

# INTERNATIONAL TROPICAL TIMBER ORGANIZATION

## ITTO

### PROJECT PROPOSAL

TITLE	CHEMICAL MODIFICATION OF BAMBOO CULMS AND THEIR RESISTANCE TO WEATHERING
SERIAL NUMBER	PD 20/95 Rev.2 (I)
PERMANENT COMMITTEE	FOREST INDUSTRY
SUBMITTED BY	GOVERNMENT OF CHINA
ORIGINAL LANGUAGE	ENGLISH

#### SPECIFIC OBJECTIVES

- (1) To improve the dimensional stability and the resistance of bamboo culms to degradation by means of chemical modifications;
- (2) To determine the feasibility of chemical modifications in large scale production in the industry;
- (3) To investigate the weathering effects on chemically modified bamboos;
- (4) To introduce the knowledge and extend the technique of chemical modification on bamboos to the relevant units in the producing countries.

EXECUTING  
AGENCY

INSTITUTE OF BOTANY, CHINESE ACADEMY OF SCIENCES

COOPERATING  
GOVERNMENTS

GOVERNMENT OF CHINA

DURATION

4 YEARS

APPROXIMATE  
STARTING DATE

MARCH 1996

BUDGET AND PROPOSED  
SOURCES OF FINANCE

Source	Contribution in US\$	Local Currency Equivalent
ITTO	83,345	
Gov't of China	79,000	
TOTAL	162,345	

## PART I. LEGAL CONTEXT

This project meets the following objectives as set out in Chapter 1, Article 1 of the ITTA:

- (c) To promote and support research development with a view to improving forest management and wood utilization.

The project is particularly in accordance with the following areas of ITTA stated in Chapter VII, Article 23, paragraph 5:

- (b) Natural forest development;
- (d) Harvesting, logging infrastructure, training of technical personnel;
- (e) Institutional framework, National planning.

The project on Production of Chemically Modified Bamboo and its Resistance to Weathering is consistent with the criteria as laid down in the ITTA, Chapter VII, Article 23, paragraph 6 which reads:

- (a) They should be related to the production and utilization of industrial tropical timber;
- (b) They should yield benefits to the tropical timber economy and be relevant to producing as well as consuming members;
- (c) They should be related to the maintenance and expansion of the international tropical timber trade;
- (d) They should offer reasonable prospects for positive economic returns in relation to costs; and
- (e) They should make maximum use of existing research institutions and, to the greatest extent possible avoid duplication of efforts.

The project is also relevant to the ITTO Action Plan on Criteria and Priority Areas for Programme Development and Project Work as stated under part 4 - Strategies and Action Plans: Forest Industry, especially on the following:

- (a) Promotion of development of high value-added products in producing countries;
- (b) Improving the marketing and distribution of processed tropical timber products;
- (d) Promotion of more efficient processing and use of tropical timber including waste reduction and recovery and utilization of logging residues.

## PART II. THE PROJECT

### 1. OBJECTIVES

#### 1) Development objectives

To explore an effective means of relieving pressure on the major tropical timber species by improving a range of bamboo-culm properties.

## 2) Specific objectives

To improve the dimensional stability and the resistance of bamboo culms to degradation by means of chemical modifications;

To determine the feasibility of chemical modifications in large scale production in the industry;

To investigate the weathering effects on chemically modified bamboos;

To introduce the knowledge and extend the technique of chemical modification on bamboos to the relevant units in the producing countries.

## 2. BACKGROUND AND JUSTIFICATION

Bamboos have been used as a main material for house construction, furniture, handicraft articles and for pulp and paper-making in many tropical and subtropical countries and it is considered as a highly promising NTFP (non-timber forest product) because of its unique properties and the fast growing habits (Liese, 1992). However, bamboos undergo twisting, splitting and surface degradation during exterior exposure due to the solar irradiation and stresses imposed by cyclic wetting and fungal attack (Wu, 1993). In order to improve the dimensional stability and the resistance of bamboo culms to the degradation caused by the weathering or organisms, it is of significance to make an overall investigation on the chemical modification of such an important material. Although various kinds of chemical treatments have been applied to wood products and earlier reports have shown that the treatments have greatly enhanced the biological resistance and physical properties of wood (Rowell, 1988; Imamura, 1993). From a survey of Bamboo Abstracts published by Bamboo Information Centre, Chinese Academy of Forestry in Beijing and Technical Reports issued by International Network for Bamboo and Rattan (INBAR) in New Delhi, it was found that most of earlier researches concerning bamboo utilization dealt with the structure, physical and mechanical properties of bamboo culms themselves, while the effects of chemical treatments on bamboo culms received only little attention. Therefore, it is highly essential to improve a range of bamboo culm properties by chemical modification as to expand their utilization in the industry and enhance the quality of products which will result in great beneficiaries to both bamboo producing and consuming countries. The present study is undertaken to assess effects of different chemical treatments on bamboo culms including the mechanical properties, dimensional stability, morphological and color changes of chemically modified bamboos under accelerated conditions and ascertain the suitable concentration of chemical reagents for different species of bamboos.

Since 1985, we have undertaken a project entitled CHEMICAL MODIFICATION OF IMPORTANT WOODS under the support of Natural Science Foundation of China and have published several papers concerning the weathering of modified woods and their morphological and structural changes (Li, 1992). Furthermore, our research group had made up three highly effective prescriptions in improving the stability and physical

properties of hardwoods with the assistance of experts from Institute of Chemistry, Chinese Academy of Sciences.

Apart from the necessary instruments and equipments, we also gained much experience in undertaking the similar research projects.

References:

Imamura, Y. 1993. *Morphological changes in acetylated wood exposed to weathering. Wood Research No. 79: 54-62.*

Li, P.D. 1992. *Review of chemical modification research on woods. Forest Products 16: 12-22.*

Liese, W. 1992. *The structure of bamboo in relation to its properties and utilization. In: Bamboo and Its Use. Pp 95-100. Proceedings of International Symposium on Industrial Use of Bamboo held by International Tropical Timber Organization (ITTO) and Chinese Academy of Forestry (CAF) in Beijing.*

Rowell, R.M. 1988. *Chemical modification of wood: Its application to composite wood products. Proceedings of the Composite Wood Products Conference, Rotorua, New Zealand.*

Wu, K.T. 1992. *The effect of high-temperature drying on the antisplitting properties of makino bamboo culm (Phyllostachys makinoi). Wood Science and Technology 26: 271-277.*

### 3. OUTPUT

- 1) To submit a research report on the production of chemically modified bamboos.
- 2) To edit, publish and mail an treatise of "Chemical modification of bamboo culms and their resistance to weathering" (in English)

The treatise will mainly contain:

- a) A review of chemical modification of woods with implications for bamboo utilization;
- b) Reasons of selecting chemical agents for bamboo culms in this project;
- c) Selections of bamboo culms and chemical agents;
- d) Effects of different chemical treatments on dimensional stability and mechanical properties of different taxa of bamboo culms (In this project, five species of commercially important bamboos will be tested. They are *Bambusa sinospinosa*, *Phyllostachys pubescens*, *Phyllostachys*

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*bambusoides, Pseudosasa amabilis, Sinocalamus latiflorus*).  
Besides, some species from South America will also be tested.

- e) Effects of weathering on modified bamboos under accelerated conditions;
- f) The useful prescription for bamboo treatment and its potential applications in the industry.

#### 4. ACTIVITIES

- 1) To collect experimental materials from South China.
- 2) Two scientists will visit Department of Forest Products Sciences, The University of Tokyo, Wood Research Institute, Kyoto University and Forestry and Forest Products Research Institute in Tsukuba, Japan to collect scientific data on chemical modification of woods.
- 3) Laboratory works to be undertaken in Chinese Academy of Sciences including:
  - Sectioning and drying of rotary-peeled culm veneer;
  - Selecting and preparation of chemical agents;
  - Pretreatment of samples;
  - Reaction of culm veneer with boiling chemicals in the chambers;
  - Posttreatment of samples;
  - Weathering of samples under both natural and accelerated (in Weatherometer) conditions;
  - Measurement of color change using Monolta chromameter;
  - Observation of structural changes under light and scanning electron microcopy (SEM);
- 4) Editing and date-sorting
  - To publish and disseminate a treatise on production of chemical modified bamboo and its resistance to weathering.

#### 5. INPUT

- 1) Input by China

The Institute of Botany, Chinese Academy of Sciences will provide the project with a laboratory and six researcher scientists (2 research fellows, 2 engineers, 2 research assistants). IN addition, 2 experts who had long research experience in bamboo chemistry and wood science will participate in as advisors. The laboratory contains two rooms together with microscopes, a sliding microtome, mechanical testing equipment, chemical analytical instrument and computers.

If the project is approved, the Science Foundation of China will also donate funds for the administrative expenses and purchasing new instrument.

2) Input by ITTO

- Expenses for collection of bamboo culms in South China.
- Expenses for collection of scientific data on chemical modification of woody materials in Japanese research organizations.
- Expenses for the testing chemicals.
- Expenses for purchasing instrument.
- Expenses for the compilation of research report which includes editing paper, printing and mailing of the treatise.

6. INSTITUTIONAL FRAMEWORK

Chinese Academy of Sciences (CAS, or Academia Sinica) is the largest and most highly ranked academic research unit directly under the State Council of China. It consists of over 100 institutes and research centers of various fields of natural sciences including several botanical institutes, of which Institute of Botany at Beijing is the best and leading institute in the field of life sciences. The Institute is composed of nine departments including department of plant anatomy, utilization, chemistry, taxonomy, physiology, ecology, etc., and a botanic garden which has a total staff of nearly 700 employees. It has the largest botanic library in the country with self-owned stocking over 460,000 books, journals and magazines. The herbarium has the largest collection in Asia with over 1.9 million plant specimens. In addition, more than 4,000 living plants has been introduced to the botanical garden. Our research group endeavors particularly to, both in theory and practice, structural modification of woody materials for the industry for over ten years. It wins over the country a high honor and reputation for uses and modification of plant materials.

The institute is fully capable of completing the tasks mentioned in the proposal.

PART III.  
SCHEDULES OF MONITORING, EVALUATION AND REPORT

1. TECHNICAL REVIEWS

The project will be subject to periodic technical review in accordance with ITTO's rules and procedures for implementing the plan of the project.

2. EVALUATION

The project will be subject to evaluation in accordance with the policies and procedures of ITTO. The organization, scope of investigations and timing of the evaluation will be decided in consultations between ITTO and the Chinese Academy of Sciences.

### 3. PROGRESS REPORTS AND FINAL REPORT

- 1) Progress reports will be annually presented in English.
- 2) The final report will be presented upon the completion of the project in English, French, Spanish and Chinese.

### PART IV. BUDGET

1. <u>Contribution by the Chinese Government</u>	<u>US\$</u>
Salaries for 6 scientists	27,000
Instrument	
a) Sliding microtome & knives	8,000
b) Computers	3,000
c) Microscopes	5,000
d) Physical testing equipment	6,000
e) Chemical analytical equipment	15,000
Natural Science Foundation	15,000
TOTAL .....	<u>79,000</u>
2. <u>Contribution by ITTO</u>	<u>US\$</u>
Travel expenses	
a) To South China	4,000
b) To Japan	12,000
Equipment	
a) Reaction chambers	4,000
b) Weatherometer	6,000
c) Chromameter	6,000
Experiment	
a) Collection of culm samples	2,000
b) Sectioning of culm veneers	4,000
c) Expenses in testing chemicals	4,000
d) Expenses in SEM observations	4,000
e) Determination of color changes	3,000
f) Measurement of dimensional changes	4,000
Scientific documents	6,000
Miscellaneous	5,000
Contingency	4,000
Examination and Print of Reports	6,000
ITTO monitoring and evaluation	5,000
ITTO administrative service charge	4,345
TOTAL .....	<u>83,345</u>

APPENDIX 1

WORK PLAN

ITEMS	YEARS											
	1996			1997			1998			1999		
	1	2	3	1	2	3	1	2	3	1	2	3
1. Collecting data & bamboo specimens	_____											
2. Making experiments		_____										
3. Writing final report							_____					
4. Translating, printing & disseminating the research report									_____			