International Bamboo and Rattan Organisation

Feasibility Study on Bamboo Plantations and Opportunities for its Utilisation in Sarawak, Malaysia, 2016

INBAR
INTERNATIONAL BAMBOO AND RATTAN ORGANISATION

PUSAKA

Contents

Introduction

The Sarawak Timber Industry Development Corporation (STIDC), set up to promote the timber industry in Sarawak, Malaysia, has a vision to develop a new local bamboo sector that emulates the socio-economic and environmental success of other bamboo industries in countries such as China, India and Vietnam.

Therefore, STIDC commissioned the International Bamboo and Rattan Organisation (INBAR), an international intergovernmental organisation, to conduct a feasibility assessment of the opportunities for bamboo and its utilisation in Sarawak.

This study presents the findings of the assessment. The key conclusion of the study is that bamboo plantation and industry development in Sarawak has significant potential, but requires further piloting work before moving to a larger scale.

To support future development of the bamboo sector, the study provides a series of recommendations on appropriate bamboo species for plantation development and outlines the framework for a pilot plantation programme at STIDC-identified sites. The report also assesses the feasibility of developing carbon credit trading for the proposed plantations as an additional source of financing. Finally, the study provides guidance on enterprise and local market development that can complement the establishment of plantations and guide species selection.

These recommendations are described in detail in the following three thematic sections:

Section A: Feasibility of undertaking a pilot bamboo plantation project in Sarawak

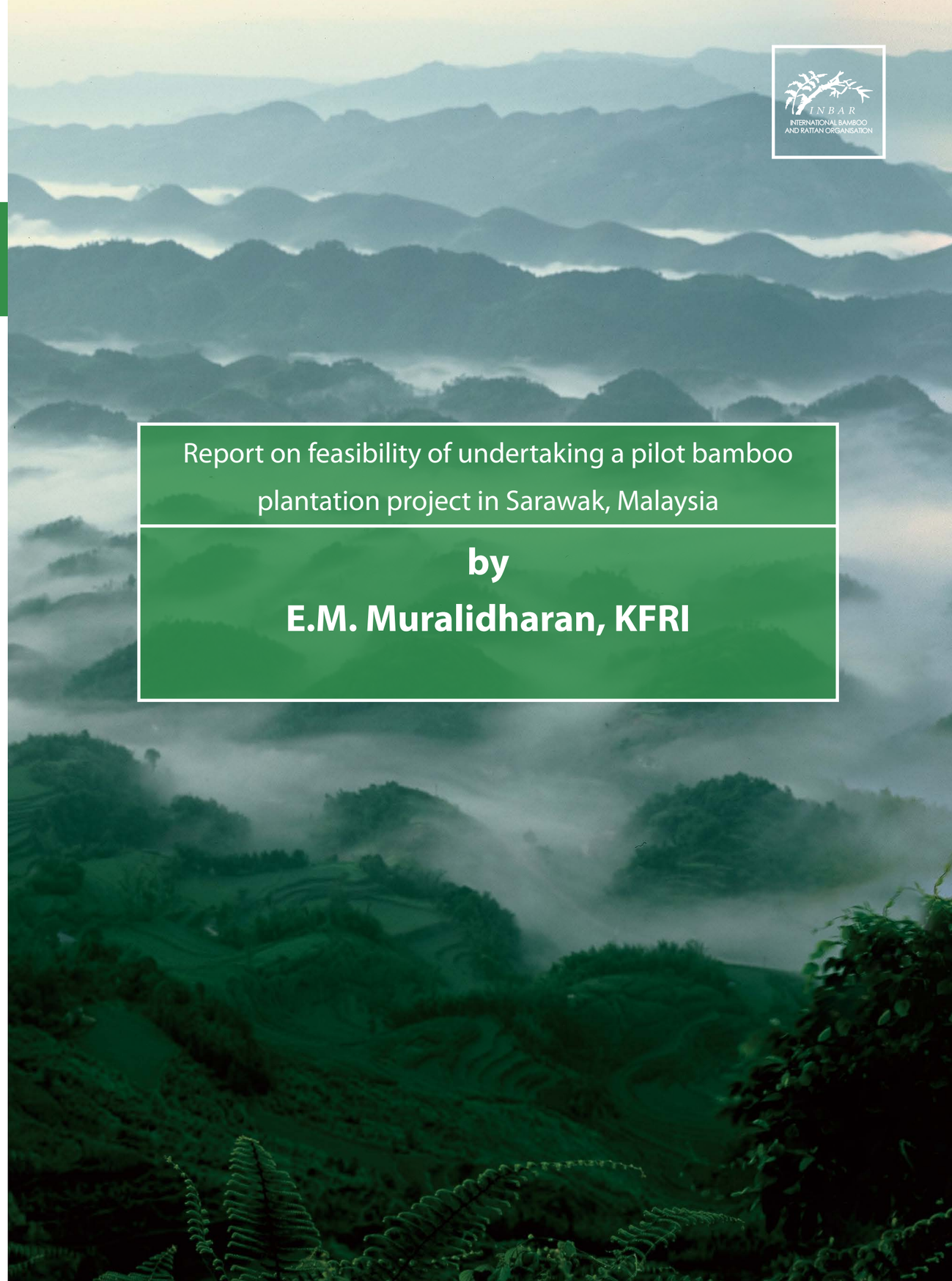
Section B: Feasibility of the proposed potential pilot bamboo afforestation carbon project in Sarawak

Section C: Accessing market potential for bamboo in Sarawak

Please refer to Annex 1 for further information related to the sites.

Acronyms

CFC	Common Fund for Commodities
CGCF	China Green Carbon Foundation
FRIM	Forest Research Institute Malaysia
IBA	Indole Butyric Acid
INBAR	International Bamboo and Rattan Organisation
KFRI	Kerala Forest Research Institute
MHDC	Malaysian Handicraft Development Corporation
NAA	Naphthalene Acetic Acid
PDD	Project design documents
RCC	Reinforced Cement Concrete
SALCRA	Sarawak Land Conservation and Rehabilitation Authority
STIDC	Sarawak Timber Industry Development Corporation
VVB	Validation & Verification Body



Executive Summary

Based on a limited survey of a few bamboo growing areas in western Sarawak and a literature survey, a list of 17 bamboo species was compiled for the region (including both native and introduced bamboo). Most of the native species were medium-sized, thin-walled types, and the introduced species were both medium- and large-diameter types. Based on potential uses - value-added traditional crafts, construction, furniture, laminates and composites, edible shoots, bioenergy feed stock, conversion of bamboo waste to useful products and eco-restoration and watershed management - selected species, including a few additional exotic species, are recommended for plantation trials. The proposed pilot study will generate information on their performance in two site conditions which are typical of Sarawak: overlogged forest sites, and riverine areas with occasional water logging, so that the best species can be considered for future large-scale plantations.

The objectives of the four-year pilot plantation study were:

- To assess the potential of the selected species under various silvicultural regimes to yield: quality poles for selected uses; fast renewable woody biomass for fibre; or feedstock for bioenergy production;
- To test various silvicultural treatments (spacing/density, site preparation, management regimes) for suitability across sites earmarked for large-scale plantations in Sarawak;
- To assess the response of the selected bamboo species to the regulation of nutrient and moisture;
- To assess the potential of bamboo as an agroforestry crop with inter-planting of annual crops in the initial three years.

Accordingly, it is recommended that for the pilot study the following should be tested:

i. Spacing/density for three size classes – small, medium and large bamboo:

1. 4 x 4m for the smaller species (*D. stocksii, T. oliveri, G. brachycladum*),

2. 5 x 5m for the medium sized species

3. 7 x 7m for the larger species (*B. bambos, D. asper, , D. brandisii, G. angustifolia*)

ii. Three site conditions:

1. Level land (square planting at spacing ideal for the size class)

2. Planting on slopes along contours (4, 5 or 7m between plants and 4m between rows)

3. Slopes with terracing (4, 5 or 7m with 4 metres between rows on narrow terraces or square planting on wide terraces)

iii. Two landscapes:

1. Level overlogged forest land (Site I and II)

2. Riverine areas with annual waterlogging [river overflow] of less than one week (Part of Site III).

iv. Agroforestry plantation: Intercropping with selected annual crops of local importance to increase profitability during the non-productive phase of plantations (one to three years).

An Action Plan for establishing the pilot plantations will require expertise and infrastructure for bamboo propagation, and the establishment of nurseries and plantations. Details of propagation methods used for bamboo and how to establish a small bamboo nursery are given in the document. For the trial plantations, the selection of sites for plantations from the potential areas indicated by STIDC was made based on the site conditions, accessibility and availability. Accordingly the following were recommended:

- Site I - Plots 8314A; 8315A; 8316A (11 ha) for a small bamboo nursery of about 0.5

  ha and an agroforestry plantation trial.

- Site II - Plots 8310B; 8309B; 8308B; 8307B (49 ha) for two trials

  a. planting on slopes along contours

  b. terracing of 5-8m width with access to planted rows for tractor or harvesting machinery.

- Proposed alternate sites (if permission is granted by Forest Department)

  New Site 1: – Plot 8406B (37.1 ha) and Plot 8406 (30.7 ha), with a total of 67.8 ha, of which 3 ha was already planted with bamboo in 2002. This plot is easily accessible from the road.

  New Site 2 (opposite the above New Site 1): Plot 8303A (6.0 ha), Plot 8302A (7.2 ha), Plot 8301A (8.7 ha), Plot 8302B (9.0 ha), Plot 8301B (9.0 ha), Plot 8212 (10.0 ha) and Plot 8304 (2.0 ha), with a total of 51.9 ha. This plot is also easily accessible from the road.

Specific plans for site preparation, planting design on land with different slopes, planting and aftercare are also described, as are the calendar of activities and a road map for the trial plantation programme expected to lead to large-scale plantations in Sarawak. An Excel worksheet on computing the costs of nursery and plantation establishment based on local variables is also given. Depending on the timeframe within which the trials are to be initiated, there are options to procure propagules ready for planting (if planting is envisaged for the upcoming season) or set up a nursery for production of planting material for the next year,.

A. Assessment of bamboo species suitable for plantation in Sarawak, Malaysia

On the basis of observations made during the field trips undertaken by the INBAR team to Kuching, Serian and Sri Aman Divisions of Sarawak, and from the literature survey, the following species are found to be most prevalent in wild and cultivated areas.

Bambusa blumeana (Buluh duri)

B. vulgaris (Buluh minyak)

B. vulgaris var. vittata (Buluh gading)

Gigantochloa laevis (Buluh beting)

G. ligulata (Buluh tumpat)

G. scortechnii (Buluh semantang)

Schizostachyum brachycladum (Buluh lemang)

S. grande (Buluh semaliang)

S. zollingerii (Buluh nipis/kasap)

The following additional species are also available:

Bambusa heterostachya (Buluh galah)

Dendrocalamus pendulus (Bulung Teli/akar)

Gigantochloa atter

G. ligulata (Buluh tumpat)

G. tholi (Buluh beting)

G. wrayii (Buluh beti/mata rusa)

The following exotic species are also found in the study area:

Dendrocalamus asper (Buluh beting/betong)

D. latiflorus

The data available on the extent of resources of bamboo in Sarawak is meagre and only a thorough survey (preferably supported by remote sensing data and on a geographic information system platform) can generate this data. No well-stocked or pure bamboo stands were noticed in any of the areas visited. This information needs updating based on surveys in other areas of Sarawak. Precise identification was also not possible in all cases and hence local names were taken into consideration to arrive at the species names. A thorough inventory will require taxonomic expertise since identification of many species in the field is often confusing. It is however clear that much of the forest and overlogged areas in Sarawak have existing native species and are suitable for bamboo plantations. Detailed topographical figures about the

land available for bamboo plantations in Sarawak was not available but from a preliminary appraisal of information available in the public domain it was found that the altitude, rainfall, and type of forests are favourable to bamboo cultivation.

The native species of Sarawak are mostly medium-sized and thin-walled and therefore suitable for slivering, mat making and basketry. These are also suitable for products such as toothpicks, skewers, chopsticks, incense sticks and handicrafts. Those with a thicker culm wall like *G. scortechnii, G. laevis, B. blumeana* and exotic species would be suitable for construction, furniture and for industrial manufacture of timber substitutes. It is therefore recommended that the native bamboo species and a few exotics be included in a pilot study, to assess performance in a variety of silvicultural treatments and so help decide the scope of large-scale plantations in Sarawak.

B. Bamboo species recommended for the pilot study

The species listed below, including native, naturalised and exotic ones, are recommended for the pilot study based on their potential for utilisation in a wide variety of applications. Since most of the species have not been tested at a plantation level in Sarawak, the proposed pilot study will generate information on their performance on two characteristic site conditions typical of Sarawak: overlogged forest sites, and riverine areas with occasional water logging, so that the best species can be considered for future large-scale plantations.

(A revision of this list - based on updated information on distribution, features of the local species and of other site conditions found in Sarawak, provided by the Sarawak Land Conservation and Rehabilitation Authorit [SALCRA] - may be required later)

(a.) Native species

1. B. blumeana

2. B. vulgaris (green)

3. Gigantochloa laevis

4. G. ligulata

5. G. scortechnii

6. Schizostachyum brachycladum

7. S. grande

8. S. zollingerii

(b.) Introduced species

9. Dendrocalamus asper

10. D. latiflorus

(c.) Exotics to be introduced*

1. Bambusa balcooa

2. B. bambos

3. Dendrocalamus brandisii

4. D. stocksii

5. Guadua angustifolia

6. Thyrsostachys oliveri

** Any introduction of exotic species should ideally be accompanied by precautions taken against inadvertent introduction of pests and diseases and the possibility of the species turning into a weed. For more information, see INBAR's report 'Bamboos and Invasiveness' (INBAR 2016). The long flowering cycle of most bamboo minimises but does not totally remove the risk of weediness in some of the species in some situations. This is something which can be assessed during the pilot plantations.*

C. Scope of pilot plantation to assess potential for undertaking large-scale plantations in Sarawak

Long-term plantations are to be established based on the policy decision regarding the major end uses envisaged for the bamboo industry in Sarawak. These fall under the following classes, all of which show potential and can be considered in a phased manner after the pilot plantation programme is evaluated in four to six years:

i. Value addition to traditional crafts: Species with thin walls combined with long internodes, such as *G. laevis* and G. *brachycladum*, are suitable for producing thin slivers, which can be used for woven products like baskets and mats. Woven mats will be suitable for a variety of uses, including diverse types of handicrafts and the production of mat boards which are an alternative to plywood.

ii. Construction: Medium-diameter bamboo with medium to high wall thickness is ideal for use as structural components in building and construction. Species recommended are *G. angustfolia, D. stocksii, T. oliveri, D. brandisii , G. scortechnii, G. laevis* and D. *asper*.

iii. Furniture: The above class of bamboo, as well as species with solid culms (exotic species) are useful for furniture making. *D. asper, G. angustifolia, D. stocksii, T. oliveri* and *B. blumeana* are the appropriate species.

iv. Laminates and composites (Timber alternatives): Species with good wall thickness and density (at least in the lower internodes) are ideal for the industrial production of flooring tiles, strand woven timber board, laminates and composites. *B. balcooa, B.bambos* and *G. angustifolia* are suitable for this. Other species are also suitable for fibre-based products like strand woven boards.

v. Edible shoots: Many species are already used for their edible shoots by local communities. Based on reports from other countries, *D. asper, D. latiflorus, G. laevis, B. blumeana* and *D. brandisii* are particularly recommended.

vi. Bioenergy (briquettes or pellets for gasification): Species with faster growth and higher productivity of biomass like B. balcooa, *B. bambos* and *D. asper* are recommended.

vii. Biochar, activated carbon and other by products: Most of the species are suitable and waste generated in other uses can be profitably utilised.

viii. Eco-restoration and watershed management: All native bamboo species can be used for this.

(Paper and traditional uses of bamboo are not being considered for this study as they are applications with low value addition, which diminish the potential of bamboo as a major driver of economic growth in a bamboo-based regional economy).

D. Objectives of the pilot plantation study

A four-year pilot plantation study is envisaged:

- To assess the potential of the selected species under various silvicultural regimes to yield: quality poles for selected uses; fast renewable woody biomass for fibre; or feedstock for bioenergy production;
- To test various silvicultural treatments (spacing/density, site preparation, management regimes) for suitability across sites earmarked for large-scale plantations in Sarawak;
- To assess the response of the selected bamboo species to regulation of nutrient and moisture;
- To assess the potential of bamboo as an agroforestry crop with inter-planting of annual crops in the initial three years.

Accordingly it is recommended that for the pilot study the following should be tested:

i. Spacing/density for three size classes – small, medium and large bamboo:

1. 4 x 4m for the smaller species (*D. stocksii, T. oliveri, G. brachycladum*).

2. 5 x 5m for the medium sized species.

3. 7 x 7m for the larger species (*B. bambos, D. asper, D. brandisii, G. angustifolia*).

ii.Three sites (based on topography):

- Level land (square planting at spacing ideal for the

size class).

- Planting on slopes along contours (4, 5 or 7m between plants and 4m between rows).
- Slopes with terracing (4, 5 or 7m with 4m between rows on narrow terraces or square planting on wide terraces).

iii. Two sites (based on forest or land types)

- Level overlogged forest land (Sites I and II).
- Riverine areas with annual waterlogging of less than a week (part of Site III).

iv. Agroforestry plantation:

Intercropping with selected annual crops is of local importance to increase profitability during the non-productive phase of plantations (one to three years).

(*It is not unusual to find that a species performs poorly in a new site against expectations based on similar climatic conditions in native habitats. Even the features like branchiness or culm diameter may be expressed differently and the species then found unsuitable for large-scale plantations*)

E. Action Plan for establishing pilot plantations

1. Propagation of bamboo

Conventional vegetative propagation methods are to some extent already practised by farmers in Sarawak. The method of preparing single-, two- or three-noded culm cuttings and planting these erect in polythene bags until the sprouts root, followed by hardening in the nursery for a year and transferring to pits, will be appropriate as a simple and rapid means of obtaining planting material - as long as this is found to be successful for the species selected, and sufficient cuttings are available from clumps growing in forests or on farms.

The transplanting of the rhizome offsets (rhizomes extracted from the bamboo mother clump along with a length of culm with about 3-5 nodes) is to be considered along with this method if sufficient material is available. On the other hand, if shortage of planting material of this type is anticipated, it will be necessary to create rooted stem cuttings using rooting hormones and use of propagation units. Training in propagation methods (of 3-4 days) can be considered at the Forest Research Institute Malaysia (FRIM) or at the Kerala Forest Research Institute (KFRI), Thrissur, India or arranged at site, if required. Briefly, the method consists of preparing culm cuttings of different lengths and treating these with a rooting hormone (usually Indole Butyric Acid [IBA] or Naphthalene Acetic Acid [NAA]) at concentrations of 100 to 2000 mg/l, and placing these on a suitable medium in a nursery or greenhouse or mist chamber bed.

Hollow culms are prepared with an opening made in the centre of the internode into which the hormone solution is poured and thereafter sealing with a plastic film. Solid or narrow bore culms are dipped in the solution for some time before placing in the medium. After rooting and preferably after rhizome formation, the plants that develop at the nodes are separated and planted into polythene bags. These are transferred to the nursery for further hardening. Further multiplication of the plants can be done through the method of macro-proliferation, wherein the plants - after several months of growth in the nursery and having multiple shoots - are split so that each section has at least one rhizome attached, so it can continue growth after transfer to a new polybag.

Better establishment and faster culm production can be expected only when one-year-old propagules (seedlings/rooted culm/branch cuttings) are used for field planting. However, in the case of rhizome/offsets, well-established propagules in plastic bags, which have been nurtured in the nursery at least for one to two months, will ensure better field survival and early culm production. It is time-consuming and labour-intensive to collect rhizome/offsets, pot these in large (30 x 45cm) plastic bags and maintain them in a nursery, etc. In case better field supervision and aftercare - protection from grazing animals, profuse watering when plants show symptoms of wilting) - can be provided, rhizome/offset cuttings can be directly field planted soon after extraction without need for the nursery.

For mass production of planting material, tissue culture is the ideal method, especially for building up selected superior mother stock that is in short supply. Protocols for all the selected species will probably not be available with tissue culture companies, and for large orders of species on their list advance orders will have to be placed. With this in mind, the establishment of a tissue culture facility under STIDC has been recommended, to cater for long-term requirements after the pilot study. INBAR can undertake to set up a facility through a containerised laboratory that it has developed. Training of technicians will also then be a requirement before plant production can begin. The availability of planting material for those exotic species selected for the pilot plantations could be ascertained from the following companies, which have large production capacities:

a. PT Bambu Nusa Verde

Jl. Mangunan, Tebonan
Harjobinangun, Pakem, Sleman
Yogyakarta 55582, Indonesia
Phone: +62 274 898 055
Fax: +62 274 898 022
E-mail: info@bambunusaverde.com

Yogyakarta Contact (Wholesale: big volumes, minimum 500 plants)
Mr. Indra Gunawan
E-mail: indra@bambunusaverde.com
Mobile: +62 812 279 1743

b. Growmore Biotech Ltd.

41-B, Sipcot Phase 2 IV Cross Road,
Hosur, Tamil Nadu 635109, India
Phone: +91 04344 260 564

(*Seeds are not being considered in this study since seedlings take longer to reach harvesting age, and populations derived from seeds are heterogeneous. In the context of plantations where selection for improved productivity is essential, seeds are not desirable, although in the wild they serve a useful function in conserving genetic variability*).

2. Establishing Bamboo Nurseries

To produce the planting material required for the pilot plantations (estimated at 60 ha but depending on the site selected) it is suggested that simple vegetative methods be adopted and a nursery be set up at a suitable site. The typical requirements are about 0.75 to 1 ha of flat land with protection against animals and good access to water and sunlight. Availability of skilled labour and ease of transport to the planting site will also be a consideration. If possible, the nursery site should be located adjacent to or included in the site selected. When large-scale plantations are being planned, decentralised community-based nurseries can also be considered, instead of a central STIDC nursery.

Nursery activities are spread out throughout the year to ensure production of quality graded bamboo planting stock for the oncoming planting season, and because a substantial number of bamboo will be required for causality replacements and macro-proliferation. As such, it is always advisable to have extra space for the nursery. Accordingly, sufficient area will have to be earmarked, demarcated and fenced off right at the beginning of the process, prior to establishing a permanent nursery for bamboos.

(*In addition, it has to be decided whether the nursery is intended for the pilot study alone or for a larger long-term plantation programme that is likely to result after the pilot study. If the latter is the case, the location and size of the nursery must be given more consideration, A temporary nursery is very different in terms of its infrastructure and the investment required.*)

The layout of the bamboo nursery will take into consideration nursery infrastructure facilities such as

a site office, vehicle shed, storage areas, drying yard, potting shed, composting shed and mist chamber from its planning stages. Separate areas for raised nursery beds to enable vegetative propagation of culm/branch cuttings, transplantation beds for keeping the potted propagules, and grading and hardening areas must be designated.

Irrigation through sprinklers/drip and shade nets are recommended for the bamboo nursery. Mild fertigation can also be practised in the nursery to boost propagule growth, at least during the earlier days of its operation. However, for the pilot plantation project, temporary nurseries need only consider the essential requirements of the nursery. These are as follows:.

Nursery site requirements

- Well drained
- Easy accessibility with good roads
- Availability of adequate labour force within the vicinity of the nursery
- Year-round availability of good quality water
- Located in an area where edaphic and climatic conditions are conducive to rapid multiplication and healthy growth of bamboo species propagules
- Availability of good quality top soil, preferably alluvial
- Site free from any legal encumbrances
- Not affected by human interventions and wild animals.

Sites having all the above attributes can be developed as an ideal bamboo nursery. Once all the legal documents pertaining to the land have been found satisfactory, the area will have to be demarcated after proper surveying and fenced off, preferably with chain links or barbed wire using concrete posts. The fence should have a height of 1.5mabove ground level. Use of chain link fencing is recommended, as it will prevent animals like porcupines and wild pigs entering the nursery. However, in the case of barbed wire fencing, providing a separate wire mesh barrier at the bottom of the fence will also prevent the entry of small animals.

ii. Division into sectors

The demarcated and fenced nursery site should be divided into smaller sectors to separate out nursery activities such as: nursery infrastructure, propagule production, and management and maintenance of parent stock (clones for propagation). This will help in managing the system more effectively. Overall, the nursery establishment will be facilitated and routine operations will be streamlined and in a sequence as in an assembly line resulting in improved efficiency and cost reduction. An idealised diagram showing the different sectors in a medium-sized bamboo nursery is given below (Figure 1).

Dimensions and sector-wise area of a Bamboo Nursery of 2 ha.

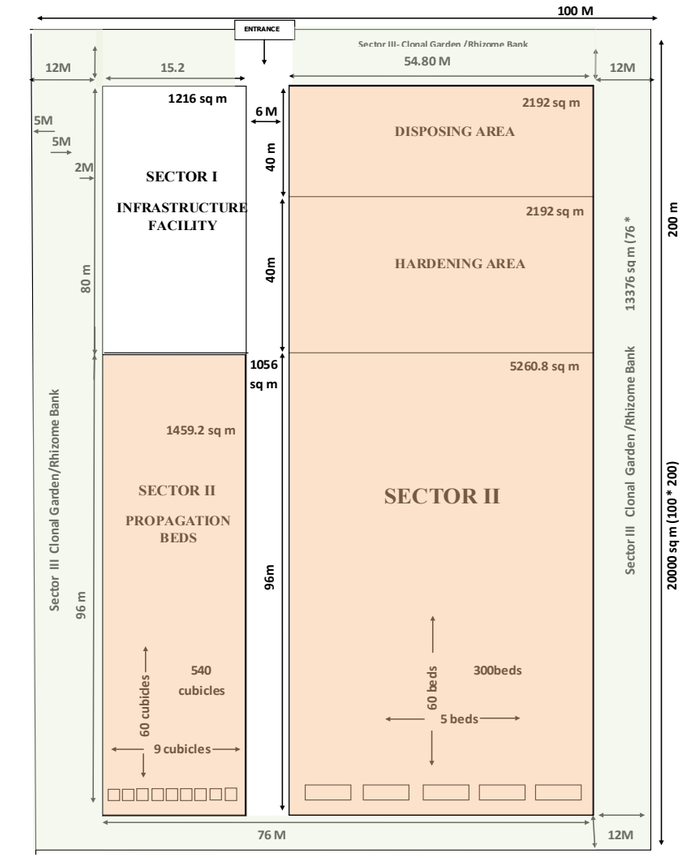


Figure 1: Dimensions and sector-wise nature of a bamboo nursery of 2 ha.

Sector 1

Essential infrastructural facilities include: the nursery office building, laboratory, implement/fertiliser/vehicle shed, compost shed and potting shed, and should be accommodated in this sector. All future infrastructural developments should be planned and implemented only in this sector.

Basic nursery infrastructure

Office building

The office building is best located by the side of the main entrance so that visitors can get firsthand information about the availability, price and procedures for obtaining certified bamboo planting stock from the nursery. The office

building must have an office room for the officer in charge, a spacious hall for the clerical, technical and skilled staff, and a separate space for the storage of nursery records. The front room should have a reception desk and display boards indicating the nursery certification document, species available for sale, selling prices, and current stock position for visitors.

Laboratory

The nursery laboratory must be equipped with the following: an electronic balance, oven, refrigerator, seed purity board, glassware, chemicals and growth hormones. The laboratory will be used by the technical/skilled staff for preparing hormone solutions, gathering information on the growth, development, disease/pest infestations and nutritional deficiencies/imbalances observed in bamboo propagules being raised in the nursery. Any abnormalities observed during the developmental stages of the propagules must be documented and timely remedial measures taken. Maintenance of all the above data and their proper documentation will be an important criterion for getting the funding and authority for certification of the planting stock.

Stores

Separate store rooms with wall -shelves will be required for the safe keeping of nursery implements: machineries such as weed cutters, branch pruners, hedge cutters and chain saws, mechanical/hand sprayers etc. Separate store rooms are required for fertilisers (urea/di-ammonium phosphate etc.), sieved soil, sand, insecticides/pesticides etc. Information regarding antidotes, and their method of usage and dosage, should be clearly displayed in the respective stores and main office building.

Nursery vehicle

A trailer jeep/mini truck is required in a nursery for easy transportation of planting stock to distant planting areas. For this, hire charges should be levied from customers in order to make the facility sustainable. A vehicle will be used for transporting nursery items like manures, fertilisers and other stationery items to and from the nursery. A vehicle shed attached to the nursery will ensure the vehicle is safely parked. The nursery design should take into account the smooth and unhindered movement of the vehicle within the nursery premises so it can load and unload materials.

Composting unit

It is advisable to reduce the quantity of soil being used in potting mixtures. The best substitute for soil is mixed weed compost: a rich source of organic matter and one that can be used as an active ingredient in the potting mixture along with clean soil and sand. Mixed weed compost can be easily and economically made in the nursery through aerobic composting and will involve only minor initial investments. The unit for aerobic composting should be a well ventilated hall of any convenient size, with a roof so that rain will not spoil the composting process. The partially open side walls ensure free air circulation during the composting process. A separate room is required to store the clean, sieved compost and ensure its availability throughout the year in the nursery. The main piece of equipment required for composting in the shed is a weed chopping machine, which may cost less than US$750. As monitoring and controlling the temperature in each of the composting heaps is an important activity, a set of digital thermometers, which are locally available in the market, will be useful, though manual checking is equally reliable.

Soil sterilisation

Soil used in the potting mixture and even in the propagation beds should be free from extraneous materials like stones, roots, plant debris and plastic wastes, and all these can be eliminated manually. The soil can be sterilised easily and economically through 'solarisation': a process which disinfects the soil and frees it from harmful fungi, bacteria, viruses, nematodes and other soil-borne tiny pests. Traditionally, solarisation makes use of solar energy to heat the soil to a high temperature. This is achieved by spreading out the soil as a flat layer outdoors for several weeks and covering it with a transparent plastic sheet with the edges buried in the soil to trap maximum heat inside. Alternatively, the nursery may invest in a steam-sterilisation system with boilers.

Potting shed

The nursery should have a shed with a roof and free air circulation, and be accessible for vehicles and with storage space for consumables like soil, sand, polybags, and trays. The shed should provide protection from rain and sun, as well as adequate protection from rodents and stray animals. Ideally, there will be mechanical devices for sieving, preparing the soil mixture and filling the bags, to reduce labour requirements. Soil filling hoppers are available which save time and labour costs and bring some uniformity in filling. Proper blending and mixing of different ingredients like fertilisers and growth regulatory chemicals in the potting mixture should be ensured.

Pump house with overhead water storage

Ready availability of fresh water round the year and at any given point of time is very important in a bamboo nursery. The nursery should have a pump house to provide sufficient irrigation water to plants, and a water storage tank to meet requirements for at least 2 days. Pumping water from a dug well or flowing river to an overhead tank will ensure continuous water availability in the nursery. A water purification system attached to the pumping process will make available pure water throughout the year. Such an uninterrupted supply of quality water is essential when sprinklers/drip/misting units are in use in the nursery. Overhead water tanks can be installed above one of the Reinforced Cement Concrete (RCC) buildings in Sector I itself so that extra space need not be provided for accommodating the overhead water tanks.

Sector-2: Propagation and hardening

Shade net house

Bamboo seedlings/propagules require partial shade at two points: initially in the propagation bed, and soon after transfer into poly bags or larger containers. Plastic woven shade nets are available in different colours and shade percentages. The installation of the shade nets will require fabricated structures with angle iron and galvanised iron pipes or bamboo for support. Shade nets in a black colour with a shade of 50% are recommended.

Planting material is placed under the shade net nursery in clearly labelled batches and in a manner that avoids any inadvertent mixing during handling. Sufficient space should be left between rows of plants to permit removal of containers without damaging the adjacent plants.

Irrigation system

Developing seedlings/propagules of bamboo requires intermittent watering to ensure survival and faster establishment. A modern irrigation system consisting of mini-sprinklers, drip systems and fogging equipment, polyethene hose/pipes, valves and nozzles dispenses water in the desired volume and frequency at the root zone/aerial part of the developing bamboo propagule. Modern nurseries administer fertilisers along with irrigation water ('fertigation') and specially designed equipment available in the market.

Greenhouse / Polytunnel

A greenhouse with automated misting equipment and temperature control is desirable, but low cost polytunnels can also be used instead. Polytunnels are fabricated structures, which can be set above the raised beds with the dome covered with UV resistant polythene sheets and sprinklers/ misting units fitted inside to maintain desired humidity to encourage sprouting of buds.

Propagation area

Mass production of propagules will have to be carried out only in this area/sector and hence all the germination beds, container beds, raised beds and cubicles are to be set up here. The final product of the nursery - the field-plantable propagules - are to be dispatched from this sector/area of the nursery to the customers.

Production through vegetative propagation

When seeds are not available, vegetative propagation methods are used for the production of planting stock. Two major methods - macro- and micro-propagation - are available for vegetative propagation in bamboos. In macro-propagation, conventional methods of rhizome/offset, rooted culm/branch cuttings are used; in micro-propagation tissue culture techniques are employed.

Macro-proliferation

Bamboo seedlings start producing tillers right from the third month of germination and the number will increase with better management practices. These tillers can be separated from each other from the fifth month of potting. The process is termed macro-proliferation. It enables the production of large number of propagules from a single seedling and also ensures the availability of a large number of planting stock.

The process of macro-proliferation can be continued every two months, provided tiller formation is profuse as in the case of *Bambusa balcooa, B. bambos* and D. *strictus*.

While carrying out macro-proliferation, part of the stock can be used for field planting and the remainder can be kept in the nursery as parent stock material for further proliferation. This will ensure a sustainable production of planting material every year. However, beyond a certain extent (three times in a year) there are chances of the propagules becoming weaker and less vigorous with poorer survival rate in the field.

Macro-proliferation can also be practised in culm/branch cuttings and rhizome/offset cuttings; however, compared to seedlings only a lower level of multiplication need is expected.

Nursery beds

Though a standard forest nursery bed is 12m long, 1.2m broad and 0.30m elevated from the ground level, these dimensions need not be closely adhered to in bamboo nurseries. The height of raised beds can be reduced to 15cm as the bamboo propagules will have to be transplanted into poly bags or larger containers after approximately three months. However, it is better to keep to the standard length and breadth of forest nurseries as this will help in calculating the dosages of prophylactic treatments and fertilisation on a per bed basis. The raised beds are to be filled with 3:2:1 clean sieved soil, sand and powdered compost/dried cow dung. Howe Conversely, in the North-eastern region of India, sand is considered the best medium to use in raised beds, to enable maximum rooting from culm/branch cuttings. Side wall partitions of the raised beds can be made of Ferro-cement slabs held in position with iron/cement pegs. In case Ferro-cement slabs are not available, good quality bricks or tiles can also be considered for the purpose.

Treatment with rooting hormones like IBA or NAA promotes rooting in most of the bamboo species. The treatment is given either through the dip method or by pouring the hormone solution into the culm cavity. New sprouts usually appear after about 10 days but it may take more time for the roots to develop and establish. Under normal conditions the sprouted plantlet can be lifted from the bed and potted in larger plastic bags (28 x 22cm) after about three months' growth in the nursery bed.

The rhizome/offset cuttings are best raised in square cubicles of the dimension 1.2 or 1m^2. The height of the cubicle should be 30cm from the ground level, filled with the same combination of potting mixture as mentioned earlier. The side partitions can be of Ferro-cement slabs, bricks or tiles. Each of the cubicles can be used to accommodate at least 4 pieces of rhizome/offset cuttings which ultimately will be utilising approximately 0.50cm^2 of space for their root growth. The inside partition of the cubicles are made by smaller Ferro-cement slabs/bricks/tiles, thus separating a cubicle in to 4 sub units. Since the side partition walls are removable, the rooted offset/rhizome cuttings can be taken out without causing any injury to the delicate developing rhizome/root system. Raised cubicles are preferred for rooting of offset/rhizome cuttings.

Sector-3 -Rhizome/Clone Bank

Bamboo nurseries should use only parent material from a known source of origin so as to ensure or ascertain: the correct species name, the quality and growth potential (like culm productivity, culm size, disease resistance, previous flowering cycle etc.) of the resultant propagule. In order to ensure this, a rhizome/clone bank of identified clones is recommended in the nursery itself. This will enable the production of known superior planting stock which can be sold with an authentic quality/species assurance certification by any certified Bamboo Nursery. The clone bank will have to be developed ultimately into a production centre of superior clonal planting stock of bamboo from identified parent clumps. The clone bank can be developed either as a block plantation or as a boundary plantation along the border of the nursery. The decision can be on the basis of space availability. Ultimately the clone bank will contain selected, tested, genetically superior mother clumps of different bamboo species of known parentage/flowering cycle. Only through these mother clumps can certified planting stocks be produced and sold for the establishment of all future area expansion programmes.

When bamboo is planted along the boundary, care should be taken to see that the clumps are spaced at 5 x 5m so as to facilitate periodic cutting and cleaning of the mother clumps as part of routine clump management. A minimum of 2m space should be left between the bamboo clump and any other structures like the buildings/nursery beds. In addition, propagules retained for further multiplication in the nursery during the next season will also form a part of rhizome/clone bank.

iii. Records to be maintained in the nursery

1. Nursery Journal

A nursery journal must be maintained in every bamboo nursery and should be made available for inspection by officials of STIDC. The journal must contain the details listed below.

-(On the first page) Ownership details including full address, contact number and email address

-A plot chart showing the location of different sectors and the purpose for which they are being used

-Types of bamboo planting stock being produced in the nursery

-Annual target for production of each type of planting stock in the nursery

-Certificates showing the origin of all plant material used for propagation

-Passport data of plant material used for propagation

-Month and date of culm collection and hormone treatment

-Name of the hormone used / concentration and details of application

-Date of sprouting and details of prophylactic treatments administered during raising of the planting stock

-Date and method of potting (container size and potting mix used) and shifting of the planting stock to larger containers

-Dates and detail of fertilisers or pesticide applications

-Whether or not macro-proliferation was carried out; if yes, age at which it was done / potting mixture used / size of bag with which potting was done

-Dates of grading carried out

-Date of dispatch of each batch of seedlings

-Number of seedlings / propagules dispatched under each species

-Income generated through seedlings/propagule sale

2. Attendance register

The register is essential to monitor the number of persons attending to different works in the nursery.

3. Stock register

The register should record all details regarding the production and sales of planting stock raised in the nursery so as to assist in the evaluation of the nursery regarding its achievements in meeting its annual targets.

4. Purchase register

The register will be used to monitor the total assets of the nursery and its appropriate running cost.

5. Instruments / equipment required in the laboratory

Electronic balance / weighing balance / seed purity board / pH meter / distillation unit / oven / refrigerator

6. Growth hormones required in the nursery

Ethyl alcohol / NAA / IBA

7. Fertilisers / pesticides / insecticides

Bavistin-Carbendazim, 50% / WP (Broad spectrum systemic fungicide)

Chlorpyriphos, 20 % EC (Insecticide/termiticide)

Thimet, 109 or equivalent for white grub infestation.

Sumicidin, 5 % (Insecticide) or equivalent

Malathion, 0.25 % (Pesticide) or equivalent

8. Other essential items:

Nursery implements like bill hooks, crow bar, shovels, scoops, secateurs, plastic buckets, plastic mugs, water sprayers, soil sieves, plastic crates / trays, First Aid box.

3. Establishment of Bamboo Pilot Plantations

i. Site characteristics

Tropical clumping bamboos can grow in a range of areas: rainfall can be between 900-4000mm, altitude 500-4000 metres above sea level and the temperature 20-38°C. Best growth performance can be expected in level terrain, or terrain with mild slopes, as drainage is very important in bamboo plantations. Well-drained sandy loam, or loamy clayey type alluvium is the best medium for growth. Bamboo also prefers acidic soil with a pH ranging from 4.5 to 6.0. Bamboo responds well to soil ameliorations and hence clayey soil, which appears to be predominant in the selected sites and can be properly modified prior to planting. A minimum of 2 to 3m soil depth is ideal for profuse rhizome growth and proliferation. Windy and heavily sloping terrains are to be avoided as there are chances of clumps toppling down; this is due to the heavy weight of the aerial parts, which usually grow towards the uphill side in such hilly terrains.

In both sites the above guidelines may be followed and adhered to as far as possible, while demarcating the planting site for the pilot plantations. In both the sites as the soil is clayey, the planting pits may be filled with a mixture of clean red/forest soil, sand and mixed weed compost or finely ground manure, prepared in the ratio 2:2:1. Level sites or those areas where the slope grade is lower that 10% are ideal for undertaking the pilot plantations since the interventions required are minimal. In case the site has slopes with a grade higher than 20%, any operations will have to consider the danger of soil erosion and landslides, depending on the soil's performance during heavy rain. Options like terracing the slope or inwardly sloping platforms around each pit may be implemented as per the advice of an expert so that the soil is minimally disturbed and loosened during the operation.

A performance trial with 10 species of bamboo through the establishment of a 50-ha pilot plantation is proposed, along with a species trial with six exotic species in 2 ha each.

ii. Selection of sites for plantations

- Site I Plots - 8314A; 8315A; 8316A (11 ha)

Besides being a good site for a nursery of about 0.5 ha, it is recommended that an agroforestry plantation be trialled here, since this plot of land has already been used for agroforestry purposes, and cultivation of hill paddy appears to be successful The spacing of bamboo remains 5m. In the trial, annual crops chosen based on the local tradition and profitability, could be grown as under-crops for the first three years or until the canopy closes. Bamboo can be considered for a farm border, for protection as well as a source of produce for the farm.

Suggested crops are: banana, brinjal, capsicum, ginger, groundnuts, maize, hill paddy, pineapple, papaya, sweet potato, sugarcane, turmeric or vanilla.

- Site II Plots - 8310B; 8309B; 8308B; 8307B (49 ha)

This plot is mostly undulating land with ravines/gullies. Testing can involve two trials:

(a.) planting on slopes along contours

(b.) terracing of 5- 8m width with access to planted rows for tractor or harvesting machinery.

- Proposed alternate sites (if permission is granted by Forest Department):

New Site 1: Total: 67.8 ha: Plot-8406B (37.1 ha) and Plot-8406 (30.7 ha).

3 ha has already been planted with bamboo in 2002. It is near a highway and river.

New Site 2 (opposite the above New Site -1): Total o51.9 ha.

-Plot 8303A: 6.0 ha.

-Plot 8302A: 7.2 ha.

-Plot 8301A: 8.7 ha.

-Plot 8302B: 9.0 ha.

-Plot 8301B: 9.0 ha.

-Plot 8212: 10.0 ha.

-Plot 8304: 2.0 ha.

iii. Site preparation

Level sites may be prepared at least two months in advance of aligning, stacking and pitting. If required, soil should be ploughed and the stumps of trees or boulders removed. In case the site is undulating or mildly sloping, the possibility of the soil getting washed off during the rains must be given a serious thought. Depending on the nature of slope, options like terracing or inward slopping platforms around each pit can be implemented to ensure that soil disturbance is low during the operation.

Terracing is an option to be considered only if level land is scarce, since it entails higher costs as well as the risk of top soil erosion. However, it facilitates management operations and mechanisation of the harvesting of bamboo when the plantations mature. On slope grades above 10%, planting in pits on inwardly sloping platforms is recommended to prevent water runoff and facilitate moisture conservation. Terraces should be designed such that the width is at least twice the intended height of each level from the lower one. Planting can be done in the middle of the width of the terrace, or on wider terraces in multiple rows if possible. Bamboo clumps tend to grow uphill on the slope.

iv. Spacing

The typical spacing of bamboo species of medium-sized clumps is 5 x 5m (400 plants per ha). Alternatively, spacing of 4 x 4m (625 plants per ha) can also be adopted for species with smaller clump diameter like *G. ligulata, G. brachycladum, S. zollingeri, Thyrsostachys oliveri* and *D. stocksii*, and 7 x 7m for the larger exotic species like *D. asper, Guadua angustifolia* and *D. brandisii*. Square pits of 45 x 45 x 45cm are typically used for planting bamboo but when machinery is used a pit of approximately this size will suffice. Pits are prepared at least two to three weeks in advance of planting. These pits are filled with top soil and a mixture of clean soil, sand and mixed-weed compost in the ratio of 3:2:1, preferably during the showers that sometimes precede rainy season. For rhizome offset planting, pits of 60 x 60 x 60cm are better. These larger pits are also preferred on sites where the soil is of poor quality so that good soil is used to fill the pits before planting. Bamboo responds well to organic fertilisers which modify the soil physical properties.

v. Specific plan for site preparation

a.Flat lands and slopes up to 10% (Site I and New Sites I

and II)

Square planting is advisable for the selected sites. The site after demarcation may be fenced with either barbed wire or chain links so that the plot is safe from grazing animals. As the slope is very mild the area may be ploughed with a tractor, weeds removed, and stumps uprooted and transported outside the plot. Once the area is clear, aligning and staking may be done. All these operations may be initiated about two to three months ahead of planting, which will have to be done along the pre-monsoon showers in November to December at Sarawak. A standard spacing that can be followed for all medium-sized species in such terrain is 5 x 5m (400 plants per ha). However, for larger and taller species like *Bambusa balcooa, G. angustifolia* and *D. asper* a spacing of 7 x 7 m (204 plants per ha) will be ideal. The ideal pit size will be 45 x 45 x 45cm especially when one-year-old propagules are used for field planting. Larger pits with soil are recommended.

b. Sites with slopes of above 10-20% (Site II and New Site II)

Contour planting will be ideal in terrain with slopes up to 20%. Planting lines can be aligned along the contours, keeping a minimum distance of 5m between plants, and at least 4m between the contour lines (accommodating 500 plants per ha). Contour trenches may also be dug along the lines and planting of bamboo should be done on the uphill side of the trenches. The ideal pit size will be 45 x 45 x 45cm.

c. Site with slopes above 20% (parts of Site II and parts of New Site II)

Terracing may be done in such sloping terrain (in which case the configuration and size of the terrace will have to be determined, ideally by a land survey expert). The danger of severe soil erosion and even landslides is present in such situations if the terracing is not done under supervision. The spacing in this case is also 5m between plants and the minimum distance between lines 4m (500 plants per ha).

d. Sites with river nearby and occasional flooding (New Site I and part of Site I)

Since bamboo can only tolerate intermittent submergence in water for short periods of less than a week, such areas can be avoided; however, if the risk is low, planting on mounds of 2-3ft height can be attempted in areas on river banks prone to flooding during rains.

(*The recommendation is that land with slope grades above 20 % should be considered only if they form a significant proportion of land available for bamboo plantations, since the interventions are more expensive at planting and harvesting stages, and the danger of erosion and landslides is increased*).

vi. Planting and aftercare

Planting will have to be completed prior to the setting in of the rains in full strength in December.

Conventional planting of one-year-old propagules raised from culm/branch cuttings in nurseries will be less cumbersome and cheaper than rhizome/offset cuttings, but nursery activities will have to be initiated one year prior to the planting work to ensure that the rooted cuttings develop a rhizome and a good root system. The presence of a rhizome is the indication of a good planting material capable of establishing itself well in the field.

vii. Calendar of Activities

a. Pre-planting activities

Site selection, demarcation, fencing, ploughing (only in level terrains), and weeding	October
Aligning, staking, soil amelioration (if required) and pitting (square pits of 45 x 45 x 45cm size, or as described above for larger or smaller species)	November – December
Planting of one-year old propagules. (The graded propagules must have a minimum height of 45cm [leading shoot], and more than 5 leading shoots in the clump)	December, prior to setting in of heavy rains
Causality replacements	January – February

b. Plantation management

Year 1

Water the plants once every week soon after planting, if rains fail.

After the rains, watering during the latter half of the first year is important to ensure survival of the plants. Water should be applied as and when required to avoid wilting.

Three months after planting, fertilisation can be done (preferably after testing the soil). Fertilisation may be repeated after six months if required, and if advised by a soil scientist.

Weeding should be carried out preferably three months after planting and two months after the cessation of rains (since most weeds start smothering the plants by this time).

Soil working (loosening and heaping around the clump) two months after the rains have stopped (loosening of soil / mounding / leaf mulching) is important. Repeat after six months.

Year 2

Repeat all operations of the first year except watering. Replace all dead and non-surviving clumps during initial showers as per the previous year.

Repair fencing if required.

Mark newly emerging culms with paint of a colour chosen for the year, if they have attained a diameter close to the maximum attained for the species.

Year 3

Repeat first year operations and fertilisation as advised by soil scientist.

Remove any dead culms or branches.

Mark new culms with paint of a different colour.

Year 4

Remove all dead and damaged culms.

Start selective harvesting of older culms/branches if growth performance is satisfactory. If not, postpone for next year.

F. Road map for pilot plantations leading to large-scale bamboo plantations in Sarawak

i. Pilot study in approximately 60 ha in Sabal.

Year 1: Nursery and propagation activities and planting in part of the sites.

Year 2: Complete planting in prepared sites.

Years 3-4: Management of plantations with assessment of survival and adaptability and growth

parameters.

Year 5 onwards: Harvesting operations.

i.Bamboo plantations on a large scale based on species performance in pilot study

Years 5-6: Setting up of additional nurseries in other areas of Sarawak. Setting up of tissue culture facility.

Year 7: Planting of selected bamboo species in suitable sites all over Sarawak.

NNEX 2: Excel file 'Nursery costs'

NNEX 3: Excel file 'Plantation costs'

Executive Summary

This report focuses on the feasibility for developing proposed pilot bamboo afforestation carbon projects, combining the feasibility study for the potential pilot project on bamboo plantation development by STIDC in the Sarawak region of Malaysia.

According to the methodology for bamboo afforestation carbon project and findings, and results of the field inspection and preliminary field assessment of the INBAR team in Sarawak, Malaysia, the conclusions of this feasibility study are as follows:

- The proposed pilot bamboo afforestation carbon project is technically feasible, but not economically feasible.

- It is suggested that in order to explore the bamboo afforestation carbon project in Malaysia, gather bamboo carbon project experiences, and direct the development of the bamboo carbon projects in Malaysia, the pilot bamboo plantation area needs to be expanded to 500 ha. It is estimated that preliminary carbon emission reductions totalling 120,000 tCO_2e will be produced over 20 years. Depending on the price set on carbon by a specific carbon project, the carbon income could be more than double the development costs of the pilot carbon project, overcoming economic obstacles and ensuring the pilot project is economically feasible.

A. Study objective

The objectives of this study are to assess the feasibility for developing the proposed pilot bamboo afforestation carbon project, drawing on the feasibility study for the potential pilot project on bamboo plantation development of STIDC in Sarawak of Malaysia, and to put forward a chart and steps for developing the proposed pilot carbon project.

B. Results and analysis

1. The feasibility of silviculture and management techniques for the proposed pilot project

According to the field investigation by INBAR's expert team and the information introduced by STIDC, 3 ha of bamboo plantations were planted in 2002; the main bamboo species planted were *Dendrocalamus asper* and *Gigantochloa levis*. The bamboo plantation has grown well: some bamboos are more than 15min height and more than 10cm in DBH (diameter at breast height). However, the management of the bamboo plantation is weak. Necessary selected cutting for old bamboo stems has not been carried out, some old bamboos have died, and the bamboo density within bamboo clumps is very high. The investigation shows that technical staff and forest workers had only basic techniques and practical experience of bamboo planting in 2002.

In addition to the field investigation, there is a bamboo research and development unit under SALCRA. SALCRA has been cooperating closely with INBAR's team as its local agent for this feasibility study.

The proposed pilot bamboo carbon project to be undertaken by STIDC is technically feasible from a bamboo silviculture standpoint. Management techniques can be enhanced and supported by INBAR's experts, as well as SALCRA.

2. The sites and area of the proposed pilot project

The total area of the first two pilot sites in Sabal Forest Reserve (SABAL FR) suggested by STIDC is 60 ha: one is 11 ha and the other is 49 ha. With INBAR's field investigation and verification, based on the local climate and soil conditions, the two sites are suitable for planting bamboo, and are suitable for potential pilot bamboo plantation project sites.

However, two new sites in SABAL FR were suggested to INBAR's team by STIDC during the field investigation. One is 67.8 ha, another 51.9 ha, totalling 119.7 ha. The result of the field investigation shows the two new sites demonstrate better suitability for pilot bamboo plantation project sites: a 3 ha bamboo plantation was planted in the first new site in 2002, and the site is near the highway and a river; the other new site is on the other side of this highway. This means the new sites are better in terms of transportation and water availability, thus helping the management of the bamboo plantation.

Therefore, these new two sites are recommended as proposed pilot sites. The total area is 119.7 ha, and the net area is 116.7 ha (minus 3 ha planted).

3. The technical feasibility of developing the pilot bamboo afforestation carbon project

According to the methodology of the bamboo afforestation carbon project (methodology number AR-CM-002-V01), the technical feasibility of developing the pilot bamboo afforestation carbon project has been analysed as follows:

- Baseline scenario of the proposed project

If the proposed bamboo plantation pilot project is not carried out in the future, the sites will be left uncultivated (see Figure 1). The possibility of developing a forest naturally in the proposed sites in future is limited because of the limited number of seedlings and small trees, which lack necessary scientific management or strict protection; in addition, local people will cut the young trees for firewood. Therefore, the baseline of proposed project is clear and acceptable.

Figure 1. Present situation of land use in proposed pilot project sites

- Land eligibility of the proposed project

The land ownership of the proposed project sites rests with the state of Sarawak, and the land use right belongs to STIDC. Land rights are clear, with no disputes. Moreover the proposed sites of the project have been left uncultivated since 2002, as there were no suitable investments and no scientific management or strict protection.

It is obvious that the lands of the proposed project meet the requirements of clear land rights and has been non-forest land since 16 February2005. Therefore, the land eligibility of the proposed project is acceptable.

- Additionality of the proposed project

An additionality test assesses whether a project or activity creates 'additional' emissions reductions that would not have occurred in the absence of the incentive. The proposed pilot carbon project needs high cost investment, a longer payback period, and does not have enough technical support for bamboo silviculture, plantation management, bamboo wood processing, comprehensive utilisation, and carbon project development. Therefore, the project owner will not be able to decide to implement the proposed pilot carbon project without technical support and carbon credit income.

In addition, the proposed carbon project is the first bamboo carbon project in Sarawak. Also, in Malaysia, the afforestation, management and carbon monitoring such as site preparation and planting techniques are different from the fragmentary bamboo planting around the houses of local farmers.

Therefore, the proposed carbon project meets the requirement for carbon project additionality.

- Project area and project boundary of the proposed project

The project area of the proposed project is 116.7 ha, located in SABAL FR of Sarawak. Every site is clearly within the map boundary. In addition, the project area is near

the highway and a river, so it is convenient to implement the proposed bamboo afforestation and management project activities.

- Feasibility for bamboo afforestation and plantation management techniques

Under the technical support of INBAR's expert team (including Chinese bamboo experts) the silviculture and management techniques of the proposed pilot project will be up to professional level. Therefore, the project owner can overcome obstacles in the afforestation and management techniques of the proposed pilot project.

- The process of developing carbon credits

The process of developing the proposed pilot bamboo afforestation carbon project, according to the relevant regulations and methodology of bamboo afforestation carbon projects, can be divided into seven steps as follows:

Step 1. To implement field visits and develop project design documents (PDD), and prepare the project document materials and the evidence for project validation by the third party, the Validation & Verification Body (VVB).

Step 2. To carry out proposed carbon project validation by VVB, answer VVB's questions, and obtain a positive Validation Report of the proposed project.

Step 3. To apply for the carbon project register in Green Carbon Standard, managed by the China Green Carbon Foundation (CGCF).

Step 4. To implement the proposed bamboo afforestation carbon project based on the project afforestation design and PDD by the STIDC project team.

Step 5. To implement project monitoring based on the registered PDD and Monitoring Plan, created by the STIDC project team and guided by INBAR's expert team, and to write the Monitoring Report.

Step 6. To implement the proposed project verification by VVB, answer VVB's questions, and get a positive Verification Report of the proposed project.

Step 7. To apply for project emissions reductions or credits issued under the Green Carbon Standard, managed by CGCF, and get GC-VER (CGCF-verified emission reductions issued by CGCF.

The issued GC-verified emissions reductions can be traded in the voluntary carbon market in China.

4. The economic feasibility for the proposed pilot bamboo afforestation carbon project

The economic feasibility for the proposed pilot bamboo afforestation carbon project is analysed below.

Based on the area of the proposed pilot project - expanded from the previous 60 ha to 116.7 ha (minus 3 ha planted in 2002) - and given the scenario of a preliminary estimate of producing 225 tons net carbon sinks or carbon emission reductions per ha during the future twenty-year accounting period, a total of 26,000 tCO_2e of carbon emission reductions will be produced by the proposed pilot project over the coming 20 years.

According to carbon prices in the international and Chinese voluntary reduction carbon markets, the common carbon prices are US$3-5 per tCO_2e. So, the total output of carbon emission reductions is USD78,000 to US$130,000, with an average output of US$104,000. However, least US$100,000 (about RMB650,000) is required to pay the necessary consulting and validation and verification costs of the proposed pilot project. This includes the costs of the proposed carbon project development and consulting, project validation by VVB, and two project verifications by VVB (not including local ground transport, accommodation, and meals in Sarawak, Malaysia for the project visits and validation and verifications).

From this it can be seen that the carbon income of the proposed project almost equals the cost of developing the proposed carbon project. This is because the area of the pilot project is too small, the output of carbon emissions reductions is also small, and the total carbon income of the proposed project is low.

Therefore, even if the lowest costs of project development and validation and verification are adopted, the economic feasibility is not acceptable.

5. The potential benefits of the proposed project

The proposed pilot bamboo afforestation carbon project will have many benefits, such as enhancement of income for farmers, bamboo plantation development, improving bamboo forest management, capacity building, community engagement, biodiversity conservation, environmental improvement, climate change awareness arising, and promoting local sustainable development.

C. Conclusion & Suggestions

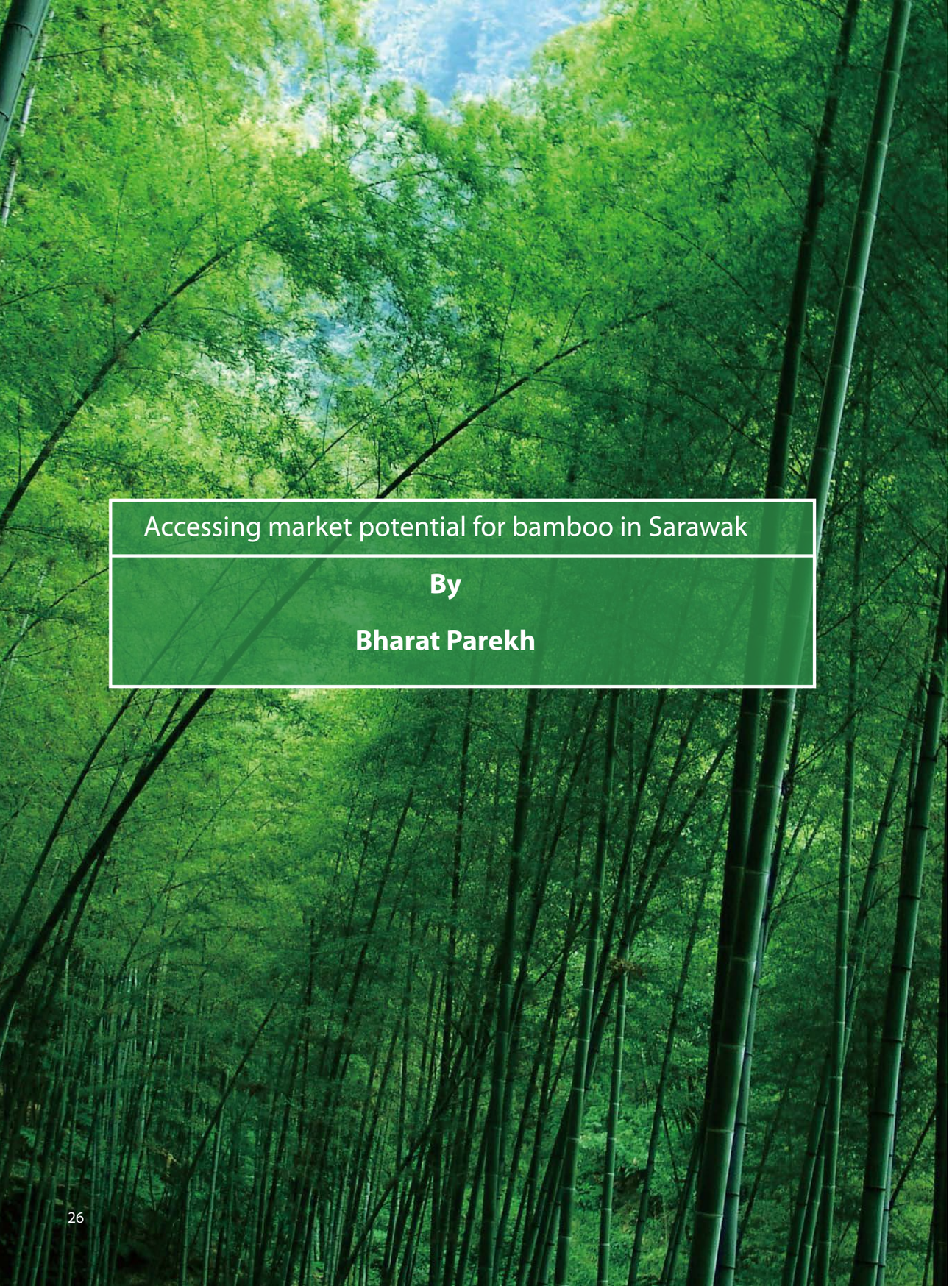
According to the field visits, discussions and feasibility study above, the conclusions of the feasibility study for the proposed pilot bamboo afforestation carbon project are as follows:

The proposed pilot bamboo afforestation carbon project is technically feasible, but is not economically feasible.

In order to explore the bamboo afforestation carbon project in Malaysia, it is important to gather bamboo carbon project experiences, direct the development of the bamboo carbon projects in Malaysia, and expand the pilot bamboo plantation area to 500 ha.

The preliminary estimate for carbon emissions reductions for a 500-ha site will total 120,000 tCO_2e over an accounting period of 20 years, and the carbon output will reach US$360,000-600,000. In this scenario, the carbon income will be more than double the development costs of the pilot carbon project. This means the economic obstacle of the pilot project would be overcome, and the pilot carbon project would be economically feasible.

Note: Expanding the pilot plantation to 500 ha from the much smaller area suggested in Section A will need further exploration and permissions. If it is being considered, all of it need not be part of the trials suggested and a uniform spacing could be adopted.



Accessing market potential for bamboo in Sarawak

By

Bharat Parekh

INBAR
INTERNATIONAL BAMBOO AND RATTAN ORGANISATION

Executive Summary

This part of the study was to make an assessment of the market opportunities for bamboo development . Based on a review of existing markets in Sarawak, where bamboo could potentially be used as a variable alternative or substitute to timber and/or other materials, the study identified priority value chains with the greatest market potential. For each priority value chain, financial models have been generated to project potential internal rates of return on interest, as well as net present value and cause benefit ratios for establishing local enterprises.

The four-member team of INBAR that went into the field discovered the long history of bamboo in the region - in the form of longhouses, musical instruments and handicrafts.

Although no inventory was made available, INBAR's team found out that the existing local species of bamboo, as well as a couple of species propagated by STIDC, were in good condition and could be used effectively for making furniture and construction. A few edible species were also found.

This report focuses on these existing products and the possibility of introducing market-driven products in synergy with plans for bamboo plantations and recommended species.

The initial observations revealed a prevailing distrust for bamboo since it was considered non-durable. It was found that the main reason for this was that the bamboo used was not well treated and was susceptible to powdering and cracking. The state of Negeri Sembilan is engaged in bamboo furniture making, but the products lacked fine workmanship. The furniture was also made from untreated bamboo, thus reducing its durability. Also, the team observed that iron nails were used in the bamboo furniture, which is strictly not advised, since rusting nails may impact bamboo in a negative way and will also loosen its grip, thus reducing product life.

It was inferred that the market potential is incredible, and embraced the idea of overcoming their product flaws, provided a systematic and scientific approach is taken in developing the bamboo sector in Sarawak. Bamboo is widely available in the region and so is the basic skill needed to utilise this resource. What is required, however, is investment in machinery, coupled with skill development training to workers from professional agencies with a proven track record in producing whole culm bamboo products.

It was also concluded that engineered bamboo components and products could be introduced later, after bamboo products have established a market for themselves. To address issues related to the availability of raw material, concentrated efforts on the pilot plantation and scaling up of agroforestry activities would be needed.

A. The Study

This part of the study aimed to make an assessment of the market opportunities for bamboo development — based on a review of existing markets in Sarawak, where bamboo could potentially be used as a variable alternative or substitute to timber and/or other materials, the study will identify priority value chains with the greatest market potential. For each priority value chain, financial models will be generated to project potential internal rates of return on interest, as well as net present value and cause benefit ratios for establishing local enterprises.

In the course of this study visits were made to: the Malaysian Handicraft Development Corporation (MHDC) to see the activities conducted and understand their role in the promotion of bamboo craft; the State Museum, to see the traditional usage of bamboo in Sarawak; and the Main Bazaar, to do a market assessment.

The team also visited a group of bamboo artisans in Kampong Kichin and held a meeting with an artisan, Adrian, whose family had been involved in bamboo for three generations. A visit was also made to Sebu, where shopkeepers were interviewed to get feedback and assess

local market potential.

B. Findings

One of the most typical and distinctive features in Sarawak is the traditional longhouse. Made from bamboo, these are now a feature of the past, except for a few tribal families who still follow this practice. Bridges or walkways to cross narrow rivers are also made from bamboo and often tied with sugar palm fibre or creepers. Traditional musical instruments of Sarawak, the Sape - from the Orang Ulu community or 'upriver people' of central Borneo and Angklongare - are also made of bamboo. They are widely popular and an indicator that Sarawak has a long history of using bamboo.

Products and Market

Though Sarawak has a traditional affiliation with bamboo in the form of longhouses, musical instruments and many craft items, the team failed to find any furniture or structures made from Sarawak bamboo. Some of the furniture products found on display at the MHDC were made in the Negeri Sembilan region.

Later, it was discovered that there were a number of factories making bamboo furniture, but no particular designers. Furniture was mostly custom-made as per the client's requirements. The team was also informed by an owner of a bamboo furniture-making enterprise in Negeri Sembilan that no treatment facilities for bamboo exist. The most common treatment method used is boiling the bamboo in carbolic acid and applying a bitter gourd extract during the boiling process. He mentioned that he averaged a sale of MYR3000 per day. This would make the s of a single unit MYR750,000 or USD187,500 per year, based on 250 working days.

During a visit to the main bazaar opposite Kuching Waterfront, one of the most popular places for souvenir shopping, it was observed that most of the bamboo craft items looked similar and were sourced from a group promoted by the MHDC. Besides craft items, a lot of mats were being sold which were made from rattan, palm leaves and some from bamboo. The mats were meticulously woven, thus widening the scope of introducing mat boards. In rattan, mainly round chairs in different sizes were seen in most of the shops. When asked about the potential of bamboo furniture, most of the sellers expressed their doubts about the durability of the product.

The team interviewed two big shopkeepers selling rattan furniture. When they were shown photos of the products being made in India, the sellers expressed interest and remarked on the market potential for such products, provided the durability of the product was ensured.

During the Bazaar visit it emerged that most of the handicraft products available in the bazaar were produced and supplied by Adrian, promoted and supported by MHDC living in the village of Kampong Kichin. Adrian and his wife work on making small bamboo handicraft items. In conversation with Adrian, it emerged that earlier 15 people worked from their homes and were involved in making bamboo products under a 'One Town One Product' scheme.

Adrian informed the team that he was the third generation working with bamboo, but his children are not interested in the trade. Adrian was mostly using his traditional scalpel and had few tools in his craft making kit. The proficiency with which he worked on bamboo was remarkable. Despite his expertise, he did not have a wide range of products. Adrian collected the produce from the families who made them and sold these at Kuching and fairs and exhibitions in Kuala Lumpur. Further surveying the market, it was discovered that the products were sold at double the price at which they were procured. Most of the families working with bamboo shifted to stone craft during the monsoons, due to lack of availability of bamboo. Even the handmade bamboo products made by Adrian and others products were showing cracks.

Adrian showed interest in the possibilities of different products, the availability of treated bamboo, the establishment of a bamboo bank for ready raw material available throughout the year, and skill development in handicraft, furniture and structures.

In Sibu, another study site, many bamboo items and rattan products were seen. During a discussion with Mr. Achai in Sibu Jaya New Township, it emerged that all the bamboo and rattan products came from across the border i.e. Indonesia, which is about 300km from Sibu. He also indicated that it was more economical to buy bamboo products from Indonesia rather than make them locally.

Along the banks of the waterways of Kuching, several temporary, semi-permanent and prominent structures made out of iron, steel, plastics and other synthetic material were seen. It was concluded that if bamboo was used it would help in the beautification of the site while also contributing to the environment. During a small discussion with the management staff of a hotel it emerged that bamboo was not being promoted to its true potential.

Another observation was that though were a few edible species of bamboo available, nothing was being done to promote bamboo shoots in the local markets or for export.

Based on global demand, much of the bamboo available in Malaysia could be used as biomass for gasification and energy purposes. Although a few wood pelleting units reportedly exist, they were not operational during the team visit.

Resources and Raw Material

It is evident that bamboo can play a key role in Sarawak and STIDC can definitely promote bamboo as an alternative to timber. Seventeen species of bamboo (See list in Section A) including both native and exotic species were identified as available in Sarawak. Suitable species for the pilot plantation trial have also been identified and listed in Section A.

C. Summing Up the Observations

a) Use of available local species not optimised

b) No equipped facility centres

c) No facilities for treatment of bamboo

d) Skill development and training limited to a few people and handicraft product types

e) Small industrialised products for which local bamboo is suitable are yet to be explored

f) No efforts being made to enter the furniture or construction sectors

g) Distrust of locals regarding the durability of bamboo

h) Tremendous scope to promote bamboo markets through strategic planning and inter-departmental synergy

i) Bamboo and bamboo products do not have the necessary exposure

j) There is very little or no local knowledge/awareness of the eco-friendly and other salient properties of bamboo.

D. Recommendations

As indicated by the picture below (Figure 1), every part of a bamboo plant can be used and the industry should try to address the optimisation of value chains or set up subsidiaries that would purchase by-products as commodities. About 70-90% of bamboo has a core usage, while the balance could be utilised for various purposes.

Observing the figure, one also needs to look at the species available in Sarawak and those that have been recommended for propagation and grown as a pilot with potential usage, as shown in the table below:

Sl	Species	Characteristics				Usage
		Height	Culm Diameter	Wall Thickness	Internode length	
Native and existing species						
1	B. blumeana	Medium	Large	Thick	Long	Construction, Furniture, Edible shoots
2	B. vulgaris	Medium	Small	Medium	Medium	Ornamental, Edible shoots
3	Gigantochloa laevis	High	Medium	Medium	Medium	Construction, Furniture, Edible shoots
4	G. ligulata	Small	Small	Medium	Medium	Construction, Furniture, Edible shoots
5	G. scortechnii	Medium	Medium	Medium	Medium	Construction, Engineered bamboo, Handicrafts
6	S. brachycladum	Small	Small	Thin	Long	Mat-based products, Handicrafts
7	S.grande	Medium	Medium	Medium	Long	Mat-based products, Handicrafts
8	S. zollingerii	Small	Small	Thin	Long	Mat-based products, Handicrafts
Introduced Species Existing						
9	Dendrocalamus asper	Medium	Large	Thick	Long	Construction, Furniture, Engineered Bamboo, Edible shoots
10	D. latiflorus	Medium	Large	Thick	Long	Construction, Edible
Exotic Species Recommended						
11	B. balcooa	Medium	Medium	Thick	Medium	Construction, Engineered bamboo, Edible shoots, Bioenergy
12	B. bambos	High	Large	Medium	Medium	Construction, Furniture, Engineered Bamboo, Edible shoots
13	D. brandisii	High	Large	Thick	Medium	Construction, Engineered bamboo, Edible shoots
14	D. stocksii	Small	Small	Thin	Medium	Furniture, Construction
15	Guadua angustifolia	High	Large	Thick	Medium	Construction, Edible shoots
16	Thyrsostachys oliveri	Medium	Small	Thin	Long	Furniture, Construction, Handicrafts

A look at Figures 1 and 2 and the table above indicates the various possible usages of bamboo, with which STIDC could become involved: if not as a startup, then through a gradual process.

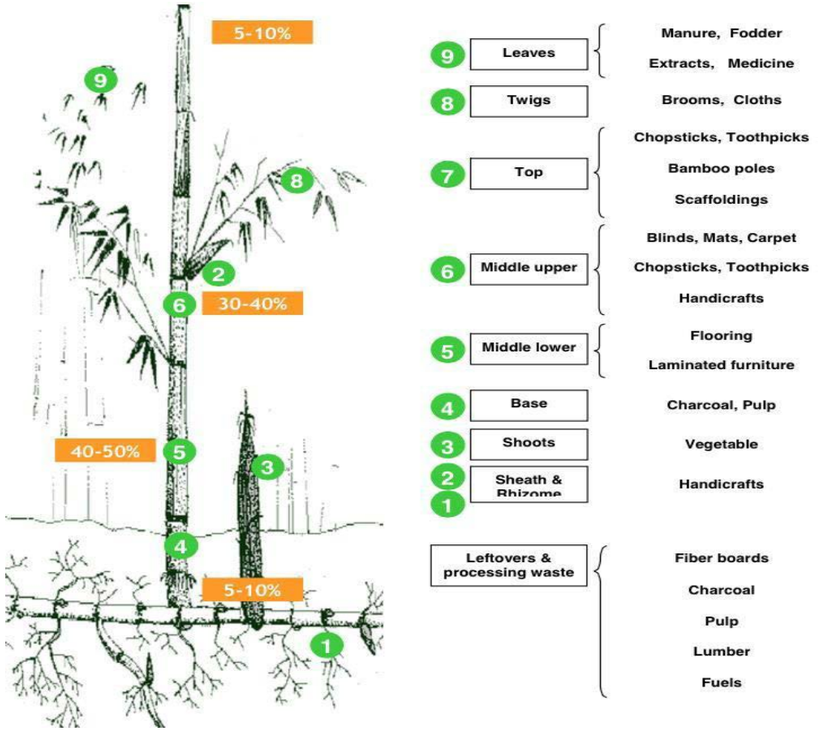


Figure 1

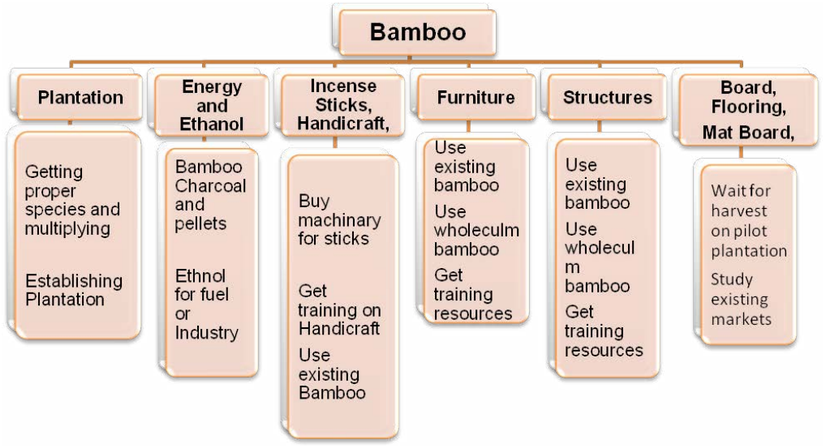


Figure 2: Inputs generally required for different bamboo products

Looking at the potential along the various value chains, INBAR has in a separate report suggested the species of bamboo to be piloted, and the methodology. Since it would take five years for the bamboo on the pilot to grow and be ready for harvest, it is suggested that STIDC has the required bamboo for certain products and can start the process right away.

Energy and Ethanol

The first two components of the value chain can be grouped together, since both could be made from by-products of the total bamboo culm. Ethanol would not be a viable proposition at this stage since the collection cost would be higher than the returns. This can be started once the market for eco-friendly fuel begins to grow. Bamboo pellets are certainly something to look at. STIDC reportedly has a number of pelleting units and waste bamboo could be sold to these units.

Incense Sticks

This is a highly recommended product and should be on the priority list of STIDC because of its high market demand. India itself is importing raw round sticks to make incense sticks from Vietnam; looking at the figures, imports from 30 March to 9 April 2016 were around 2.1 million metric tons. It is recommended that STIDC purchases one set of machines that make round sticks, which would cost around USD25,000, and pilot stick making. These could be raw incense sticks, skewers, toothpicks or even sticks that could be used as a component for handicrafts.

At a capital cost of USD25,000 for a machine with a capacity of 1.5MT per day, including installation and trials, the returns would be:

(USD 1 = RM 4)

Input	Processing	Output		
		Quantity	Unit Value	Total Value
1MT at USD140 per ton or 140 poles of bamboo at USD1 per pole.	Sticks	200 KGs	2 USD per KG	400 USD
	Bamboo Pellets	550 KGs	1.5 USD for 10 KGs	82.5 USD
	Biochar (by-product)	50 KGs	1 UDS from 5 KGs	10 USD
Total	140 USD			492.5 USD
Less labour, supervision and administration at 49%	197 USD			
Total	337 USD			492.5 USD
Estimated profit per MT				155.5 USD
Estimated annual production considering 60% capacity utilisation and 250 working days a year = 250MT per year. Total Annual Profit				38875 USD
Cost Benefit Ratio				1/1.5

This calculation is based on raw sticks and value addition is possible using the biochar produced as a by-product to make rolled sticks.

Handicrafts

A handicraft industry already exists, but its quality and product range can be enhanced by introducing small tools/machines and high level skill development training which can be provided by INBAR through its Indian partner organisations.

A bamboo fountain is highly recommended by Feng Shui experts and is a household product, which can be made easily from the bamboo available. There are 42 variant designs of bamboo fountains.

Fruit baskets and multipurpose trays are found in the Sarawak markets with 'Made in China' tags, but these could easily be made in Sarawak too. To bring about uniformity in the products, a few jigs could be developed and skill development training could be imparted to the local craftsmen.

Utility products like trays, mugs, bamboo flower vases, bamboo clocks, bamboo fountains, spoon and fork holders etc. can be promoted. An added benefit would be treated/ carbonised bamboo. A common facility centre could be started in each district to treat bamboo before using it for making handicrafts.

Furniture

There are some good species of bamboo available in Sarawak to start the furniture industry, once the treatment unit is in place. Good furniture could be made using a mix of bamboo and rattan, bamboo with ply wood/timber, bamboo with cloth/upholstery, bamboo with glass and other combinations. Just bamboo could be expensive, but combinations make the furniture affordable, attractive, and comfortable and keep the aesthetics of bamboo.

One common facility-cum-training centre could be established and started right away, working with whole-culm bamboo, which is available in abundance. The common facility centre could be equipped with the necessary tools and machineries as per the list provided below:

Cost in USD (1USD = 4RM)

Tools and Machines	Units	Unit Cost	Total Cost
Carboniser	1	10000	10000
Cross cutter	1	875	875
Node remover	3	1,000	3000
Stand drills	3	100	300
Air compressor	1	1500	1500

Tools and Machines	Units	Unit Cost	Total Cost
Grinder with circular grinder attachment	1	1000	1000
Belt sander	1	750	750
Bamboo splitter	1	1250	1250
Planer	1	1000	1000
Jig saw	1	625	625
Spray booth	1	5000	5000
Power hand-held tools	1	1500	1500
Manual tools	1	1000	1000
Other equipment	1	1500	1500
Total			29300

The cost of machines at current rates would be USD29,300, rounded off at USD30,000. These machines would manufacture furniture as well as provide most of the components for handicrafts and structures. This does not include infrastructure costs, assuming STIDC has existing infrastructure.

School furniture is a very popular product and the Philippines, along with India, has made a policy decision in certain states that all government-run schools must use bamboo furniture. This policy has been made on the grounds that bamboo furniture is more sustainable than steel furniture (Figure 3).

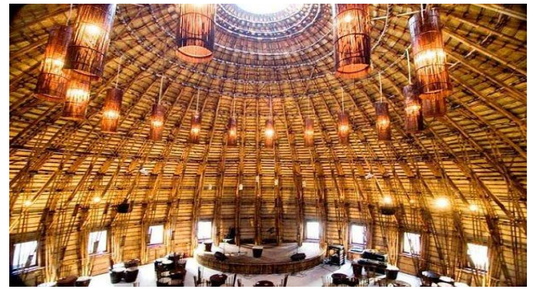
Figure 3. Comparison between two-year-old conventional steel and bamboo furniture

Structures

As mentioned earlier in the report there is a tremendous scope for creating structures, and the bamboo available is suitable for making structures like gazebos, kiosks, longhouses, restaurants, eateries and small cottages. The existing bamboo may have to be engineered, considering the thinness of the walls, but this is the practice with any bamboo all over the world. House fencing and garden fencing have a large market as well. All this could be done with whole culm bamboo.

Machines mentioned above for the common facility centre would suffice for the pre-fabrication and some tools, like hand-operated circular saws, hand grinders and drills, would be needed at the construction sites. Training would be required for structures, initially trainings of three-month duration covering the basics (for one month) along with two months onsite. Support from architects, structural engineers and trainers would be required as and when new products are to be designed, as per market demand.

If this is the house Jack built-



Then why not STIDC???

Costing

It would be difficult to work out the costing of each product given the ambiguity of bamboo prices, daily wages of non-skilled, semi-skilled and skilled workers and the cost of consumables. This could not be ascertained due to the rather short working period of the study, but as a general rule of thumb in Africa, South America and most places in Asia:

Man, Material and Machine	% age
Treated Bamboo	25
Consumables	5
Designer Cost	3
Artisan Cost	25
Depreciation of Machine	3
Electricity	2
Administration and Supervision	10
Contingencies	2
Profits	25

A profitability calculator is given in the Annex for furniture and construction.

It should be noticed that we do not refer to bamboo workers and labour but rather 'artisans' as the value of their products are comparable to art, and products fetch a price based on their aesthetics.

In India we see a chair, which is not only similar but almost a carbon copy, selling for INR1500 to 10 times the price, at INR15,000. This purely depends on the finer aspects of product finish, quality, durability, and most importantly, *brand*.

The cost indicated for bamboo is only for the lower and middle parts, since the rest of the bamboo could generate income through by-products.

Board and Engineered Products

It is strongly recommended that STIDC should not venture into engineered items like board, panels, and veneer until a proper market is established and a techno-viability/ feasibility study is conducted for these products.

Currently, bamboo products are at a nascent stage in the region and the market is not ready to absorb bamboo-engineered products. Investments for these products would be extremely high and it is advised that STIDC should wait until they have raw material self-sufficiency, market acceptance and technology to enter the said market. A market study or a pilot with import of a small quantity of board from China could be tried out, enabling a scale of production on harvest from the pilot plots.

Retaining the youth and next generation

This is the most important action to be taken by STIDC. In India, a country where castes hold an important socio-economic role in the work they do, bamboo was considered to be the work of the lowest caste and was a total taboo for the higher caste. Establishing factories, providing uniforms and aprons, and giving designations gradually got the higher castes to work in bamboo. A case study of Konkan, India - 'Breaking Barriers'- can be seen on the INBAR website ('Breaking Bars and Creating Capital', INBAR, 2014). STIDC would have to follow a similar approach to retain youth to work with bamboo.

Market

To quote Steve Jobs: "If you have a product, you have a market". In Sarawak, Malaysia, and internationally, there is a big market for bamboo and bamboo products. As mentioned earlier in this report, incense sticks have a phenomenal export potential. Lessons from China indicate the same. What is critical is that the products are good quality, durable and satisfy stringent quality checks. It is essential that STIDC has a range of products at the beginning.

An internal synergy must exist between the ministries or departments to start piloting structures and furniture. The department in charge of the waterfront could build some gazebos and kiosks, government-owned hotels and resorts could promote bamboo furniture and handicrafts, and the education department could start using bamboo furniture for schools.

It is essential that bamboo products receive their deserved exposure, which will come through subsidisation of the cost. Once this is done, various potential buyers interested in displaying bamboo products would be encouraged to promote bamboo. In addition, the possibility of setting up an e-commerce portal could be explored for the range of products from STIDC. One single portal (Urban Ladder) in India did business of USD1.2 million in one year selling bamboo products, and other online portals like Pepperfry and Fab Furnishing have also fared well in bamboo furniture online market.

Potential Markets

1. Offices and institutions (STIDC could be the starting point)
2. Hospitality industry
3. Restaurants and eateries
4. Government departments involved in public structures
5. Educational institutes
6. Outlets at museums and parks which attract tourists
7. Private farm houses
8. Households
9. Retail outlets
10. Online portals

Marketing needs innovation and a bullish attitude and the case of bamboo in Sarawak is no different.

Primarily, there is a need to break the existing myth in Malaysia that "bamboo is not durable". A mass awareness campaign needs to be generated by STIDC that bamboo is not only durable but is a fast renewable environment friendly biomass. Posters, banners and points of purchase containing the salient features of bamboo need to be well displayed.

Mobilising Financial Resources

Based on the findings in this report and financials worked out, INBAR believes that STIDC would be an eligible candidate for the Common Fund for Commodities (CFC) loan finance for bamboo value chain development. Loans from the CFC range from US$50,000 to up to US$1.5 million. CFC loans require a 50% co-finance from the counterpart organisation. Loans typically last up to seven years with a maximum two-year grace period. Interest rates typically range from 5-10% based on a CFC risk assessment and prevailing local rates.

INBAR is an official Commodity Body to the CFC. While INBAR has no official role in allocation of projects by the CFC, provided STIDC has the necessary co-finance and can cover INBAR technical inputs as envisaged in the proposal, INBAR could support STIDC to present a project to the CFC.

CFC has two funding windows per year, one in April and one in October. We would recommend STIDC consider a proposal application based on the final results of the feasibility plan. More details can be found on CFC financing on their website at the links below:

- http://commonfund.org/fileadmin/user_upload/Call_for_Proposals/8th_Call/Leaflet_CFC_February_2016.pdf
- http://common-fund.org/call-for-proposals/

Going by the availability of a number of banking websites there is a possibility of loan availability against a proper business plan. Raising the required amount in equity is another possibility.

Conclusion

The observations made by the team show that bamboo has great potential in the region. A few recommendations based on the study conducted in Sarawak are listed below:

1. In order to ensure availability of the planting material, it is recommended to look at the multiplication of existing species of bamboo by exploring tissue culture.

2. It is advised to start plantations on the pilot sites.

3. It is recommended to acquire a stick-making machine and talk to buyers. INBAR/CIBART could possibly help out with this market in India.

4. Procure machines and set up a carbonisation plant.

5. Commence skill-based training on bamboo-related handicrafts, furniture and construction.

6. Initiate a marketing campaign and ensure greater involvement of potential buyers.

7. Using the BHAG theory: Big (the bamboo sector); Hairy (breaking myths, overcoming roadblocks and constraints); Ambiguous (Making markets work); Goal (USD 1 billion in the next ten years).

Profitability Calculator for Furniture, Commodity and Structure (All figures in hundreds of thousands USD)

No.	Particulars	Year 1	Year 2	Year 3	Year 4	Year 5
		0	1	1	1	1
A	**Sales Realisation**					
	Construction	200.00	300.00	400.00	500.00	600.00
	Furniture	200.00	250.00	300.00	350.00	400.00
	Sub Total (A)	**400.00**	**550.00**	**700.00**	**850.00**	**1,000.00**
B	**Cost of Production**					
	Raw Material	110.00	152.50	195.00	237.50	280.00
	Labour	112.00	137.50	175.00	212.50	250.00
	Sales Losses (Rejections)	2.00	2.75	3.50	4.25	5.00
	Packaging Expenses	12.00	16.50	21.00	25.50	30.00
	Discount Allowed		0.00	0.00	0.00	0.00
	Transportation					
	Sub Total (B)	**236.00**	**309.25**	**394.50**	**479.75**	**565.00**
C	**Design Development**					
	Designing	10.00	13.75	17.50	21.25	25.00
	Prototyping	10.00	13.75	17.50	21.25	25.00
	External Support	16.00	22.00	28.00	34.00	40.00
	Sub Total ©	**36.00**	**49.50**	**63.00**	**76.50**	**90.00**
D	**Administrative Expenses**					
	Human Resources	94.80	104.28	114.71	126.18	138.80
	Travel	23.70	26.07	28.68	31.54	34.70
	Rent and Revenues	7.80	9.36	11.23	13.48	16.17
	Communication	4.00	5.00	6.25	7.81	9.77
	Office Expenditure	2.40	3.12	4.06	5.27	6.85
	Legal & Audit	4.00	5.50	7.00	8.50	10.00
	External Support	5.00	6.50	8.45	10.99	14.28
	Marketing	4.00	4.40	4.84	5.32	5.86
	Governance	2.00	8.00	10.00	14.00	14.00
	Contingencies	8.00	11.00	14.00	17.00	20.00
	Sub Total (D)	**155.70**	**183.23**	**209.21**	**240.10**	**270.43**
	Grand Total (B+C+D)	**427.70**	**541.98**	**666.71**	**796.35**	**925.43**
E	**Profit Before Interest, Taxes and Depreciation**	**-27.70**	**8.02**	**33.29**	**53.65**	**74.57**
	Cost of Capital	8.79	14.41	20.02	33.91	28.91
	Insurance Premium	0.41	0.59	0.87	1.11	1.31
	Depreciation	4.10	5.92	8.66	11.12	13.10
	Net Profit	**-41.00**	**-12.90**	**3.75**	**7.50**	**31.25**
	Income Tax @ 30%	-12.30	-3.87	1.12	2.25	9.37
	Profit after Tax	**-28.70**	**-9.03**	**2.62**	**5.25**	**21.87**

Assumptions for the above Profitability Calculator

- USD is calculated at current XE rate of RM4 = USD1 (at time of writing)
- Minimum wages as per Government norms in Sarawak for 2016 is RM920 = USD230

per month which = USD2760 per year. Costs have been calculated at USD2800 per year.

- Artisan remuneration has risen by 25% annually which would be related to productivity.
- Bamboo is currently collected free from the forest but a costing is done by calculating using a thumb rule of 25% as the bamboo cost, 35% towards labour and 40% for others such as designing, prototyping, marketing, general administration, etc. which has been applicable in the costing of products in many countries.
- Sales have been assumed at 40% of the current estimated market of the in Negeri Sembilan and the sales of one factory in India.
- Taxation of 28% in Malaysia is rounded off at 30%.
- Insurance and depreciation is calculated as per the rates and laws applicable in Malaysia.
- Interest rates are calculated as per the CITI Bank rates in Malaysia for business.
- The break-even point is calculated at three years and the average debt service coverage ratio at 62%.

There is a loss in the first year but an artisan cost could be provided as a training stipend, since production would be at 40% capacity. This would then not show as a loss in the first year.

Figures could change with more equity infusion and a smaller debt fund. Grant component for on-the-job training would be an actual solution and could further hasten progress.

Some products which can be made right away using existing bamboo and human resources and a high level of skill development training

ANNEX 1

Place travelled: Sarawak, Malaysia

Investigators: T.P. Subramony (INBAR), Li Jinliang (CGCF, China), E.M. Muralidharan KFRI), Bharat Parekh (INBAR)

Dates: 5-13 March 2016

6 March	**As planned, all members of the INBAR team arrived at Kuching, Sarawak**
7 March	**Opening meeting & the visit to REDEEMS Centre**

The INBAR team had an opening meeting with STIDC chaired by the General Manager, Datu Sarudu Hoklai. Other key participants from STIDC included: Sarawak's Assistant Minister of Industrial Development and Community Services, Y.B. Datuk Peter Nansian Ngusie; Ms. Dayang Nena, Senior Assistant General Manager; and Mr. Paul Lau, Assistant General Manager who was in charge of the field visits.

STIDC introduced the project team that was assigned to work with INBAR, and briefed them on current bamboo activities (though not significant in scale) in Sarawak. During the brief they explained that even though STIDC's work and mandate is timber, it is now keen to bring in bamboo development activities to offset the potential shortage of timber in the future.

REDEEMS, a local NGO, gave a brief on the ongoing community-linked activities which they are undertaking on a small scale.

SALCRA, a government agency with a mandate to improve the lives of rural communities through land rehabilitation, promotion of agricultural projects, etc., has embarked on a research and development project on bamboo in Sarawak.

STIDC is working closely with SALCRA as the local agency for the potential bamboo project with INBAR. SALCRA's researchers also sit in STIDC Technical Committees on the Bamboo Plantation project.

In the afternoon, the team visited the REDEEMS Centre, a community hall built up by locals using bamboo. Later, interaction with the local communities took place on the premises.

8-11 March	**FIELD VISITS**

For the field visits, it was decided that one part of the team (including T.P. Subramony, Li Jinliang, E.M. Muralidharan), along with the STIDC officials, would visit the proposed plantation sites for inspection and preliminary field assessments for the feasibility of developing the bamboo plantation project and the pilot bamboo carbon project, while Bharat, whose proposed study focused on the market and industry, would travel to the markets, production centres, and similar locations accompanied by a designated STIDC official.

INBAR's expert team visited the proposed bamboo plantation sites in SABAL FR, which was around three hours' drive from Kuching. In SABAL FR, agroforestry activities started in the year 2000.

Proposed plantation sites

Two sites totalling 60 ha were identified by STIDC.

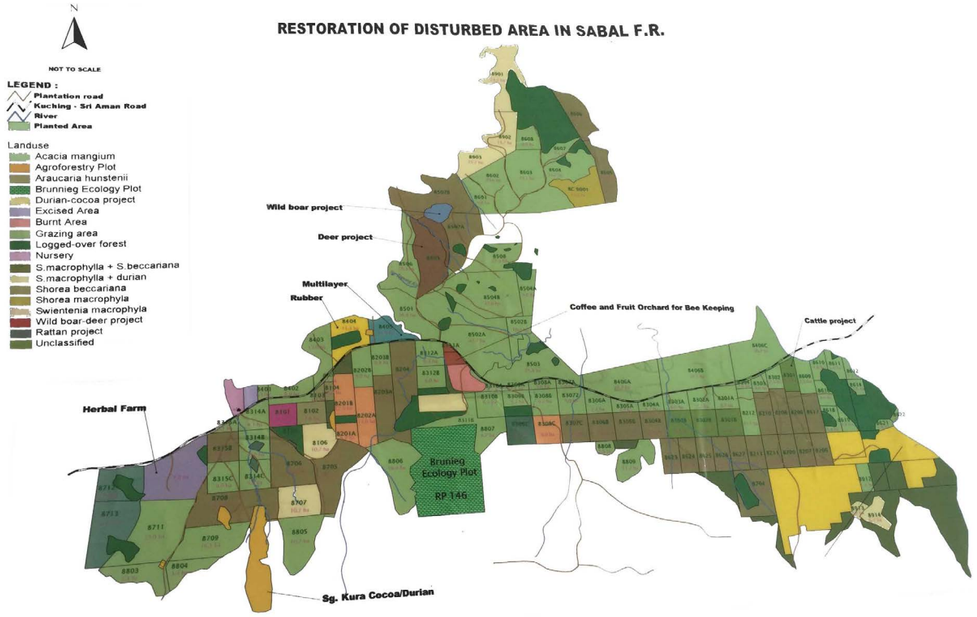


Figure1. The overall map of STIDC proposed pilot project area in SABAL FR

Site No. 1 (11-ha location)

Also an ideal location for setting up a bamboo nursery of about 0.5 ha. Water availability is assured because of the river nearby.

Plots - 8314A; 8315A; 8316A.

Site No. 2 (49-ha location)

Plots - 8310B; 8309B; 8308B; 8307B.

An additional two sites were visited which could be considered for plantations:

The INBAR team recommended two locations for the plantation for reasons given below:

New Plot 1

- Plot-8406B: 37.1 ha.

- Plot-8406C: 30.7 ha.

Total: 67.8 ha.

- 3 ha had already been planted in 2002.

- Near the highway and a river.

New Plot 2 (opposite the above New Plot-1):

-Plot-8303A: 6.0 ha.

-Plot-8302A: 7.2 ha.

-Plot-8301A: 8.7 ha.

-Plot-8302B: 9.0 ha.

-Plot-8301B: 9.0 ha.

-Plot-8212: 10.0 ha.

-Plot-8304: 2.0 ha.

TOTAL: 51.9 ha.

The INBAR team also visited a STIDC's research and development Plot in a location called Taee where good growth of three bamboo species was observed.

At the closing meeting on the last day of the trip, the INBAR team presented their brief findings from the visit to the STIDC officials.

Natural conditions in the proposed pilot area

Climate in Sarawak:

- Jan-April: Rain, with particularly heavy rains in March.

- May-Sep: Generally dry with light rains.

- Oct-Dec: Ideal for bamboo planting.

- Jun-Jul: Dry season - for site preparation.

The climate is suitable for the growth of some south Asian bamboo species.

Soils in Sarawak:

The main soil types are red soils and yellow soils which are fertile, usually cohesive.

The soil is suitable for the growth of South Asian bamboo species.

ANNEX 2

	Costs of Establishing a Bamboo Nursery				
	Heads	First Year	Second Year	Third Year	Fourth Year
1	Infrastructure costs				
	i Fencing with GI chain link (4 feet) concrete or metal pillars				
	ii Nursery office-cum-store				
	iii Potting shed and store for potting materials and tools				
	iv Propagation units : raised beds made of ferro-cement or stone slabs				
	a Polyhouse with misting				
	b Propagation Beds under shade net (50 % shade)				
	c Shade net nursery: Size: to cover 10 standard beds with shade net (50% shade)				
	v Secondary hardening area (open nursery with sunlight and protection against wind)				
2	Recurring costs				
	i. Labour costs:				
	a Supervisor/Propagator (one person) 30 man-days/month				
	b Labour for propagation, potting, watering and other jobs. 60 man-days /month				
	ii Consumables:				
	a Polythene bags				
	b Potting mix: good quality soil (free of stones and debris), sand, farmyard manure.				
	iii Water for irrigation				
	iv Pesticides: termiticides/fungicides at the time of transfer				

ANNEX 3

Field expenditure heads during the first four years of plantation establishment					
	(To be calculated based on local rates and conditions)				
	Heads	First Year	Second Year	Third year	Fourth Year
1	Site preparation: Levelling/ terracing/ ploughing/ weeding if needed. Labour and earth mover costs (if considered) 60 ha.	*			
2	Chain link fencing 60 ha.	*			
3	Aligning and staking (labour and cost of stakes)	*			
4	Digging pits of 45 x 45 x 45cm or larger	*			
5	Refilling pits with top soil and the potting mix				
	a Labour	*			
	b Cost of material (Fresh soil, sand, manure)	*			
6	Planting				
	a Cost of plants (Rhizome offsets, rooted cuttings, tissue cultures) includes mortality replacement at 10 % of total number.	*	*		
	b Labour	*			
7	Irrigation during the summer (first and second year	*	*		
8	Weeding/soil working	*	*	*	#
9	Cost of insecticides/pesticides/fertiliser	*		#	
10	Maintenance - Labour costs for soil mounding, removal of dead material		*	*	*
11	Watch and ward	*	*	#	#

Required *

Optional #

An INBAR Study commissioned and supported by STIDC, Malaysia

Investigators:
Mr T.P. Subramony (INBAR)
Dr Jinliang Li (CGCF, China)
Dr E.M. Muralidharan (KFRI)
Mr Bharat Parekh (INBAR)