibility of seedlings in self-incompatible taxa like *Bambusa vulgaris*, production of a few saplings of 'seedling size' was the only way out. With this idea we started trials in *B. vulgaris* initially and later on extended it to other species. The offset method and cutting methods were tried. In offset method, five offsets were carefully dug out, after separating them from the parent rhizome, from the established clumps of *B. vulgaris* accessioned in the bambusetum of TBGRI[12]. These offsets were planted in 30 cm pots (Figure 1 *a*) containing potting mixture of sand, cow dung and top soil in the ratio 1 : 1 : 1 and watered twice daily. Within two to three weeks new shoots thinner than the parent offset started emerging and by four months 2–5 new culms were produced. Two pots were broken due to the pressure of emerging new shoots. By the end of fifth month these potted plants were uprooted, soils removed, culms were separated and offsets prepared. These offsets were planted in 20 cm pots (Figure 1 *b*). After five months, the offsets that produced 3–5 new culms were uprooted and offsets prepared. These offsets, being thinner were planted in polybags of size 16×24 cm (Figure 1 *g* and *h*). The fourth repetition trial was conducted with still smaller polybags (13×19 cm) which resulted in the production of saplings, which looked like seedlings (Figure 1 *c*). Thus from five bulky offsets 114 saplings were obtained within a period of 20 months. A gradual reduction in culm size can be managed by reducing the size of containers until the desirable and uniform sized plants are obtained. The containers used in initial stages should be strong enough to withstand the pressure of emerging shoots. Pots made of recycled polypropylene can also be used.

In the cutting method, portions of cuttings from branch compliments from the mid region of 1–2 years old culms were used. Cuttings consisting of five nodes measuring 50 to 60 cm length were taken from wholesome culms. These were planted horizontally at 5 cm distance from one another and at 2.5 cm depth in a bed of sand in an improvised mist chamber. The beds were watered twice daily. The mist chamber consisted of a frame made out of locally available logs, covered with polyethylene sheets of 1000 gauge. The relative humidity inside the chamber ranged between 80 and 90%. In two to three weeks time, rooting and shooting (usually one, rarely two) occurred from nodes (Figure 1 *d*). Out of the 25 cuttings, four produced roots and shoots from three nodes each, 12 produced roots and shoots from two nodes each and in six one node each responded and three cuttings dried up. When the shoots attained a length of 30 cm or more, the cuttings were lifted out of the bed carefully (Figure 1 *e*) and portions of the stem bearing a node with shoots and roots were severed by means of a secateur (Figure 1 *f*). These units were planted in polybags containing a mixture of sand, cow dung and top soil in 1 : 1 : 1 ratio and were kept in the mist chamber and watered twice daily. After 15 days, the polybags were kept under shade for two weeks and later transferred into open nursery beds. The first new shoot (tiller) from these propagules was produced by 45–60 days, the second by 80–90 days and the third by 110–130 days. The saplings were ready for further splitting by the end of five or six months at three to four- tiller stage, when they resemble the seedlings. Saplings kept in the same container for more than nine months showed drying of early-formed shoots. Thus starting with 25 original cuttings 42 rooted shoots were obtained after five months, which on replanting developed into 41 saplings that yielded 122 tillers in six months. The advantage

Table 1. Production cost per sapling in 'Offset size reduction method'

No.	Items	Cost per unit at ascending levels of trials (in rupees)					
		1	2	3	4	5	6
1	Cost of propagule	50.00*	9.07	6.19	2.49	1.73	1.50
2	Collection charge	13.50	–	–	–	–	–
3	Cost of container (pot/polyethylene bag)	12.00	8.00	0.40	0.35	0.35	0.35
4	Cost of potting mixture	4.37	2.91	0.70	0.58	0.58	0.58
5	Filling and planting charge	2.01	1.34	0.67	0.67	0.67	0.67
6	Mist chamber charge	0.80	0.60	0.20	0.20	0.20	0.20
7	Maintenance charge for 6 months	1.08	1.08	1.08	1.08	1.08	1.08
	Total production cost/sapling	83.76	23.00	9.24	5.37	4.61	4.38

*The cost of propagule (offset) is zero if the culm is sold.

Figure 1 ***a–i.*** Vegetative propagation in *Bambusa vulgaris*. ***a–c***, ***g***, ***h***, 'Offset size reduction method'; ***a***, Large offset planted in 30 cm pot with 4 new shoots; ***b***, Offset from (***a***) in 20 cm pots with 4 shoots; ***c***, Offset from (***b***) in polyethylene bag which developed into a seedling-like sapling; ***d–f***, Cutting method; ***d***, Shoots from horizontally planted cuttings, in mist chamber; ***e***, Roots and shoots from nodes of horizontally planted cutting; ***f***, A severed node from (***e***) with roots and shoots – a propagule; ***g***, Offset from (***c***); ***h***, same planted in poly bag; ***i***, Polybags containing a large number of 3–4 tillered saplings ready for plantation or further splitting.

of this method is to bulk up the planting material by periodic splitting and planting.

The repetition trials with seedling like saplings obtained from both offset and cutting methods have shown similar results and propagation was done at regular intervals of 5 or 6 months.

The experience gained with *Bambusa vulgaris* was repeated with *Bambusa balcooa* Roxb., another non-seed setting species, using the offset and cutting methods. The results were nearly similar. Once a few seedling size saplings are produced through offsets, cuttings or by any other means, they can be used for further propagation by macro proliferation. Saplings at the three or four tillered stage were distributed to farmers keeping 30% as stock plants for further multiplication (Figure 1 *i*). This procedure is being successfully practised at TBGRI. About 20,000 saplings of different species have been produced, and 14,000–15,000 saplings are distributed every year based on the demand. The saplings distributed during 1995–98 period had reached the culm extraction stage in five to six years. The casualty was only 5–7%. The culm production and growth rate are similar to other bamboo plantations.

The production cost at each level of trial was calculated (Rs 135 per day per person; 5% sapling casualty). The higher cost in initial trial came down to Rs 4.61 per sapling in the 5th trial (see Table 1). If 70% saplings are sold @ Rs 6 per sapling the cost will come down to Rs 4.14 and Rs 3.32 at 5th and 6th trial respectively. In subsequent trials cost of propagules will be negligible but cost of items 3–7 (Table 1) will remain the same. In cutting method the cost will be lesser as saplings can be sold from the second trial.

The method of 'sustainable bamboo propagation' well suited to farmers, NGOs, etc. has several advantages: (i) propagules from parent clumps are required only in the initial stages, (ii) regenerated plantlets can be repeatedly grown and split to generate additional plantlets, (iii) parent clumps are saved from damage due to continuous extraction of offsets, cuttings, etc. (iv) production of saplings of uniform size and age, (v) optimum survival of saplings in nursery and plantation, (vi) low cost of production and management, (vii) protocol is simple and easy to practice.

This procedure can be successfully applied to seed producing bamboos such as *Ochlandra* spp., *Gigantochloa* spp., etc. during non-seed bearing stages as indicated by the results. We term the method (starting with offsets) as 'offset size reduction method' and recommend it for propagation of self-incompatible species in particular and taxa that have inherent difficulty in generating saplings through vegetative methods in general. It is also clear from the trials that the macroproliferation technique is yet another form of the traditional offset method.

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