

# ITTO

## PROJECT COMPLETION REPORT

Title:	Development and Extension of Rubberwood Processing and Utilization Technology
Serial Number:	ITTO PD 3/96 Rev. 2 (I)
Executing Agency:	Research Institute of Wood Industry (CRIWI), Chinese Academy of Forestry (CAF)
Host Government:	P. R. China
Starting Time:	October 1996
Actual Duration:	27 months
Actual Project cost:	US\$432,214

## **PART I. EXECUTIVE SUMMARY**

### **1. Background Information about the Project**

#### **(a). The key problems it intended to solve (pre-project situation)**

The common used preservative is a mixture of borax, boric acid and sodium pentachlorophenol (BBP). All the plants in Hainan and most plants of Guangdong province use BBP. The pentachlorophenol in BBP is highly toxic and it has been strictly restricted or prohibited in some countries. BBP is highly corrosive to the inner surface of the impregnating tank as well as the components of seasoning kilns. Furthermore, BBP also discolors the wood, thus lowering the acceptability and value of treated rubberwood. Pentachlorophenol-free preservative for rubberwood will therefore minimize many of the problems encountered at present. The procedures of treating rubberwood with preservative containing only borax and boric acid followed by kiln drying, commonly practiced in Malaysia, should be studied for possible adaptation for the industry in China.

Most of the kilns used for drying rubberwood are the conventional steam-heated ones. In addition, proper attention is generally not paid to seasoning rubberwood, either due to the lack of understanding the importance of these procedures, or the lack of training of drying technology. The drying period for rubberwood is fairly long resulting in high-energy consumption, and the discoloration of sawn timber is often serious.

There is limited assortment of rubberwood plywood in domestic market. In path with the demand of market and the requirement of the national fire-protection code, it is urgent to develop fire-retardant plywood. Fire-retardant plywood can be used as decorative materials in construction. The application of the technology, developed by CRIWI, will be used in fire retardant treatment of rubberwood plywood to improve the utilization efficiency of rubberwood, to bring greater economic benefit and to promote the trade of rubberwood products.

Awareness of technology and product development as well as production management techniques will need to be instilled to increase value-adding and upgrade the industrial competitiveness. These could be achieved through having regular training courses for the operators and supervisory staff, which will be an important component of this project. Opportunities to visit and/or participate in regional rubberwood processing industries or international conference would be beneficial to the researchers and industrialists.

#### **(b). The Specific Objective and Outputs**

##### **- Specific Objective**

To upgrade the efficiency and competitiveness of the rubberwood processing industry in China.

##### **- Outputs**

1. Establish preservation and drying techniques upon adapting mature procedure based on borax and boric acid preservative and guidelines for manufacturing fire retardant rubberwood plywood.

2. Training courses for operators, technicians and supervisory staff; participation /visits to regional /international fairs, seminars; workshop /seminar to disseminate the outputs of this project.

**(c). Strategy adopted in carrying out the project**

- Project partner

In order to get more benefits to China rubberwood industry by this project, the co-operation with many organizations was made, namely: General Bureau of Hainan State Farms (GBHSF), General Bureau of Yunnan State Farms (GBYSF), National Forestry Administration, Yunnan Forest Bureau, China Furniture Association, the Institute of Zoology, Chinese Academy of Science, Guangdong Entomological Institute, Tropical Forest Research Institute etc.

As most of the R & D works, training courses and workshop was planned to carry out in Hainan Island, the Industry Department of GBHSF was selected as the partner of this project for execution of part of the activities of this project. Its main functions are the statistics of Hainan rubberwood resource, management of rubber tree logging and rubberwood processing, etc.

- R & D

Introducing the advance technology from overseas like Malaysia and developing technology by this project were carried out at same time. And both technologies were given to the target beneficiaries, especially local rubberwood industry for upgrading the efficiency and competitiveness of the rubberwood processing industry in China.

- Technology transfer

As the training course and workshop/seminar is one of the very important ways to transfer scientific and technical knowledge, efforts were made to invite people related to rubberwood as many as possible to attend the training course, seminar, and workshop of this project. Special efforts were made to invite the National /Provincial /local government sectors, typical rubberwood companies.

Considering the acceptability of scientific knowledge by the participants, some basic knowledge about rubberwood was given at the beginning of each training course.

And the practical parts of the R & D results, development trends, and suggestions were strengthened in the presentation during the training courses, seminar and workshop. However, other parts such as the basic R & D results were given in the papers to participants.

**(d). Project's planned duration and planned overall costs**

It was planned for 24 months and the planned overall cost was US\$ 408,398 in which ITTO contribution was US\$214,798 and China Government contribution was US\$193,600.

**(e). Specific sector at country or regional level to which the project relates**

As the 4<sup>th</sup> largest rubberwood resource in the world, China rubberwood plantation was 618,500 hectares in which 374,000 hectares was in Hainan Island, 156,500 hectares was in Yunnan Province and 88,000 hectares was in Guangdong Province.

Rubberwood in Hainan Island was mostly developed in comparison with other places of China. And the General Bureau of Hainan State Farms (GBHSF) owns 66.5% of rubberwood plantation of Hainan Island. In Hainan State Farms sector, the growing stock of rubberwood was 13.5 million cubic meters. The annual supply of rubberwood was around 350,000m<sup>3</sup> (average data from 1988 to 1997). As the policy of protection of natural forests in China was taken at the end of 1997, the shortage of timber in China would last for quite long time. This would result in higher demand of rubberwood in near future. Re-plantation of 3% rubber tree each year was planned in Hainan State Farms sector. This means that the annual supply of rubberwood would be 418,000m<sup>3</sup> of log and 188,000m<sup>3</sup> of branches.

The industry use of rubberwood began at 1985-1987. In Hainan State Farms sector, the annual production capacity was 400,000m<sup>3</sup> of sawn timber, 20,000m<sup>3</sup> of plywood, and 39,000m<sup>3</sup> of MDF at 1998. The average annual output of rubberwood products from 1991 to 1996 was 60,000m<sup>3</sup> of sawn timber, 15,000m<sup>3</sup> of plywood, 25,000m<sup>3</sup> of particleboard and 779,000 sets/pieces of furniture. Other rubberwood products were flooring, blockboard, molding board, laminate, and handicrafts.

## **2. Project Achievements**

### **(a). Outputs achieved**

#### **- Reports**

##### **(1). Investigation Report of Rubberwood Fungal Infection**

After comprehensive investigation in Hainan and Yunnan Provinces in different seasons (dry and rainy season), the identification and classification of rubberwood decay, stain and mold fungi from Hainan and Yunnan Provinces were reported. 23 species of rubberwood decay fungi were identified, in which 5 species of decay fungi were firstly reported in Hainan Island and 1 species of decay fungi was firstly reported in Yunnan Province. 10 species of mould fungi of rubberwood were identified, in which 4 species of mould fungi were firstly reported and 2 species were firstly reported in rubberwood ( this was reported in other wood before). 3 species of stain fungi of rubberwood were identified, in which 2 species were firstly reported in China rubberwood.

##### **(2). Rubberwood Insect Deterioration Report**

After comprehensive investigation in Hainan and Yunnan Provinces in different seasons (dry and rainy season), the identification and classification of rubberwood insects from Hainan and Yunnan Provinces were reported. Totally 36 species of rubberwood insects were identified and classified, in which one insect (*Acicnemis sp.*) was firstly reported in the world. This is a new record in the history of the classification of insect science.

##### **(3). Report of Development of Antistain and Antimold Formulation**

The effectiveness of chlorothalonil formulations developed by CRIWI was reported, including laboratory evaluation, pilot test for rubberwood log, sawn timber and veneer, and vacuum pressure treatment with the mixture of chlorothalonil formulations and borax /

boric acid. It indicated that one of the chlorothalonil formulations could provide 15-day protection for rubberwood against blue stain and mould.

#### (4). Report of Short Term Protection for Rubberwood

In order for developing appropriate technology to replace toxic NaPCP, anti sapstain chemical of Antiblu 20EC was used to evaluate the short-term protection performance for rubberwood. It showed that the protection of fresh sawn rubberwood or the boron preservative treated rubberwood from deterioration (mould and sapstain) can be achieved for as long as 12 weeks by dipping treatment with Antiblu 20EC.

#### (5). Report of Long Term Protection for Rubberwood

In order for developing appropriate technology to replace NaPCP, pressure treatment were carried out with borax, boric acid, Parachem and Sodium Borate Special to evaluate the long term protection performance of boron preservative for rubberwood. By using borax/boric acid, Sodium Borate Special or Parachem, the boric acid equivalent over 0.4% can be achieved with pressure treatment. Therefore, rubberwood can be processed with good anti insect (especially borers) attack performance.

#### (6). Report of Drying Technique of Boron Preservative Treated Rubberwood

To determine the best drying technique, The characteristics of rubberwood treated with NaPCP free preservative were reported. It also included the relationship of drying quality (drying checks, moisture content deviation, drying stress, deformation, and timber color) with the schedules.

#### (7). Report of Flame-retardant Rubberwood Plywood

The result of the laboratory study and pilot trial of the treatment using the fire retardant formula was reported. It also included the results of fire testing and mechanical property testing according to China National Standards. The fire retardant formula was modified from that developed originally by CRIWI.

#### (8). Study Tour Report

From 2nd to 20th June 1997, 1 research organization (Forest Research Institute Malaysia), 2 government departments (Malaysian Timber Industry Board, Royal Forestry Department of Thailand), 10 rubberwood processing companies in Malaysia and 5 rubberwood processing companies in Thailand, were visited. And a seminar given by 4 organizations was attended. The topics were including: 1) rubberwood and its preservation; 2) utilization of rubberwood for panel board in Malaysia; 3) frame saw technology and solid wood flooring manufacture; 4) rubberwood downstream activities and international marketing. From this study tour, a quite lot of new ideas for how to improve the rubberwood processing industry in China were gained, mainly: a). the plantation of rubber tree for both latex and timber; b). the management of rubberwood processing; c). the treatment of rubberwood with safer chemicals.

#### (9). Reports of Attending International Conferences

a. The 28th International Research Group on Wood Preservation (IRG) Conference that was held in Whistler, North from Vancouver, Canada on 25th-30th May 1997 was attended. The paper titled "A Serial Techniques for Producing Fire Retardant Wood Products" was presented at the Section 3 of IRG conference. A brief introduction of our ITTO project program was also given during the meeting. The laboratory of Forintek and the laboratory of the University of British Columbia (UBC) were visited after this conference.

b. The International Union Forestry of Research Organization (IUFRO) All Division 5 conference which was held in the Washington State University, Pullman, Washington, USA on 7th-12th July, 1997 was attended. The paper titled "Drying Test of Some Fast-growing Planted Wood" was presented at IUFRO All Division 5 Meeting. And the utilization status of rubberwood in China was briefly mentioned and discussed with many scientists.

(10). 3-Training Course Reports

(11). Workshop Report

(12). Consulting Report

- **Technology**

(1). About 2,000 pest bodies belonging to the families of *Platypodidae*, *Scolytidae*, *Lyctidae*, *Bostrychidae*, *Curculionidae*, *Kalotermitidae*, *Rhinotermitidae* and *Termitidae* and 50 pieces of rubberwood specimens attacked by the pests were collected. The fungus specimens including decay fungi, stain fungi and mold fungi were also collected and stored in the laboratory.

(2). The chlorothalonil formulations used for temporary protection of rubberwood were developed.

(3). The preservation technique of rubberwood was developed, in which the treatment was divided into separate process:

- a. Temporary protection: spraying treatment of rubberwood log with anti sapstain chemical of chlorothalonil formulations or Antiblu 20EC (short term protection).
- b. Long term protection: pressure treatment with boron chemicals of borax, boric acid, Parachem or Sodium Borate Special.
- c. Temporary protection: dipping treatment of rubberwood sawn timber with anti sapstain chemical of chlorothalonil formulations or Antiblu 20EC if boron preservative treated rubberwood can not be kiln dried in few days, or air drying is taken to reduce the drying cost.

(4). The technique for both temporary and permanent protection of rubberwood sawn timber by vacuum pressure treatment with the mixture of chlorothalonil formulations and borax / boric acid was developed.

(5). The spot test using curcumin agent was introduced a practical way to check the quality of the preservation treatment for rubberwood. It was simple, easy to apply, and fast to show the checking result.

(6). The laboratory qualitative analysis methods of boron chemical in timber was also introduced to analyses the quality of boron treatment of rubberwood.

(7). Three optimum drying schedules for boron preservative treated rubberwood were developed.

(8). The technique of producing flame-retardant rubberwood plywood was developed, including the chemical formulation of flame retardant and the treatment process. The main components of the fire retardant are phosphor-nitrogen compounds and flame retardant resin.

(9). A product standard of the flame-retardant rubberwood plywood was formulated.

#### **- Training Courses**

(1). The first training course was held in Hongyun International Hotel, Haikou, Hainan Province on November 16-18, 1997. Totally 48 people including 6 project staff participated this training course, in which 7 participants were from 3 government departments, 9 participants were from 4 academic organizations and association, and 32 participants were from industries--companies, factories, plants, etc.

(2). The second training courses were held on May 25 - 26, 1998 in Haolaideng Grand Hotel, Kunming, Yunnan Province according to the Project Proposal. Totally 43 persons including 5 project staffs participated the training courses, in which 4 participants from 3 government departments, 20 participants from 6 academic organizations and association, 14 participants from companies and factories.

(3). The third training courses were held on May 27 - 28, 1998 in Haolaideng Grand Hotel, Kunming, Yunnan Province according to the Project Proposal. A study tour to Xishuangbanna on rubberwood processing in Yunnan Province was organized after the courses on May 29 - May 31, 1998. Totally 51 persons including 5 project staffs participated the training courses, in which 2 participants from 2 government departments, 6 participants from 2 academic organizations and association, 38 participants from companies and factories.

#### **- Workshop**

The national workshop was held on December 2-3, 1998 in Haikou, Hainan Province. Totally 79 persons participated this workshop, including 61 from rubberwood industry (company, factory, plant), 9 from research institutions and university, 7 from government, 1 from ITTO and 1 international consultant.

Mr. K.P. Jayabahnu, Adamans Timber Industries Ltd., India, was invited as an international consultant for this project from Nov. 29 to Dec. 5 in Hainan. A study tour to rubberwood industry in Hainan was conducted, including Xilian Timber factory, Rulai Rubberwood Furniture Company and Huali Furniture Company.

#### **- Others**

(1). A manual based on the papers presented in the 3 training courses was published in Chinese.

(2). A booklet based on the technical outputs of this project was published in English.

**(b). Specific Objective(s) Achieved**

The knowledge on the present status of the China rubberwood industry and the status of the advanced rubberwood industry in the world was showed to local rubberwood industry, the related government sectors, and organizations.

A package of rubberwood processing technology (including rubberwood preservation technology using NaPCP-free preservative and drying technology for NaPCP-free preservative treated rubberwood) was given to China rubberwood industry so that environmental friendly rubberwood can be processed.

The technology of manufacturing new product – fire retardant treated rubberwood plywood was given to China rubberwood industry. This product can be used as interior decoration material to meet the China National Fire Standard.

The close relationship with China rubberwood industry was established to give necessary assistance to upgrade the efficiency and competitiveness of rubberwood processing industry in China.

**(c). Contribution to the Achievement of the Development Objective**

In order for the conservation of natural forest and the sustainable management of plantation forest, appropriate fast growing tree species should be selected towards to the climate, growing conditions and the usage of timber. Rubberwood is one of the species, which fits the tropical climate region of China.

The mature processing technology is provided to China rubberwood industry for better utilization of rubberwood resources.

**- The situation before and After Project Completion**

Through the extensive promotion works done by this project, the existing problems of China rubberwood industry and how to upgrade the efficiency and competitiveness of the industry had been realized by the rubberwood processing industry. However, most of rubberwood processing workers did not understand before the implementation of the project, for instance, the problem of using sodium pentachlorophenol (NaPCP). What they understood was that the rubberwood would be sapstained, mould and decayed if it is treated without NaPCP.

A package of rubberwood processing technology (including rubberwood preservation technology using NaPCP-free preservative, and drying technology for NaPCP-free preservative treated rubberwood) is available to China rubberwood industry so that environment friendly rubberwood can be processed. The technology of manufacturing new product – fire retardant treated rubberwood plywood is also available to China rubberwood industry. This product can be used as interior decoration material to meet the China



National Fire Standard. However, no technologies were provided to rubberwood industry for making internationally accepted rubberwood and fire retardant plywood before the implementation of the project.

Some of the rubberwood companies are considering (in term of technology, process techniques, cost, market acceptability, etc.) adopting the new technology of using NaPCP-free preservative to treat rubberwood. And the usage of sodium pentachlorophenol is less by reducing its ratio in the preservative solution. The drying time is much shortened than that before the implementation of the project.

The curcumin test method for checking the quality of rubberwood preservation treatment has been used in some of the rubberwood processing factories. However, the rubberwood industry did not know how to carry out the quality control before the implementation of the project.

The document of “Management and Monitoring of Cutting and Re-plantation of Rubber Tree in Hainan State Farms” was made, which included the plan and adjustment of rubber tree re-plantation, the bidding rules of rubberwood timber, the control of rubberwood resource, the development of rubberwood industry, etc. This was effective from the end of 1998 for the state-owned rubber forest.

### **3. Target Beneficiaries Involvement**

The beneficiaries of this project include the government, local authorities, rubber plantation owners, R & D institutions, timber associations, timber industry especially rubberwood industry, machinery equipment manufacturers of timber processing, etc.

#### Government:

China has been undertaking the Natural Forest Resource Protection Program, which aims at strictly controlling the deforestation and therefore improving the ecological environment. But one of the problems caused by this plan is the more severe shortage of timber. Therefore, it is looking for some species of fast growing timber as the sustainable alternatives to meet the timber needs of the country. By better utilization of rubberwood, one of the plantation timbers in sub-tropical region of China, more timber would be supplied. This macro policy supports the project.

#### Local authorities:

Local authorities (especially the General Bureau of Hainan State Farms, General Bureau of Yunnan State Farms, and General Bureau of Guangdong State Farms), which are responsible for the development of the rubber farm, rubber tree plantation, rubber industry, and rubberwood industry, have gained results for making the strategic decisions /policies about the development of rubberwood and made the document of “Management and Monitoring of Cutting and Re-plantation of Rubber Tree in Hainan State Farms”. This was effective from the end of 1998. Other local authorities (like forestry bureau), which responsible for the development of timber processing, supply, trade and utilization, were also the beneficiaries. They supported the training courses, workshop and pilot trials.

## Rubberwood Industry

About 200 rubberwood processing factories were the direct beneficiaries, including logging companies, sawmills, preservation treatment plants, drying companies, fire retardant timber product manufacturer, plywood manufacturer, blockboard manufacturers, furniture manufacturers, and other rubberwood component manufacturers. They supported the rubberwood fungi and insect investigation, pilot trial site, equipment, materials, and processing.

### **4. Lessons Learned**

#### **a). Development Lessons**

##### **- Aspects of project design which most contributed to its success or failure in achieving the Development Objective.**

The basic idea of the project design was to promote the sustainable development of rubberwood industry so as to make contribution for more silviculture and better use of rubberwood resource. And this was designed for 6 steps:

- i). Survey of rubberwood resource and its management, industry status, technologies used in the processing and utilization, and development trends.
- ii). Technical survey of the differences between China and overseas, including the problems existed in local rubberwood development, and the advanced technologies suitable for local industry.
- iii). Technological R & D in accordance with the local situations.
- iv). Technological extension through training courses and workshop.
- v). Demonstration of good rubberwood processing with appropriate technologies in a model factory, so as to make progress of rubberwood industry and rubberwood products.
- vi). Market and marketing study of rubberwood and its products, which can be used as one of the best plantation timbers in local market, so as to make contribution to ease up the timber shortage and the deforestation of natural forest in China.

The general survey (Step i) contributed to the framework of the project. The technical survey (Step ii) contributed towards the overall picture of China rubberwood industry, including its strong and weak points. The technological R & D (Step iii) contributed to the achievement of appropriate technologies that can be adopted by rubberwood industry. The technological extension (Step iv) contributed towards the promotion of the technology transfer to improve the effectiveness and competitiveness of rubberwood industry.

The demonstration of rubberwood processing (Step v) and the market and marketing study of rubberwood and its products (Step vi) were designed for the follow-up project.

The project design was well accepted by government, local authorities, and industry. This was indicated by the documents made by local authorities, the quality test method adopted by factory, and the participation of the training courses and workshop by so many attendants.

##### **- Changes in intersectoral links which affected the project's success.**

The project was designed to target rubberwood industry /sector at beginning. It was found

during the project execution that the development of rubberwood would relate to other sectors as well. For instance, policies made for all timber and for forest conservation would affect rubberwood industry. So the connection and co-operation with other organizations in various level (government, local authorities, sector associations, professional associations, etc.) were made. And attentions were paid to the related policies.

- **Additional arrangements that could improve cooperation between the relevant parties interested in the project,**

The project proposal, objectives, execution, results, and outputs were released in many sites in written form or oral form. Many technical papers of the R & D results and news articles about the project activities were released in Journals, newsletter, training courses, workshop and in-site training etc. Some reporters were invited to attend the training courses and workshop. This would share the information, the project outputs with the public.

- **Factors which will most likely affect project sustainability after completion.**

The government policy on the restriction of natural forests would result in more silviculture and use of plantation timber. This would promote the development of rubberwood industry. The policy on promoting the development and management of rubber farms, which was made by the General Bureau of Hainan State Farms, was in compliance with the project objectives. These are the policy factors and provided good basis of the sustainability of the project.

To upgrade the efficiency and competitiveness of rubberwood industry by adopting the mature technology, however, the survey, the R & D, and the extension of technology carried out in this project are not enough. It is only in the first and second phase. The demonstration of rubberwood processing technology should be as a follow-up project for the sustainable development and utilization of rubberwood resource in China. Whether the follow-up will be carried out as the third phase would one very important factor for the sustainability of the project. The market acceptability of the new technology and the new product manufactured using the new technology would be another important factor. So the market study and marketing should be strengthened and as one of the aspects of the follow-up project to promote the sustainable development of rubberwood industry.

**b) Operational Lessons**

- **Project organization and management.**

The responsibilities of every project members were confirmed at the beginning of the project execution. The Project Leader was in charge of making the overall arrangement and management, including the project staffs, sub-budget, and cooperation parties. The Technical Leader was in charge of making the detailed work plan and action plan, managing the execution of the activities, coordinating with related parties, writing reports. The Project Secretary was in charge of coordinating with ITTO and the Government, arranging regular and irregular meeting of project members, monitoring the use of the fund, and managing the project files. The Sub-project Leaders (of preservation, drying, and fire retardant plywood) were in charge of execution of the related activities and writing the sub-reports. The Division of Science and Technology Management of CRIWI was in charge of monitoring the progress of the project every half year.

- **Project documentation.**

The project document was kept in origin and released to the parties who were interested in the project.

- **Monitoring and evaluation.**

Besides the monitoring and evaluation by ITTO, the International Cooperation Department of National Forestry Administration monitored and evaluated the execution and results of the project every 6 months.

- **Quality of project planning.**

The rule of making the project plan was as detailed as possible. In order to reach the Development Objective, some additional activities were also planned, such as making video, publishing books, arranging a study tour to Malaysia, Thailand for rubberwood industry personnel to directly view the advanced production and manufacture of rubberwood and rubberwood products. Most of them were implemented except making video and the study tour for rubberwood industry personnel.

- **Definition of the roles and responsibilities of the institutions involved in the project implementation.**

As the project partner, the Industry Department of General Bureau of Hainan State Farms was in charge of co-arranging the training course and workshop, coordinating the pilot trials, receiving the trial materials and declaring the imported trial goods in Customs, giving the data of Hainan rubberwood industry and presenting in the training course and workshop etc. The project partner provided necessary and excellent support for the project.

The General Bureau of Yunnan State Farms (GBYSF) and Yunnan Forest Bureau were responsible for giving the necessary data of local rubberwood industry and gathering the rubberwood mills to attend the training courses and workshop, and coordinating the investigation of rubberwood fungi and insects.

The National Forestry Administration was responsible for the monitoring and evaluation of the project, giving necessary support in Government level such as getting passports and visas of the project members for the study tour and the international conferences, providing the approval for tax free import of the trial goods.

The Institute of Zoology, Chinese Academy of Science, Guangdong Entomological Institute, and Tropical Forest Research Institute were responsible for the identification and classification of the rubberwood fungi and insects, which were collected, separated and purified in CRIWI.

The China Furniture Association was in charge of giving the review paper about the current situation of China furniture industry and presenting in the workshop.

- **Actions to be taken to avoid variations between planned and actual implementation (schedule, costs, etc.).**

The good cooperation relationship was established, the project proposal and work plan were reported to the related parties involved. For the training courses and workshop, the arrangement had been making 3 month before the date with the related parties.

For the pilot trials, the plans were reported to all the parties involved, including the local authority, local farms (the parent organization of companies), sawmills, plywood factory, timber treatment plants. The pilot trial plan in details was then discussed with the specific trial factory to understand what the trials were going to do. And the conditions (time, equipment, workers etc) needed for the trials were also discussed with the management of the trial factory so that good coordination can be reached without affecting its normal production.

The detailed budget of every activity was made to avoid too much excess of the costs. Regular monitoring of the use of the fund was also carried out. Although some additional activities were planned (see above), part of them were not carried out according to the fund limitation.

- **External factors that influenced the project implementation and that could have been foreseen.**

The delay of the visa approval by the Embassy of related countries affected the study tour and caused the postponement.

- **External factors that influenced the project implementation and that could not have been foreseen.**

One international consultant was not confirmed. The workshop date was affected by the availability of the main consultant so that it was delayed for 2 and half months.

## **5. Recommendations**

- **Development Recommendations**

- 1). The sustainability of the project design should be considered to reach the development objectives.

In this project, it was designed to promote the sustainable development of rubberwood industry in China. In the design, it included in 3 main stages: general survey, technological R & D and extension, and promotion (demonstration and marketing). The 1<sup>st</sup> stage was for the Pre-project, mainly focused on the survey. The 2<sup>nd</sup> stage was for this project, mainly focused on the technology R & D and extension. The 3<sup>rd</sup> stage was for the follow-up, mainly focused on the demonstration of new technology and promotion of the new product.

- 2). Demonstration of rubberwood processing technology should follow up for the development of sustainable utilization of rubberwood resource in China.

It was revealed from the former project that the huge potential of the rubberwood resources is still largely untapped or under-exploited in China. As there exists a severe shortage of wood resources in China, the further development of the rubberwood industry is of paramount importance for the future economic development of China.

Demonstrating new rubberwood preservation production using low toxic chemicals and promoting the use of environment-friendly preservative treated rubberwood is important to upgrade rubberwood processing and utilization technology in China.

3). Market and marketing study should be strengthened to promote the sustainable development of rubberwood industry.

With the alternation from planning economy to market economy in China, the market force would play more and more role for industry. Therefore, market and marketing research is getting more and more important and is urgently needed for the development of sustainable use of rubberwood.

More attention should be paid to the basic data gathering. The analysis of the basic data is important for understanding the situation and the problems existed, the development trends, and how to promote the sustainable development of a specific sector or rubberwood industry.

4). Basic science knowledge and practical skills should be treated as part of the training courses and workshop, or for the technology transfer.

The popularization of relevant scientific and technological knowledge should be carried out as part of the basis of the training courses. It is important for the trainees to understand the necessity of technology transfer and how to do with it.

#### - **Technological Recommendations**

5). Sodium pentachlorophenol should be replaced with environmental-friendly preservative.

As the sodium pentachlorophenol (NaPCP) used for rubberwood preservative is highly toxic to both human being and environment, and highly corrosive to the inner surface of the impregnating tank as well as the components of drying kilns, it is strongly recommended that sodium pentachlorophenol should be strictly restricted or prohibited.

The alternative would be boron based preservative plus anti sapstain/mould chemical. The rubberwood sawn timber can be protected in two ways:

- a. by vacuum pressure treatment with the mixture of chlorothalonil formulation and borax / boric acid;
- b. by separating the treatment into 2 processes: a). Long term protection: pressure treatment with boron chemicals of borax, boric acid, Parachem or Sodium Borate Special. b). Temporary protection: dipping treatment of rubberwood sawn timber with anti-sapstain chlorothalonil formulations or Antiblu 20EC if boron preservative treated rubberwood can not be kiln dried in few days, or air drying is taken to reduce the drying cost.

6). The quality control of the process should be strengthened in the rubberwood mills to upgrade its efficiency and the competitiveness of its product. The spot test using curcumin agent can be used as a simple and practical way to check the quality of the preservation treatment for rubberwood. It is easy to apply, and fast to show the checking result.

7). Further study on the drying technique of rubberwood, including using new style drying methods is needed.

8). More research should be done for fire retardant rubberwood plywood

The technique formed from this project was proved to be feasible and the products had required properties. It is worthwhile to put further efforts for the application and dissemination of the technique. The serviceability research of fire retardant rubber wood plywood should be conducted including the change of fire-proof property and mechanical properties as well as the degradation of fire retardant treated rubber wood or rubber wood plywood.

## **PART II. MAIN TEXT**

### **1. Project Content**

#### **- Objective**

The development objective of this project is to further improve rubberwood processing and utilization technology by adopting the mature technology so as to make contribution for better utilization of rubberwood resources in the world.

The specific objective is to upgrade the efficiency and competitiveness of the rubberwood processing industry in China.

#### **- Outputs**

Output 1: Establishment of preservation and drying techniques upon adopting mature procedure based on borax and boric acid preservative and guidelines for the manufacture of fire retardant (FR) rubberwood plywood.

Output 2: Training courses for operators, technicians and supervisors; visiting regional industries; participating international conferences/seminars; workshop /seminar to disseminate the outputs of this project.

#### **- Activities and inputs**

Activity 1.1: Laboratory research on formulation of temporary preservation at CRIWI and pilot test of these techniques at the project sites; pilot test of vacuum-pressure procedure based on borax/boric acid and its insecticidal effect at 1 or 2 rubberwood processing plants of the General Bureau of Hainan State Farms (GBHSF) and the General Bureau of Yunnan State Farms (GBYSF) by adopting the exist techniques of Malaysia (preservation techniques), by 4 CRIWI experts.

--Conduct a survey on insect and fungal infection of rubberwood logs and sawn timber in Hainan and Yunnan Province, discover principle of the insect and fungal infection occurrence in that area, provide basis for preservation procedure treatment;

--Evaluate temporary preservative for anti-mold, anti blue stain and insecticidal effect at CRIWI, conduct pilot test of temporary protection techniques at project site at Hainan Island. Establish efficient temporary protection techniques for logs damaged by typhoon and sawntimber which can not be dried promptly;

--Conduct pilot test of vacuum-pressure treatment based on borax and boric acid according to different sizes of sawntimber. Formulate relevant procedures.

Activity 1.2: Experiment on the drying schedules of rubberwood sawntimber treated with borax and boric acid preservative in the laboratory at CRIWI, then production-scale experiment in 1 or 2 plants on Hainan province(drying techniques), by 1 CRIWI expert.

--Study and evaluate the drying cost, properties, etc., find the best way to reduce discoloration and improve the insecticidal effect so as to prevent insects from re-invasion as well as possible;

--Formulate the optimum standard drying schedules.



Activity 1.3: Research on treatment technique of fire retardant (FR) rubberwood plywood in CRIWI's laboratory, by 1 CRIWI expert.

- Carry laboratory test of processing procedure of FR Plywood at CRIWI, in 1997;
- Conduct pilot test to produce 5 m<sup>3</sup> FR. plywood at Xilian wood plant or other project site on Hainan Island;
- Work out a product standard for rubberwood FR plywood.

Activity 2.1: 3 training courses (10 days/course) on preservation, drying of rubberwood, fire retardant of plywood, marketing as well as production management etc, by 6 CRIWI experts, 2 international experts.

--Trainees of the training course: 90 technicians, supervisors, operators and managerial personnel's from about 90 rubberwood processing plants of GBHSF and 4 plants of GBYSF.

--Experts input:

Item	CRIWI	FRIM
Preservation techniques	2	1
Drying techniques	1	
Fire retardant plywood technology	1	
Sawntimber marketing & production management		1

Activity 2.2: Visiting regional industries / Participating international conferences or seminars (study tour), by 5 CWIRI and 1 GBHSF experts.

- Study tour to Indonesia, Thailand for survey rubberwood industries, processing technology and market by 3 CRIWI and 1 GBHSF's expert, in June, 1997.
- International Conference on Wood Preservation, by 1 CRIWI experts, in May, 1997.
- International Union on Forestry Research Organization (IUFRO) seminar on wood drying technology, by 1 CRIWI expert, in May, 1997.
- The 3rd International Conference and Display on Fire Retardant Technology (Beijing), the sample of FR plywood will be presented to this display, the paper of processing technology of FR plywood will be represented on the seminar, 1997, Beijing, by 1 CRIWI expert.

Activity 2.3: The workshop/seminar to disseminate the outputs of this project, by 8 CRIWI experts.

- Organizer: CRIWI; Assisted by:HNGAFB;
- Participants: 20 technical and managerial personnel's from rubberwood processing plants of HNGAFB and YNGAFB.

#### - Relevance to ITTO

This project meets the International Tropical Timber Agreement (ITTA) specific objective:

- c. To help research and development which will improve forest management and wood use;
- e. To encourage more and further processing of tropical timber in producer countries;

This project is related to the following working areas of ITTA (1983), article 23 para. 5:

- 5(a) Wood utilization including the utilization of less-known and less used species.
- 5(d) Harvesting, logging infrastructure, training of technical personnel;
- 5(e) Institutional framework, national planning.

This project meets the criteria stated in ITTO article 23 para. 6 which reads:

- 6(a) Be related to the production and utilization of industrial tropical timber.
- 6(b) Yield benefits to the tropical timber economy and be relevant to producing as well as consuming members.
- 6(c) Be related to the maintenance and expansion of the international tropical timber trade.
- 6(d) Offer reasonable prospects for positive economic returns in relation to costs.
- 6(e) Make possible to avoid duplication efforts.

This project conforms to ITTO Action plan and Priorities, such as:

- Studies on supply and demand, including the availability and market acceptance of less-known species;
- The flow of technology to improve the use of tropical timber and the value of tropical timber production.

#### - **Problem to be addressed**

It was revealed from the pre-project that the huge potential of the rubberwood resources is still largely untapped or under-exploited in China. As there exists a severe shortage of wood resources in China, the further development of the rubberwood industry is of paramount importance for the future economic development of the southern provinces, as well as that of China as a whole.

At present, rubber trees are usually felled, sawn into lumber, then the lumber is impregnated and dried within about 7 to 10 days in China. As Hainan Island and coastal southern regions of China are prone to hurricane which could further delay delivery of logs to processing facilities, temporary protection of logs using cost-effective preservatives should be promoted.

The common used preservative is a mixture of borax, boric acid and sodium pentachlorophenol (BBP). All the plants in Hainan and most plants of Guangdong province use BBP. The pentachlorophenol in BBP is highly toxic and it has been strictly restricted or prohibited in some countries. BBP is highly corrosive to the inner surface of the impregnating tank as well as the components of seasoning kilns. Furthermore, BBP also discolors the wood, thus lowering the acceptability and value of treated rubberwood. Pentachlorophenol-free preservative for rubberwood will therefore minimize many of the problems encountered at present. The procedures of treating rubberwood with preservative containing only borax and boric acid followed by kiln drying, commonly practiced in Malaysia, should be studied for possible adaptation for the industry in China.

Most of the kilns used for drying rubberwood are the conventional steam-heated ones. In addition, proper attention is generally not paid to seasoning rubberwood, either due to the lack of understanding the importance of these procedures, or the lack of training of drying technology. The drying period for rubberwood is fairly long resulting in high-energy

consumption, and the discoloration of sawn timber is often serious.

Sawn timber is mainly used for the manufacture of furniture. There are 15 rubberwood furniture factories in Hainan Agricultural Reclamation System with a yearly output value of RMB 100 million (USD12.5 million). In view of the huge population and fast economic growth, China has a very large market for furniture. Hainan Island, being the largest Special Economic Region, is rich in timber resources and has great potential to further develop and expand furniture industry.

There is limited assortment of rubberwood plywood in domestic market. In path with the demand of market and the requirement of the national fire-protection code, it is urgent to develop fire-retardant plywood. Fire-retardant plywood can be used as decorative materials in construction. The application of the technology, developed by CRIWI, will be used in fire retardant treatment of rubberwood plywood to improve the utilization efficiency of rubberwood, to bring greater economic benefit and to promote the trade of rubberwood products.

#### - **Characteristics of the region or area where the project located**

Rubber tree is an important plantation tree crop in the tropical southern region of China. Rubber trees are mainly grown on the Hainan Island, in Xishuangbanna of Yunnan Province and the western part of Guangdong Province. In 1993, the total growing area was recorded as 616,000 ha., which ranked China as the fourth largest rubber growing country after Indonesia, Malaysia and Thailand. 377,100 ha. rubber planting area in Hainan Island, accounting for over 61% of the total in China. With an economic life of 30 years, 8,000 ha. of rubber plantations should be felled for replanting annually. With an average yield of 30 to 45 m<sup>3</sup> of round logs and 60 to 75m<sup>3</sup> of branch wood per hectare, the potential annual yield of rubberwood in China is about 0.9 to 1.2 million m<sup>3</sup>. This rather huge potential resource, if utilize efficiently, will ease China's dependence on the ever escalating imports of wood and wood-based materials to satisfy the growing demands resulted from the fast economic growth and promote trade of rubberwood products.

#### - **Previous preparatory activities**

Available literature on rubberwood preservation and drying has been thoroughly reviewed, surveys of the current situation of the rubberwood industry was conducted through visits to the main rubberwood processing plants of the General Agricultural Farm Bureaus in Hainan, Yunnan, and Guangdong Provinces. Information about the current situation of research and status of rubberwood processing and utilization was gathered through a study tour of the rubberwood industry in Malaysia.

## **2. Project Context**

#### - **Relevance to national policies**

##### a. Relationship to sectional policies affecting tropical timber

This project conforms to the Chinese policies about forestry and forest product industry.

--The Ninth-Five-Year Plan for Forestry and the General Ideology of the Long-term Planning to the Year 2010.

--China's Agenda 21, Forestry Action Plan.

- Sustainable Development Policy of Forest Industry.
- Policies and Measures to Improve Wood Utilization Efficiency and Output Value of Forest Industry.
- Policies and Measures Affecting Trade in Timber.
- The Action Plan on China's conservation of Biological Diversity: Forestry Report.
- The Regulation on Management and Protection of Forests in Hainan Province.

b. Relationship to subsectoral aims and programs

- Research and development of wood drying schedule, wood preservation technology and low toxic preservative.
- Research on properties, strength and fire retardant(FR) of wood-based panels to establish relevant standards and specifications.

**- Targets**

The results of surveys and study tours in the pre-project showed that a great progress of rubberwood industry has been achieved in recent years in China, but still lags behind those countries, such as Malaysia, in terms of efficiency and competitiveness.

Awareness of technology and product development as well as production management techniques will need to be instilled to increase value-adding and upgrade the industrial competitiveness. These could be achieved through having regular training courses for the operators and supervisory staff, which will be an important component of this project. Opportunities to visit and/or participate in regional rubberwood processing industries or international conference would be beneficial to the researchers and industrialists.

From what has been mentioned above, it is important to improve rubberwood processing and utilization technology in China by establishing preservation and drying techniques upon adapting mature procedure and guidelines for manufacturing of fire retardant rubberwood plywood, training programs for operators and supervisory staff.

This project was the follow-up of the pre-project ITTO PPD 6/94 Rev.1 (I): Development and Extension of Rubberwood Processing Technology.

The targeted specific aspects of the project were:

- Preservative of pentachlorophenol is toxic and has serious pollution to the environment;
- The rubberwood plywood has limited market share and the industries have no competitiveness;
- The management of the rubberwood processing industries is poor.

### **3. Project Design and Organization**

- **Adequacy of the results of the "identification phase" (correct definition of problems to be tackled, choosing the best alternative route for project implementation, etc.)**

The definition of the problem about replacing the high toxic sodium pentachlorophenol (BBP) with environmental friendly preservative and accordingly replacing the drying schedule with new drying technique were very correct. The chosen alternative route – through both overseas mature technology and local R & D was also appropriate so that

more technologies can be provided to China rubberwood industry.

The definition of developing fire retardant plywood of rubberwood was right in the view of the National Fire Protection requirement for the interior decorations of public buildings. However only part of rubberwood in China is suitable for making 3-layer thin plywood.

For the project implementation, the chosen route of cooperation with relevant parties at various levels was very appropriate and effective to carry out the project activities for the technology development and extenuation.

- **Sound conceptual foundation of the project (project rationale, correct perception of external influences, etc.)**

The project was to develop sustainable China rubberwood industry based on the correct analysis of its existing problems and the progress trend of world rubberwood industry. The roles of the relevant parties and the relevant external influencing factors at various levels were appropriately analyzed. The beneficiaries were persuaded to involve in the project implementation. These made the correct basis and success of the project.

- **Adequacy of time and other resources for project formulation**

The time planned was basically appropriate. The personnel, involved parties, and provided materials etc were also appropriate.

- **Understanding and appropriateness of the roles and responsibilities of the institutions involved with the project implementation**

The implementing agency, CRIWI, acted as the bridge among the government, local authorities, sector organizations, and rubberwood industry for the transferring the project outputs. CRIWI was responsible for the design, execution and reporting of all the activities of the project.

The Institute of Zoology, Chinese Academy of Science, Guangdong Entomological Institute, and Tropical Forest Research Institute were responsible for the identification and classification of the rubberwood fungi and insects, which were collected, separated and purified in CRIWI.

The China Furniture Association was in charge of giving the review paper about the current situation of China furniture industry and presenting in the workshop. The Nanjing Forestry University gave the presentation in the workshop.

- **Beneficiary involvement with the project's efforts and actions**

The National Forestry Administration provided the monitoring and evaluation of the project, necessary support in Government level such as getting passports and visas of the project members for the study tour and the international conferences, and the approval for tax free import of the trial goods.

The Industry Department of General Bureau of Hainan State Farms co-arranged the training course and workshop, coordinated the pilot trials, did the receiving the trial

materials and declaring the imported trial goods in Customs, gave the data of Hainan rubberwood industry and presented in the training course and workshop etc. The project partner provided necessary and excellent support for the project.

The General Bureau of Yunnan State Farms (GBYSF) and Yunnan Forest Bureau gave the necessary data of local rubberwood industry and gathered the rubberwood mills to attend the training courses and workshop, and coordinated the investigation of rubberwood fungi and insects.

The Xilian Wood Company provided the preservation and drying trial site, materials (rubberwood log and sawn timber), processing of the timber, equipment, labors etc. The Nanmao Plywood Factory provided the preservation trial site, materials (rubberwood log, sawn timber and plywood), equipment, labors etc. The Dongda Group in Guangdong Province provided the trial site and fire retardant treatment equipment for the pilot trial of fire retardant rubberwood plywood.

Many rubberwood processing factories provided the site and supported the investigation of rubberwood fungus and insect as well as the attack by them, namely: Xilian Wood Company, Nanmao Plywood Factory, Sanya Wood Factory, Danzhou Rubberwood Processing Factory, Cangjiang Wood Factory, Dongfeng Wood Factory, and many others.

Many rubberwood farms, rubberwood processing factories and rubberwood furniture companies were opened and supported the general investigation, the visiting and the study tours.

#### **4. Project Implementation**

- **The most critical differences between planned and actual project implementation (costs, components, schedules, outputs achievements, etc)**

The planned overall cost was US\$ 408,398 in which China Government contribution was US\$193,600 and ITTO contribution was US\$214,798. The actual total expense was US\$432,214. The details are listed in the table below.

	ITTO Cost (US\$)			China Gov. Cost (US\$)		
	Planned	Actual	Difference	Planned	Actual	Difference
Project Personnel	25,500	23,850	-1,650	33,600	52,200	+18,600
Duty Travel	75,000	77,830	+2,830	--	--	--
Capital Items	--	--	--	160,000	160,000	0
Consumable Items	57,000	59,860	+2,860	--	--	--
Miscellaneous	38,375	39,551	+1,176	--	--	--
ITTO Monitoring, Evaluation and Administration	18,923	18,923	0	--	--	--
<b>TOTAL</b>	<b>214,798</b>	<b>220,014</b>	<b>+5,216</b>	<b>193,600</b>	<b>212,200</b>	<b>+18,600</b>

The planned duration for the project was 24 months. As one international consultant was not confirmed, the workshop date was affected by the availability of the main consultant. So that the schedule for the workshop was delayed for 2 and half months and the actual

duration was 27 months.

More outputs including the reports, the technologies, the technical papers, the publications, etc. were achieved than planned.

**- Measures and actions which could have avoided these variations**

Making enough budgets or tightly adding the additional activities according to the budget would have avoided the excess of the project costs. Strengthening the international cooperation, which would build up good relationship between the implementing agency and other organizations, would be good of understanding the specialty of the experts /consultants and discussing the consulting issue much earlier.

**- Appropriateness of the assumptions made and correct identification of the risks involved**

No risks were identified in the project proposal, but in the matter of fact, the risks existed. For instance, the government structure changes, sector structure changes, policy changes, market acceptability of the technologies, etc. However, some changes (e.g. macro policy) were better for the project.

**- Project sustainability after project completion as a result of project implementation conditions**

To upgrade the efficiency and competitiveness of rubberwood industry by adopting the mature technology, however, the survey, the R & D, and the extension of technology carried out in this project are not enough. It is only in the first and second phase. The demonstration of rubberwood processing technology should be as a follow-up project for the sustainable development and utilization of rubberwood resource in China. Whether the follow-up will be carried out as the third phase would be very important for the sustainability of the project. The market acceptability of the new technology and the new product manufactured using the new technology would be also important. So the market and marketing study should be strengthened and as one of the aspects of the follow-up project to promote the sustainable development of rubberwood industry.

The government policy on the restriction of natural forests would result in more silviculture and use of plantation timber. This would promote the development of rubberwood industry. The policy on promoting the development and management of rubber farms, which was made by the General Bureau of Hainan State Farms, was in compliance with the project objectives. These provided good basis of the sustainability of the project.

The rubberwood processing industry has realized the existing problems of China rubberwood industry and the importance of upgrading the efficiency and competitiveness of the industry.

The survey and pilot trials in the project made a package of rubberwood processing technology (including rubberwood preservation technology using NaPCP-free preservative, and drying technology for NaPCP-free preservative treated rubberwood) available to China rubberwood industry so that environment friendly rubberwood can be processed.

- **Appropriateness of project inputs (quality and quantity)**

The financial input by both ITTO and China Government was in time according to the Agreement. The excess part of the project expenses was firstly paid by CRIWI, the implementing agency.

The national expert input by CRIWI was 8 persons, 2 persons more than that of planned. The input of 4 support personnel (technician) by CRIWI was additional. The input of 2 administrative persons by CRIWI was same as the plan. The national expert input of 4 persons by other organizations was the additional personnel. The total additional personnel were 10 persons. The international expert input was 1 person, 1 person less than that of planned according to the project proposal. The quality of the input personnel was excellent.

**5. Project Results**

- **Situation existing at project completion as compared to the pre-project situation**

Lot of persons from the relevant government, the local authorities, and especially the rubberwood processing industry has realized the existing problems of China rubberwood industry and how to upgrade the efficiency and competitiveness of the industry. However, most of rubberwood processing workers did not understand before the implementation of the project, for instance, the problem of using Sodium Pentachlorophenol (NaPCP). What they understood was that the rubberwood would be sapstained, mould and decayed if it is treated without NaPCP.

A package of rubberwood processing technology (including rubberwood preservation technology using NaPCP-free preservative, and drying technology for NaPCP-free preservative treated rubberwood) is available to China rubberwood industry so that environment friendly rubberwood can be processed. The technology of manufacturing new product – fire retardant treated rubberwood plywood is also available to China rubberwood industry. This product can be used as interior decoration material to meet the China National Fire Standard. However, no technologies were provided to rubberwood industry for making internationally accepted rubberwood and fire retardant plywood before the implementation of the project.

Some of the rubberwood companies are considering (in term of technology, process techniques, cost, market acceptability, etc.) adopting the new technology of using NaPCP-free preservative to treat rubberwood. And the usage of sodium pentachlorophenol is less by reducing its ratio in the preservative solution. The drying time is shortened than that before the implementation of the project.

The curcumin test method for checking the quality of rubberwood preservation treatment has been used in some of the rubberwood processing factories. However, the rubberwood industry did not know how to carry out the quality control before the implementation of the project.

The document of “Management and Monitoring of Cutting and Re-plantation of Rubber Tree in Hainan State Farms” was made, which included the plan and adjustment of rubber tree re-plantation, the bidding rules of rubberwood timber, the control of rubberwood



resource, the development of rubberwood industry, etc. This was effective from the end of 1998 for the state-owned rubber forest.

- **Extent to which the project Specific Objective(s) was achieved**

The knowledge on the present status of the China rubberwood industry and the status of the advanced rubberwood industry in the world was showed to local rubberwood industry, the related government sectors, and organizations.

A package of rubberwood processing technology (including rubberwood preservation technology using NaPCP-free preservative, and drying technology for NaPCP-free preservative treated rubberwood) was provided to China rubberwood industry so that environment friendly rubberwood can be processed.

The technology of manufacturing new product – fire retardant treated rubberwood plywood was provided to China rubberwood industry. This product can be used as interior decoration material to meet the China National Fire Standard.

The management of rubberwood processing is improved. For instance, the time between each process is much shorter than before, as the industry understand how to upgrade the quality of rubberwood.

The overall re-plantation plan (including the rubberwood supply, the development of rubberwood industry, etc.) was made in the document of “Management and Monitoring of Cutting and Re-plantation of Rubber Tree in Hainan State Farms”. This was effective from the end of 1998 for the state-owned rubber forest in order to upgrade the efficiency and competitiveness of the rubberwood processing industry in China.

The close relationship with China rubberwood industry and local authorities was established to give necessary assistance and support to upgrade the efficiency and competitiveness of rubberwood processing industry in China as well as to take future actions and project.

- **Impact of the project results on the sectoral programme, on the physical environment, on the social environment, on the target beneficiaries**

The project has helped the beneficiaries to learn about the success and failures they have committed by using obsolete or wrong technology and to realize the better and newer technologies to be adopted to upgrade the efficiency and competitiveness of the rubberwood processing industry in China.

Some beneficiaries have been building up new factories for better processing rubberwood.

The overall re-plantation plan (including the rubberwood supply, the development of rubberwood industry, etc.) was made in the document of “Management and Monitoring of Cutting and Re-plantation of Rubber Tree in Hainan State Farms”. This was effective from the end of 1998 for the state-owned rubber forest in order to upgrade the efficiency and competitiveness of the rubberwood processing industry in China.

- **Project sustainability after project completion as a result of project conceptualization, assumption made and conditions prevailing at completion**

The activities conducted during the pre-project and this project were to achieve the specific objective- to upgrade the efficiency and competitiveness of the rubberwood processing industry in China. These were mainly:

- i). Survey of rubberwood resource and its management, industry status, technologies used in the processing and utilization, and development trends.
- ii). Technical survey of the differences between China and overseas, including the problems existed in local rubberwood development, and the advanced technologies suitable for local industry.
- iii). Technological R & D in accordance with the local situations.
- iv). Technological extension through training courses and workshop.

The general survey (Step i) contributed to the framework of the project. The technical survey (Step ii) contributed towards the overall picture of China rubberwood industry, including its strong and weak points. The technological R & D (Step iii) contributed to the achievement of appropriate technologies that can be adopted by rubberwood industry. The technological extension (Step iv) contributed towards the promotion of the technology transfer to improve the effectiveness and competitiveness of rubberwood industry.

The recommendation made from the project were included in the following further aspects in the follow-up project:

- (a). Demonstration of good rubberwood processing with appropriate technologies in a model factory, so as to make further progress of rubberwood industry and rubberwood products.
- (b). Marketing of rubberwood and its products, which can be used as one of the best plantation timbers in local market, so as to make contribution to ease up the timber shortage and the deforestation of natural forest in China.

The project design was well accepted by government, local authorities, and industry. This was indicated by the documents made by local authorities, the quality test method adopted by factory, and the participation of the training courses and workshop by so many attendants.

The government policy on the restriction of natural forests would result in more silviculture and use of plantation timber. This would promote the development of rubberwood industry. The policy on promoting the development and management of rubber farms, which was made by the General Bureau of Hainan State Farms, was in compliance with the project objectives. These provided good basis of the sustainability of the project.

The rubberwood processing industry has realized the existing problems of China rubberwood industry and the importance of upgrading the efficiency and competitiveness of the industry.

The survey and pilot trials in the project made an appropriate package of rubberwood processing technology (including rubberwood preservation technology using NaPCP-free preservative, and drying technology for NaPCP-free preservative treated rubberwood)

available to China rubberwood industry so that environment friendly rubberwood can be processed.

Much experience has been gained through the execution of the project. This will be of benefit to the follow-up project.

## 6. Synthesis of the Analysis

- |     |                                |   |
|-----|--------------------------------|---|
| (a) | Specific Objective Achievement | <input checked="" type="checkbox"/> Realized                    |
|     |                                | <input type="checkbox"/> Partly Realized                        |
|     |                                | <input type="checkbox"/> Unrealized                             |
| (b) | Outputs                        | <input checked="" type="checkbox"/> Realized                    |
|     |                                | <input type="checkbox"/> Partly Realized                        |
|     |                                | <input type="checkbox"/> Unrealized                             |
| (c) | Schedule                       | <input type="checkbox"/> In advance / on time                   |
|     |                                | <input checked="" type="checkbox"/> Delayed but not seriously   |
|     |                                | <input type="checkbox"/> Seriously delayed                      |
| (d) | Actual Expenditures            | <input type="checkbox"/> Below planned                          |
|     |                                | <input checked="" type="checkbox"/> More than 10% above planned |
|     |                                | <input type="checkbox"/> More than 20% above planned            |

## **PART III. CONCLUSIONS AND RECOMMENDATIONS**

### **(a) Development Lessons**

- The design of this project was well accepted by government, local authorities, and industry. This was indicated by the documents made by local authorities, the quality test method adopted by factory, and the participation of the training courses and workshop by so many attendants. The sustainability of the project design should be considered to reach the development objectives.
- Demonstration of rubberwood processing technology should follow the project -- Development and Extension of Rubberwood Processing and Utilization Technology.
- Market study and marketing should be strengthened to promote the sustainable development of rubberwood industry.
- The basic data should be gathered and analyzed for understanding the situation and the problems existed, the development trends, and how to promote the sustainable development of a specific sector or rubberwood industry.
- Basic science knowledge and practical skills should be treated as part of the training courses and workshop, or for the technology transfer.
- Sodium pentachlorophenol in the rubberwood preservative, which is highly toxic to both human being and environment, should be replaced with environmental-friendly chemical. Technically, this can be solved with the technologies developed by this project. Some rubberwood companies in Hainan Island is considering in terms of technology, cost, market acceptability, etc.
- The quality control of the process should be strengthened in the rubberwood mills to upgrade its efficiency and the competitiveness of its product.
- Further study on the drying technique of rubberwood, including using new style drying methods is needed.
- The technology of producing fire retardant rubberwood plywood could be applied to make new rubberwood product. The serviceability research needs conducted.
- Upgrading the efficiency and competitiveness of rubberwood industry should be carried on and based on the technological transfer.

### **(b) Operational Lessons**

- The organization structure was fairly representative of the Government, local authorities, research institute, non-government organizations (e.g., association), industry, economic department and other relevant bodies. This should be kept in the future of the development of rubberwood.
- Established good relationship with relevant parties and the clear responsibility ensured

the excellent implementation of the project. This should also be kept in the future actions.

- Many beneficiaries were involved in the project, including the government, local authorities, rubber plantation owners, R & D institutions, timber associations, timber industry especially rubberwood industry, machinery equipment manufacturers of timber processing, etc.
- The project consultant should be invited as early as possible during the project execution in order to trace the project progress, to understand the project results in each phase, and to give necessary support and assistance to the implementing agency.

### **(c) Recommendations for Future Projects**

#### **- Identification**

Future project should be identified on the basis of its relevance to the sustainable development of rubberwood, and the macro policies of the country and local authorities. More attention should be paid to the economic scenario of the timber. A follow-up project is suggested as below:

Title: Demonstration of Rubberwood Processing Technology and Promotion of the Sustainable Development of Rubberwood

Summary: This project proposal intends to establish a rubberwood preservation production demonstration using environment-friendly timber preservative by adopting the technology developed in the former project and to promote the sustainable development of rubberwood by market study and marketing in China domestic market.

#### **- Design**

The design of the future project should be based on the results and recommendations made from the project. The sustainability should also be considered in the design of the future project. Example of objective, output and activity of the future project is given below:

Specific Objective 1: To further improve rubberwood-processing technology by adopting the technologies developed in the former project

Output 1: Establishment of rubberwood preservation production demonstration using environment-friendly chemicals and formulation of rubberwood preservation standard.

- Output 1.1 A model rubberwood preservation production using environmental-friendly chemicals
- Output 1.2 Manual of rubberwood preservation standard
- Output 1.3 Report of study tour to Malaysia, Thailand, and India
- Output 1.4 Presentation of a paper based on the output of former project PD 3/93 Rev. 2(I) in IUFRO World Congress

--Output 1.5 Training course

Specific Objective 2: To further upgrade the efficiency and competitiveness of China rubberwood industry by market and marketing study

Output 2: Promotion of the use of rubberwood and rubberwood product in domestic market

- Output 2.1 Data of preliminary market survey.
- Output 2.2 Report of preliminary market survey.
- Output 2.3 Report of market research.
- Output 2.4 Workshop / International Seminar.

- **Implementation**

Implementing Agency should have enough experience of carrying out the project. And good cooperation with other organizations is very important for implementation of the project. For instance, the project group of this project was of very professional from the Research Institute of Wood Industry (CRIWI), Chinese Academy of Forestry (CAF).

The implementation of the future project should be split into various specific activities. Taking the example above, it could be:

Activity 1.1 Improvement of Rubberwood Preservation Technology

- Modification of existing production equipment accordingly.
- Formulation and dissemination of appropriate preservation technique.
- Assessment of the end-use performance of the preservative treated rubberwood and rubberwood product.

Activity 1.2 Formulation of Rubberwood Preservation Specification

- Assessment of the end-use requirement on the preservation of rubberwood and rubberwood products.
- Development of a manual on rubberwood preservation treatment.

Activity 1.3 Study Tours to Malaysia, Thailand, and India to study:

- a. the production and technique of rubberwood processing, including sawing, preservation treatment, drying, and packaging of rubberwood.
- b. the different products made from rubberwood.

Activity 1.4 Attending international conference to disseminate the outputs of the former ITTO project PD 3/93 Rev. 2(I), paper(s) will be presented in the IUFRO World Congress in Malaysia in 2000 (if accepted by IUFRO).

Activity 1.5 Training course

Activity 2.1 Market study of rubberwood and rubberwood product

- Formulation of questionnaire
- Conduct preliminary market survey in the selected cities

- Identification of the data of the preliminary market survey
- Conduct market research
- Analysis of the data of market research
- Development of marketing skills and strategy

#### Activity 2.2 Workshop/ International Seminar

##### - **Organization**

The organization structure should be wide representative of the Government, local authorities, research institute, non-government organizations (like association), industry, economic department and other relevant bodies in the viewpoint of the development of rubberwood.

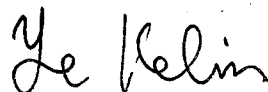
##### - **Management**

The management of the future project should be handled by a specific organization /institution (the executing agency) with the support of the Government, local authority and rubberwood industry, and supervision of ITTO.

#### **Responsible for the Report**

Name: Prof. Ye Kelin

Position held: Project Leader,  
Director of CRIWI



Date: March 8, 1999.