Sustainable Management and Utilization of Sympodial Bamboos in South-China

Final Report (Short Form)

Serial Number: PD 10/00 REV.2 (I,F)

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of the Chinese Academy of Forestry

Supported by:

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A. Project Identification

1) Title: Sustainable Management and Utilization of Sympodial Bamboos in South-China

2) Serial Number: PD 10/00 REV.2 (I,F)

3) Implementing Agency: The Research Institute of Subtropical Forestry, The Chinese Academy of Forestry

4) Host Government: The People's Republic of China

5) Starting Date: Jan. 1, 2001

6) Duration (months): 48 months

7) Project Cost (US$): US$ 620,150

PART I: Executive Summary

1. INTRODUCTION

1.1 Background

This Project proposal derives from the need to develop technologies and superior planting materials for the sustainable management and effective utilization of sympodial bamboo resource in the southern region of China so as to ensure the sustainable social and economic development of the region and the preservation of ecosystem and biodiversity.

China is the largest bamboo-growing country in the world, where more than 40% and 30% of the world total bamboo species and growing areas are located. Bamboo stands covers 7 million hectares in 16 provinces of south China, mainly in mountainous areas. The economic development of the region is relatively fast, but is very unbalanced. There are 984 mountainous counties with dense population and less developed economy, about half of the 58 million poverty population of the country live in this area, their main way of development depend on mountainous economy and forestry. The total output of bamboo sector of China valued 2.2 billion US$ in 1997, bamboo economy played very important role for the life of mountainous farmers since 93% of the managed bamboo area is contracted to farmers.

There are more than 500 bamboo species in 39 genera in China, Moso bamboo (*Phyllostachys heterocycla var. Pubescens*), a monopodial species, is the most of economic importance which covers 2.72 million hectares, accounting 70% and 76% of the total managed bamboo stand area and volume respectively. The more than 290 species in 20 genera of sympodial bamboo, widely distributed in the south subtropical and tropical region of southern China, accounts less one third of the total managed bamboo stands, only a few species have been utilized on certain scale in some regions. Compared with moso bamboo, the research activities of sympodial bamboo are less. Although the managed area is increased, but the management and utilization level has no big change, the production effect is lower. At the same time, large areas of natural bamboo stands have been reformed as low-value forests, resulting the increased water and soil erosion, deteriorated living environment of human and biodiversity loss.

Chinese forestry management departments and researchers, understanding the important role of bamboo for the ecological environment and social and economic development, have deep consciousness that it is necessary and urgent to adjust the economic structure of bamboo forestry and change the economic development pattern for the present knowledge of the management technology of sympodial bamboo can't meet the demands and the management pattern is unfavorable for the sustainable forestry development.

This program proposal focuses on the need of sympodial bamboo development, researching and putting up the sustainable management and utilization technologies of the main prior species, and launching the technical demonstration and transfer, so as to promote the economic development and the improvement of human life of the region, protect the ecological environment and biodiversity.

1.2 PROJECT OBJECTIVES

1.2.1 Development objective

To develop the knowledge and technologies on sustainable management and improved utilization of sympodial bamboo resources, so as to contribute the socio-economic development of the rural communities, to ensure the conservation and preservation of southern-subtropical and tropical forest ecosystems and biodiversity in south China.

1.2.2 Specific objectives

To understand the ecological function of the bamboo stands and the biodiversity state in order to facilitate sustainable management system of sympodial bamboo.

To promote efficient utilization of sympodial bamboo resources with the aim of promoting economic development and improving the living standard of rural poverty population.

1.3 PROJECT JUSTIFICATION

Sympodial bamboo stands have been managed for timber, shoot, and pulping. There are large area of mixed forests in remote mountains and also vast stands for embankment-protecting along rivers in some regions. The stands play important role for the regional economy and land safe.

In a period of past, bamboo had been considered as low-value non-timber products. Along with the fast decrease of forest area and the valuable timber resources, the management and utilization of bamboo stands have being paid attention popularly. Generally speaking, however, sympodial bamboo resource has not been given reasonable development and protection in China. Among the 290 species, only about ten more species, including *Dendrocalamus latiflorus, Bambusa texilis, B. pervariabilis, Neosinocalamus affinis, Dendrocalamopsis oldhami, D. hamiltonii, Lingnania chungii* etc., have being managed in certain levels. Taking *Bambusa texilis* stands as an example, the annual productions of different sites and management levels are between 3880~33580kg/ha, showing the great potential. It needs to develop researches and technical extension to reform the low-yield stands and increase the productivity.

In some main growing areas, the monopodial bamboo stands are usually managed in high intensity to ensure the high yield, with the treatments such as purified stand culturing, high-intensity harvesting in short rotation, overall land preparation, chemical fertilizer application. However, those treatments just improve the short-term economic outputs, and usually damage the ecological functions and the bases of long-term site productivity of stands. Under such states, the high stand productivity can only be maintained by frequent intensive culture activities. Such kind of management pattern would cause the decrease of site quality, and the harmful effects for the stability and sustainability of ecosystem and social economy.

Due to the special biological characteristics, bamboo plants extend their limits mainly by vegetable propagation. Most of the planting materials are not the superior ones of genetic meaning, so the increases of management effects are mainly depending upon the improvement of culture methods. The knowledge of genetic variation and genetic resource of bamboo are very limited. Although some new raising methods of planting material have been conducted, there are few genetically improved elite materials to be propagated. Finite activities of hybridization breeding are also done unsystematically. So the backward of genetic improvement restricts the increase of production level of bamboo plantations in great extent.

Traditionally sympodial bamboo plants are mainly used for raw culms and shoots. In recent years, the processing industry of bamboo culms has been run rapidly in China, but mainly upon moso bamboo resource. The popular development of village and township enterprises bring certain economic benefits, however, it has the disadvantages of low rate of culm utilization and unstability of product market.

Local governments have had the ideas of reforming the structure of bamboo species resource and developing the local economic species of regional characteristics with certain efforts. It needs to manage the resources in scale and develop new products so that the competition ability of products and economic effect could be increased. Chinese bamboo researchers have been studying the technologies of intensive silviculture and utilization of sympodial bamboo resource in unsystematically, and the results are still not meet the demands of sustainable development of bamboo forestry due to the past limits of science knowledge and research conditions.

2. Project Achievements

2.1 Outputs Achieves

2.1.1 Outputs No.1

1) To set up three collection areas of sympodial bamboo genetic resources and two bamboo species garden, and collecting 139 sympodial bamboo species in Maoming Forstry Gardon and 159 sympodial bamboo species in Nanxiong Bamboo Garden.
2) Finished to divide 3 zones in molecular level by analyzing with RAPD marker for the whole natural distribution range of *D. latiflorus* McClure.
3) Finished to analysis on genetic pattern and diversity of priority bamboo species.
4) Finished six technical reports and five papers.

Four technical reports are as follows:

1) The Current Status of the Sympodial Bamboo biodiversity in Southern China
2) Development Strategy for Protecting Sympodial Bamboo Genetic Resources in China
3) Techniques of Vegetative Propagation for Sympodial Bamboos
4) The genetic variation patterns of main sympodial bamboo species and the selection of superior clones

Five paper have been published in different Chinese periodicals, which are as follows:

1) Study on Bamboo Resource in China and Its Effective Utilization
2) High Pressure Sap Displacement (HPSD) Method for Treatment of Bamboo culms for Anti-spliting and Antimoth
3) Study on the optimization of RAPD condition of *Dendrocalamus latiflorus* McClure
4) RAPD analysis on genetic variation of *Bambusa pervariabilis* McClure
5) Studies on the sowing property of controlled pollinated seeds and the growth of young seedlings of *Dendrocalamus latiflorus* McClure

2.1.2 Outputs No.2

1) To establish 202 research plots for study on sustainable management techniques of sympodial bamboo and 2390 hm^2 high-yield demonstration stands in six bamboo species stands, which are distributed in Guangdong, Guangxi and Fujian province.
2) To establish total 16 surface runoff stations in Guangning, Guangdong province and Nanjing, Fujian province.
3) To find seven best cultivation models for sympodial bamboos.
4) To obtained large income from the high-yield demonstration areas.
5) Finished three technical reports.

Five technical reports are as follows:

1) Management Analysis and Development Strategies of Sympodial Bamboos in China
2) Bamboo ecosystem and carbon dioxide sequestration
3) Environmental Role of Sympodial Bamboos
4) China's Criteria and Indicators (C&I) for Sustainable Management of Bamboo Forests
5) The sustainable high-yield and high-efficient management models of sympodial bamboo forests.

2.1.3 Outputs No.3

1) Improving the technology of bamboo flooring-processing for Lida Bamboo Concrete Forming Co. Ltd. In Fuyang City, Zhejiang province.
2) Building a pilot plant to produce bamboo charcoal in Guangning County, Guangdong province, collaborating with Xinchang Fustar Co. Ltd, Guangning Forestry Bureau, and Bamboo Engineering Research Center, Nanjing Forestry University.
3) Finished study on preservation of bamboo culms
4) Finished three technical reports.

Three technical reports are as follows:

1) Market and Cost Analysis on Bamboo Charcoal Made from Sympodial Processing Residual,

2) Production Technologies, Properties, and Uses of Bamboo Charcoals

3) A Case Study of Production-to-consumption System of bamboo weaving industry in Xinyi City

2.1.4 Outputs No.4

1) To improve the bamboo shoot processing technology for Nanjing Yilong Foods Co. Ltd, in Nanjing County, Fujian province.
2) To develop preservation method for sympodial bamboo shoots.
3) To develop new soft-packed seasoning bamboo products.
4) To finish t the experiments of antibiotic activities of the extractives from leaves and skins of *Phyllostachys glauca* McClure and *Indocalamus tessellates* (Munro) Keng f.
5) To establish the Good Manufacture Practice to ensure hygienic quality-control and food security of shoot.
6) Finished three technical reports.

Four technical reports are as follows:

1) Current Status and Demand Potential of Market for Bamboo Shoot Products

2) Good Manufacturing Practice for Bamboo Shoots Factory

3) The processing technology of sympodial bamboo canned shoots and preservation

4) Testing for Chemical Utilization of Bamboos- Bacteriostasis Effect of the Extractive of Bamboos

2.1.5 Outputs No.5

1) To finish two technical manuals on processing sympodial bamboo products and sympodial bamboo cultivation in Chinese version. They are being translated into English now.
2) Compiling all sixteen technical reports into a book, and will be published.
3) To hold three training course for bamboo cultivation and ecological management in Nanjing of Fujian province in 2002, 2003 and Wuyishan City of Fujian province in 2003 respectively, and more than 280 participants have taken part in these course.
4) Organized two times exhibitions during Yong-an Bamboo Shoot Festival in Oct. 2002 and 2004 respectively. The products, such as bamboo board, bamboo shoot and bamboo charcoal, have been exhibited and 500 copies of propagation material have been provided for visitors.
5) ITTO project and its products have been reported by CCTV, Fujian TV station, Sanming TV station,Yong-an TV station, Fujian daily newspaper, Fujian news net, Fujian government net, Yong-an government net, Yong-an bamboo net, etc. Through the TV program, newspapers and broadcast, ITTO project were well known by local government and farmers, which come out the excellent propagation effects.

PART II: Main Text

1 Conservation of the genetic diversity of sympodial bamboo, and hybridization and cultivation of superior clones.

1.1 Gathering of information and establishment of research strategy

Two technical reports for development strategy for protecting sympodial bamboo genetic resources in southern China and the current status of the sympodial bamboo biodiversity in southern China have been finished (See annex A and B).

1.2 Conservation of the genetic diversity of sympodial bamboo

1.2.1 Biodiversity maintenance of sympodial bamboo

Two collection areas of sympodial bamboo genetic resources and two sympodial bamboo species gardens have been established in Maoming city and Nanxiong city of Guangdong Province respectively. A contrast experimental area for geographical provenances of priority bamboo species has been established in Maoming City of Guangdong Province. And a research plot for the genetic improvement of sympodial bamboos has been established in the state forestry nursery in Nanjing County of Fujian Province.

Up to now, 139 sympodial bamboo species in Maoming Forstry Gardon and 159 sympodial bamboo species in Nanxiong Bamboo Garden from 7 provinces in southern China have been introduced. Both species name lists have been finished (See Annex C1 & C2).

1.2.2 Analysis on genetic pattern and diversity of priority bamboo species

The whole natural distribution range of *D. latiflorus* McClure might be divided obviously into nto 3 zones in molecular level by analyzing with RAPD marker, i.e. the southeast, south china-southwest and Yun-Gui altiplano provenance zone based on the result of cluster analysis.

The RAPD analysis and construction of genetic mapping by using the DNA of the parents and their hybrids of *Dendrocalamus latiflorus* has been finished preliminarily.

The genetic linkage maps have been formulated by using a family of *D.latiflorus* including the parents and 44 progenies. 16 primers have been screened out and 101 belts have been amplified by using RAPD, the DNA fragments ranges from 200bp to 2000bp, 46 belts were 1:1 distributed in the progenies by X^2 test and used for the illustrations. By using MAPMAKER3.0 software, the results showed that 24 belts were linked in 7 linkage groups (See Fig. 1), and the total map distance was 305.7cM with the longest 100.0 cM and the shortest 12.4 cM, the average is 12.74 cM.

1.3 Implementation of study on genetic improvement techniques of bamboo

The hybridized seedlings from artificial pollination from 2001 to 2004 have been afforested in three sites after the nursery of seedling and certain fostering measure have been implemented. The progeny test is located in Nanxiong Bamboo Garden, Guangdong province. The test design is 2 seedlings in a section with repeat of four times at a random sequence. In addition, all the hybrids have a whole forestation test in Nanjing, Fujian province, and 68 seedlings have been planted in Maoming Forestry Garden and all are survived.

In spring 2004, 457 seedlings have been successfully coming out from 1251 seeds, among which 25 were albinism ones, accounting for 5.5%. Albinism emerged at every experiment these years, which possibly results from nutrition lack of the maternal parents, some recessive genes or some virus, that needs to further study.

Big differences exist among the population in diameter, high and shoot number of *D. latiflorus* seedlings at Two years old. There is a significant correlation between diameter and high, but all have no correlation with shoot number. All seedlings that are of mean number of shoot growing have good growth performance in diameter and high, while those with a large or small number of shoot growing have a worse growth performance, which provide superior seedlings for purpose of bamboo shoot production or timber production.

In this part, the technical report for the genetic variation patterns of main sympodial bamboo species and the

selection of superior clones has been finished (See Annex D).

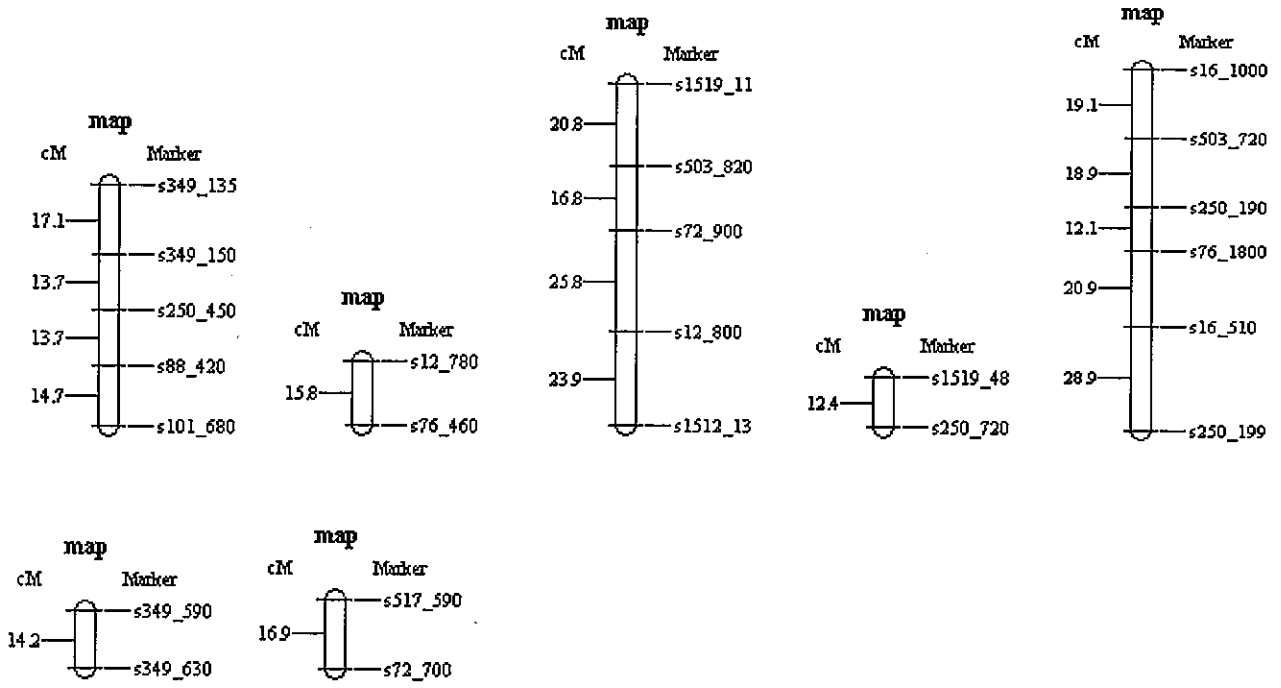


Fig. 1. The genetic linkage maps of *D. latiflorus*

1.4 Study on asexual reproduction techniques of bamboo

1) Tissue culture: The tissue culture propagation technique has been conducted. By using embryo of *D. latiflorus* as explants, the plantlets have been divided and reproduced in vitro. Some progress has been obtained by using buds of infant culms of *D. latiflorus* and adult culms of *D. minor* var. as explants, but the medium needs to further improve.

2) Sub-branch propagation: the study on branch or sub-branch propagation technique has been finished and it has been used in Fujian, Guangdong and Guangxi province.

In this part, the technical report for techniques of vegetative propagation for sympodial mambos has been finished (See Annex E).

2 Ecological functions of various sympodial bamboo stands and sustainable management of sympodial bamboo stands

2.1Gathering of information and definition of research plan

In this part, the technical report for management analysis and development strategies of sympodial bamboos in China and the research plan have been finished (See Annex F)

2.2 Surveying on the ecological functions of sympodial bamboo stands

Two surface runoff stations have been set up in each forest type stands (the intensive and extensive stands of ***B. textilis***, intensive stands of ***Ps. amabilis***, intensive stands of ***D. hamiltonii***, ***D. latiflorus***, natural forest and conifer forest) with about 25^0 slopes. This means total 16 surface runoff stations have been established and the three years data have been obtained (see 1). All data analyses have been finished. The results shows that Runoff coefficient order of different forest type from the highest to lowest: *Dendrocalamus brandisii*> Bamboo + pine Mixed > *Pseudosasa amabilis* > *Bambusa textilis* > Natural forest.

In this part, two technical reports for environmental role of sympodial bamboos and function of sympodial bamboo stands on carbon dioxide sequestration have been finished (See Annex G & H).

Table 1 Distribution of Runoff stations

No.	Forest types	Location	Amount of surface

			runoff stations
1	Bambusa textilis intensive stand	Chunshui, Gaungning	2
2	*Bambusa textilis* extensive stand		2
3	Natural forest		2
4	Pseudosasa amabilis intensive stand	Gushui, Guangning	2
5	Dendrocalamus hamiltonii intensive stand	Guangning forest research institute	2
6	Conifer forest		2
7	D. Latiflorus	Nanjing	4

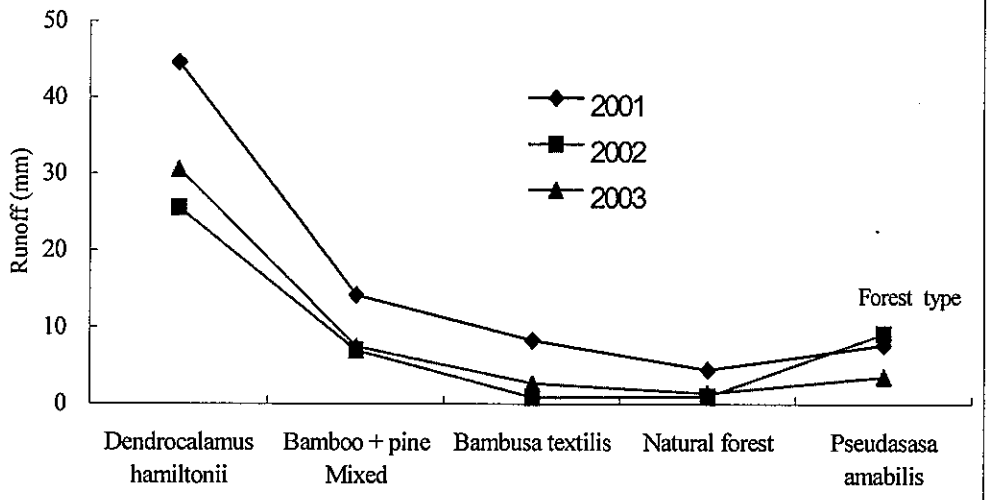


Fig. 2 Average runoff of different forest types in years of 2001-2003

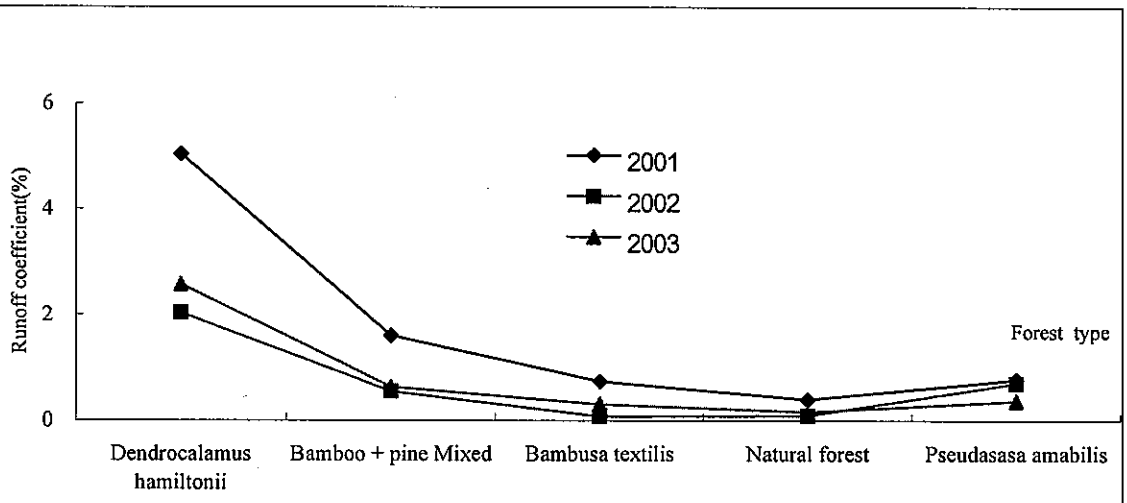


Fig. 3 Average runoff coefficients of different forest types in years of 2001-2003

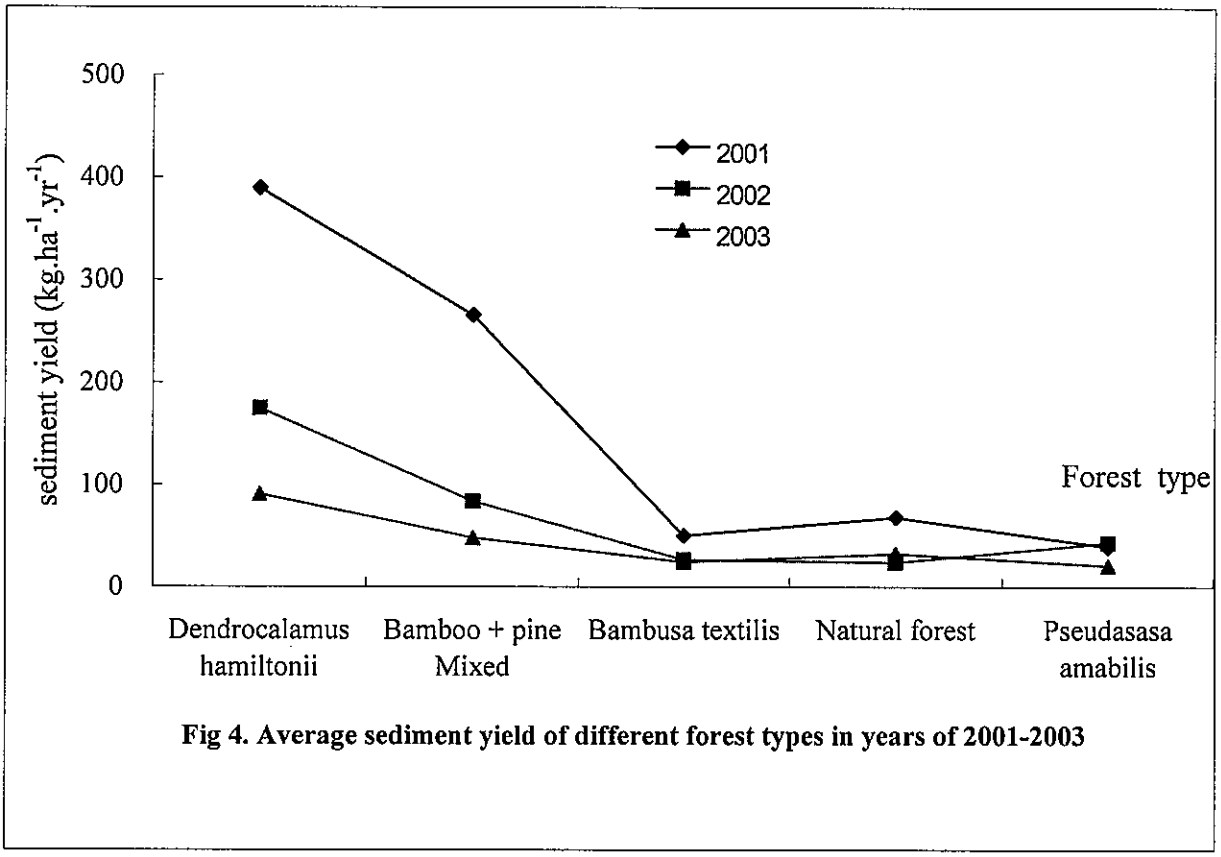


Fig 4. Average sediment yield of different forest types in years of 2001-2003

2.3 Establishment of demonstration areas and research plots

There are 202 research plots for study on sustainable management techniques of sympodial bamboo and 2390 hm^2 high-yield demonstration stands (See Table 2) have been setup in six bamboo species stands, which are distributed in Guangdong, Guangxi and Fujian province.

Table 2. The area distribution of demonstration areas

No.	Type	Location	Area/hm^2	Setup time
1	D. brandisii	Guangning, Guangdong	120	2001.6
2	D. latiflorus	Nanjing, Fujian	200	2002.9
3	*B. textilis* (river bank)	Guangning, Guangdong	600	2001.6
4	B. textilis (mountain)	Guangning, Guangdong	210	2001.6
5	B. chungii	Cangwu, Guangxi	410	2001.9
6	B. pervariabilis	Cangwu, Guangxi	650	2001.9
7	Pseudosasa amabilis	Guangning, Guangdong	200	2001.6
	Total		2390	

2.4 Implementation of study on sustainable management techniques of sympodial bamboo

All the research plots have been observed for four years and all data analysis have been finished. The seven best models have been found.

2.4.1 High-yield techniques study of sympodial bamboo timber stands

The high-yield cultivation techniques of *Bambusa textiles* stands (in mountain and river bank), *Bambusa* chungii, Bambusa pervariabilis and Pseudosasa amabilis for timber production have been conducted. Some high-yield cultivation technical measures, such as clump density and structure modification, fertilization, weeding, etc., have been token, and four years bamboo growing databases has been established and analyzed. Their best models have been found.

1) For ***Bambusa textilis*** stand (in river bank), the best cultivation model is adjusting the bamboo stand density structure to 765 clumps·hm^{-2} and keep 18 culms·clump^{-1} as mother culms in Jan. and Feb., which age structure of 1-year-old : 2-year-oid is 2:1; harvested old culms before March, and removed all old bamboo stumps, raking out soil around clumps for ten days to 2 weeks for shoot buds differentiation, and then adding soil in 15cm depth around each clump base in April and fertilizing 0.5 kg composed fertilizer of N, P and K for each·clump by digging soil around clump in March, June and July respectively, etc. If this model has been adopted, the shoot yield of ***Bambusa textilis*** stands (in river bank) can reach 20.03~20.83t·hm^{-2} (See Fig 5), which is 1.5 times higher than control one, and its net income and adding income can be obtained 8145.3Yuan·hm^{-2} and 2720.59Yuan·hm^{-2} respectively.

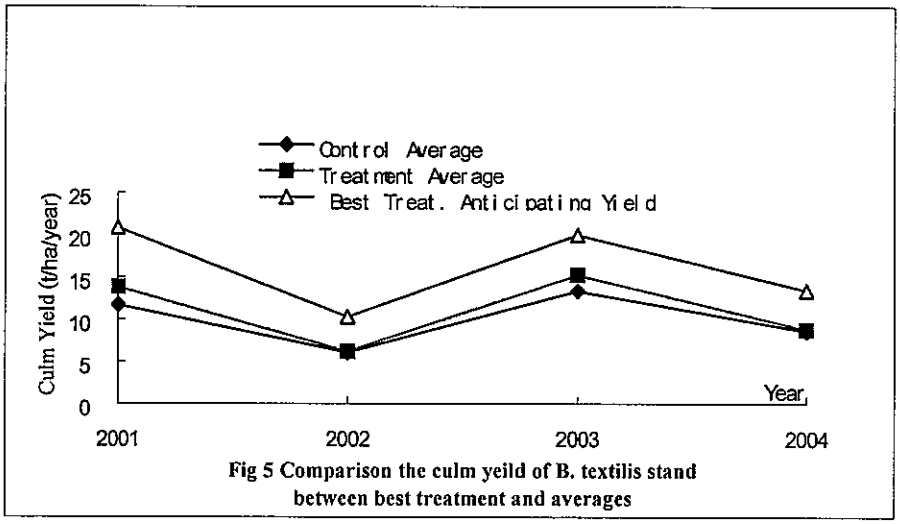


Fig 5 Comparison the culm yeild of B. textilis stand between best treatment and averages

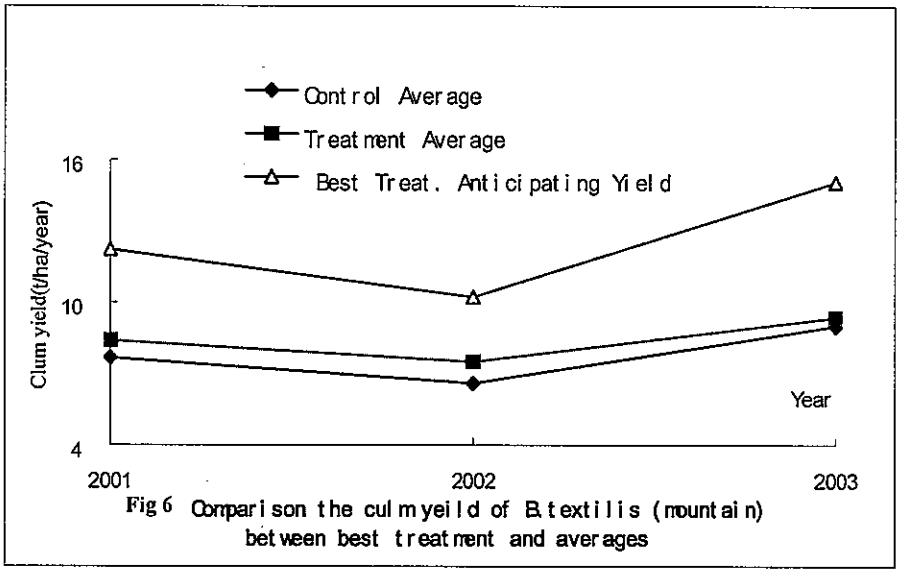


Fig 6 Comparison the culm yeild of B.textilis (mountain) between best treatment and averages

2) For ***Bambusa textilis*** stand (in mountain), the best cultivation model is adjusting the bamboo stand density structure to 2505 clumps·hm^{-2} and keep 12 culms·clump^{-1} as mother culms in Jan. and Feb., which age structure of 1-year-old : 2-year-oid is 2:1; harvested old culms before March, and removed all old bamboo stumps, raking out soil around clumps for ten days to 2 weeks for shoot buds differentiation, and then adding soil in 15cm depth around each clump base in April and fertilizing 0.5 kg composed fertilizer of N, P and K for each·clump by digging soil around clump in June and July respectively, etc. If this model has been adopted, the shoot yield of ***Bambusa textilis*** stands (in mountain) can reach 12.22~15.05t·hm^{-2} (See Fig. 6), which is 1.6 times higher than control one, and its net income and adding income can be obtained 3263.29Yuan·hm^{-2} and 1003.68Yuan·hm^{-2} respectively.

3) For ***Bambusa pervariabilis*** stand, the best cultivation model is adjusting the bamboo stand density structure to 945 clumps·hm^{-2} and keep 15~18 culms·clump^{-1} as mother culms in Jan. and Feb., which age structure of 1-year-old : 2-year-oid is 2:1; harvested old culms before March, and removed all old bamboo stumps, raking out soil around clumps for ten days to 2 weeks for shoot buds differentiation, and then adding soil in 15cm depth around each clump base in April and fertilizing 0.5 kg composed fertilizer of N, P and K for each·clump by digging soil around clump in June and July respectively, etc. If this model has been adopted, the shoot yield of ***Bambusa pervariabilis*** can reach 12.35~13.88t·hm^{-2} (See Fig. 7), which is 1.85 times higher than control one, and its net income and adding income can be obtained 8695.74Yuan·hm^{-2} and 2315.08Yuan·hm^{-2} respectively.

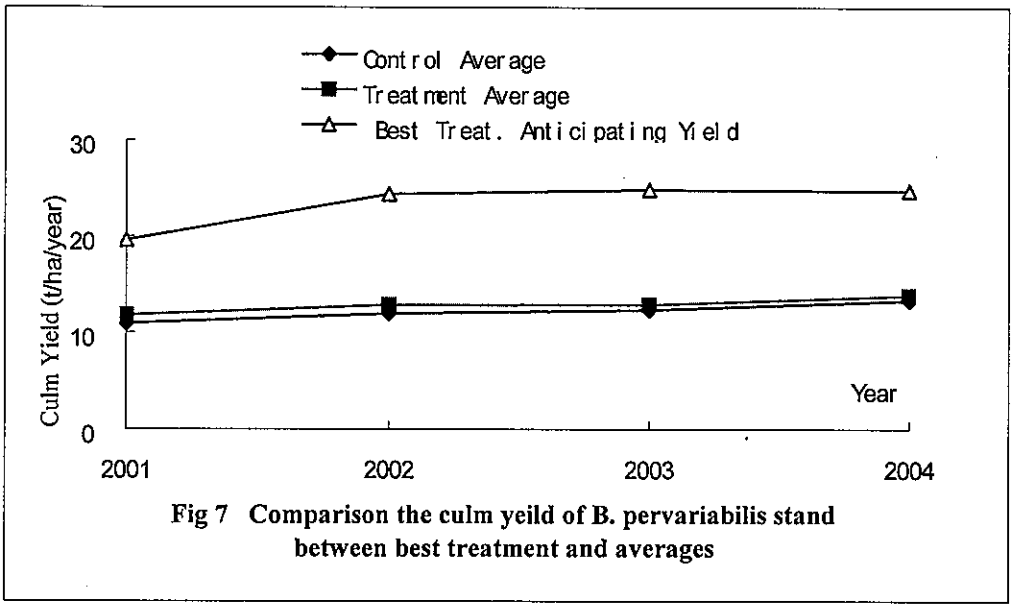


Fig 7 Comparison the culm yeild of B. pervariabilis stand between best treatment and averages

4) For ***Bambusa chungii*** stand, the best cultivation model is adjusting the bamboo stand density structure to 1500 clumps·hm^{-2} and keep 15 culms·clump^{-1} as mother culms in Jan. and Feb., which age structure of 1-year-old : 2-year-oid is 2:1; harvested 50% old culms in Jan. and March respectively, and removed all old bamboo stumps, raking out soil around clumps for ten days to 2 weeks for shoot buds differentiation, and then adding soil in 15cm depth around each clump base in April and fertilizing 0.5 kg composed fertilizer of N, P and K for each·clump by digging soil around clump in March, June and July respectively, etc. If this model has been adopted, the shoot yield of ***Bambusa chungii*** can reach 46.43~47.6t·hm^{-2} (See Fig. 8), which is 1.92 times higher than control one, and its net income and adding income can be obtained 19565.87Yuan·hm^{-2} and 6101.43Yuan·hm^{-2} respectively. The net income of this model is the highest one among seven kinds of models.

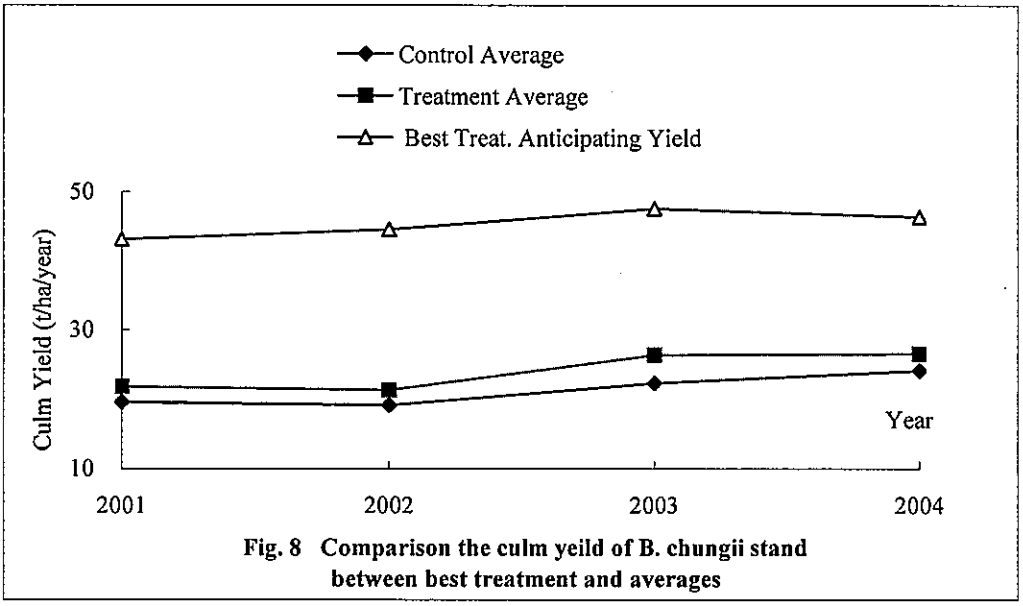


Fig. 8 Comparison the culm yeild of B. chungii stand between best treatment and averages

5) For ***Pseudosasa amabilis*** stand, the best cultivation model is adjusting the bamboo stand density structure to 30000 culms·hm^{-2} and keep the age structure of 1-year-old : 2-year-oid is 1:1; fertilizing 375kg·hm^{-2}·time^{-1}composed fertilizer of N, P and K by digging soil along contour line in Feb. and Sep. respectively; harvested old culms in Nov. of on-year, etc. If this model has been adopted, for two year, the shoot yield of ***Pseudosasa***

amabilis can reach 31.39t·hm^{-2} (See Fig. 9), and its net income and adding income can be obtained 7349.3Yuan·hm^{-2} and 2943.5Yuan·hm^{-2} respectively.

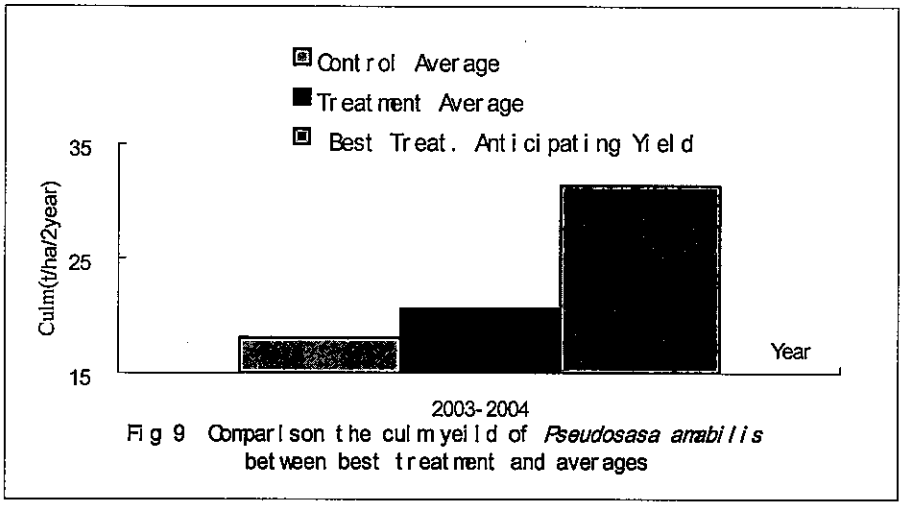


Fig 9 Comparison the culm yeild of *Pseudosasa amabilis* between best treatment and averages

2.4.2 High-yield techniques study of bamboo shoot stands

2.4.2.1 High-yield techniques study of *D. brandisii* bamboo shoot stands

In this experiment, three factors with three levels have been adopted. The result (Table 3) shows that the factor of clump density is the most important one among three factors for *D. brandisii* stands, and keep 6 culms·clump^{-1} as mother clums, adding soil in 15cm depth around each clump base in April and 0.5 kg composed fertilizer of N, P and K for each·clump in June are the best treatment levels for each factor levels respectively.

Because a continuance of dry weather in Guangdong and Fujian province in 2003, it has produced a negative effect for sympodial bamboo stands growth. The shoot yield of D. brandisii in 2003 only has less than 1/3 of normal year shoot yield.

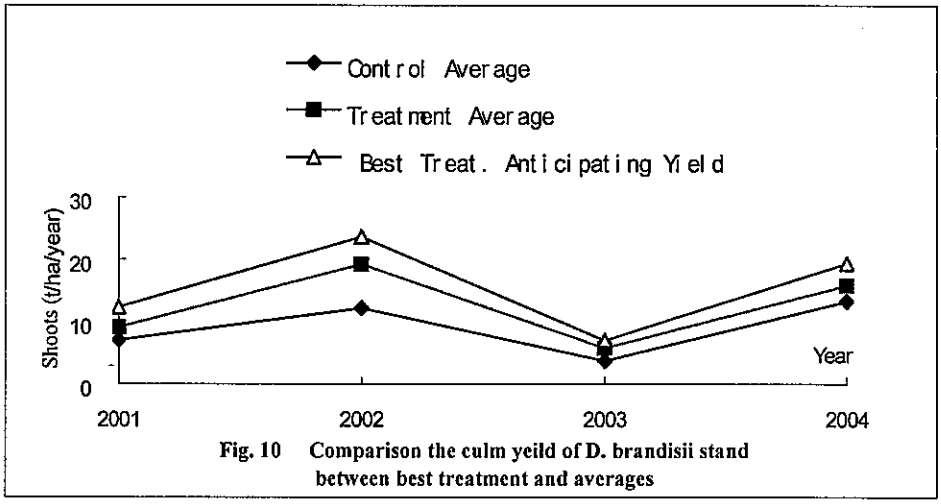


Fig. 10 Comparison the culm yeild of D. brandisii stand between best treatment and averages

For ***D. brandisii*** stand, the best cultivation model is adjusting the bamboo stand density structure to 450 clumps·hm^{-2} and keep 6 culms·clump^{-1} as mother culms in Jan. and Feb., and removed all old bamboo stumps before April; raking out soil around clumps for ten days to 2 weeks for shoot buds differentiation, and then adding soil in 15cm depth around each clump base in April and fertilizing 0.5 kg composed fertilizer of N, P and K for each·clump by digging soil around clump in June, etc. If this model has been adopted, the shoot yield of *D. brandisii* can reach 19.32~23.57t·hm^{-2} (See Fig. 10), which is 1.46~1.94 times higher than control one, and its net income and adding income can be obtained 14989.01Yuan·hm^{-2} and 5941.52Yuan·hm^{-2} respectively.

3.4.2.2 High-yield techniques study of *D. latiflorus* bamboo shoot stands

In this experiment, three factors with two levels have been adopted. The result (Table 4) shows that the two factors of keep new culm amount as mother clums and adding soil in depth are more important than factor of fertilizer for *D. latiflorus* stands, and keep 2 new culms·clump^{-1} as mother clums, adding soil in 15cm depth around each clump

base in April and 0.5 kg composed fertilizer of N, P and K for each·clump in June are the best treatment levels for each factor levels respectively.

The continuance of dry weather in Guangdong and Fujian province in 2003 also has produced a negative effect for *D. latiflorus* stands growth. The shoot yield of *D. latiflorus* in 2003 has less than the normal year shoot yield.

For ***D. latiflorus*** stand, the best cultivation model is adjusting the bamboo stand density structure to 600 clumps·hm^{-2} and each year keep 2 new culms·clump^{-1} as mother culms in Jan. and Feb., and removed all old bamboo stumps before April; raking out soil around clumps for ten days to 2 weeks for shoot buds differentiation, and then adding soil in 15cm depth around each clump base in April and fertilizing 0.5 kg composed fertilizer of N, P and K for each·clump by digging soil around clump in June, etc. If this model has been adopted, the shoot yield of *D. latiflorus* can reach 23.12t·hm^{-2} (See Fig. 11), which is 1.92 times higher than control one, and the net income and adding income can be obtained 11329.63Yuan·hm^{-2} and 6145.46Yuan·hm^{-2} respectively.

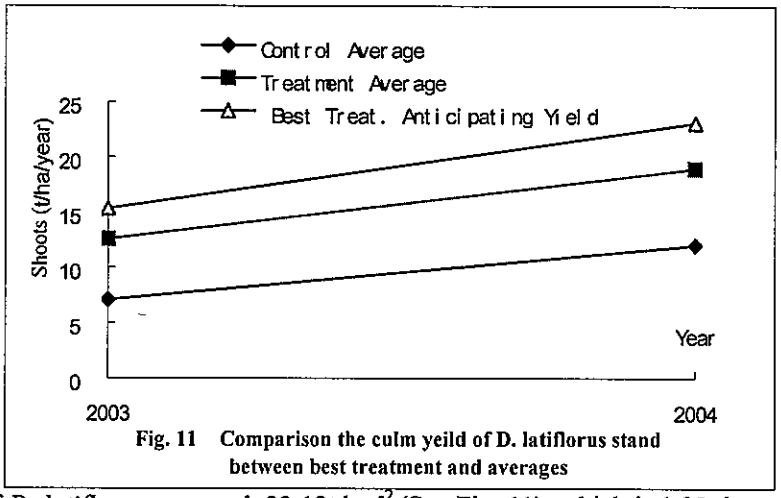


Fig. 11 Comparison the culm yeild of D. latiflorus stand between best treatment and averages

Table 3 Orthogonal design analysis for High-yield techniques study of *D. brandisii* bamboo shoot stands

fo	lump density (culms·clump^{-1})	dding soil depth (cm)	ertilization time; equency and quantity	2001(kg/200m2)		2002 (kg/200m2)		2003(kg/200m2)		2004(kg/200m2)	
				1	2	1	2	1	2	1	2
1	3	0	une; 0.5kg/clump/time	186.8	190.6	354.8	345.4	111.6	141.8	293.2	285.5
2	3	15	une, July; 0.5kg/ clump/time	142.9	177.0	371.0	358.7	107.0	102.9	306.6	296.4
3	3	30	larch, June, July; 0.5 clump/time	193.1	169.4	356.0	353.7	122.0	107.9	294.2	292.3
4	6	0	une, July; 0.5kg/ clump/time	212.0	202.7	412.2	391.0	119.0	102.9	340.7	323.2
5	6	15	larch, June, July; 0.5 clump/time	195.4	230.0	418.9	395.6	115.5	104.1	346.2	326.9
6	6	30	une; 0.5kg/clump/time	191.3	198.1	424.5	418.6	114.4	110.2	350.9	345.9
7	9	0	larch, June, July; 0.5 clump/time	163.9	164.8	371.3	360.0	112.5	124.3	306.8	297.5
8	9	15	une, 0.5kg/ clump/times	170.6	164.6	407.5	398.0	130.2	120.6	331.8	325.6
9	9	30	larch, June, July; 0.5 clump/time	154.4	153.6	379.8	380.2	115.1	115.2	313.9	314.2
10	6	0	------	135.5	148.5	235.50	251.30	79.8	69.3	258.7	271.3
11	176.6	186.8	183.6		181.2		383.2		115.4		316.2
2001 12	204.9	180.1	173.8								
2001 13	162.0	176.6	186.1								
.	42.9	10.1	12.3								
11	356.6	372.4	391.5								
2002 12	410.1	391.6	382.2								
2002 13	382.8	385.5	375.9								
.	53.5	19.2	15.6								
11	115.5	118.7	121.4								
2003 12	111.0	113.4	110.4								
2003 13	119.6	114.1	114.4								
.	8.6	5.3	11.1								
11	294.7	307.8	322.1								
2004 12	339.0	322.3	315.8								
2004 13	315.0	318.6	310.7								
.	44.2	14.5	11.5								

Table 4. Orthogonal design analysis for High-yield techniques study of *D. latiflorus* bamboo shoot stands

	No	A new Culm (culms·clump^{-1})	B Age Structure	C Adding soil n depth (cm)	2003(kg/200m2) 1	2	3	2004(kg/200m2) 1	2	3
	1	2	-year old:2-year-old= 1:1	15	319.2	303.3	313.2	480.9	456.9	471.8
	2	2	-year old:2-year-old = 1:1	30	225.0	245.7	234.0	339.0	370.1	352.5
	3	2	-year old:2-year:3-year-old= 1:1:1	15	139.2	155.4	159.3	209.7	234.1	240.0
	4	2	-year old:2-year:3-year-old= 1:1:1	30	361.8	343.7	355.0	545.0	517.8	534.7
	5	3	-year old:2-year-old= 1:1	15	255.0	278.5	265.2	384.2	419.5	399.5
	6	3	-year old:2-year-old= 1:1	30	157.8	176.1	180.5	237.7	265.3	272.0
	7	3	-year old:2-year:3-year-old= 1:1:1	15	316.5	292.6	352.4	476.8	440.9	530.9
	8	3	-year old:2-year:3-year-old= 1:1:1	30	204.2	198.7	207.2	307.6	299.4	312.1
	9	2	-year old:2-year-old= 1:1	0	148.9	143.5	155.8	253.6	244.3	265.4
	10	3	-year old:2-year:3-year-old= 1:1:1	0	135.0	128.0	137.0	229.9	218.0	233.3
2003	M_1	262.9	246.1	262.5			251.6			379.1
2003	M_2	240.4	257.2	240.8						
2003	R	22.5	11.0	21.7						
2004	M_1	396.1	370.8	395.4						
2004	M_2	362.1	387.4	362.8						
2004	R	33.9	16.6	32.7						

2.5 Implementation of establishing the demonstration model of sympodial bamboo stands.

Above 2.2.2 mentioned, there are 2,390 ha of sympodial bamboo model stands have been established in Guangdong, Guangxi and Fujian. The economic benefits for them have analysis. The results have shown that the seven demonstration areas of sympodial bamboo stands have produced economic effects largely (See Table 5 & Fig. 12). Every year, there is more than 19,445,784.72 Yuan of net income have been obtained.

Table 5 Economical Benefits analysis for each Demonstration Area

No.	Type	Net income /Yuan·hm-2	Add income /Yuan·hm-2	Area /hm2	Total Net income/Yuan	Total Add income/Yuan
1	*D. brandisii*	11598.85	2551.36	120	1,391,862.06	306,163.27
2	*D. latiflorus*	8899.72	3715.56	200	1,779,944.81	743,111.34
3	*B. textilis* (river bank)	7094.46	1669.75	600	4,256,677.42	1,001,851.19
4	*B. textilis* (mountain)	2403.08	143.47	210	504,647.75	30,129.24
5	*B. chungii*	15030.45	1566.01	410	6,162,485.01	642,063.31
6	*B. pervariabilis*	6615.12	234.46	650	4,299,826.59	152,400.55
7	*Pseudosasa amabilis*	5251.71	845.90	200	1,050,341.09	169,180.32
	Total			2390	19,445,784.72	3,044,899.24

If recent research achievements obtained from this project have been applied in these demonstration areas in future, it is found that the large potential benefits from demonstration areas can be obtained further (See Table 6).

In this part, the technical report for the sustainable high-yield and high-efficient management models of sympodial bamboo stands (Chinese) has been finished (See Annex I).

Table 6. Potential benefits analysis of demonstration areas

	Type	Demonstration area		Best cultivation model		Benefit	
		Net income /Yuan·hm^{-2}	Add income /Yuan·hm^{-2}	Net income /Yuan·hm^{-2}	Add income /Yuan·hm^{-2}	Net income /Yuan·hm^{-2}	Add income /Yuan·hm^{-2}
1	D. brandisii	11598.85	2551.36	14989.01	5941.52	3390.16	3390.16
2	D. latiflorus	8899.72	3715.56	11329.63	6145.46	2429.91	2429.9
3	B. textilis (river bank)	7094.46	1669.75	8145.30	2720.59	1050.84	1050.84
4	*B. textilis* (mountain)	2403.08	143.47	3263.29	1003.68	860.21	860.21
5	B. chungii	15030.45	1566.01	19565.87	6101.43	4535.42	4535.42
6	B. pervariabilis	6615.12	234.46	8695.74	2315.08	2080.62	2080.62
7	Pseudosasa amabilis	5251.71	845.90	7349.30	2943.50	2097.59	2097.6

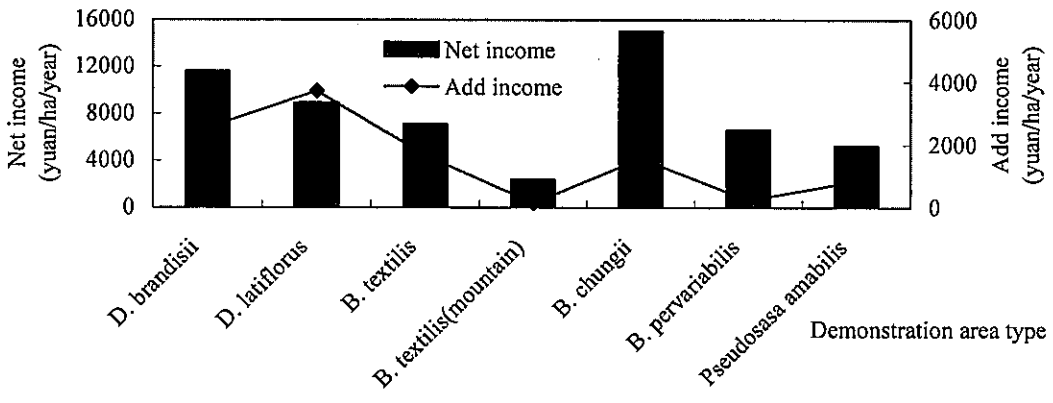


Fig. 12 Comparison the net income and add income among different types of demonstration area

3 Timber Utilization of Sympodial bamboo

3.1 Market survey and marketing strategies

In this part, three technical reports for market and cost analysis on bamboo charcoal made from sympodial processing residual; production technologies, properties, and uses of bamboo charcoals, and a case study of production-to-consumption system of bamboo weaving industry in Xinyi City, Guangdong Province, have been finished (See Annex J, K & L).

3.2 Improving the technology of bamboo flooring-processing

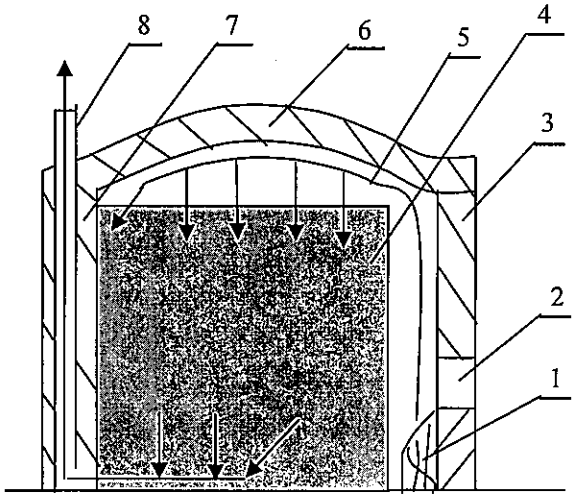
Running in October 2002, the line is on track. Besides bamboo floor, the bamboo and wood composite floor were developed and produced. In order to develop new products and enhance benefit on the base of existing equipment, under the technical support of the Project, Lida Bamboo Concrete Forming Co. Ltd. Fuyang of Zhejiang province has carried out the trial of laminated bamboo square timber that is used to produce bamboo super-veneer, which formed a new surface ornament sheet after combining with no-spin cloth. Bamboo super-veneer will be popular in decorate market because of its natural fine texture and unique color. Lida has successfully fabricated bamboo square timber via bamboo floor making equipment and sold some products to a decorate panel company.

3.3 Building a pilot plant to produce bamboo charcoal

This part of the sub-project is implemented by Guangning-Fustar Co. Ltd, which is set up by collaborating of Xinchang Fustar Co. Ltd, Guangning Forestry Bureau, and Bamboo Engineering Research Center, Nanjing Forestry University. On Aug.27 to Aug.28, 2003, the project researchers have visited Guangning County, Guangdong Province for settling the questions of uneven moist content in bamboo residues in production and of insufficient raw material. After understanding the situation of production and discussing with officials of local government, a method has been identified that the dry phrase of production line should be elongated via adding another dry pipe that would be fabricated by Fustar Co. Ltd at once. Adopting the measure combined with raw material pretreatment, the production line ran very well even during the humid weather. Regarding insufficient raw material supply, the problem was over when local small paper making mill halted using bamboo residues as raw material. At present, bi[illegible]iquett[illegible]duced[illegible]ne ke[illegible]The[illegible]chart of bamboo stick charcoal is as follows:

Residual → Breading down → Filtrating → Drying in a furnace → Convey by air → Forming → Loading kilns → Heating → Carbonizing → Cooling → Unloading kilns → Cutting → Checking → Package

The forming of bamboo sticks is implemented with an extruding machine with a screw in it under the temperature 120 ℃ to 140 ℃. It should point out that the temperature in the kiln at heating stage can be divided into 3 periods: smoking (60 ℃ to 100 ℃), heating (100 ℃ to 150 ℃), and pre-carbonizing (150 ℃ to 300 ℃), during carbonizing stage it can be separated two periods: carbonizing (300 ℃ to 450 ℃) and refining (450 ℃ to 1000 ℃) depending upon the demand of final products. Usually the cooling time is 7~10 days (in winter 7days and in summer 10 days). But cooling time during trial production was much longer then that of regular production when the temperature in the kilns reach the top and then the gates of kilns was sealed with mud. It took near 20 days and the temperature didn't cool down to normal situation. This was caused by that the kilns were built on the thick sand ground and are difficult to completely isolate the air entrance. The little air resulted in burning



1. firewood 2. entrance of firewood 3. front wall 4. bamboo sticks 5.smoking track 6. roof made of brick 7. back wall 8. chimney

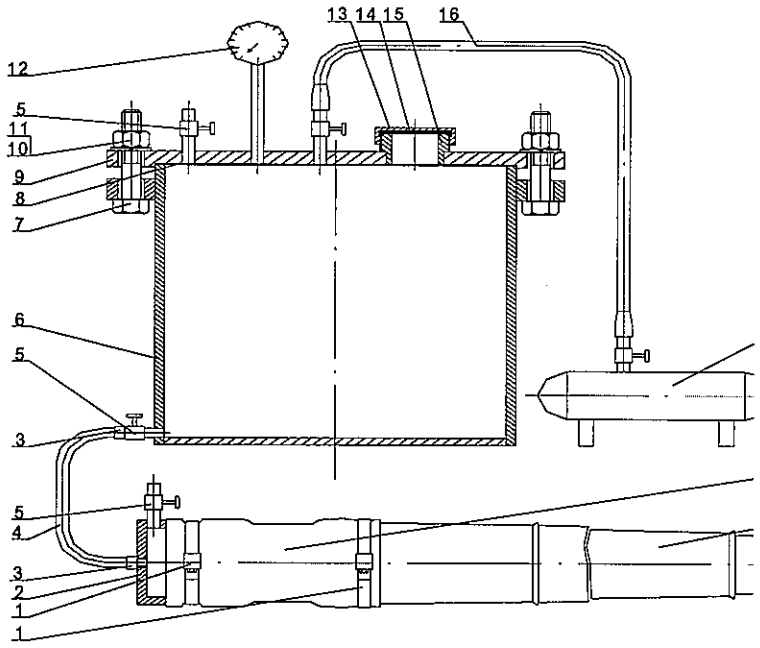
Fig. 13 sketch map of a brick kiln heating bamboo charcoal

slowly of part of charcoal. So bamboo charcoal's quantity was less and its quality was poor than normal production during the first trial production. We analyzed the failure and made a determination of building another 4 kilns using 2 improvement methods: 1) decrease the size of kilns to get even temperature in the kilns; 2) remove sand on the ground and replace with clay, then cast cement on the ground.

3.4 Study on preservation of bamboo culms

Bamboo, unlike wood, shows hollow cylinder in structure with density gradually reducing from out layer to inner layer. Moreover, almost all vascular bundles are longitudinal direction without transverse tissue. So bamboo features outstanding anisotropic and tends to crack on its surface when its temperature and moisture change. On the other hand, bamboo is rich in nutrients including 1.5%~6% protein, 2%sugar, 2%~6% starch, 2%~4% fat and wax. Insects easily attack it under suitable temperature and humidity. So unsettled bamboo culms has short lifetime under outdoors condition.

In order to extend lifetime of bamboo culms, a few of BERC members tread bamboo culms with inorganic salts such as sodium chloride, magnesium chloride, and calcium chloride and polymeric compounds such as polyethylene glycol, polyvinyl alcohol, and polyvinyl butyral and thermosetting phenol-formaldehyde resin to bulk the surrounding wall of fiber and the parenchyma cell by pressing these agents into a bamboo culm from its top. The top-pressing device shows in Fig. 14.



1.rings 2. cap 3. joints 4. pipe 5. valve 6. solution container 7. screws 8. large seal ring 9. container cover 10. nuts 11. gasket 12. air pressure meter 13. cap for solution entrance 14. small seal ring 15. solution entrance 16. pipe 17. air compressor 18. rubber pipe 19. a bamboo culm for treatment

Fig.14 .device for bamboo culm end pressing

Experimentation result indicates: 1) the tangential shrinkage ratio of culms reduces from 3.85% to 1.34%~2.68% after treated with inorganic salts. This is able to lessen the checking tendency of culms; 2) according to anti-checking effect, polyethylene glycol is the best agent, second inorganic salts and phenol formaldehyde resin; 3) 3.5% NaF solution has the best insecticide effect, second 34% solution $CaCl_2$ and 4% NaPCP solution; 4) regarding the integrated effect both anti-checking and insecticide, $CaCl_2$ is best, and the polyethylene glycol and phenol formaldehyde resin not including insecticide in them have only anti-checking effect.

4 Comprehensive processing techniques of bamboo shoots and chemical utilization of bamboos

4.1 Market survey and marketing strategies

In this part, technical reports for current status and demand potential of market for bamboo shoot products has been finished (See Annex M).

4.2 Research and development of seasoning shoots and preservation of bamboo shoots

The test of preservation of bamboo shoots has been implemented successfully in Nanjing Yilong Foods Co. Ltd. and the analysis of nutrients of different shoot products have been finished, the technical reports on preservation of bamboo shoots and the nutrients of sympodial bamboo shoots has been finished (See Annex N). In addition, new soft-packed seasoning bamboo products have successfully been developed, technically supported by the project,

which have been exported to Japan market.

4.3 Doing some experiments for comprehensive chemical utilization of bamboos

4.3.1. Materials and methods

4.3.1.1 Testing materials

4.3.1.1.1. Bamboos:

Phyllostachys glauca McClure and Indocalamus tessellatus(Munro)Keng f., Sampled in Anji Bamboo Botanic Garden.

4.3.1.1.2 Bacterial strain

Staphylococcus aureus, Escherichia coli, Bacillus subtills, Candida albicans and Saccharomyces cerevisiae, Purchased from Zhejiang Microbiology Institute.

4.3.1.1.3 Culture medium

Solid medium for Bacteria: Peptone 5.0g, Beef cream 3.0g, NaCl 5.0g, agar 15.0g, water 1000ml.

Liquid medium for Bacteria: Peptone 5.0g, beef cream 3.0g, NaCl 5.0g, water 1000ml.

Solid medium for microzyme（Sabouraud's agar）: Glucose 40.0g, peptone 10.0g, agar15.0g, water 1000ml.

Liquid medium for microzyme: Glucose 40.0g, peptone 10.0g, water 1000ml.

4.3.1.1.4 Extractive of bamboos

60g airing dried bamboo leaves of *Phyllostachys glauca* and *Indocalamus tessllatus*, after grounded into powders, were submerged in solution of 50 ml ethanol, 30 ml glacial acetic acid and 200 ml distilled water for 24 hour. After it become chocolate brown, the solution was filtrated and distilled for removing the ethanol and acetic acid, and then added the water into 60 ml for the antibiosis testing. The acetone extractive and ethyl acetate extractive of bamboo leaves were prepared in a similar way.

4.3.1.1.5 Preparing bacterium solutions

Five bacterium were activated in slope culture mediums respectively, and then after inoculated in corresponding culture mediums they were cultured in temperature control cabinet for 24 hours at 30℃. And then they added proper amount of sterilized water and librated.

4.3.1.2 method of antibiosis testing

The prepared 7 mm diameter filter papers were sterilized and water, acetone and acetic acid soliquoids of bamboo leaves of *Phyllostachys glauca* and *Indocalamus tessllatus* in the density of 500mg/ml respectively. And then the sterilized filter papers were submerged in prepared soliquoids for 24 hours and 0.2ml prepared bacterium solution were coated on the plates respectively. The submerged filters papers by water extractives of *Phyllostachys glauca* and *Indocalamus tessllatus* were adhibited on the plates (two plates each vessel) with 3 repetitions for each bacterium in comparison with sterilization water submerged paper (see Fig.15). In same way, the acetone extractive of two bamboo species were tested in comparison with sterilization water or acetone submerged papers, and the ethyl acetate extractive were tested in comparison with water or acetate submerged filter papers. Finally, the diameters of the (have cultured in the temperature control cabinet for 24 hours.

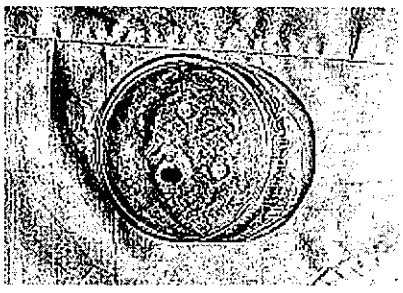


Fig.15 Antibiotic test by bamboo

4.3.2. Results and Analysis

Table 7 shows that the water extractive of *Phyllostachys glauca* leaves have different effects of antibiotic activities, but it is more strong antibiotic activities for *Candida utilis* and *Staphylococcus aureus* than for *Bacillus subtills* and *Saccharomyces cerevisiae* and the water extractive of *Indocalamus tessellates* have strong effects of antibiotic activities on all testing bacterium except for *Candida utilis*. The acetone extractive of *Phyllostachys glauca* leaves has also antibiotic activities, which rank as: *Bacillus subtills*>*Escherichia coli*>*Staphylococcus aureus*>*Candida utilis*, while the antibiotic activities of acetone extractive of *Indocalamus tessellates* rank as: *Escherichia coli*>

Bacillus subtills > *Candida utilis* > *Staphylococcus aureus* > *Saccharomyces cerevisiae*(see Table 8). The ethyl acetate extractive of *Phyllostachys glauca* leaves has antibiotic activities on five testing bacterium, but ethyl acetate itself has also antibiotic activities. The ethyl acetate extractive of *Indocalamus tessellates* has strong antibiotic activities for 5 bacterium, while ethyl acetate itself has no obvious inhibition on *Candida utilis* and *Saccharomyces cerevisiae* but has obvious inhibition on *Staphylococcus aureus*(see Table 9).

Table 7. Bacteriostasis effect of the water extractive from bamboo leaves

(bacteriostasis circle diameter in mm)

	Candida utilis	Saccharomyces cerevisiae	Bacillus subtills	Escherichia coli	Staphylococcus aureus
Water	7.0	7.0	7.0	7.0	7.0*
Phyllostachys glauca McClure	11.0	8.5	8.5	9.0	11.0
Indocalamus tessellatus(Munro)Keng f.	8.2	11.0	13.0	15.2	13.0

* diameter of filter paper

Table 8. Bacteriostasis effect of the acetone extractive from bamboo leaves

(Bacteriostasis circle diameter in mm)

	Candida utilis	Saccharomyces cerevisiae	Bacillus subtills	Escherichia coli	Staphylococcus aureus
Acetone	7.5	7.5	7.0	8.0	7.0
Phyllostachys glauca McClure	10.0	12.0	18.0	19.0	12.0
Indocalamus tessellatus(Munro)Keng f.	14.5	12.0	20.5	19.0	12.5

Table 9 Bacteriostasis effect of the hexyl acetate extractive from bamboo leaves

(bacteriostasis circle diameter in mm)

	Candida utilis	Saccharomyces cerevisiae	Bacillus subtills	Escherichia coli	Staphylococcus aureus
Hexyl acetate	14.0	11.0	12.0	11.0	11.5
Phyllostachys glauca McClure	28.0	17.0	18.5	30.0	25.0
Indocalamus tessellatus(Munro)Keng f.	18.0	22.0	19.2	23.0	32.0

4.3.3.Conclusions

The preliminary results have been obtained by examining their antibiotic activities of the water, acetone and hexyl acetate extractives from the leaves of *Phyllostachys glauca McClure* and *Indocalamus tessellatus(Munro)Keng f.*, which shows that all the extractives have obvious strong antibiotic activities on some bacterium such as *Staphylococcus aureus*, *Escherichia coli*, *Bacillus subtills*, *Candida utilis* and *Saccharomyces cerevisiae*. And acetone and ethyl acetate extractive have more strong antibiotic activities than water extractive. But the antibiotic activities is influenced by extracting solution, such as the ethyl acetate that has inhibition effect on some bacterium.

4.4 Establishing the Good Manufacture Practice to ensure hygienic quality-control and food security of shoot products

The manual of the good manufacture practice for bamboo shoots factory (See Annex P) has been documented for establishing quality control system for bamboo shoot processing factory, which include organization framework, environmental hygiene, workshop and equipment's hygiene, requirements of raw materials, staffs' hygiene, hygienic control during manufacturing, quality control during sterilizing, checking, testing, packing, storing and transporting, as well as management system.

5 A training and promotion program on the sustainable management and utilization of sympodial bamboos.

5.1 Preparation of technical manual on sympodial bamboo cultivation and Utilization

Two finished draft technical manuals on processing sympodial bamboo products and sympodial bamboo cultivation

in Chinese version has been further improved/revised with more boxes, and figures-maps-graphs so that get farmers easily understand, and are being translated into English now. Meanwhile the Project are continually contacting with the Chinese Forestry Publishing House to exchange the publishing schedule. Advanced technical manual on utilization of sympodial bamboo are reviewed.

5.2 Preparation of technical reports

Sixteen technical reports of this project have been finished and five papers have been published in different Chinese periodicals. Some finished technical reports have being revised/improved for publishing based on suggestion and comment of project consultant. All technical report will be compiled a book and published.

Sixteen technical reports are as follows:

1) Management Analysis and Development Strategies of Sympodial Bamboos in China
2) Market and Cost Analysis on Bamboo Charcoal Made from Sympodial Processing Residual
3) Current Status and Demand Potential of Market for Bamboo Shoot Products
4) Good Manufacturing Practice for Bamboo Shoots Factory
5) The Current Status of the Sympodial Bamboo biodiversity in Southern China
6) Bamboo ecosystem and carbon dioxide sequestration
7) Production Technologies, Properties, and Uses of Bamboo Charcoals
8) Development Strategy for Protecting Sympodial Bamboo Genetic Resources in China
9) Techniques of Vegetative Propagation for Sympodial Bamboos
10) China's Criteria and Indicators (C&I) for Sustainable Management of Bamboo Forests
11) Environmental Role of Sympodial Bamboos
12) The sustainable high-yield and high-efficient management models of sympodial bamboo forests.
13) The processing technology of sympodial bamboo canned shoots and preservation
14) Testing for Chemical Utilization of Bamboos- Bacteriostasis Effect of the Extractive of Bamboos
15) The genetic variation patterns of main sympodial bamboo species and the selection of superior clones
16) A Case Study of Production-to-consumption System of bamboo weaving industry in Xinyi City

Five paper have been published in different Chinese periodicals, which are as follows:

1) Study on Bamboo Resource in China and Its Effective Utilization
2) High Pressure Sap Displacement (HPSD) Method for Treatment of Bamboo culms for Anti-spliting and Antimoth
3) Study on the optimization of RAPD condition of *Dendrocalamus latiflorus* McClure
4) RAPD analysis on genetic variation of *Bambusa pervariabilis* McClure
5) Studies on the sowing property of controlled pollinated seeds and the growth of young seedlings of *Dendrocalamus latiflorus* McClure

5.3 Training courses on sympodial bamboo management and utilization

Three training course for bamboo cultivation and ecological management have been conducted in Nanjing of Fujian province in 2002 and Wuyishan city of Fujian province in 2003 respectively. The details are as follows:

1) Training Course 1: the course of cultivation and vegetative propagation techniques of sympodial bamboos has been held in Nanjing county, Fujian Province, on Nov. 11 to 16, 2002, and 70 participants have taken part in this courses.

Fig.16 Training Course in Wuyishan,

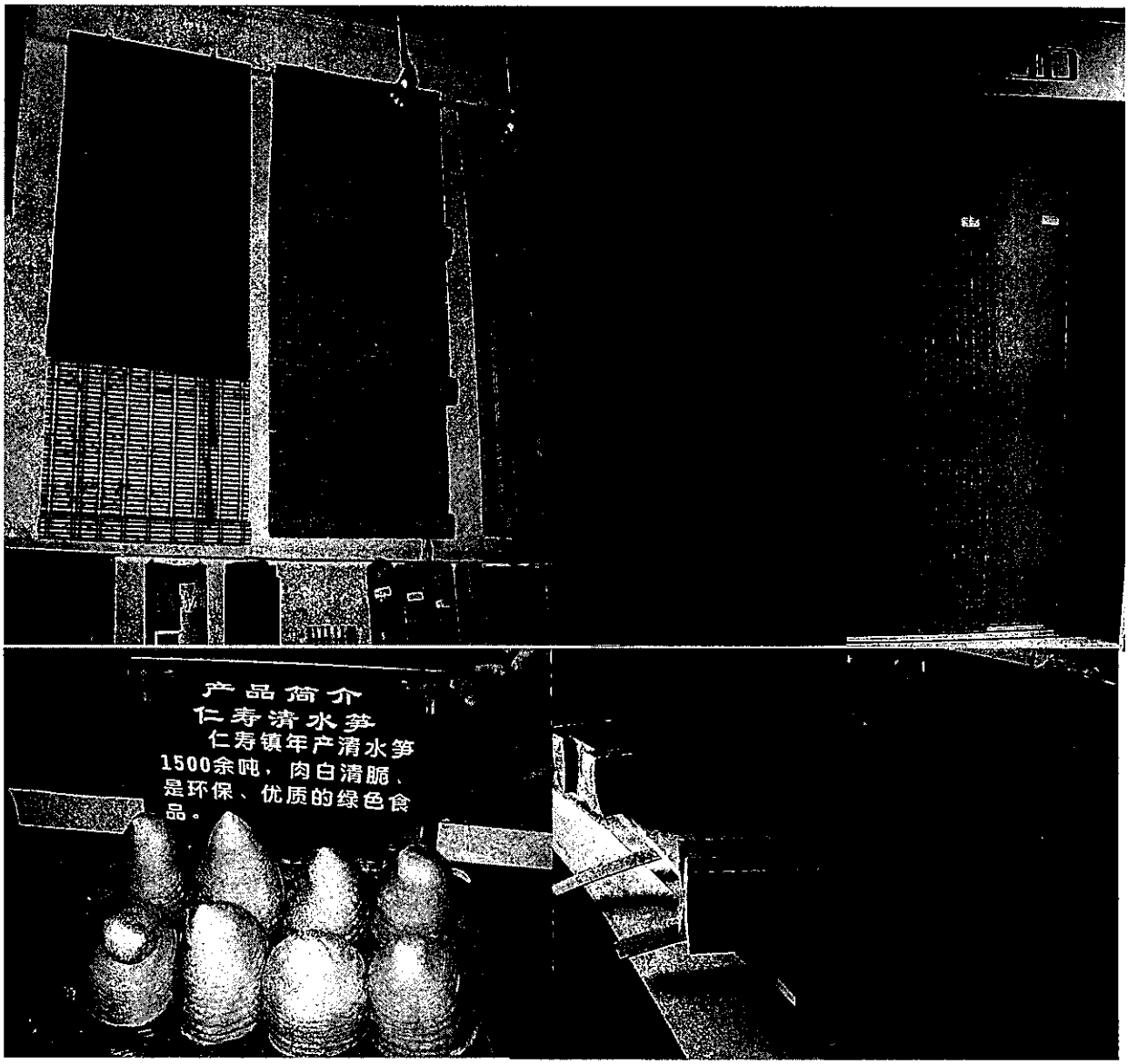
2) Training Course 2: the course of biodiversity and ecological function of sympodial bamboo has been held in Nanjing county, Fujian Province, on Oct. 8 to 15, 2003, and 60 participants have taken part in this courses.

3) Training Course 3: the course of cultivation technology and improvement of bamboo land has been held in

Wuyishan City, Fujian Province, on Nov. 25 to 27, 2003, and 150 participants have taken part in this courses (see Fig. 16).

5.4 Exhibition of sympodial bamboo products

Two times exhibitions have been organized by relevant bamboo processing factories to participate in the exhibition during Yong-an Bamboo Shoot Festival in Oct. 2002 and 2004 respectively. The products, such as bamboo board, bamboo shoot and bamboo charcoal, have been exhibited and 500 copies of propagation material have been



Exhibiton of bamboo board & bamboo shoots

provided for many visitors.

5.5 Promotion of benefits of sympodial bamboo sector in the media

The Yong-an Bamboo Shoot Festival has been reported by Fujian TV station, Sanming TV station and Yong-an TV station and also reported by CCTV, Fujian daily newspaper, Fujian news net, Fujian government net, Yong-an government net, Yong-an bamboo net, etc. Through the TV program, newspapers and broadcast for festival, ITTO project were well known by local government and farmers, which come out the excellent propagation effects.