INTERNATIONAL NETWORK FOR BAMBOO AND RATTAN
(INBAR)

TRANSFER OF TECHNOLOGY MODEL
(TOTEM)

VILLAGE BAMBOO PRESERVATION UNIT

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TRANSFER OF TECHNOLOGY MODELS (TOTEMS)

Transfer of Technology Models (TOTEMs) are focussed educational tools providing relevant information and distance training on one specific area of bamboo/rattan management, processing or utilization. They are a means of technology transfer between similar regions throughout the world, with the emphasis on South-South transfer for livelihood development. They enable those involved in the management and use of bamboo and rattan resources to more efficiently and effectively develop and use skills relating to these resources.

TOTEMs are primarily intended as practical information resources and teaching aids for those at the local extension level in their communities, who can utilize them to assist local community development. Each TOTEM consists of a detailed written report of the technology, a PowerPoint presentation, a film, and, where relevant, a set of technical photographs. They also include information on target users, financial analyses of sample set-ups from the partner country preparing the report and information on where to source particular technologies (such as equipment). The TOTEM thus provides all the information required for establishing similar technologies within interested countries and regions.

- The **report** contains all the technical details of the particular processes involved, as well as other relevant information for establishing the technology such as costs of business establishment, running costs and cash flows.

- The **PowerPoint** presentation contains details of the relevant technologies and their applications, and is intended to provide an overview of the potential of the technology for development.

- The **film** provides a visual guide to the processes involved and helps to bring them alive in the minds of the learners.

The different parts of the TOTEM are targeted at slightly different audiences, via the local extension workers. The report and film are intended to be the main means of extension to the individuals and communities who will implement the technology and who will directly benefit from it. The PowerPoint presentation is primarily intended as a tool for the extension worker to sell the technology and its role in development to those who provide the infrastructural, policy and financial support for its implementation, such as government departments, donors and NGOs. There is considerable flexibility, however. Local extension workers will be able to incorporate the TOTEMs in their own work as they wish and adapt and develop them to suit their particular requirements and conditions.

This TOTEM on the **village bamboo preservation unit** has been produced at the Forest Research Institute, Dehra Dun, India. It may be used alone, or in conjunction with the TOTEM on preservation by sap displacement, which has been produced at the Institute of Wood Science and Technology, Bangalore, India. The report part of this TOTEM describes the technology for producing and establishing bamboo preservation facilities at the village level for rural development in regions where bamboo is available as a raw material. It is intended to be used in conjunction with the illustrative film included in this TOTEM package

The first part of the report introduces the technology, discusses its history, its development attributes and its applicability. The second part of the report provides detailed information on the technical aspects of preserving bamboos.

This TOTEM is one of the first to be produced by INBAR/ FRI and your feedback is most welcome - kindly contact INBAR or FRI with your comments or suggestions.

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Note 1: This TOTEM has been edited at INBAR and differs slightly from the form in which it was received from the authors.

Note 2: All financial calculations are in Indian Rupees. At the time of writing 1 USD = 46 Rs.

VILLAGE BAMBOO PRESERVATION UNIT AT-A-GLANCE

Why preserve bamboo?

Preserving bamboo extends its life and maintains its quality. Bamboo culms are a natural material and will decay with time. They are also susceptible to insect and fungal attack. This will limit the useful lives of the products they are used to produce and may reduce the quality of the raw material to the point that it is no longer useable.

How are bamboos preserved?

There are many methods of preserving bamboos but they can be divided into two general categories; non-pressure methods and pressurised methods. Non-pressure methods allow the preservative to penetrate the bamboo at a natural rate. Soaking the bamboo in preservative and allowing the preservative to penetrate by capillary or wick action are the main non-pressure methods. Pressurised methods force the preservative into the bamboo. These methods are more rapid but require pressurised vessels and facilities that are more expensive to establish and run.

What are the uses of preserved bamboos?

Almost every bamboo processing unit producing large items (e.g. furniture, fencing, housing) requires preserved bamboos and preservation is preferable if bamboos are used for scaffolding. Preserved bamboos may also be required for smaller items such as household goods and farm implements.

What is the role of a village bamboo preservation unit in rural development?

A village bamboo preservation unit will provide income generating opportunities for local people. The preserved bamboo produced by the unit will be applicable for a wide range of uses and can be used to supply local rural bamboo processing units that can be established concurrently. The unit will promote the sustainable management of nearby bamboo stands to supply a regular quantity of bamboos for preservation.

How do I establish a village bamboo preservation unit?

A village bamboo preservation unit can be established with two or three US dollars for a bucket, or up to US $5000 for a pressure treatment plant. A “modified Boucherie” processing unit requires US $500 and other non-pressure methods are much cheaper to establish. Note that preservation is an intermediary stage in the processing of bamboo into useable end products. Knowledge of market requirements for the preserved bamboo is vital to ensure the unit can remain in business and some market research may be needed before establishment.

PART ONE

INTRODUCTION

DEVELOPMENT ATTRIBUTES, TARGET GROUPS and BENEFITS of a

VILLAGE BAMBOO PRESERVATION UNIT

1. Bamboo preservation

Bamboo is a natural material and will decay with time. The life of a bamboo culm once severed from the plant is rarely more than 3 years under natural circumstances and is often much less. Additionally, it is susceptible to attack by insects and fungi. Preserving bamboo increases the lifespan of the products it is made into and maintains their quality. In some situations, such as when bamboo is used as load bearing structural components in buildings or bridges, preservation is vital to increase the time before replacement and improve the safety of the structure.

The earliest preservation methods were intended to prevent attack by powder post beetles. These insects attack dried bamboo and can eventually cause structural failure if the infestation is great. The traditional Asian preservation method is simply to soak the bamboo in water. This is believed to reduce the starch content in the cells and make them less attractive to the adult insects. Although this method is practical on a small scale there are other methods that can be used to treat bamboos on larger scale and for a wide range of uses. Most of them are relatively simple and effective and are very suitable for a village-level preservation unit.

2. General development attributes and advantages

The main development attributes of the technology are as follows:

- Promotes the sustainable use of wood-alternatives
- Provides employment and income generation opportunities for rural people
- Promotes the sustainable management and development of bamboo resources
- Promotes the development of the local bamboo sector

The main advantages of the technology are:

- Lengthens the useable life of the bamboo
- Maintains the quality of the bamboo
- Improves the safety of the bamboo if used in structural applications
- Promotes the greater acceptance of bamboo amongst consumers and secondary processors

3. Suitable agro-ecological regions

All bamboo growing regions of the world are suitable. If it is intended to preserve only fresh bamboo then a supply of bamboo within a maximum of one day's travelling time of the unit will be required. Due to the greater market requirements for large bamboos in

processing industries and construction the unit may be preferably established in tropical and sub-tropical regions, where the climate is more suited to the growing of these bamboos. Management of plantations and natural stands is highly desirable, both to guarantee a standard level of supply to the unit and to maximise the benefits of the plantation to the owner and cultivators. The technology is especially suitable for areas where bamboo plantations are desirable for the restoration of degraded forests or wastelands such as abandoned shifting cultivation areas, or where bamboos can be grown to reduce soil erosion, particularly on steep slopes in high rainfall areas.

4. Target groups

There are two main target groups. The first are those who will run the unit. The unit requires only unskilled and semi-skilled labour although if pressurised facilities are installed some technical skill will be required. The work can be done by both men and women. The other main target group are those who will be involved in cultivating and harvesting the bamboo to supply the unit. Establishing the unit as a cooperative venture within the village will also benefit the community as a whole and lead to increased community prosperity and sustainability.

5. Requirement for success

The essential requirements for a successful village bamboo preservation unit are:

- Start-up capital ranging from a few US dollars to $5, 000 depending on the type of preservation involved.
- Willingness of the village community to establish a cooperative.
- Access to a local supply of bamboo.
- Proper linkages to the users of the treated culms.

Concluding remarks

The village bamboo preservation unit is a socially effective means of providing employment and income generation opportunities to rural people in bamboo growing regions. The unit can be established and run cheaply and the benefits will accrue directly to the village. The unit may even be run as part of wider community-based bamboo growing and processing facilities.

As an intermediary stage between cultivation and final processing the unit requires well developed linkages to its clients. Proper connections need to be established and it may be preferable to implement the technology with the assistance of state agencies or NGOs to ensure these linkages are in place.

PART TWO

THE VILLAGE BAMBOO PRESERVATION UNIT

1. Introduction

Bamboo culms start deteriorating as soon as they have been harvested and they are also vulnerable to attack from insect pests and fungi. It is therefore advisable to treat them as soon as possible after harvest. Simple treatments such as soaking in water or painting the culms impart some durability but they are not covered in this report. All of the methods covered here involve the use of chemical preservatives. The non-pressure methods are the easiest and cheapest to apply, are widely used and are very effective. The pressurised methods are much faster and allow a greater throughput of culms, but involve more capital investment. Split bamboo decays more rapidly than whole culms and most of the processes described below are suitable for both.

2. Preservation methods for bamboo

2.1 NON PRESSURE METHODS

Green Bamboo: It is very convenient to treat bamboo in the green condition. Sap displacement methods are easily adaptable for treating small quantities of bamboo. These methods have the advantage that no expensive equipment is required and bamboo can be treated immediately after felling. Only water-soluble preservative formulations are suitable for such treatment. Important formulations with established performance are: boric acid: borax, copper chrome arsenic (CCA), copper chrome boric (CCB) and acid copper chrome (ACC).

(i) ***Steeping*:** Freshly cut bamboo culms are immediately placed upright in containers of concentrated solutions of water-borne preservatives (5-10%). The basal end is immersed up to 25 cm deep in the preservative solution. During treatment drops of preservative solution may be observed emerging at the nodes. The treatment takes between 7 and 14 days, depending on the length of the culm and the quantity of solution in the container must be constantly topped-up. Bamboo can be satisfactorily treated by this method without any equipment or technical skill.

(ii) ***Sap displacement***: Round, half, quarter and 1/8 split fresh bamboos are immersed vertically up to 25 cm deep in 10% aqueous solutions of water-borne wood preservatives in a small bucket. The preservative solution rises by wick action and the solution level is maintained by adding fresh quantities as required. Adequate absorption is obtained in a two metre long bamboo in just six days. The remaining solution should be carefully disposed of. In many cases, these two treatments are not favoured because of the danger of environmental pollution from the waste chemicals.

(iii) ***Diffusion process****:* In the diffusion process, freshly felled bamboo culms with high moisture content (above 50%) are kept submerged in solutions of water-borne preservatives for a period sufficient to attain the required preservative loading. A diffusion period of 10 to 20 days is satisfactory in round bamboo, while split bamboo can be treated in about seven days. Absorption and penetration of the chemicals is greater in split than in round bamboo as the outer layer of bamboo is more or less impervious but the inner cuticle is permeable to diffusing ions. Therefore, boring holes near the nodes or increasing the diffusion time results in better penetration and absorption of round culms. An alternative is to puncture the inner diaphragm of the nodes, or make small notches near them to allow free access of the solution to the inner epidermal layer of the bamboo, and also to enable subsequent drainage of the preservative solution from the internode

Preservatives that fix slowly, or have high diffusion coefficients like boron-based preservatives, penetrate better. Those based on ammoniacal solutions not only diffuse faster, but can also be heated for better penetration and more rapid loading. Ammoniacal-copper-arsenite can be used for treating green bamboo by diffusion, taking advantage of the better penetration of ammoniacal solutions.

(iv) ***Boucherie process***: [1] This is a widely recognized process which has been recently adopted on commercial scale in Costa Rica. The basal end of the freshly felled bamboo is attached to a hose-pipe fixed to a reservoir of water-borne wood preservative solution. This process is suitable for freshly felled green bamboo with branches and leaves intact. Even one-day-old felled bamboo can be treated by just chopping off the basal 15 cm of the culm. In this process, the preservative is pushed through the bamboo by gravity from a container placed at a height. This method has been modified by using a simple hand operated cycle pump to apply a pressure of 1.0 to 1.4 kg/cm^2 to the preservative in a container at ground level. This reduces the period of treatment significantly. The penetration and absorption of the preservative depends upon several factors such as concentration of solution, treatment time, nature of chemicals used, dimensions of the bamboo, its age and moisture content. A schematic diagram of the equipment required for treating a number of bamboos at one time is shown in Appendix I.

It usually takes 30-60 min to treat short bamboo lengths using pressures of up to 2 kg/cm^2. The equipment is simple and the technique can be used to treat a number of bamboos at a time, by using an air-compressor to better control the pressure at the delivery end. In order to obtain uniform distribution of preservative from bottom to top, it is recommended to initially use a concentrated solution (6%) until the solution drips out of the apical end. This should be followed by pumping in a solution of a lower concentration (2%) for the same period of time.

[1] For further details please see the INBAR TOTEM on bamboo preservation by sap replacement.

Air-dry Bamboo: Bamboo culms should be stacked horizontally to dry quickly for treatment. Both non-pressure or pressure methods can be adopted for treating dry bamboo.

(i) ***Soaking*:** Air-dried bamboo is merely submerged in the preservative solution (solvent type) for a period that depends upon the species, age, thickness and the required absorption. Penetration is predominantly by capillary action. The soaking method requires minimal equipment and technical knowledge. Dip treatments are considered safe as these are applied to finished products and generate no toxic dust or residues. However proper care should be taken to avoid spillage and contamination of soil. Recommended preservatives for such treatment are copper/zinc napthenates/abietates/ soaps suitably blended with insecticides like Lindane/chloripyrifos. A 2% copper solution blended with 1% insecticide is recommended for total protection against fungus and insects.

(ii) ***Hot and cold process*:** The hot and cold process is also known as the open tank process. It is often used for treating wood with creosote and has been adopted for treating bamboo. Air-dried material is loaded into a tank that is fitted with steam coils or some other heating arrangement. Split bamboo requires no preparation, but holes should be drilled near the nodes of round bamboo to allow the preservative to pass into the inner surface of each internode. The tank is then filled with a hot creosote: fuel oil mixture and heating is continued to raise the temperature to about 90^0C. This is maintained for a period of about 2-3 hours. The preservative is then allowed to cool, after which the oil is drained out. The round bamboo culms are then left erect in the tank to allow the preservative to drain from the internodes. The performance of creosote treated bamboo is better than the salt treated material and this treatment should be adopted where possible.

2.2 PRESSURE TREATMENT METHODS

Pressure treatment is universally used for treating wood and has been adopted for treating bamboo as well. Pressure processes may be employed with any type of preservative. In the case of creosote preservative, a temperature of 80 to 90^0 C should be maintained during the pressure period.

(i) ***Full cell or Bethel process*:** This process is used when maximum absorption of the preservative is desired (ground contact use). The bamboo is introduced into the pressure cylinder. The door is tightly closed and a vacuum of at least 56cm of mercury is created and maintained for half an hour. The purpose of this operation is to remove as much air as possible from the cells. At the end of the vacuum period, the preservative is introduced into the cylinder. When the cylinder has been filled with preservative, the vacuum pump is stopped and the cylinder is subjected to pressure of 3.5 to 7.0 kg/cm^2. The pressure is held until the desired absorption is obtained, after which the preservative is withdrawn from the

cylinder. Finally a vacuum of 38 to 56 cm of mercury is applied for about 15 minutes to free the material from the dripping preservative. Specified retention of toxic chemicals during treatment may be obtained by a proper selection of the concentration of the toxic material in the treatment solution and a suitable absorption of the preservative solution, which is controlled by the duration of pressure and vacuum periods.

(ii) ***Empty-cell processes*:** These processes aim at a maximum penetration of the preservative with the minimum of net absorption. The Lowry process is suitable for treating bamboo. In this process, the cylinder is loaded with the material and the door is closed. It is then filled with the preservative solution and a pressure of 3.5 to 7.0 kg/cm^2 is applied until the required absorption is obtained. The pressure is then released and a portion of the preservative in the material is expelled due to the expansion of the entrapped air in the cells. The cylinder is then drained and a final vacuum is applied to remove unabsorbed preservative

Pressure treatment is best suited for quick/large scale production of treated bamboo. Such equipment has the advantage of producing material of uniform quality with very little risk of chemical spills.

3. EQUIPMENT REQUIRED

(i) ***Steeping***: No special equipment is required for this process. Preservative solutions can be prepared in steel/plastic drums or buckets and the bamboo culms can be made to rest along a wall. Equipment costs will vary with capacity. A secondhand steel drum capable of treating about 5-10 bamboos at a time will cost only US$ 5.

(ii) ***Sap displacement***: The same equipment as required for steeping can be used.

(iii) ***Diffusion*:** Dipping tanks of adequate capacity to keep the bamboo completely immersed in solutions are required. A 5m x 60cm x 60cm mild steel/masonry tank can treat about 18 bamboo culms (round) at one time. A mild steel tank may cost around US$ 500 while a masonry outfit will cost US$ 200.

(iv) ***Boucherie process***: Simple equipment consisting of a preservative solution tank capable of withstanding pressure of 3.5 kg/cm^2 having an outlet with a manifold for fixing a number of bamboo culms is required. Bamboo culms are fixed to each outlet using a pressure rubber hose to prevent leakage of solution. The pressure is generated in the container by a cycle pump/air compressor. The manifold outlets can be made active by opening the respective valve depending on the number of culms to be treated. Up to 50 bamboo culms per day can be easily treated by using such an outfit. Equipment capable of treating 50 bamboos at a time will cost around US$ 500 including an air compressor.

(v) ***Hot and cold process*:** The hot and cold bath treatment is applied in an open tank fitted with a means of heating the preservative. Heating can be done by steam

using a mini boiler or with thermic fluids heated electrically. The cost of the equipment will be around US $ 2,000.

(vi) ***Pressure treatment***: A normal vacuum/pressure treatment plant, used for treatment of wood can also be used for treating bamboo. A 6m-long cylinder, 1m in diameter, is required to treat bamboo for structural uses. One charge will treat about 25 round bamboos. The equipment will cost US$ 5000 including transportation and installation charges.

4. CHEMICALS/PRESERVATIVES

(a) **Coal tar creosote and fuel oil** (50:50) by weight. In areas of high termite infestation it is preferable to add 1% chlorpyrifos or Lindane. Coal tar creosote should meet the relevant standard specification for preservation purposes.

(b) **Copper-chrome-arsenic** comprising copper sulphate ($Cu\ SO_4.\ 5H_2O$), sodium or potassium dichromate ($Na_2Cr_2O_7.\ 2H_2O$ or $K_2Cr_2O_7$ and arsenic pentoxide ($As_2O_5.2H_2O$) in a 3:4:1 proportion. In some countries different formulations of CCA are also used.

(c) **Borated-copper-chrome-arsenic** (SBOR) conforming to Forest Research Institute, Dehra Dun composition (Patent pending).

(d) **Acid-copper-chrome** comprising 50 parts copper sulphate ($CusO_4\ 2H_2O$), 47.5 parts sodium dichromate ($Na_2Cr_2O_72H_2O$) and 1.68 parts chromic acid (CrO_3), which is equivalent to 2.5 parts of sodium dichromate).

(e) **Copper-chrome-boron** containing boric acid (H_3BO_3), copper sulphate ($CuSO_4.5H_2O$) and sodium or potassium dichromate ($Na_2Cr_2O_7.2H_2O$) or ($K_2Cr_2O_7$) in 1.5:3:4 proportions.

(f) **Ammoniacal-copper-arsenite** containing copper-sulphate, arsenic trioxide dissolved in ammonia in a 3: 1 ratio.

(g) Boric acid: borax: water (1:1:54).

(h) **Copper naphthenate/abietate** and **zinc naphthenate/abietate** containing 0.5% copper or 1% zinc.

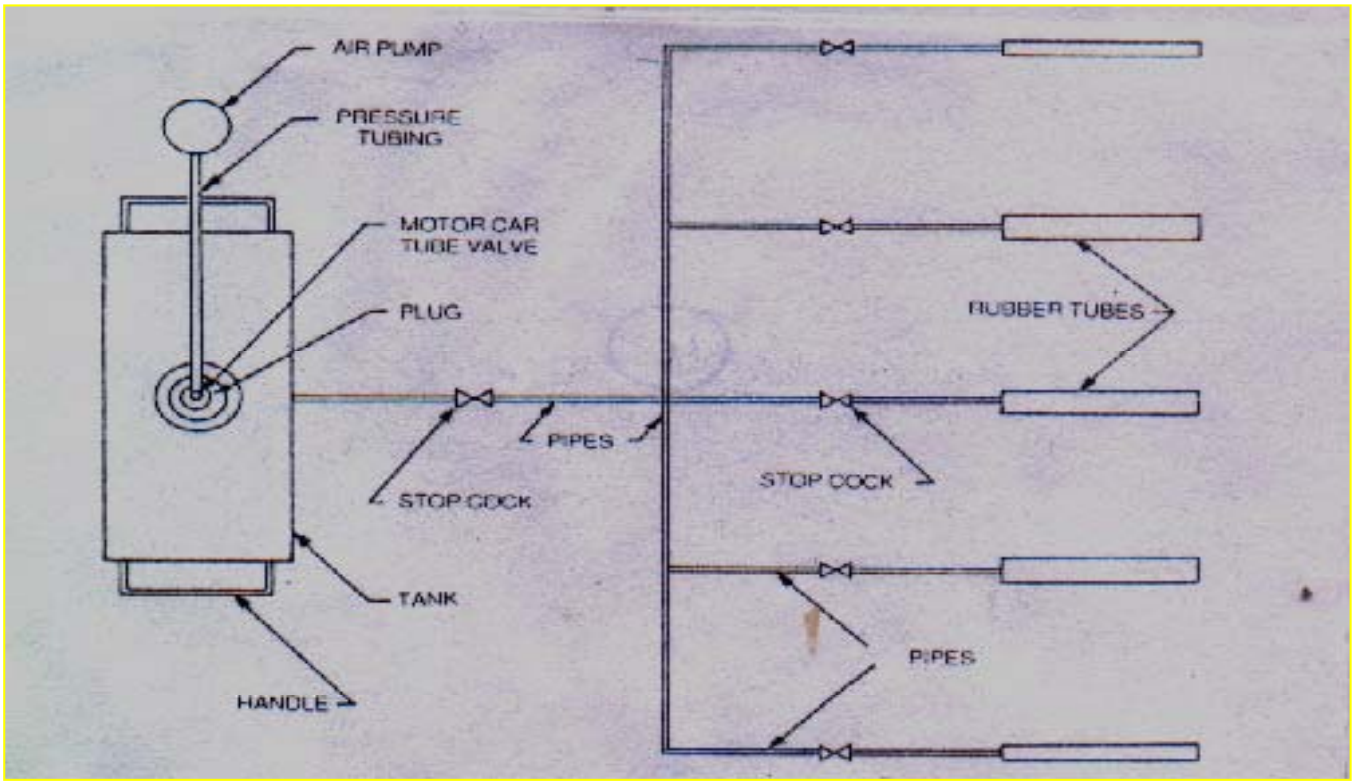
5. ECONOMICS OF TREATMENT

Treatment and equipment costs vary from a couple of dollars for bucket or drum to US$ 5,000 for a pressure treatment plant and have been noted above. Land, sheds for equipment and storage of treated material and a small laboratory for quality control may cost another US $ 4.000 for a Boucherie/ pressure treatment plant. The cost of treatment also varies according to the use of bamboo and scale of operation. Bamboo costs about 10-15 cents per metre and treatment cost may vary from 5-8 cents per metre.

APPENDIX

Appendix I

Schematic diagram of equipment used for treating bamboo by the modified boucherie process



Appendix II

SITES SUITABLE FOR DEMONSTRATION IN INDIA

1. **Sangli, Maharashtra**. It is bamboo rich area and one NGO is developing bamboo treatment facilities for local people.
2. **Jorhat, Assam.** ICFRE is having an Institute and thus can provide basic infrastructure for demonstration, training and treatment of local material.
3. **Angmally, Kerala.** It is bamboo town and hub of reed-mat weaving industry
4. **Jabalpur, Madhya Pradesh**. Madhya Pradesh is bamboo rich state and the area falls in earthquake prone zone. ICFRE has an institute that can provide basic infrastructure for demonstration, training and treatment of local material.
5. **Agartala, Tripura**. Agartala is the northeast hub for bamboo processing.