PHI/85/008
Terminal Report

BAMBOO RESEARCH AND DEVELOPMENT PROJECT

PHILIPPINES

PROJECT FINDINGS AND RECOMMENDATIONS

Report prepared for the Government
of the Philippines

by

the Food and Agriculture of the United Nations acting
as executing agency for
the United Nations Development Programme

UNITED NATIONS DEVELOPMENT PROGRAMME
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Rome, 1995

PHI/85/008
Terminal Report

BAMBOO RESEARCH AND DEVELOPMENT PROJECT

PHILIPPINES

PROJECT FINDINGS AND RECOMMENDATIONS

Report prepared for the Government
of the Philippines

by

the Food and Agriculture of the United Nations acting
as executing agency for
the United Nations Development Programme

UNITED NATIONS DEVELOPMENT PROGRAMME
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Rome, 1995

TABLE OF CONTENTS

I. INTRODUCTION

1.1. Project Background

The dwindling supply of timber resources has become a nationwide problem in the Philippines that alternative materials have to be developed. Bamboo has been considered an ideal substitute because of its many uses and marketability as wood. In addition, bamboo is a suitable reforestation species that could provide both livelihood and environmental protection in the upland communities and watershed areas.

There are 48 native and introduced bamboo species in the Philippines which are widely distributed from near sea level to the highlands of about 2400 m. Only 11 of these species have high economic value (Appendix 1). However, the economic and ecological potentials of these bamboo species have not been fully tapped because their propagation and management have not been adequately developed. It was for this reason that the Philippine government requested the technical assistance of the FAO and the financial support of UNDP for the implementation of the Bamboo Research and Development Project.

1.2. Outline of Project's Arrangement

1.2.1. The project document was signed on December 05, 1986 by representatives of

NEDA, FAO and UNDP. The initial UNDP inputs amounted to US $536,290.00 with a government counterpart of P8,156,024.00.

1.2.2. The DENR Secretary, Fulgencio Factoran, made the final indorsement of the project in June 1987.

1.2.3. The Project Management started the organization of the project and initial selection of sites for the pilot plantations in July-August 1987.

1.2.4. The Project Management designated the Field Coordinators of the project, initiated the development of the pilot plantations and implementation of bamboo research studies at ERDB.

1.2.5. The CTA of the Project, Dr. F.M. Schlegel reported for duty on February 14, 1989.

1.2.6. The TPR on November 16, 1989 approved the creation of the post of National Professional Project Personnel (NPPP) due to the completion of the CTA's tour of duty at theend of July 1990. The NPPP post was filled up on April 15, 1990 with Dr. F. D. Virtucio. One year after, Dr. V. P. Veracion was designated NPPP from September 1991 to May 1992.

1.2.7. The TPR on May 26, 1992 approved the extension of the project for 30 months

with additional UNDP inputs of US$146,475 which raised the total revised UNDP inputs to US $885,000.00. The GOP inputs for the extension phase of the project amounted to P5,484,946.00.

1.2.8 The TPR on September 28, 1993 reviewed the performance of the project during the extension phase. It was agreed that the project extension shall continue with UNDP inputs until April 1995 and extended only in time until December 1995 with GOP inputs.

1.2.9 NEDA and UNDP informed the Project Management during the TPR on April 7,1995 that the UNDP and the goverment earlier agreed to operationally close the Fourth Country Programme (CP) projects by June 1995. Onthis basis, the UNDP inputs have been extended until June 30, 1995 with the reprogramming of the UNDP budget savings amounting to US$25,500.00 while the GOP counterpart budget has been extended until December 1995 for the implementation of ongoing field experiments.

1.3. Objectives of the Project

a. Initial Phase

a.1. **Development Objective:** To assist the govenment create new sources of employment and thereby raise income levels in appropriate rural areas of the country through research and development and promotion of bamboo production.

a.2. **Immediate Objectives**

1. To develop through research and experimentation in pilot scale and private bamboo plantations packaged sets of technology that would address the specific requirements of developing bamboo as raw material for construction purposes, cottage and agro-based industries, as well as developing bamboo for reforestation and watershed production;
2. To disseminate generated technology through training and extension work, technical assistance and distribution of manuals for reforestation and watershed production;
3. To strengthen the government's ecosystems research and development capability to undertake continuous research and development of bamboo resources through

upgrading of equipment and training of researchers;

4. To reduce information gaps concerning economic propagation, establishment, management and harvesting, including demand-supply situation for bamboo as raw material for construction purposes, for food, cottage and agro-based industries; and

5. To develop bamboo introduction areas (Bambuseta) for the preservation of genetic variability of Philippine bamboo species and diversification of raw material.

b. Extension Phase

b.1. **Development Objective**: To assist the government develop strategic measures and practices for sustainable management of the bamboo pilot plantations and bambusetum through applied silvicultural treatments and management studies.

b.2. Immediate Objectives

1. To develop appropriate plantation management and harvesting technologies for selected bamboo species established in the pilot plantations;

2. To generate information on the production and consumption patterns in the bamboo industry;

3. To develop the Bambusetum in Baguio, Los Banos and Davao for the preservation of the genetic variability of the bamboo species and diversification of raw materials; and

4. To disseminate the generated technology and other information through technical assistance, publication and extension work.

1.4. **Personnel**

The government personnel and the technical cooperation personnel involved in the project are listed in Appendices 2.1 and 2.2. All government personnel of the project were on part-time basis considering that they were also involved in other projects, both ERDB-based and region-based researchers.

1.5. **Organizational Structure**

The Bamboo Research and Development Project was coordinated and implemented by the Department of Environment and Natural Resources (DENR) through the Ecosystems Research and Development Bureau (ERDB), based at College, Laguna. At the national level, the Director of ERDB was the concurrent Project Director while the Assistant Director was

the Assistant Project Director. A National Project Coordinator was also designated to assist the project management in coordinating research studies and field activities .

The Regional Technical Directors for research of the DENR where the pilot plantations and the Bambuseta were located were designated Field Research Coordinators.

At the department level (DENR), the Foreign-Assisted and Special Projects Office (FASPO) monitored the physical and the financial status of the project. The Project Management submitted progress reports to the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD) for monitoring and record purposes.

2. RESULTS AND CONCLUSIONS

The project constituted the following components, namely: research, technology transfer, research capability building, pilot plantations and bambusetum development.

2.1. Research

Several research studies were undertaken by the project. The specific title of the project, names of researchers and duration of the studies are presented in Appendix 3. Significant findings are discussed below:

a. Bamboo taxonomy - A number of taxonomic problems have been tackled by the project. Thirty (30) different bamboo species have been collected and deposited at ERDS herbarium. Of this collection, 25 were erect and five were climbing. The taxonomic study includes the identification of the following species:

a.1. Bayog - This bamboo species was previously called *Dendrocalamus merrilianus*. Because of its spiny characters and long rachilla on its spikelets, bayog could not be included in the genus *Dendrocalaus* but in the genus *Bambusa*. Pending further verifications, bayog has been temporarily named: *Bambusa* cf. *blumeana* var. *luzonensis*.

a.2. Laak - This species which is commonly found in some parts of Mindanao is widely propagated and used for banana props. It was initially identified as *Bambusa philippinensis* but preliminarily evaluated by taxonomists as *Bambusa* cf. *dolichoclada*.

Complete specimens of bayog and laak had been sent to Royal Botanical Garden at Kew, England for their correct identification.

a.3. Kayali - This bamboo species was not previously identified. However, the project taxonomist consultant, Dr. Elizabeth Widjaja, identified itas *Gigantochloa atter*.

b. Bamboo Pests and Diseases

Survey of 69 sites in the Philippines revealed the occurrence of nine diseases and three pests. Tar spot caused by *Phyllachora shiriana* complex and leaf rust caused by *Phakopsora louditiae* cumm have been observed to be the most common diseases of k. tinik, bayog and machiku. White mite (*Schizotetramychus floresii*) Rimando is the most prevalent pest observed.

Laboratory tests of 10 chemical fungicides were found effective in eradicating rust and tar spot disease.

c. **Propagation**

c.1 **Micropropagation (Tissue Culture)**

The tissue culture studies have been initiated on the following species: bayog, bolo, buho, k. tinik, k. kiling, giant bamboo and machiku. Callus formation had been achieved while induction of calli to form plantlets did not go beyond the experimental stage.

c.2. Vegetative Propagation

Propagation technique using two-node culm cuttings has been successfully developed for the following species, namely: bayog, k. tinik, k. kiling, giant bamboo and yellow bamboo.

The technique required the selection of one to two-year-old culms from which two-node cuttings were produced. As source of planting stock, the lower culm portion (lower 13 internodes) had been found to produce nearly 100 % rooting propagules while the upper internodes tended to produce lower rooting percentages of 40 to 60 %.

The two-node cuttings have been also studied for bolo, buho and kayali. These *Gigatochloa and Schizostachyum* species have been found more difficult to vegetatively propagate than the Bambusa species.

One-node cutting technique has been also studied. With some restrictions, the following species were found to respond well to one-node culm cuttings: bayog, bolo, k. kiling, k. tinik and laak.

With one-node cuttings, only the upper portion of the one- to two-year-old culms with well-developed side branches successfully produced rooting propagules. The technique

proved very appropriate with laak in Davao del Norte because the lower culm portions of this species could be used for banana props. Discarded upper portions could be used for propagation.

Propagation using unsegmented culms of laak has been also studied. The results indicated that the one- and two-year-old culms had higher rooting percentage than the three- and four-year-old culms. It was observed that the three- and four-year-old culms took longer time to sprout and root compared to one and two-year old culms.

The propagation study on unsegmented culms of laak also revealed the following:

1. The production of sprouts exhibited a pattern in that the basal and top portions of the culms sprouted earlier than the middle portions.
2. At the end of three months, most of the sprouts produced well-developed roots ready for segmentation and transfer to containers.
3. The survival of prerooted and subsequently segmented cuttings was high and ready for planting three months after transplanting into containers.

4. It can be concluded that this method of propagation of rooting unsegmented culms reduced bag size from 20" x 20" to only 5" x 4", hence, reduction in cost.

d. **Phenology**

Information on the flowering months has been established for the following species:

1. K. tinik . . . . December-June
2. Bayog. . . . . March-July
3. Giant bamboo . . May-August
4. Kayali . . . . . May-August
5. Bolo . . . . . October-July
6. Buho . . . . . December-February

Of the abovementioned species, bolo and boho were observed to have viable seeds while the rest did not have.

e. **Physiology**

The study on the chlorophyll content of immature culms of important bamboo species ascertained how immature culms obtained their nutrients. Beside the chlorophyll determination, boho, had the lowest amount of chlorophyll and seems to be the most dependent on the mother culm, followed by bayog and k. kiling. The least dependent are machiku, giant bamboo and k. tinik. The results indicated that the growth of immature culm is the contributory effect of reserved nutrients from the mother culm and carbohydrates produced during photosynthesis.

Another research related to growth and development of bamboo was on the role of culm sheath in the development of culm. Results showed that one of the observed roles of the culm sheath is to protect the hormone (suspected to be sibberelin) present on the nodes. This hormone is responsible for cell divisionand enlargement of tissues. Secondly, the culm sheath performs the function of supporting and stiffening the still soft internodes.

f. **Fertilization and Soil Amendment**

Three (3) commercial fertilizers containing nitrogen (N), phosphorous (P) and potassium (K) were tested on k. tinik under nursery conditions. N was observed to be the main factor that controls the performance of k. tinik in terms of plant height. However, about 45 kg/ha, P and K had more effect on the plant growth.

A study was conducted to determine the microflora associated on the rhizosphere of bamboo species that can enhance their growth. Root and soil samples of different species were collected from different regions of the country. From root and soil samples planted to k. tinik 10 microorganisms were isolated: oneactinomycete, four bacteria and eight fungi. In the case of k. kiling, one streptomycete, three bacteria and four fungi. Five (5) microorganisms were isolated and

identified from buho; three bacteria and two fungi; one bacterium and two fungi from bolo; while only one (1) actinomycete from machiku. From laak, four microorganisms were isolated. In the case of black bamboo and yellow bamboo, one bacterium and two fungi were isolated, respectively.

g. **Harvesting Experiments**

g.1. Effect of different harvesting intensities on the performance of k. tinik.

Five harvesting treatments were studied. Preliminary analysis revealed that 50% harvest intensity yielded the highest harvest cut (98 culms); followed by 75% (92 culms); 100% (60 culms); and 25% (57 culms). It may be concluded that 50% of harvestable age (two-year-old culms and above) may be employed in harvesting k. tinik at the Los Baños Experiment Station.

g.2. **Harvesting study on existing k.tinik stands in Tanay, Rizal.**

This study was established in existing k. tinik plantation of known age. Two felling cycles and three harvesting intensities have been applied. Preliminary results indicated that harvesting all (100%) the matured culms of three years old and above on a yearly felling cycle produced the highest number of shoots. However, it had been observed that

due to the intensity of cutting, the shoots were more exposed or vulnerable to strong wind damage.

g.3 Effect of cropping treatments on culm yields and biomass productivity of laak in flatland and hillside sites in Davao del Norte.

This study compares four cropping treatments as applied to both flatland and hillside laak plantations. The cropping treatments, namely: T_1 -harvesting all three-year and two-year-old culms and defective culms; T_2 - harvesting all three-year-old culms and half of two-year-old culms; T_3 - harvesting all the three-year-old and two-year-old culms and defective culms; and T_4 - the conventional practice of clear-cutting all the three-, two- and one-year-old culms.

Results revealed that among the four cropping treatments, T_1 gave the highest average annual yield of 12.10 and 4.69 culms per clump for the flatland and hillside, respectively. In terms of annual litter production fresh weight, 5,985 kg/ha for flatland and 334 kg/ha for hillside were produced. With these results, it may be concluded that in harvesting laak plantations, both in flatland and hillside, all three-year-old and two-year-old culms and defective ones should be harvested on a two-year felling

cycle rather than the conventional clear-cutting clearcutting method.

h. Economics

1. Bamboo raw materials in Luzon and Visayas are of varied types as sold in the market to fit the requirement of the so many bamboo-based industries. They are as follows:
   a. bamboo poles in varying diameter and length depending on the end use (i.e. furniture, fishpen poles, etc.).
   b. bamboo splits in varying thickness and length depending on the use (i.e. house construction, chicken shed, etc.)
   c. bamboo spokes in varying diameter and length depending on the end use (i.e. handicrafts such as hampers, planters, trays, toy chests, etc.).
2. The price of bamboo raw materials in Luzon and Visayas varied according to the classification system existing in each of the areas visited. Most common classification is that one relating the diameter of the bamboo pole to the sizes of common measures such as "caltex size", "family size coke" and "beer size".

Other regions use the "primera", "segunda" and "tercera" category. Still others use A, B, C where A is bigger than B and B bigger than C. Furthermore, the price of bamboo depends also on the species, with kauayan tinik commanding a higher price compared to other species given equal diameter and length.

3. Luzon, the flow of bamboo raw materials follows a general route given an intervention of regulating body (i.e. farm - gatherer/cutter/hauler - shipper - trader -middleman - consumer). It is determined largely by the CENRO/PENRO Offices whereby the shipper/trader secures the necessary permit and documents. In contrast, the flow of bamboo in the Visayas where bamboo poles did not have such process is determined largely by the bamboo-based industries. Therefore, the market flow of bamboo in the Visayas could be observed only on an industry basis.

4. Based on the records, the major sources of bamboo in Luzon include La Union, Benguet, Sorsogon, Albay, Quezon, Isabela, Camarines Sur, Batangas and the Ilocos provinces.

5. Based on the recorded total transported bamboo poles, majority (66%) of the bamboo raw materials are transported to Manila being the most common market outlet of bamboo-producing provinces.

2.2. **Technology Transfer**

a. **Farmers' training**

A total of 20 trainings on bamboo farming were conducted in the 12 regions of the country 625 farmers and trainors. An assessment of the training revealed that about 84 % of those trained actually practiced bamboo propagation in their backyards as well as in private and government projects.

b. **Symposia**

Three national bamboo research and development symposia were held. These symposia were attended by students, researchers, teachers and representatives from the bamboo industry. A total of 33 papers were presented during these symposia covering a wide range of subjects on bamboo utilization and production.

c. **Publications**

c.1 **Proceedings**

The technical papers presented during the symposia were published in proceedings. These proceedings

constituting 33 papers (Appendices 4.1, 4.2 and 4.3) on bamboo propagation, utilization and management were distributed to various sectors, individuals and institutions.

c.2 Published articles

Several articles have been published in national and international publications. Some of these publications are listed in Appendix 4.4. Published in the CANOPY International and other local publications include articles on bamboo propagation, management and general information about Philippine bamboo.

The taxonomy and other basic characteristics of *Bambusa blumeana, Dendroclamus latiflorus, Schizostachyum lima* and *s. lumampao* have been published in the 1995 PROSEA, Plant Resources of South-East Asia 7, Bamboos.

c.3 Manuals and Handouts

Manuals on bamboo farming and Philippine Bambusetum as well as several handouts on bamboo have been published as listed in Appendix 4.5 These manuals and handouts have been distributed to various sectors and clientele of the project throughout the country.

c.4. Other Publications (Appendix 4.6)

The following have been prepared and edited for publications:

1. Bamboo Farming - translated into three majorlocal dialects, namely: Tagalog, Ilocano and Cebuano.
2. Field Guide in the Identification of Economically-Important Species in the Philippines.
3. Growth Performance of Eight Bamboo Species in Pilot Plantations sites.

2.3. **Research Capability Building**

a. Training

As presented in Appendix 5, postgraduate and nondegree training had been awarded to several of the project staff. Of the postgraduate fellowships, one graduated with a Ph.D. on Natural Resource Economics from the University of Michigan, USA and three with M.S. degrees on Genetics, Physiology and Pathology from the University of the Philippines at Los Baños.

Nondegree training was also given as follows: (a) eight attended the study-tour on bamboo technology in China and Japan; (b) 24 researchers attended the three-week bamboo taxonomy training conducted by International Bamboo Taxonomists; and (c) one attended a

three-month training conducted by International Bamboo Taxonomists; and (c) one attended a three-month training on bamboo taxonomy in Bogor, Indonesia.

b. Laboratory Equipment and Facilities

Research capability was also enhanced with the acquisition of laboratory equipment and facilities. Their utilization in various studies is presented in Appendix 6.

2.4. **Bamboo Pilot Plantations**

The bamboo pilot plantations have been established in six sites with a total of 57 ha (Appendix 7.1). The five-year growth performance of the eight bamboo species variably planted in the six sites is discussed below:

a. Kawayan tinik

This species was most productive in Surigao del Sur with an average of 19 culms per clump at the fifth year, followed by Pampanga with 16.09; Cebu with 11.99; bukidnon with 8.12; and Capiz with 6.67. La Union had 6.10 culms in the fourth year. It had also the biggest and tallest culms of 7.33 cm and 12.55 m, compared to Pampanga with 5.67 cm and 7.63 m, respectively. The smallest was in Cebu with an average of 3.97 cm and length of 5.48 m.

b. Kawayan kiling

This species was also most productive in Surigao del Sur with 27.50 culms per clump in five years followed by Pampanga, 14.56; Capiz, 11.93; Cebu, 10.44; and Bukidnon, 7.51 culms per clump. It follows that kiling in Surigao del Sur had the biggest and tallest culms with an average of 5.91 cm and 15.38 m, respectively. Kiling in Bukidnon had the smallest basal diameter of 3.91 and the shortest height of 5 m.

c. Bayog

This species was most productive in La Union with 10.91 culms per clump in four years followed by Pampanga, 10.61; Cebu, 6.93; Bukidnon, 4.92; and Capiz, 3.62.

d. Bolo

This species was planted only in three sites, namely: Pampanga, Capiz and Surigao del Sur. It was most productive in Surigao del Sur with 34.80 culms per clump followed by Pampanga and Capiz with 8.73 and 5.37 culms per clump, respectively.

e. Giant bamboo

This species was planted only in three sites, namely: La Union, Cebu and Bukidnon. The age of the plantations varied from three to five years old. The productivity

assessment was deferred until further clump development due to poor growth of this species.

f. Buho

This species was planted only in Cebu and Surigao del Sur. It was more productive in Cebu with 37.10 culms compared to 30.40 culms per clump in Surigao del Sur in five years. However, buho in Surigao del Sur was bigger and taller with an average of 3.96 cm in basal diameter and height of 9.17 m compared to Cebu with 1.96 cm and 3.97 m, respectively.

g. Laak

This species was planted only in Surigao del Sur. It was very productive, attaining 33.90 culms per clump in four years with an average basal diameter of 4.33 cm and height of 6.92 m.

Compared with k. tinik, laak was three times more productive with 33.90 culms per clump than tinik with 11.00 culms per clump in four years. Compared with kiling in terms of culm density, laak was about 60% more productive in the same site.

h. Kayali

Surigao del Sur was the only site planted to this species. This species attained its harvestable culm in four years with an average

stand of 22 culms per clump and an average diameter and height of 6.73 cm and 8.49 m, respectively.

Kayali produced twice that of tinik in terms of number of culms while about as much productive as kiling in this site.

2.5. **Bambuseta**

Three sites have been developed as Bambuseta, namely: Baguio with 56 species (Appendix 8.1); Los Baños with 32 species (Appendix 8.2); and Davao with 30 species (Appendix 8.3).

Included in the Bambuseta are important bamboo species from other countries and the Philippines. For genetic conservation, rare and endangered Philippine species have been also collected for the Bambuseta, namely:

1. *Bambusa cornuta* - found only in Nueva Viscaya and Benguet.
2. *Schizostachyum ferrixii* - found only in Abra and Ilocos region.
3. *Schizostachyum luzonicum* - found only in Masinloc, Zambales.
4. *Schizostachyum textorium* - found only in Taysan, Batangas.
5. *Yushemia niitahayamensis* - found only in Mt. data and Mt. Pulog in Benguet.

3.0 RECOMMENDATIONS

3.1 Research

Further studies should be conducted on the following:

3.1.1. Bamboo Taxonomy

It is imperative that cooperation between the Ecosystems Research and Development Bureau (ERDB) and the Philippine National Herbarium (PNH) be established to work on a common programme, especially on the bamboo flora of the Philippines. These two agencies should draw up plans for the taxonomic revisions of Philippine bamboos.

Revision or updating of the correct scientific names for the economically-important bamboo species include bayog and laak. Specimens for their identification have been sent to Kew Herbarium, England.

In developing the Philippine Bamboo Taxonomic Research the following are recommended:

a. Herbarium - A good working bamboo herbarium should be developed to keep permanently-preserved specimens for reference in bamboo identification. The herbarium

should be registered with the International Association of Plant Taxonomy (IAPT) so that it will be recorded in the future edition of the Index Herbarium.

b. Exchange of Specimens - Specimens collected by ERDB should be distributed to international herbaria where bamboo taxonomists are working. These herbaria include: (1) Philippine National Herbarium (Manila); (2) Herbarium Bogoriense (Bogor); (3) Rijks herbarium (Leiden, The Netherlands); (4) Herbarium of the Royal Botanic Gardens (Kew, U. K.); and (5) Smithsonian Institute (Washington, D. C.)

3.1.2. **Bamboo Pests and Diseases**

Some nine diseases and three pests mostly from existing or natural stands of important bamboo species have been documented. Continuous monitoring of the occurrence of pests and diseases, particularly in newly-established bamboo plantations is highly recommended.

3.1.3. Phenology

The flowering of six important bamboo species in natural or existing stands has been initially studied. The species are: k. tinik, bayog, bolo, giant bamboo, buho and kalayi. Monitoring of the flowering of these species in various localities should be continued while the phenology of other species in plantations should be initiated.

3.1.4. Propagation

a. Micropropagation (tissue culture)

Although plantlets produced through tissue culture are not yet used on a commercial scale for large-scale planting of bamboos, this should not preclude the development of satisfactory protocols for economically-important bamboo species in the Philippines.

It is, therefore, recommended that the study being undertaken by researchers at ERDB be continued. It is also suggested that tissue culture research be concentrated on difficult-to-root species such as buho (*S. lumampao*), bolo (*G. levis*),

kayali *(G. atter)*, and giant bamboo *(D. asper)*.

It is recommended that researchers should try out different levels of nutrients, hormones and growth factors. The effects of light and temperature also need to be studied.

For effective implementation, it is recommended that ERDB establishes linkages with the Institute of Plant Breeding (IPB) at the University of the Philippines Los Baños; also with the University of New Delhi, India; and the Royal Forest Department, Bangkok, Thailand, where considerable amount of work on bamboo is being done under the auspices of IDRC.

b. Vegetative Propagation

Present methods for the vegetative propagation of bamboos use both one-and two-node culm cuttings. Although the present practice is the most satisfactory, it has the distinct disadvantage of being cumbersome to raise and costly

to handle and transport. Also, colossal amounts of culms are wasted, which could otherwise be put to other good value added uses.

For these reasons, it is recommended that future efforts should concentrate on reducing of the size of planting materials and containers which can lower the cost of planting materials drastically. With this in view, the following studies (details are given in Appendix 9) are recommended:

b.1. Prerooting of unsegmented culms and segmenting of rooted nodes

This method involves burying the entire culm in raised nursery beds and irrigating the beds when necessary.

b.2. Propagation using split-single nodes

This method has been successfully used to mass-propagate Bambusa vulgaris in Sri Lanka. It is less cumbersome and cheaper than the one-or two-node cutting

methods. This may be tried with "easy-to-go" species.

b.3. Propagation using two-node sections for difficult-to-root species.

This method may be tried for difficult-to-root species such as *Dendrocalamus asper*, *D. latiflorus*, *Gigantochloa atter*, *G. levis* and *Schizostachyum lumampao*.

3.1.5. **Bamboo Shoot Production**

To date, no systematic study has been done on the management of bamboos for the production of shoots in the Philippines. There is plenty of scope for the development of the industry in the country considering the favorable climateprevalent here.

The project should focus its attention on this aspect during the coming years.

3.1.6. **Field Experiments**

The extension phase of the project was initiated specifically to generate technologies on harvesting and management of bamboo species in the pilot plantations. The three field experiments

(Appendix 7.2) have been successfully established in the six pilot sites and their continued implementation, until adequate data shall have been collected, is strongly recommended.

3.2. **Bamboo Pilot Plantations**

3.2.1. Purpose and Protection

The Bamboo Pilot Plantations in six regional sites have been successfully established to attain the following objectives: (1) accommodate field experiments for the development of appropriate harvesting and management regimes for the eight economically-important bamboo species; (2) serve as demonstration farms to farmers, students, researchers, bamboo entrepreneurs, and the general public; and (3) serve as source of planting stock for the propagation and development of the eight important bamboo species. It is, therefore, recommended that adequate and sustained protection and maintenance of these pilot plantations be assured.

3.2.2. **Species Performance and Yield Data**

Accurate and continuous monitoring of the growth and yield of the eight bamboo species in the pilot plantations

is very necessary. To attain this objective, it is recommended that a computer-based central file system at ERDB be established. The system should contain information on bamboo species, site, clump identity and its development as a function of time/year and treatments for the eight bamboo species with provision for data entry/manipulation, inquiry and report generation.

3.3. **Bambuseta**

3.3.1. **Genetic Resource Conservation**

The ex-situ preservation of endangered bamboo species and some of their provenances, is one of the objectives in establishing Bambuseta in three locations. The first one, known as Philippine Bambusetum is in Baguio, the second one in Los Baños; and the third in Bukidnon. Some rare and endangered bamboo species have been collected and introduced in these Bambuseta.

The collection of rare and endangered native species as well as other native commercial species not yet included in the Bambusetum be conducted. The different provenances of economically-important bamboo species collected and introduced in the three strategic sites of the Bambuseta will serve as

the basic stock for the bamboo genebank in these localities.

3.3.2. Propagation and Distribution

It is recommended that the propagation of newly- introduced species be expanded which can be facilitated with the installation of a mist spray unit in the three Bambuseta for easier and faster rooting of cuttings. The distribution of the propagated new species to various small farmers, DENR field offices, pilot plantations and other bamboo collections should be systematically expanded.

3.3.3 **International Bamboo Species Exchange**

The Project has established an ample network of international contacts for the exchange of bamboo species. New ecologically-suitable tropical, sub-tropical and temperate commercial bamboo species should be introduced in the Bambuseta.

It has been noted that the extensive highland areas with subtropical and temperate climate are devoid of bamboo. Bamboo species suitable in these areas can be extremely valuable for their development and also for urgently-needed watershed protection.

3.3.4. Documentation and Library

A systematic file and monitoring system be established at ERDB and the three Bambuseta. This is necessary to obtain complete information on species, provenances and other valuable information for future bamboo research and extension work. The established bamboo bibliography collections should be completed or expanded.

3.4. Sustainability Plan

The sustainability of the project is the ultimate objective with the end in view of sustaining the development of bamboo for environmental protection and source of livelihood in the countryside. Toward this end, a multisectoral seminar and workshop is recommended to draw up the necessary plan with the project outputs as initial working papers. The seminar/workshop shall be attended by representatives from NEDA, FAO, UNDP, DTI (Department of Trade and Industry), BOI (Board of Investment), PCARRD, the Bamboo Furniture Industry, Bamboo Farmers Associations, DENR National and Regional Offices, Nongovernment Organizations (NGOs)and the Bamboo Industry Sector.

APPENDIX 1

PHILIPPINE COMMERCIAL BAMBOO SPECIES

	Scientific Name	Vernacular Name	Origins
1.	*Bambusa blumeana* Schultes f.	Kawayan tinik	Philippines
2.	*Bambusa oldhami* (Munro) McClure	Ryoku-chiku	China
3.	*Bambusa* cf. *blumeana* var. *luzonesis* Hack.	Bayog	Philippines
4.	*Bambusa* cf. *dolichoclada* Hayata	Laak	Philippines
5.	*Bambusa vulgaris* Schrad. ex Wendl.	Kawayan kiling	Asia
6.	*Dendrocalamus asper* (Schultes f.)	Giant bamboo	Indonesia
7.	*Dendrocalamus latiflorus* Munro	Ma-chiku	Taiwan
8.	*Gigantochloa atter* (Hassk). Kurz	Kayali	Indonesia
9.	*Gigantochloa levis* (Blanco) Merr.	Bolo, botong	Philippines
10.	*Schizostachyum brachycladium* Kurz.	Bulo-padi	Malaysia
11.	*Schizostachyum lumampao* (Blanco) Merr.	Buho	Philippines

APPENDIX 2

GOVERNMENT PROJECT PERSONNEL

Post Title	Name and Gender of Incumbent		Full/part-time	Assumed Duty (date)
National Proj. Director	Dr. E. Rosario	M	P	01.93
National Asst. Proj. Director	Dr. E. Tandug	M	P	02.94
National Project Coordinator	Dr. A. Piñol	M	P	07.88
	Ms. V. Sinohin	F	P	12.94
Field Coordinators:				
CAR	RTD G. Tortoza	M	P	01.93
Region 1	RTD F. Barangan	M	P	01.90
Region 3	Mr. C. Tarun	M	P	10.87
Region 6	RTD N. Uriate	M	P	01.90
Region 7	RTD R. Basada	M	P	01.92
Region 10	RTD D. Melana	M	P	01.90
Region 11	RTD B. Apura	M	P	07.90
ERDB Researchers:				
	Mr. E. Baltazar	M	P	07.87
	For. P. Umali, Jr.	M	P	07.87
	For. L. Gonzales	M	P	07.87
	Ms. V. Sinohin	M	P	07.87
	Ms. C. Roxas	M	P	07.87
	Ms. M. Dayan	M	P	07.87
	Ms. N. Calinawan	M	P	07.87
	Ms. A. Lapis	M	P	07.87
	Ms. M. Pollisco	M	P	01.92
Field Researchers:				
CAR	Ms. F. Tangan	F	P	07.87
	Mr. T. Baldino	M	P	01.92
Region 1	Mr. C. Orallo	M	P	07.87
Region 3	For. C. Tarun	M	P	07.87
Region 6	Mr. C. Marquez	M	P	01.90
Region 7	Mr. A. Bueno	M	P	01.93
Region 10	Mr. R. Lanuza	M	P	10.87
	Ms. M. Decipulo	F	P	01.90
Region 11	Dr. R. Basada	M	P	01.88
	Mr. B. Manipula	M	P	01.90
Support Staff:				
Disbursing Officer	Ms. C. Apolinar	F	P	01.88
Secretary/Clerk	Ms. N. de Leon	F	P	01.90
Driver	Mr. E. Silvoza	M	P	10.87

Remarks:

1) Dr. F. S. Pollisco left the NPD's last May 07, 1989
2) Dr. C. C. Tomboc left the NPD part January 1993
3) Dr. E. Eusebio left tht Asst. NPD's part February 1994.

APPENDIX 2.2

TECHNICAL COOPERATION PERSONNEL

Post No.	Post Title	Name and Gender and Nationality of Incumbent		Entry on Duty (date) Sch'd:	Entry on Duty (date) Actual / Est.	Departure (date) Sch'd:	Departure (date) Actual / Est.
NPPP	Consultant (Bamboo Taxonomy)	Dr. J. Pancho (Pilipino)	M		02.89		03.89
	Consultant (Resource Economics)	Dr. R. Tagarino (Pilipino)	M		12.89		03.89
	Consultant (Bamboo Management)	Dr. F. Virtucio (Pilipino)	M		04.90		04.91
	Consultant (Bamboo Management)	Dr. V. Veracion (Pilipino)	M		09.91		05.92
	Consultant (Bamboo Management)	Dr. F. Virtucio	M		11.92		04.95
	Consultant (Soil Fertility & Plant Nutrition)	Dr. H. Nguyen	M		06.93		07.93
IPPP	Chief Technical Adviser (CTA)	Dr. F. Schlegel	M	02.88		03.90	
	Consultant (Bamboo Taxonomy)	Dr. E. Widjaja	F	02.89		03.89	
	Consultant (Bamboo Silviculture & Tissue Culture)	Dr. K. Vivikandan	M	01.91		03.91	

APPENDIX 3

Bamboo Research and Development Studies

	TITLE	DURATION
1.	Specimen collection, classification and identification of the different bamboo species in the Philippines. Study Leader: Cristina Roxas	5 years (11.87-7.92)
2.	Determination of chlorophyll distribution of selected bamboo spec ies in immature culms and components. Study Leader: Veronica Sinohin	2 years (6.88-6.90)
3.	Studies on the role of culm sheath in culm development of selected bamboo species. Study Leader: Veronica Sinohin	2 years (6.88-6.90)
4.	Isolation and identification of different diseases of bamboo in the Philippines. Study Leader: Maria Dayan	2 years (10.87-12.90)
5.	Microflora associated with rhizosphere of bamboo species. Study Leader Maria Dayan	2 years (10.87-12.90)
6.	Mass propagation of bamboo using tissue culture technique. Study Leader: Nenita Calinawan	4 years (9.87-12.91)
7.	Site characterization for bamboo plantations establishment. Study Leader: Nguyen H. Hoanh	5 years (9.87-12.91)
8.	NPK requirements of some bamboo species Phase 1, nursery experiment under Los Baños conditions. Study Leader: Nguyen H. Hoanh	5 years (9.87-9.91)
9.	Influence of hormone concentrations and sources on the survival and growth of culm cutting of some bamboo species in different soil media. Study Leader: Nguyen H. Hoanh	5 years (9.87-6.92)
10.	Bamboo growth and development as affected by types of planting stocks and media of planting. Study Leader: Nguyen H. Hoanh	5 years (9.87-6.92)

	TITLE	DURATION
11.	Documentation of bamboo utilization in the Philippines. Study Leader: Eliseo M. Baltazar	5 years (9.87-6.92)
12.	Economic analysis of production and marketing of bamboo in selected sites in the Philippines. Study Leader: Bienvenido Maligalig	2 years (1.89-12.91)
13.	Harvesting study on existing bamboo stands in Tanay, Rizal. Study Leader: Paulino Umali, Jr.	5 years (9.90-12.95)
14.	Effect of different harvesting intensities on the performance of established kawayan tinik in Los Baños Experimental Station. Study Leader: W. Natividad/M. Lanting	5 years (1.89-12.95)
15.	Effect of sanitation cutting and cropping treatments on culm yield and biomass productivity of laak. Study Leader: B. Manipula/F. Virtucio	5 years (3.89-3.94)
16.	Planting stock production of laak (*Sphaerobambos philippinensis*) of various ages through even planting under nursery condition. Study Leader: B. Manipula	2 years (1.89-12.90)
17.	Phenology of different bamboo species in the Philippines. Study Leader: Maria Dayan	5 years (1.88-6.92)
18.	Germination, storage and microflora associated with bamboo seeds. Study Leader: Maria Dayan	3 years (1.90-6.92)
19.	Ecological impact assessment of kawayan tinik (*Bambusa blumeana*) plantation under Los Baños conditions. Study Leader: Nguyen H. Hoanh	3 years (1.90-6.92)
20.	Vegetative propagation of kayali (*Gigantochloa atter*). Study Leader: B. Manipula	2 years (1.90-12.91)

APPENDIX 4. PROCEEDINGS AND PUBLICATIONS

4.1 Papers presented during the First National Bamboo Research and Development Symposium on February 28, 1989 at ERDB, College, Laguna.

1. Chlorophyll content of immature culms of *Bambus, Dendrocalamus* and *Schizostachyum* species of bamboo.
   V. O. Sinohin, M. V. Pacho and P. Q. Vinh.

2. Growth of direct-planted and transplanted *Bambusa vulgaris* and *B. blumeana* cuttings with complete mulching at Mt. Makiling, Los Baños, Laguna.
   N. H. Hoanh.

3. Survival of cuttings of bamboo species *Bambusa vulgaris, B. blumeana* and *B. vulgaris* var.*striata* under nursery conditions at Mt. Makiling, Los Baños.
   N. H. Hoanh.

4. Branch marcottage, a practical method of propagating kawayan tinik (*Bambusa blumeana*).
   D. J. Alfonso

5. Spacing and harvesting of bayog (*Gigantochloa levis*) and laak bamboo (*Bambusa philippinensis*) for production of poles as banana props.
   C.C. Basio, D. D. Ellarda and C. D. Carcallas.

6. Propagating laak bamboo (*Bambusa philippinensis*) incubation method for livelihood and environmental protection in Davao Province.
   M. G. Caasi.

7. Sprouting of laak bamboo (*Bambusa philippinensis* Gamble) as influenced by bud nodal location and culm age.
   B. M. Manipula and F. D. Virtucio.

8. Tissue culture of *Dendrocalamus, Bambusa, Gigantochloa* and *Schizostachyum* species of bamboo.
   A. B. Zamora, S.S.M. Gruezo and O.P. Damasco.

9. Survey, identification and pathogenicity of pests and diseases of bamboo in the Philippines.
   M. P. Dayan

10. Specimen collection, classification and identification of bamboo species in the Philippines through quantitative principal component analysis.
    C. A. Roxas.

4.2 Papers presented during the Second National Bamboo Research and Development Symposium on December 14, 1990 at ERDB, College, Laguna.

1. Phenological observations on seven Philippine bamboo species by Veronica O. Sinohin.

2. Survey, identification and pathogenicity of pests and diseases of bamboo in the Philippines by Maria P. Dayan.

3. Vegetative propagation of giant bamboo (*Dendrocalamus asper*) and bayog (*Bambusa* sp.) under nursery conditions by Nguyen H. Hoanh.

4. NPK requirements of kawayan tinik (*Bambusa blumeana* Schultes) under nursery conditions by Nguyen H. Hoanh.

5. Survival and growth of culm cutting and whole culm of kayali (*Gigantochloa atter*) as affected by age and culm portion by Bighani M. Manipula, Noel So. Gianan and Felizardo D. Virtucio.

6. Marcotting of kawayan kiling (*Bambusa vulgaris* Schard.) using polyacrilamide by Francisco C. Carino.

7. Early growth and survival of bayog as affected by fertilization and planting position by Maximino L. Generalao and Danilo C. Cacanindin.

8. Survival and growth performance of selected bamboo species planted along riverbanks by Roberto C. Apigo and Noel S. Soriano.

9. Effect of thinning, cutting age and felling cycle on culm yield of buho (*Schizostachyum lumampao*) natural stands by Felizardo D. Virtucio and Carlos C. Tomboc.

10. Pulp yield and physico-mechanical properties and six Philippine bamboo species and the implications on optimal harvesting age by Felizardo D. Virtucio, Monina Torres-Uriarte and Nicolas S. Uriarte.

11. Marketing of bamboo in Luzon and Visayas by Bienvenido B. Maligalig and Dave Rodney C. Saguin.

4.3 Papers presented during the Third National Bamboo Research and Development Symposium on December 1991 at ERDB, College, Laguna.

1. Some factors affecting callus formation and other responses of kawayan tinik (*Bambusa blumeana* Schultes f.).
   Mitzi T. Pollisco.

2. Plant selection, potting mixes and field planting of tissue culture-derived plants of *S. lumampao* and *D. strictus*.
   Alfinetta B. Zamora, Sunny Sm. Gruezo and Gregorio Rodis.

3. Effect of complete fertilizer (14-14-14) on the performance of *B. blumeana* in Mt. Makiling.
   Nguyen Hoang Hqanh.

4. Optimal plantation development scheduling of *Bambusa blumeana* by LP: The small farmholders' case.
   Nicolas S. Uriarte.

5. Production of laak (*Bambusa* sp.) planting stock from whole culms of various ages under open nursery condition.
   Bighani M. Manipula, Felizardo D. Virtucio and Bonifacio A. Apura.

6. Nursery and plantation techniques from the viewpoint of a private practitioner.
   Jose Ma. M. Pastor.

7. Nepa Q-Mart Industries bamboo production pilot project for countryside development.
   Florencio P. Mauricio.

8. Bamboo R & D Project pilot plantations: A slide presentation.
   Paulino A. Umali, Jr. and Lucas L. Gonzales.

9. Supply and demand analysis of bamboo materials by industry in Region 1.
   Nicolas S. Uriarte and Bienvenido M. Maligalig.

10. Effect of thinning, cutting age and felling cycle on culm yield of k. tinik (*Bambusa blumeana*) natural stands.
    Felizardo D. Virtucio, Nicolas S. Uriarte and Monina T. Uriarte.

11. Treatment and preservation of bamboo.
    Antonio V. Reyes.

12. Properties affecting bamboo utilization.
    Zenita Espiloy.

4.4 Published articles

1. Bamboo in the Philippines. China Study Tour. IUFRO p 5.04 Bamboo Newsletter. Dec.2, 1989.

2. 1988 Outputs of the bamboo research and development project.
IUFRO p 5.04 Bamboo Newsletter. June 1,1988.

3. Bamboo and the Philppine bamboo research and development project.
A Merriam Bamboo Society Newsletter. Vol. X No. 4. 1989.

4. Philippine bamboo research and development project supported by FAO/UNDP/PHILIPPINE Government. IUFRO p 5.04 Bamboo Newsletter. June 1, 1988.

5. Three new bamboo species introduced to the U.S. from the Philippine Bambusetum. American Bamboo Society Newsletter. Nov. 1990.

6. Bamboo paracline Philippines EBS Bamboo, H. No. 5. May 1989.

7. In-situ conservations of Philippine bamboo species. Forest Genetic Resources. FAO. 1990.

8. Bamboo silviculture training for small farmers in the Philippines. FAO. 1990.

9. Philippine bambusetum. F. Tangan and V. P. Veracion. CANOPY International. Vol. 15 No. 2. College, Laguna, Philippines. 1989.

10. Bamboo production research and development
M. A. Eusebio, N. Hoanh and P. Q. Vinh
CANOPY International. Vol. 14 No. 6 pp. 4-8. Nov.-Dec. 1989.

11. Philippine bambusetum: Where bamboos exude their usefulness and charm.
F. T. Tangan and V. P. Veracion
CANOPY International. Vol. 15 No. 2 pp. 8-11. March-April 1989.

12. The flowering of the bamboo. C. A. Roxas
CANOPY International. Vol. 15 No. 4. July-Aug. 1989.

13. Spiny bamboos in the Philippines. C. A. Roxas
CANOPY International. Vol. 16 No. p. 12. Jan.-Feb. 1990.

14. Fire-adapted bamboo. C. A. Roxas
CANOPY International. Vol. 16 No. 5 pp. 3, 12. Sept.-Oct. 1990.

15. The bamboo plantation in pampanga. L. Gonzales, P. A. Umali and A. A. Pinol.
CANOPY International. March - April 1990.

16. Propagation of kawayan-kiling through split-culm cuttings. L. Gonzales, M. J. Quimio and N. S. Uriarte.
CANOPY International. May 1991.

17. Improved method of propagating bamboo. R. Basada and F. D. Virtucio.
SMARRDEC Journal. No. 1. July-Sept. 1988. Davao City.

18. Published in PROSEA, Plant Resources of South-East Asia 7. Bamboos:
9.1 Bambusa blumeana, pp. 60-64, By C. A. Roxas
9.2 Dendrocalamus latiflorus, pp. 87-90, By C. A. Roxas
9.3 Schizostachyum lima, pp. 138-140, By C. A. Roxas and S. Dransfield
9.4 Schizostachyum lumampao, pp. 140-142, By F. D. Virtucio and V. O. Sinohin

4.5 Manuals and other handouts

1. How To Grow Bamboo in the Cordillera
   By F. Tangan and A. B. Costales. Techno-transfer Series Vol. 1 No.2. 1991. DENR, CAR.

2. Agmulatayo Ti kawayan (Let's Plant Bamboo)
   Techno-transfer Series Vol. 1 No.1. 1990. DENR, Region 1.

3. How To Produce Decorative Bamboo
   Techno-Bulletin-Special Issue 1990.
   DENR, Region 2.

4. Mga Gabay sa Pagtatanim ng Kawayan
   Techno-transfer Series Vol. 3 No. 1. June 1992.
   DENR, Region 3.

5. Project Development Manual for Bamboo in Western Visayas DENR, Region 6, Iloilo City.

6. Unsa-on Pagpatubo ng Kawayan
   DENR, Region 7.

7. Micropropagation of Bamboo
   Techno-transfer Series Vol. 4 No. 4. Dec. 1992.
   DENR, Region 8.

8. Bamboo Production. Techno-transfer Series Vol. 2 No. 4. April-June 1991.

9. Bamboo Production at the Village Level
   Techno-transfer Series Vol. No. 1. 1989. DENR, Region 10.

10. Growing Bamboo for Livelihood and Environmental Protection Techno-transfer Series Bulletin No. 1. Oct. 1988. DENR, Region XI, Davao City.

11. How To Propagate and Establish Laak Bamboo Plantation Techno-transfer Series Bulletin No. 11. DENR, Region XI, Davao City.

12. Transfer of Bamboo Production Technologies to ISF Beneficiaries in Region XI.
    Primer Vol. 1 No. 1 Dec. 1993. DENR, Region XI, Davao City.

13. The Philippine Bambusetum
    A Nature Protection, Research and Extension Area for Native and Introduced Bamboo Species DENR, CAR, Baguio City

14. Bamboo Farming
    Propagation and Plantation of Important Bamboo Species 1994. Los Baños, Laguna, Philippines .

15. RISE: Bambusa blumeana var. luzonensis Hack. and Bambusa blumeana Schult. Vol. 3 No. 12. December 1991.

16. RISE: Bambusa vulgaris Schrad. and Gigantochloa levis (Blanco) Merr. Vol. 4 No. 4, July-Aug. 1992.

4.6 For Publication (In process)

1. Field Guide in the Identification of Economically-Important Bamboo Species in the Philippines
   C. A. Roxas and V. O. Sinohin

2. Translation to Three Local Dialects of the Bamboo Farming annual

3. Growth Performance of Eight Bamboo Species in Pilot Plantation Sites
   F. D. Virtucio (Paper presented during the DENR Management Conference, Davao City, Aug. 24, 1994).

APPENDIX 5. TRAINING

Fellowship, Training Course, Study Tour, or In-service Training	Duration months	Name and gender of Fellow(s). If training undertaken aboard, indicate country and institution of study		Started (date) Scheduled	Started (date) Actual	Completed (date) Scheduled	Completed (date) Actual
Fellowships:							
For.Resources/ Economics	36	Nicolas S. Uriarte USA Michigan State University	M	09.01.89	09.01.89	08.01.90/ 12.01.90	09.01.91
Genetics	24	Ms. F. Aala	F	06.01.87	10.01.87	05.01.89	05.01.89
Physiology	24	Ms. M. Pollisco	F	-do-	06.01.87	-do-	-do-
Pathology	24	Ms. M. Pacho	F	-do-	06.01.88	05.01.90	04.01.95
Bamboo Congress	5 days	Ms. A. Lapis (France)	F	06.01-88	06.01.88		
Training Course Bamboo Taxonomy	20 days	Project Researchers & other DENR Researchers (24 participants)		01.06.89	01.06.89	06.01.89	01.24.89
Study Tour**	14 days	N. Calinawan	F	06.01.89	09.01.89	06.01.89	09.30.90
		M. Dayan	F	-do-	-do-	-do-	-do-
		C. Roxas	F	-do-	-do-	-do-	-do-
		V. Sinohin	F	-do-	-do-	-do-	-do-
		F. Tangan	F	-do-	-do-	-do-	-do-
		P. Umali	M	-do-	-do-	-do-	-do-
		L. Gonzales	M	-do-	-do-	-do-	-do-
		A. Pinol	M	-do-	-do-	-do-	-do-
International Training on Bamboo Taxonomy	3	C. Roxas	F	08.01.90		10.01.90	12.01.90

Remarks:

** Study Tour to China and Japan

APPENDIX 6. LIST OF ERDB UNDP-FAO BAMBOO RESEARCH AND DEVELOPMENT PROJECT EQUIPMENT (PHI/85/008)

6.1 LABORATORY

		Utilization
1.	Convention oven	For drying of specimens (diff. parts of bamboo species) for herbarium collections
2.	Bacterial incubator	For storage of microorganisms that could be isolated from any diseases of bamboo observed in the project plantation
3.	Laminar flow station	For isolation chamber of any micro-organism associated with bamboo diseases
4.	Electronic balance	For weighing of chemicals in studies on tissue culture and bamboo biomass
5.	Pressure steam sterilizer	For sterilizing media in bamboo tissue culture and bamboo biomass
6.	Analytical centerifuge	For nutrient analysis of bamboo biomass
7.	Furnace	For ashing bamboo tissues for nutrient analysis
8.	Upright plasma freezer	For storing bamboo plant parts for nutrient analysis
9.	Willy mill	For grinding samples of different parts of bamboo for nutrient analysis and biomass production
10.	Inverted biological microscope	For the examination of bamboo diseases organism associated with
11.	pH meter	For determining pH of media for bamboo tissue culture
12.	Reciprocating oil-less piston vacuum pumps & air compressor	For the implementation of studies on site characterization of bamboo plantation establishment; determination of hormones.
13.	Incubator model 300 A Blue M. Chamber (Blue M. vapor-temperature controlled temp. & humidity chambers)	For the incubation of bamboo seedlings under controlled condition in the implementation of studies on diseases of bamboo and isolation of microorganisms on bamboo rhizosphere
14.	pH meter, portable digital includes combination eletrode ATC probe elect. holder support rod	For determining soil pH in the implementation of study on site characterization and pH of media for tissue culture study

6.2. LABORATORY ACCESSORIES

		UTILIZATION
1.	Precision Pipetman cap. 200 ml	
2.	Precision Pipetman cap. 1000 ml	
3.	Rotor for mill	
4.	Hopper, stainless steel	For general use in all studies like:
5.	Delivery tube 10 mush	a) Diseases of bamboo
6.	-do- 30 mush	b) Tissue culture
7.	-do- 80 mush	c) Taxonomy
8.	Receiver stainless steel	d) Physiology
9.	Beltguard	e) Biomass
10.	Belt V-shaped	f) Soil fertility
11.	Stage micrometer B & L 2.2 mm	
12.	Eyepiece micrometer disc B & L	
13.	Hemacytometer	
14.	Dialyzer, micro crowe England	
15.	Dialyzer tubing MW cut-off 1200 spectrum 100 ft. roll	
16.	Dialyzer membrance technilab 299 cut-off box of 100	
17.	Handy spark gas lighter battery operated	
18.	Glass woll pyrex	
19.	3 Blade knife (Buck knife)	
20.	Benton type tally meter	
21.	Buret holder, precision	
22.	Buret holder	
23.	Clamp x 38 mm	
24.	Clamp x 89 mm	
25.	Clamp Holder	
26.	Pinch clamp No. 18A	
27.	Pinch clamp No. 12	
28.	Buret stand, fisher base	
29.	Whatman No. 3 mm chromatography sheet (pkg of 100)	
30.	Whatman No. 3 mm chromatography sheet (pkg of 100)	
31.	Foot switch	
32.	Ampule 1 ml case of 52	
33.	Sterilizer indicator tape (pkg of 6 rolls)	
34.	Rubber bulb	
35.	Rubber bulb 1/4 oz. (pkg of 12)	
36.	Rubber bulb (carton of 12)	
37.	Aluminum alcohol burner	
38.	Wicking	
39.	Chromatography tubes 10 x 30 mm	
40.	Chromatography tubes	
41.	Bulb Pipettle pump Model PVC	
42.	Goggles for YV and glare protection	
43.	Platinum-inidium wine 26 gauge	
44.	Nichrome gauge 4" (10 pcs/pk)	
45.	Timer	
46.	Blue felt-tipped pen (pk of 6)	
47.	Red felt-tipped pen (pack of 6)	
48.	Emergency blanket	
49.	Vernier caliper	
50.	Watchmaker forceps	
51.	Eye forceps	
52.	Fine point forceps	
53.	Entomological forceps	
54.	Safety lock scalpels	
55.	Weksler max-min six thermometer from -30°C to 50°C	
56.	Model-A soil thermometer 12" pointed stem	
57.	Model-A soil thermometer 24" pointed stem	
58.	Sensor activated Bunsen 20 x 400 mm burner	
59.	High temperature Bunsen burner	

6.3 FIELD EQUIPMENT

		UTILIZATION
1.	Auger, half-fitted 8" earth	For soil characterization and fertility study
2.	Auger, not fitted 18" extension	
3.	Diameter tape model 283	
4.	Digital caliper	
5.	Tamaya (up knee level protractor)	
6.	Pocket transit	
7.	Soil moisture tester	
8.	Protimeter	
9.	Altimeter barometer	
10.	Pedometer	
11.	Haga altineta w/ case	
12.	Post hole drill	
13.	Soil moisture tester/ Soil temperature sensor	
14.	Clarimeter	
15.	Compass	
16.	Pruner hand saw	For studies on harvesting of bamboo species
17.	Chainsaw, 3 HP model	
18.	Chainsaw, model 100	
19.	Brush cutter model BC 250 2.1 Hp w/ sta. acc.	
20.	Brush cutter Blade, 8T	
21.	Pruning saw T540	
22.	Recording rainfall system w/ tipping bucket raingage event recorder	For implementation of ecological studies on bamboo species
23.	Cable for use in connection w/ Ws-1000 FRT 150 fi	
24.	Model WS-1000 printer computer compatible w/ printer system	
25.	Sunlight sensor	
26.	Solar radiation sensor	

6.4 EQUIPMENT FOR DOCUMENTATION

1. Video 8 handy cam (Sony) CCd-F501
2. Cannon T-70 camera with zoom and macro lenses
3. Overhead projector
4. Slide projector
5. Screen projector

6.5 OFFICE EQUIPMENT

1. Electronic typewriter
2. Computer w/ printer
3. Copying machine (3)
4. Air conditioner (3)
5. Computer (ACER/VIEW IID SVGA)
6. Laser printer (OKILASER 400)
7. Pilot W-120240
   Dry marker board

6.6 VEHICLES

1. Toyota hi-lux model 1987 (6 units)
2. Honda motor (4 units)

APPENDIX 7.

BAMBOO PILOT PLANTATIONS

SPECIES	S I T E (ha)						
	La Union	Pam-panga	Capiz	Cebu	Bukid-non	Surigao	Total
Bambusa blumeana (k. tinik)	2	2	2	2	2	2	12
Bambusa cf. dolichoelada (laak)	-	-	-	-	-	2	2
Bambusa vulgaris (k. kiling)	2	2	2	2	2	2	12
Bambusa blumeana var. luzonensis (bayog)	2	2	2	2	2	-	10
Dendrocalamus asper (k. tinik)	2	-	-	2	2	-	6
Gigantochloa atter (kayali)	-	-	-	-	-	2	2
Gigantochloa levis (bolo)	-	2	2	1	1	1	7
Schizostachyum lumampao (buho)	-	-	-	2	2	2	6
TOTAL	8	8	8	11	11	11	57

APPENDIX 7.1 ESTABLISHED FIELD EXPERIMENTS IN BAMBOO PILOT PLANTATIONS

1. Experiment No. 1 : Effect of harvesting and felling cycle on the performance of selected species at the following sites:

1.1	La Union	-	*B. blumeana, B. blumeana* var. *luzonsis* and *B. vulgaris.*
1.2	Pampanga	-	*B. blumeana* and *B. vulgaris*
1.3	Cebu	-	*B. blumeana, B. blumeana* var. *luzonensis, B. vulgaris, Dendrocalamus asper* and G. levis.
1.4	Capiz	-	*B. blumeana, B. blumeana* var. *luzonensii* and *G. levis*
1.5	Bukidnon	-	*B. blumeana, B.* var. *luzonensii* and *B. vulgaris*
1.6	Surigao del Sur	-	*D. dolicholada, B. vulgaris, G. atter* and *S. lumampao*

2. Experiment No. 2 : Effect of nitrogen and phosphorus on the performance of selected species at the following sites:

2.1	Pampanga	-	*B. blumeana, B. var. luzonensis, B. vulgaris* and *G. levis*
2.2	Cebu	-	*B. blumeana, B. blumeana* var. *luzonensis, B. vulgaris, and Dendrocalamus asper*
2.3	Capiz	-	*B. blumeana, B.* var. *luzonensii, B. vulgaris* and *G. levis*
2.4	Bukidnon	-	*B. blumeana, B. vulgaris* and *D. asper*
2.5	Surigao del Sur	-	*B. vulgaris* and *S. lumampao*

3. Experiment No. 3 : Effect of harvesting intensity, felling cycle and NPK fertilizer on the performance of selected species at the following sites:

3.1	Pampanga	-	*B. blumeana, B. var. luzonensis,* and *G. levis*
3.2	Cebu	-	*B. blumeana, B. vulgaris and S. lumampao*
3.3	Capiz	-	*B. blumeana, B.* var. *luzonensii, B. vulgaris* and *G. levis*
3.4	Bukidnon	-	*B. blumeana, B. var luzonensis and B.. vulgaris*
3.5	Surigao del Sur	-	*B. dolicholada, B. vulgaris, G. atter* and *S. lumampao*

Appendix 8.1

BAMBOO SPECIES AND PROVENANCES AT BAGUIO BAMBUSETUM

Scientific name	Provenance	Plant type	Climate
Arundinaria amabilis	Arboretum, Valdivia, Chile	OS	TE-O
B. bambos (L.) Voss (*B. arundinacea*)	College, Laguna	RC	TR
B. bambos (L.) Voss	Kachanaburi, Thailand	S	TR
B. bambos (L.) Voss	Encinitas, California, U.S.A.	CL	TR
B. blumeana Schult f.	College, Laguna	RC	TR
Bambusa cf. blumeana var. luzonensis	Pugo, La Union	RC	TR
Bambusa cf. dolichloclada	La Union, Tagum, Davao del N.	RC	TR
B. multiplex 'elegans (*B. glaucescens*)	College, Laguna	CL	S-O
B. multiplex Fernleaves Young	Baguio, Benguet	CL	S-O
B. multiplex 'Golden Goddess' Young	Arboretum, Valdivia, Chile	OS	S-O
B. multiplex 'A. Karr' 'Young'	Arboretum, Valdivia, Chile	OS	S-O
B. oldhami (Munro) McClure	Baguio, Benguet	CL	S
Bambusa sp. "Jariegata"	Pansol, Laguna	CL	TR-O
B. tuldoides Munro (B. ventricosa)	College, Laguna	CL	S-O
B. vulgaris Schrad ex Wendl.	College, Laguna	RC	TR-O
B. vulgaris 'Vittata' McClure	College, Laguna	RC	TR-O
Chimonobus falcata	Encinitas, California, U.S.A.	CL	T
Dendrocalamus asper (Schult) Backer ex Heyne	Tublay, Benguet	CL	S
D. latiflorus Munro	College, Laguna	CL	S
D. latiflorus Munro	Cagayan		
D. strictus (Roxb.) Nees	Queensland, Australia	OS	TR
Dinochloa sp.	Mt. Sto. Tomas 2300m Baguio, Benguet	OS	TE-O
Dinochloa sp.	Mt. Makiling, Laguna, 680 m	S	ST
D. diffusa Merr. ef.	College, Laguna	CL	TR
Dinochloa sp.	Mt. Sto. Tomas 1800 m Baguio, Benguet	CL	TE-O
D. luconiae (Munro) Merr. ef.	Kennon Rd., Benguet	CL	TR-O
D. luconiae (Munro) Merr. variegata ef.	Kennon Rd., Benguet	S	TR-O
D. pubiramea Gamble	Carranglan, Nueva Ecija	OS	TR-O
Dinochloa sp.	Naguilan Rd., Burgos, La Union	S	S

Dinochloa sp.	Rizal	OS	TR
Dinochloa sp.	Puerto Galera, Mindoro Or.	OS	TR
G. atter (Hassk.) Kurz	Colorado, Digos, Davao del Sur	OS	TR
G. levis (Blanco) Merr.	Pozorrubio, Pangasinan	OS	TR
G. levis (Blanco) Merr.	Nagcarlan, Laguna	OS	TR
Gigantochloa sp. (atroviolacea)	Queensland, Australia	OS	TR
Guadua angustifolia Kunth.	Cali, Colombia	OS	TR
G. angustifolia Kunth.	Cali, Colombia (1020)	OS	TR
G. angustifolia Kunth. var bicolor Londono	Cali, Colombia	OS	TR-O
Pleioblatus argenteo-striatus f. Akebono	Cali, Colombia	CL	TE-O
P. chino Makino f. elegantissimus	Fuji Bamboo Garden, Mishima, Japan	CL	TE-O
P. chino f. pumilus Mak.	Arboretum, Valdivia, Chile	OS	TE-O
P. chino f. pgymaeus Miq.	Arboretum, Valdivia, Chile	OS	TE-O
P. distichus Muroi et H. Okamura ef.	Fuji Bamboo Garden, Mishima,	CL	TE-O
P. fortunei ev fortunei	Fuji Bamboo Garden, Mishima, Japan	CL	TE-O
Phyllostachys aurea (Carr.) A.et C. Riv.	Baguio, Benguet	CL	TE-O
P. bambusoides Sieb.et Zucc.	Queensland, Australia	OS	TE
P. nigra Munro	Baguio, Benguet	OS	TE
P. pubescencs Mazel ex Leh	Kyoto University, Kamigamo, Japan	CL	TE
P. pubescens Mazel ex Leh.	Nanjing University, Nanjing, China	S	TE
P. pubescens Mazel ex Leh.	Queensland, Australia	OS	TE
P. pubescens Mazel ex Leh.	Baguio, Benguet	OS	TE
S. kurilensia (Rupr.) Mak. et Shibata	Arboretum, Valdivia, Chile	OS	TE
S. nipponica Makino	Rakussai Bamboo Park, Kyoto, Japan	OS	TE-O
S. palmata Nakai	Arboretum, Valdivia, Chile	OS	TE-O
Sasaella ramosa (Mak.) Mal. et Shibata	Arboretum, Valdivia, Chile	OS	TE-O
Schizostachyum brachy-cladum Kurz (yellow)	Pansol, Laguna	CL	TR-O
S. lima (Blanco) Merr.	Rosario, La Union	OS	TR
S. lima (Blanco) Merr.	Kennon Rd., Benguet	CL	TR
S. lumampao (Blanco) Merr.	Masinloc, Zambales	RC	TR
S. lumampao (Blanco) Merr.	Rosario, La Union	OC	TR
S. lumampao (Blanco) Merr.	Lamut, Ifugao	CL	TR

Schizostachyum sp. cf.	Pansol, Laguna	CL	TR-O
Schizostachyum sp.	Minuli, Carranglan, Nueva Ecija	OS	TR
Thyrsostachys siamensis	Sta. Fe. Los Baños, Laguna	OS	TR
Yushabia niitakayamensis (Hayata) Keng. P	Mt. Data, Mountain Province 2360 m	CL	TE

Legend:

RC: Rooted cutting
CL: Clumps
TE: Temperate, TR: Tropical
O: Ornamental (indicated in climate column as O)
OS: Offset, Basal Stem Cutting
S: Seedling
S: Subtropical

Appendix 8.2

BAMBOO SPECIES AND PROVENANCES AT LOS BAÑOS BAMBUSETUM

Scientific name	Provenance	Plant type	Climate
Bambusa atra	Maco, Tagum, Davao del Norte	RC	TR
Bambusa bambos	College, Laguna	RC	TR
Bambusa blumeana	College, Laguna	RC	TR
Bambusa cf. blumeana var. luzonensis	College, Laguna	RC	TR
Bambusa cf. dolichoclada	Nabunturan, Davao del Norte	RC	TR
Bambusa dolichomerithalla	College, Laguna	RC	TR-O
Bambusa glaucucens	College, Laguna	RC	TR-O
Bambusa oldhamii	Baguio, Benguet	CL	S
Bambusa ventricosa	College, Laguna	CL	S-O
Bambusa vulgaris	College, Laguna	RC	TR-O
B. vulgaris var. striata	College, Laguna	RC	TR-O
B. vulgaris var. masulata	Nabunturan, Davao del Norte	RC	TR-O
B. vulgaris var. Wamin	Nabunturan, Davao del Norte	RC	TR-O
Dendrocalamus asper	College, Laguna	RC	TR
Dendrocalamus giganteus	Bogor, Indonesia	S	TR
Dendrocalamus latiflorus	College, Laguna	RC	S
Dendrocalamus strictus	India	S	TR
Dendrocalamus sp.	Thailand	S	TR
Gigantochloa atter	Digos, Davao	OS	TR
Gigantochloa levis	College, Laguna	RC	TR
Guadua angustibolia	Cali, Colombia	OS	TR
Phyllostachys aurea	Baguio, Benguet	CL	TE-O
Schizostachyum brachy-cladum (yellow)	College, Laguna	CL	TR-O
Scgizostachyum brachy-cladum (gree)	Davao	CL	TR
S. lima	Laguna	CL	TR
S. lumampao	College, Laguna	S	TR
Thyzzsostachys siamensis	College, Laguna	OS	TR
Pleioblastus distichus	Mishima, Japan	CL	TE-O
Sasa palmata	Valdivia, Chile	OS	TE-O
Sasaella ramesei	Valdivia, Chile	OS	TE-O
Sasa nipponica			
Pleioblastus fortunei cv fortunei			

Legend:

RC:	Rooted cutting	S:	Seedlings	O:	Ornamental
OS:	Offset, Basal stem Cutting	TR:	Tropical	T:	Temperature
CL:	Clump	S:	Subtropical		

APPENDIX 8.3

Bamboo Species and Provenances Planted at the Davao Bambusetum

Scientific name	Provenance	Plant type	Climate
Bambusa atra	Tagum, Davao del Norte	RC	TR
Bambusa bambos	College, Laguna	RC	TR
Bambusa blumeana	College, Laguna	RC	TR
Bambusa dolichomenthalla	College, Laguna	RC	TR-O
Bambusa sp.1 (bayog)	College, Laguna	RC	TR
Bambusa sp.2 (laak)	Davao	RC	TR
Bambusa glaucescens	College, Laguna	RC	TR
Bambusa ventucosa	College, Laguna	RC	TR-O
Bambusa vulgaris	College, Laguna	RC	TR-O
Bambusa vulgaris var. striata	College, Laguna	RC	TR-O
B. vulgaris var. maculata	Bausalan, Davao	RC	TR-O
B. vulgaris var. wamin	Bausalan, Davao	RC	TR-O
B. sp "variegata	Pansol, Laguna	OS	TR-O
Dendrocalamus asper	Malaybalay, Bukidnon	RC	TR
Dendrocalamus gigantens	Bogor, Indonesia	S	TR
Dendrocalamus sp.	Thailand	S	TR
Dendrocalamus latiflorus	College, Laguna	RC	TR
Dendrocalamus strictus	India	S	TR
Gigantochloa atter	Digos, Davao	OS	TR
Gigantochloa levis	College, Laguna	RC	TR
Phyllostachys aurea	Baguio, Benguet	CL	TE-O
Schizostachyum lima	Laguna	CL	TR
Schizostachyum brachycladum (yellow)	Laguna	CL	TR-O
S. brahycladum (green)	Laguna	CL	TR
S. lumampao	Laguna	S	TR
Thyrsostahys seamensis	College, Laguna	OS	TR
Pleioblastus distichus	Mishima, Japan	CL	TE-O
Sasa nipponica			
Yushania niitahayamensis			

Legend:

RC: Rooted cutting
CL: Clump
TE: Temperate
S: Subtropical

OS: Offset, Basal Stem Cutting
S: Seedling
TR: Tropical
O: Ornamental (indicated in climate column as O)

APPENDIX 9. PROPOSED VEGETATIVE PROPAGATION METHODS (Source: Dr. K. Vivekanandan's FAO Consultant Report on Bamboo Silviculture, March 1991)

The present method of vegetative propagation is rather cumbersome to handle and costly to produce. The size of the bag is 50 x 30 cm and each bag contains around 10 to 20 kg of soil. The cost of production per plant is around P25.

NEW METHODS TO BE TRIED

1. Prerooting of Unsegmented Culms and Segmenting of Rooted Nodes

This method involves burying the entire culm in raised nursery bed and irrigating the beds when necessary. It has been tried on *Bambusa* species (laak) and *Gigantochloa atter* (kayali) in Pandapan, Tagum by ERDS - XI researchers on a limited scale.

1.1 Methodology

a. Select one to two year-old fresh, healthy culms and place them in raised nursery beds as shown in Fig. 2.

b. The beds should be in the open. Water the beds when necessary.

c. After one month when buds start sprouting examine the culms at random by removing the soil and replace soil after examining.

d. After two months, when roots are well developed, water the beds thoroughly and remove the rooted culms gently from the nursery bed and take to shaded place.

e. Sever the rooted nodes from the main culm without damaging the shoot roots. This may be done by using a hand saw (Fig. 2).

f. Place the severed segment of the node in plastic bag (15 cm x 10 cm) one-third filled with soil and fill it up with soil and keep in shade for two-three weeks, water when necessary (Fig. 2).

g. Transfer to the open when the plants are well established and keep for about two-three months by which time they would be ready for planting.

2. Propagation Using Split-Single Nodes

This method has been successfully used to mass-propagate *Bambusa vulgaris* in Sri Lanka and the method is less cumbersome and cheaper than the one-or two-node-cutting methods. This may be tried with "easy to root" species.

2.1 Methodology

a. Select one-to two year-old fresh healthy culms.

b. Prepare split one-node section as shown in Fig. 3. The section should have a well formed bud at the node.

c. Place the split node in plastic bags (20 cm x 15 cm) and filled with soil. Cover the top portion of the soil with 2 cm layer of coconut coir dust to serve as a mulch.

d. Place the bag in the shade and water when necessary.

e. After 2 months when the plants are well established transfer to partial shade and then to open place for the plants to harden. Water regularly.

f. The plants attain plantable size in about 4 months.

3. Propagation Using Two-Node Sections for Difficult-To-Root Species

This method may be tried for difficult-to-root species such as *Dendrocalamus asper, Dendrocalamus latiflorus, Giganthochloa atter, Gigantochloa levis* and *Schizostabhyum lumampao.*

Methodology

The method described below is based on the work done at the Kerala Forest Research Institute,

India and has been proved to be quite successful with difficult-to-root species.

a. Collection of material and preparation of cuttings

(i) Extract two-to three- years old culms from healthy clumps by cutting just above the first node during March-April.

(ii) Trim the leaves and side branches as shown in the figure. Take care not to injure the axillary buds while removing leaves and branches.

(iii) Transport the culms to the nursery site as quickly as possible. Maximum care should be taken to prevent drying. This can be done by either wrapping in moist gunny bags or embedding in boxes containing moist sawdust.

(iv) Prepare two-noded cuttings (a cutting with two nodes leaving about 5-7 cm on either side of the nodes) using a sharp knife or saw. For bamboos with thin walls use of a saw is advised to avoid splitting of the cut ends.

(v) Make an opening (about 2 cm in length and 1 cm in width) or drill two holes (about 7 mm dia.) in the centre of the internode.

b. Treatment for root induction in cuttings

(i) Dissolve 10 g of NAA (1-Napthalne acetic acid) in 250 ml of ethylalcohol (90%) in a container by stirring the solution gently.

(ii) Pour this solution to a clean container and add water to make up 100 liters.

(iii) Mix the solution thoroughly by stirring. The final concentration of NAA will be 100 mg/1 of water or equivalent to 100 ppm. This solution is sufficient to treat 1000 cuttings.

(iv) Pour about 100 ml of the solution into the culm cavity. To avoid spillage, use

a wash bottle to pour the solution through the drilled holes.

(v) Close the hole by wrapping and tying with a polythene strip (60 cm x 6 cm). Ensure that the polythene wrapping is tight so that the solution does not leak out.

(vi) Keep the cuttings horizontally with the opening facing upwards. For bamboos with narrow culm cavity like *D. strictus* the treatment is given by dipping the basal portion of the culm cutting in a solution of NAA for 24 hours.

(vii) After extraction, culm, cuttings should be treated with NAA as quickly as possible (preferably the same day). If the planting site is far away there is unavoidable delay for planting, the treated cuttings can be preserved up to three days by keeping in moist sawdust.

c. Preparation of nursery and planting

(i) Prepare raised nursery beds of 10 m x 1 m and fill with a mixture of soil and sand (3:1).

(ii) One week prior to planting, drench the nursery bed separately with the insecticide, Aldrin and the fungicide, Bavistin to prevent termite and fungal attack. For each bed, use 40 l of 0.015% (a.i.) Bavistin prepared by adding 1 g of Bavistin 50 wp per litre of water.

(iii) Place the cuttings horizontally (the opening facing upwards) across the nursery bed. About 50-60 cuttings may be conveniently planted on a raised nursery bed of 10 m x 1 m. Cover the cuttings with a thin layer (2-3 cm) of soil.

d. Nursery management

(i) <u>Shade</u>
Nursery beds must be provided with a thatch to protect the cuttings from direct sunlight, which may be removed at the onset of monsoon.

(ii) Watering schedule

The beds should be watered regularly in the morning and evening with 30-40 l of water per bed at each watering. Take due care to avoid water logging.

(iii) Fungicidal treatment

Treat the sprouts after one month with 0.01% a.i. of Bavistin to avoid fungal attack.

(iv) Manuring

If necessary, farmyard manure may be applied to increase the vigour of the sprouts.

e. **Transplanting**

Rooted cuttings can be uprooted and transplanted in the field after about four months. If cuttings are sprouted and rooted at both the nodes, cut carefully at the middle of the cutting to get two plants. The rooted nodes can also be transplanted into containers as described under 2.1.