FAO FORESTRY PAPER 16

china: integrated wood processing industries

FOOD AND AGRICULTURE ORGANIZATION
OF THE UNITED NATIONS ROME

FAO FORESTRY PAPER 16

china: integrated wood processing industries

report on an fao/undp study tour to the people's republic of china

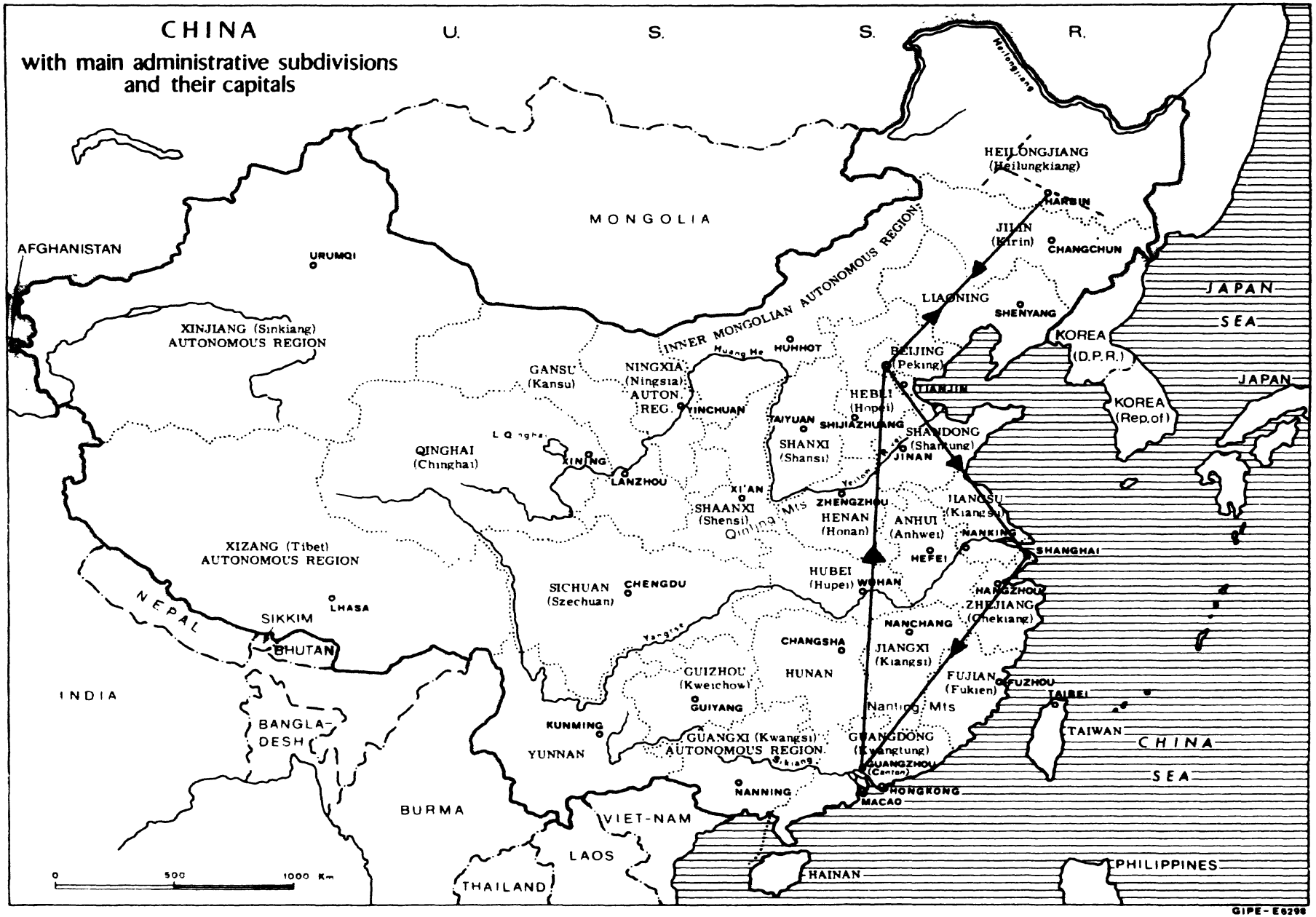
20 august – 17 september 1978

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome 1979

The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

M-38

ISBN 92-5-100770-5



ITINERARY OF THE FAO/UNDP STUDY TOUR TO CHINA ON INTEGRATED WOOD PROCESSING INDUSTRIES

_____ air - - - - - - - rail

ACKNOWLEDGEMENTS

The members of the FAO/UNDP Study Tour to China on Integrated Wood Processing Industries which took place from 19 August to 18 September 1978, wish to express their appreciation to the Government of the People's Republic of China, to the Food and Agriculture Organization of the United Nations and to the United Nations Development Programme for the opportunity to take part in this tour.

The study team was greatly impressed by the excellent organizational arrangements made by their Chinese hosts for the study tour and appreciated the friendliness and warmth shown to them by the people of China at all stages of the team's visit.

In China the team visited the municipalities of Beijing (Peking) and Shanghai and the province of Heilongjiang and Guangdong(Kwangtung). The willingness of their Chinese hosts to share without reserve their wide experience in the whole field of integrated forest industries was an experience which will prove of immense value to team members in developing the forest industries of their own countries.

The members of the team wish to express special thanks to their hosts at the State Administrative Bureauof Forestry, Beijing (Peking),in particular Mr. Li Shihkang, Division Director of the Bureau who conducted the team's visit throughout China and to the interpreters, Mr. Huang Yinyi, Mr. Chu Kueilin and Mr. Liu Mingkang, whose understanding and patience made this visit a most memorable and rewarding experience.

TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION

The FAO/UNDP Study Tour on Integrated Wood Processing Industries arose as a development from the First FAO Forestry Mission to China which took place in September/October 1976. At that time, the mission had been impressed with the progress made in the integrated use of residues in the wood processing industries of China. They recommended to the Chinese authorities that a seminar on small-scale integrated wood processing industries could be of value to developing countries. This suggestion was carefully considered by the Chinese and they decided that a study tour in China for representatives of a number of developing countries would allow them to evaluate at first hand the integrated wood processing industry relative to their own situations.

The tour was arranged for August/ September 1978 and two representatives from each of nine developing countries, namely Afghanistan, Ghana, India, Malaysia, Nigeria, Papua New Guinea, Sierra Leone, Sudan and Uganda, attended. Two representatives of the Forest Industries Division of FAO completed the team of 20 members with Mr. A.J. Leslie, Director of the Forest Industries Division acting as team leader. A list of participants is given in Appendix 1.

The team assembled in Karachi, arriving in Beijing (Peking) on 20 August. They studied industries in Beijing (Peking) and then moved to Heilongjiang Province in the northeast of China, where the wood resource and the harvesting were studied as well as a sample of forest industries. They then travelled to Shanghai, studying the processing plants and machine-building enterprises in that area, and subsequently to Guangzhou (Canton) in the Province of Guangdong. This itinerary, carefully prepared by the Chinese authorities, enabled the team members to see a wide and representative cross-section of the wood processing industry.

In the north and north-east, the wood raw material is mainly Korean pine and a range of temperate decidous hardwoods. In Shanghai, logs transported from northern areas as well as some imported logs are processed. Shanghai industry also makes use of some imported veneers and plywood. In Guangzhuo (Canton) the wood processed is mainly of tropical and sub-tropical species and either originates from the mainland or is imported from Hainan Island.

Besides seeing wood processing plants, the team had an opportunity to see machine-building factories making equipment for wood processing and logging. It was of special value to representatives of developing countries to see the close relationship which exists in China, between the production of machines and the industry which makes use of them.

Although not a specific item in the tour, the considerable amount of travelling through the widely varying countryside, gave the members of the team some acquaintanceship with other aspects of Chinese life. In addition, the opportunity to see places of historical interest and the evening musical and cultural performances further extended the team's awareness of the many facets of Chinese life and culture. This sort of background is, as the team found, essential for a full appreciation of the nature and the magnitude of the Chinese achievement.

Fig. 1 Virgin Korean Pine Forest near Tailing, Heilongjiang Province

Chapter 1

RAW MATERIAL SUPPLY AND PRODUCTION

1.1 INTRODUCTION

The nature of the forest resource - whether it be for instance natural forests or plantations, hardwood or softwood, relatively homogeneous or heterogeneous in respect of species and log size distribution - has a major influence on the structure and the products of the industries drawing their wood supplies from it. Although the characteristics of the wood raw material base for the Chinese wood processing industry were not of major concern to the team, they play such a basic role in the location, planning, technology and development of the industry that some consideration has to be given to them in this report. There is no need, however, to do this in any great detail as Wang (1961) and Richardson (1966) have given comprehensive reviews of the forest zones and types of China.

Before 1949, decades of economic and political chaos and the plunder of natural resources by occupying powers caused great damage to the forests of China, both natural and man-made. With the proclamation of the People's Republic in 1949, all the forests were placed under national ownership and a start was made on managing and restoring them. The application of this policy over the past twenty-nine years has greatly improved the state of China's forests and allowed the establishment of considerable areas of useful planted industrial forests, in addition to large plantings for control of erosion, shelterbelts, catchment protection, and so on.

In general, the forests of China are classified under twelve phyto-geographical regions, whose natural vegetation and land-use patterns can be broadly correlated with physical geography, climate and soil types. Very broadly, in the south and east of China, the natural forest distribution is determined by soil type. In the arid west and north-west, steppe desert conditions determine vegetation types. In the mountain and plateau regions vertical zonation of soils and vegetation is particularly marked.

1.2 THE NATIVE FORESTS

The surviving native forest zones of major economic importance are those of the north-east, mainly located in Heilongjiang Province and part of inner Mongolia and those of the south-west located in the mountains and plateaux of eastern Tibet. However, there are other important areas of mixed deciduous/conifer forests still remaining in the central parts of the country, where difficulty of access spared them from destruction in the past.

In the north-east, the most important forest zone, virgin forest remains only in the less accessible parts of the horse shoe-shaped region formed by the eastern margin of the Mongolian plateau, the big and the small Hinggan ranges and the Chanpaishan Massif. This region contains approximately 60 percent of China's total timber reserves, and at present most of the large wood processing plants are located there or in nearby cities. During its visits to wood processing plants, the team had a brief opportunity to see some aspects of the wood harvesting and transport system especially in Heilongjiang Province. Generally the methods seen were rather conventional and, by western standards, somewhat obsolete but it was generally found that they corresponded to the availability and low cost of labour power.

Fig. 2 Forest viewed from fire tower, Tailing Forest Reserve - note valley bottoms cleared for agriculture

1.3 FOREST RESOURCES

According to Richardson, the standing timber resource of China amounted in 1965 to more than 7 000 million m^3 of all species. Most of it was located far from consumption centres, but it was considered that 75 percent of the total resource could eventually be made accessible. Richardson gave estimates for China's average annual requirements for the period 1960-1990 as 150 million m^3 and indicated that the afforestation programmes would render China more than self-sufficient by the time the existing resource ran out in 1990. In recent years, the annual cut (which was 28 million m^3 in 1962 instead of the 40 million m^3 planned), has been supplemented by the import of some speciality species of wood necessary to meet the demands of the furniture industry.

Some information given to the team on the forest resource in Heilongjiang, supplements the data given by Richardson.

In Heilongjiang Province, the forest area amounts to 27 million ha. There are more than 300 species of trees, of which 20 are the major ones used. The forest is found in the north, east and west but not in the south. It is distributed mainly in: 1) the big Hsunan range; 2) the small Hsunan range; 3) the Wanta mountains; 4) the Chenkang Chai mountains, and 5) the Lao Yeh mountains.

Before the Twentieth century, almost the whole province was virgin forest. There was no industry - just hand workshops. In 1903, the Russian Government completed the far-eastern railway and set up sawmills along the line. Subsequently Japan, during its occupation, set up many enterprises, some being joint ventures with Chinese capital.

In 1949, there were 16 sawmills and one plymill. Sawn production then was 440 000 m^3 per year and plywood 6 000 m^3. In the past 28 years, fifteen large modern enterprises have been set up, of which six have entirely imported equipment and another three have partially imported plants.

To balance the distribution of industry, a total of six new enterprises have been set up in the west of the province where little industrialisation existed before. Enterprises have grown from 17 in 1949 to fifty in 1978. Workers employed have increased from 5 500 to 48 300 in the same period.

The annual log cut is now 17 million m^3 per year. Wood residues from this total 5.3 million m^3, of which 3 million m^3 is utilised. These 3 million m^3 consist of the following: 1.36 million m^3 of felling waste; 1 million m^3 of sawmill waste; 0.34 million m^3 of other processing waste and 0.30 million m^3 of bark.

1.4 SILVICULTURE AND LOG SUPPLY

The team was able to visit a logging area near Tailing in Heilongjiang Province and the information obtained is related to operations in this type of forest.

Enquiries were made with the aim of finding out which silviculture system was used. Special reference was made to clear cutting and selection methods in which the role of shelter wood systems was not significant. As far as integrated forest industries are concerned, the Bureau of Forests in some cases orders logs of specific diameters to meet special requirements. Obviously, the system of exploitation is heavily influenced by the demands of industry.

1.5 LOGGING TECHNIQUES

Demonstrations took place (summer conditions) at the Logging Operations Centre in the Tailing Forestry Station. Normal logging had in fact been suspended because of the lateness of the season and fire risk, so that the demonstration had to be specially organised for us through the kindness of our Chinese hosts. However, the methods used were said to be typical of those used under full-scale operations. Power chain saws and axes were used for the felling. Direction of felling selected was down-slope and debranching took place on the felling site.

The logs, after delimbing at the stump, were skidded in long lengths downhill to a loading point on the road along the floor of the valley. By taking advantage of the downhill conditions, the standard Chinese built version of a Russian 50 H.P. low ground pressure crawler tractor accomplished the skidding with no difficulty. The logs were loaded on to a 20 ton truck and trailer, using a winch-operated overhead cable system strung across the road.

Although the roading density seemed to be rather low it was difficult to form any firm opinion about this aspect from the one demonstration and inspection.

1.6 ROAD AND RAIL TRANSPORT OF LOGS

Logs are transported by the logging truck to depots near the railway where they are sorted and then shipped to their destination mainly by rail. Logs of Korean pine were seen even in sawmills in Guangzhou (Canton) so the rail distribution system must involve some rather lengthy journeys.

The team did not visit a railway siding log yard, but the log yards in major sawmill enterprises were generally well equipped with travelling bridge cranes and seemed efficiently organised. The SABF [1] takes final responsibility for the distribution of log supplies to plants according to their planned requirements. It is these requirements which appear to determine the cut from the forests rather than any silvicultural management plan. This is reasonable at present, since the forests being logged are overmature and contain most of their volume in large diameter classes. When these areas have been cut out, the annual cut will require to be brought into balance with sustained yield management.

1.7 PRE-TRANSPORT PROCESSING

Lop and top cutting is carried out at stump, manually, immediately after logging. Slash and débris are collected for fuel. No pre-transport processing is carried out, other than length-wise cutting to fit rail transportation needs. Volume is calculated and sorting and marking of timber is carried out. No chemical treatment for preservation takes place and no further pre-transport processes are carried out. Logs are not debarked before transport.

1.8 LOG STORAGE AT PROCESSING PLANTS

In the north of China where the climate is cool, logs can be stored without serious deterioration. This was in contrast to the problems of log storage familiar to most team members from tropical developing countries, where log storage problems are serious and require that special care be taken. The usual methods seen consisted of piling logs in the open without special protection of any kind. When required for processing, they are crane-handled to the conveyor leading to the sawmill or other processing plant.

1/ State Administrative Bureau of Forestry.

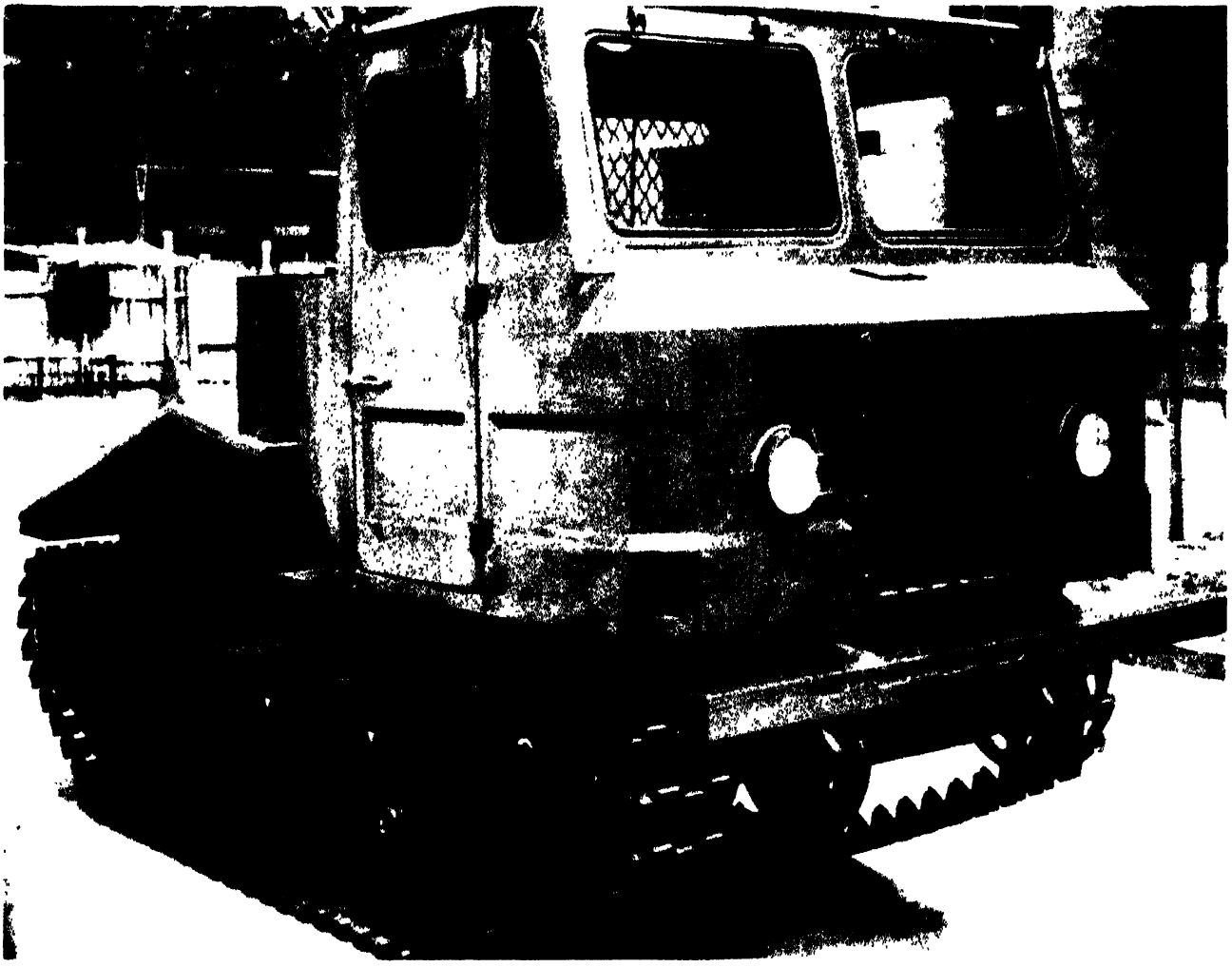


Fig. 3 Tracked logging tractor made in China

Fig. 4 Wheeled articulated skidder made in China

1.9 DEBARKING

The team saw no debarking machines during their visit. In fact, the absence of debarking of softwood logs before processing in sawmills was noteworthy and caused problems subsequently in utilisation of residues. Installation of debarking machinery at major sawmills would be a worthwhile initial step in modernising the larger sawmills and it would make it easier to use residues for other products subsequently. Bark could be used for fuel or for tannin extraction, etc. and the bark-free residues are more versatile raw materials for paper and panel products. In addition, productivity in the sawmill would be improved as there is less wear on saws and machinery from the abrasive bark.

At present, where bark-free residues are required, as for pulping, the slabs and off-cuts are laboriously debarked by hand before the wood is chipped. For most other products, residues with bark are used and produce a lower quality though still acceptable product.

1.10 FUTURE LOG SUPPLY

As the surviving natural forests are cut, the wood processing industry will have to be developed in the south and central zones of the country, based on the wood resource provided by the post-liberation plantations and the opening up of new native forest areas by road construction and the development of river transport.

In Heilongjiang, the species seen in plantations were Siberian larch (Larix sp.) Korean pine (Pinus koriaensis) and Scots pine (Pinus sylvestris). Rates of growth were rather slow, as would be expected in this climate. A rotation age of about 60-80 years seemed the shortest period for the plantations seen. A problem noted is the competition for the best sites in valley bottoms with agriculture. This means that most available sites are on sloping land, which raises the cost of establishment and tending and gives a reduced rate of growth.

Some information given to the team regarding reforestation in Guangdong Province gives some idea of the scale of plantation activities.

In Guangdong Province, in the south, the forested area which includes planted forests, increased from 3.67 million ha. in 1949 (17 percent of the province area) to 8.4 million ha (39 percent) by 1978. There are 0.87 million ha of industrial plantations located in 37 counties on 100 communes and 40 state forestry farms. There are 1 million ha of plantings established by aerial seeding and 0.4 million trees have been line-planted along roads, rivers and near houses.

Under the provincial administration there are 109 forest farms (districts) and 88 under prefecture and county-level administration. There are 18 000 forest farms run by communes or brigades, and 840 felling and planting teams equivalent to 420 000 people. An additional 90 000 workers are employed by the state in this province on forestry work. Thus, there are 510 000 workers employed full-time in forestry activities in Guangdong Province.

1.11 AFFORESTATION

The visit to forestry operations, though brief, left two strong impressions; firstly, the tremendous extent of the Chinese afforestation efforts and, secondly, the balance between the efforts and resources devoted to afforestation and those devoted to natural regeneration which, in general, is of secondary importance. In the plantation programme the need for more systematic methods of seed collection and improved nursery organization have been recognized and the bulk of seed collection is now organized by the SABF through seed centres. These operate either by directly employing collecting teams or by purchasing surplus seed from the production brigades which run the communal nurseries. Closer state control is also said to be helping in the improvement of tree seed quality through the introduction of more careful selection, and the use of higher-quality planting stock produced by raising the seedlings for large-scale afforestation schemes in centralised nurseries.

1.12 ADMINISTRATION

The State Administrative Bureau of Forestry (SABF) is the executive body responsible for all reforestation, management and exploitation of the natural forests.

Provincial bureaux of forestry work under the leadership of the state bureau; then follow county and district divisions and branches of forestry. Districts are split into communes and communes into production brigades. In addition, there are regional administrative organizations. Communes may themselves pursue forest industry activities on their own land parallel with SABF activities, but this is not frequent.

More information on the structure of the forest administration is given in Chapter 3 (Section 3.6).

Chapter 2

WOOD PROCESSING PLANTS - HISTORY, LOCATION AND CURRENT SITUATION

2.1 INTRODUCTION

The general impression of the wood processing plants of China was obtained partly from the mills actually visited and partly from the discussions held with the officials of the state and provincial bureaux of forestry. Twenty plants were visited and, as these mills were chosen by our Chinese hosts, we may assume that they tend to be the better ones. Therefore, this general impression of the overall status of the integrated wood processing plants of China would be on the optimistic side. The plants, in general, were running effectively with almost all mills visited being ahead of their production targets for the year.

2.2 DEVELOPMENT OF THE WOOD PROCESSING PLANTS

The development of the wood processing industry has followed a chequered path, in line with the country's development and history during the twentieth century. It has experienced surges of expansion and also endured periods of stagnation. The history of the development of the industry can be divided into a number of distinct phases. They are:

(i) the pre-liberation or colonial period (pre-1949);
(ii) liberation, Soviet technical assistance and the Great Leap Forward (1949-1960);
(iii) recovery from the Great Leap Forward and economic consolidation (1960-1966);
(iv) the Cultural Revolution and consequent disturbances (1966-1976);
(v) the current period (1976-1978).

2.2.1 The Pre-Liberation period (pre-1949)

Before 1949, the wood processing industry in China was at a very primitive stage. There were few mechanical mills and even sawing was done by hand in many places. The main industrial activity was exploitation of the virgin forests of north-east China in the interest of the occupying foreign powers. First Czarist Russia and then Japan were the main entrepreneurs in these wood processing industries.

Plants were located in the coastal cities, e.g. Shanghai and Guangzhou (Canton), where shipping facilities were available and also in the north-eastern provinces of Heilongjiang, Jilin and Liaoning, where the forest resource was mainly located. The main product was sawn timber, which was shipped out of the country for foreign consumption.

By 1949, there were sixteen sawmills and one plywood mill in Heilongjiang Province, all of which were privately owned. These plants were haphazardly sited along the railway and very often were little more than a collection of wood workshops. Their recovery rates were low and only about 10 percent of wastes were utilized, not counting fuelwood. No consideration was given to a more complete utilisation of the available residues.

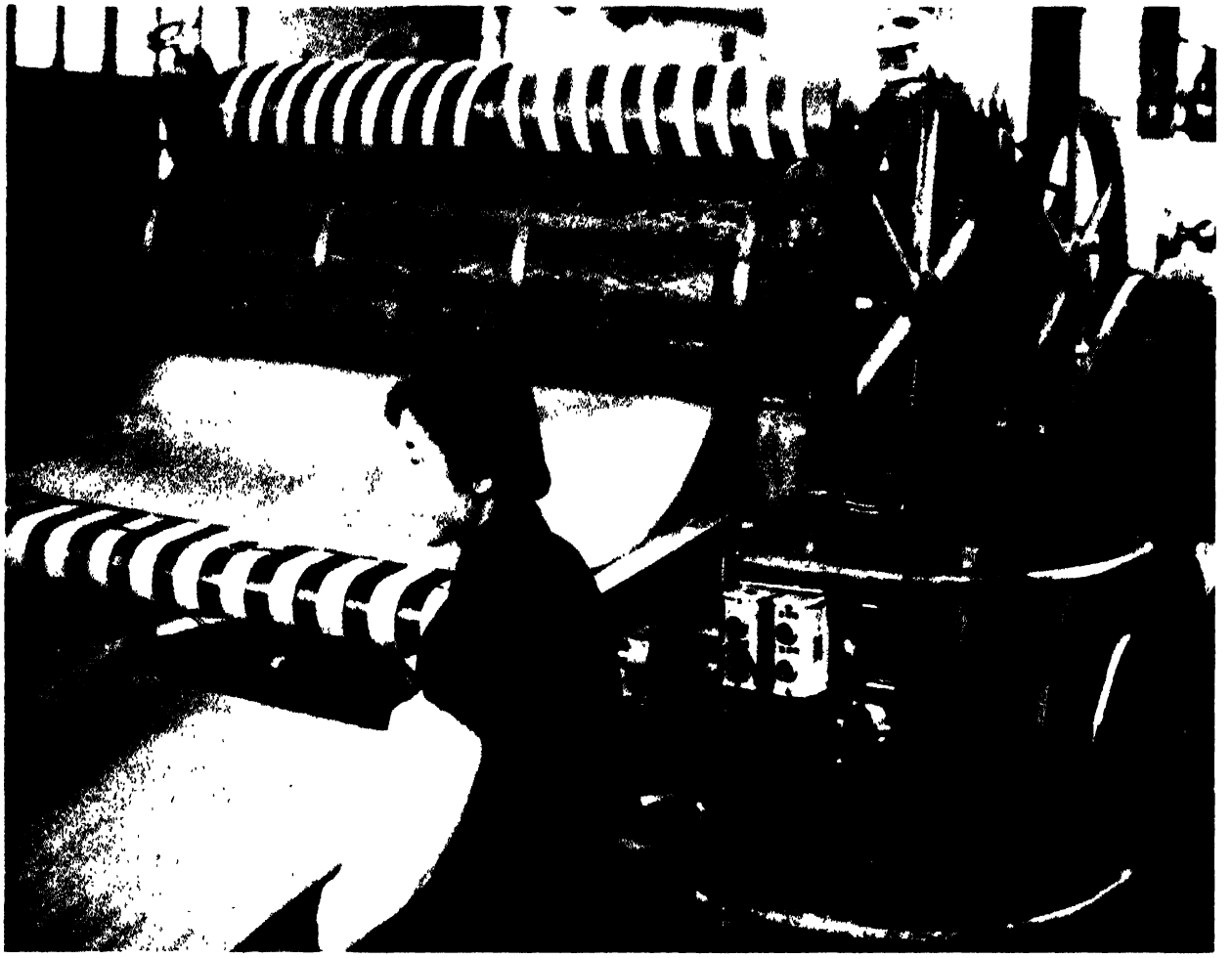


Fig. 5 Multi-wall bag paper production on 2000 tons/year semi-chemical plant at Fanglin Forest Farm, Heilongjiang Province

2.2.2 Liberation and Soviet Technical Assistance (1949-60)

This was the period of consolidation by the new nation. All wood processing plants, along with most other industries, were nationalised. An interim policy on forestry and forest industry was drawn up. The immediate aim was to consolidate the assorted mills into productive units to supply the nation's post-war requirement for timber. In line with this practice, many sawmills were mechanized and restructured into some form of integrated factory.

During the period of the first five-year plan (1953-58), many wood processing plants were set up. These mills were mechanized to a greater extent than before. Many of the plants, including their equipment and technologies, were adopted from the Russians in the form of technical aid.

By the end of the first five-year plan period, annual sawn timber production had increased two and a half times over the annual production during the pre-liberation period. Figures for plywood production jumped sevenfold.

The guidelines for the restructuring and expansion of wood processing plants during this period were as follows:

(a) Where possible, processing should be done at source. This was to cut down transport costs. This policy has resulted in 80 percent of the mills in Heilongjiang Province being established in and around the forest area.

(b) Where possible, existing plants, which were normally old, small and of low productivity, were to be renovated by the addition of modern equipment. This guideline was tempered by limited funds and often a mixture of local ingenuity and foreign techniques was adopted.

(c) Where possible, new factories should be built to increase production and also to produce products of high quality. These factories were to be the mainstay of the industry, with the smaller and older existing plants playing a back-up role.

(d) Where possible, the wood processing plants should be relocated to give a better regional balance. In Heilongjiang, this guideline resulted in six new mills being established in the west where none existed before.

On the whole, the plants that were set-up during this period were better planned and were more integrated. Utilisation of wastes and residues was also given priority and efforts were directed to developing plants to utilise these resources. Fibreboard and particle board plants were built to convert residues into products. By the end of this period, 25 percent of wood wastes were utilised. Although these achievements were a great improvement over the performance of the industry during pre-liberation days, they by no means brought the industry up to the standard achieved in some other countries.

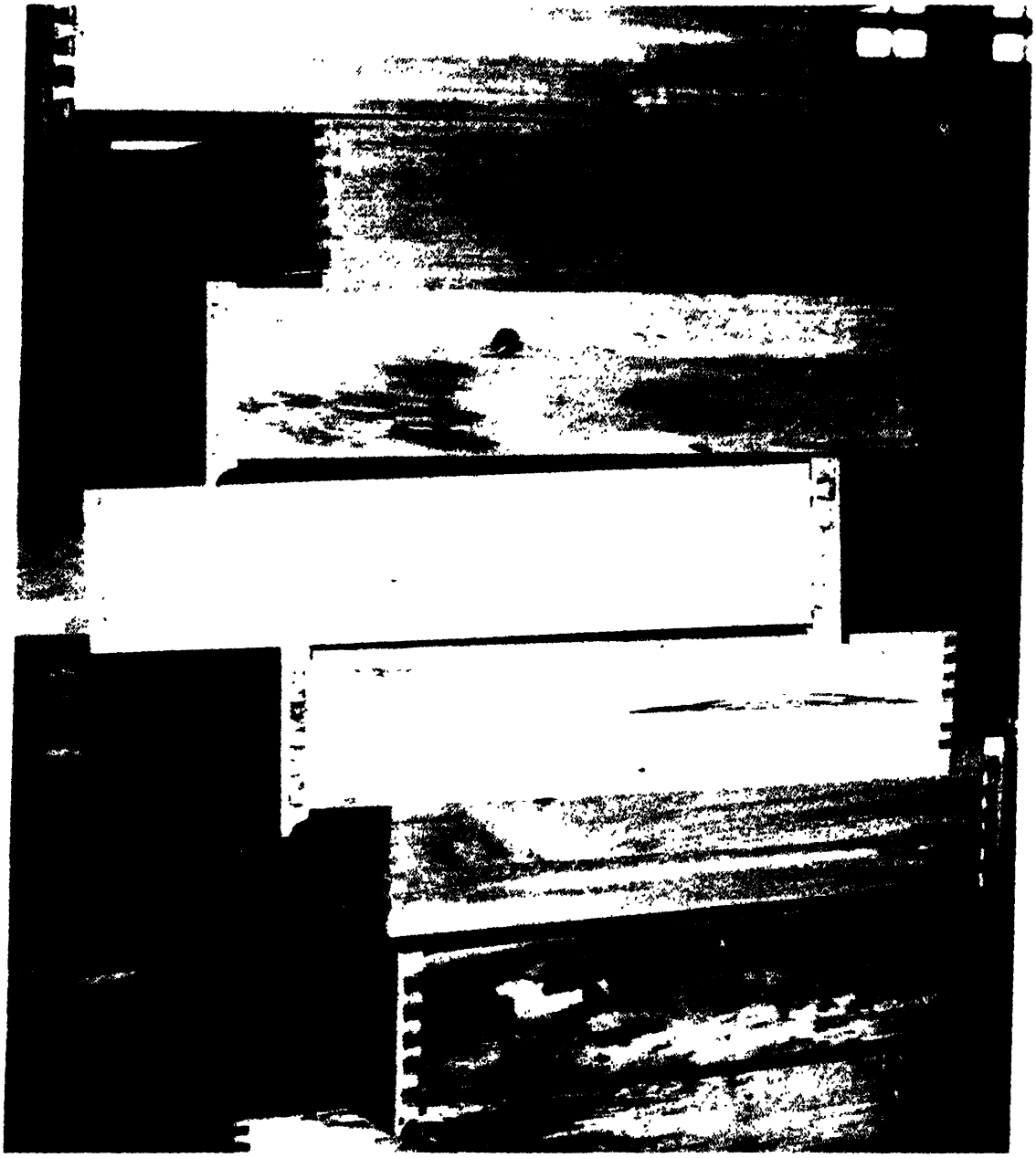


Fig. 6 Drawer sides made from mixed tropical hardwoods at Jiefang Furniture Plant, Guangzhou (Canton)

2.2.3 Economic construction after the Great Leap Forward (1961-65)

Towards the end of 1960, the Soviets withdrew their technical aid towards China. The wood industry, which had just begun to move ahead, was consequently badly affected. Plants which were necessary for the continued restructuring of the industry and were to be imported from U.S.S.R. were either delayed or did not arrive at all. For instance, the Nancha wood hydrolysis plant to produce alcohol, which was of Soviet design, was not delivered until 1963.

The problems prompted the Chinese to intensify their campaign of "hard struggle and self-reliance" on all fronts, including industries. Machinery and plants which were required for the wood processing industry were manufactured within the country. This was a factor which led to one of the most extraordinary features of the wood processing plants visited; that is, many of the plants have auxiliary workshops which are capable not only of servicing and maintaining the machinery of the plants but also of producing the machinery itself.

Under the impetus of the campaign of hard struggle and self-reliance, and impelled by the exploits of other industries, the wood processing industry flourished and expanded. Many new wood-based panel plants came into operation to utilize the milling wastes generated by the sawmills. During this period wood-based panel production increased by 60 percent over production in 1958.

2.2.4 The Cultural Revolution Period (1966-76)

Growth in production was hampered during this decade by the frequently shifting policies and disturbances of the Cultural Revolution which led to repeated disruptions of established development plans. The negative impact upon both production and progress slowed down appreciably the rates of growth in major sectors, such as that of wood-based panels where output increased only two-fold during the Third and Fourth Five-Year Plans (1966-75).

2.2.5 The Current Period

The current period dates from the coming into office as head of the government of Mr. Hua Kuofeng and the downfall of the so-called "Gang of Four" after Chairman Mao's death. During this period it appears that the government has returned to the "Four Modernization" policy, the goals of which had been announced much earlier but had somehow fallen into abeyance. Under this policy, science and technology, both national and foreign, are being used as tools for economic progress. Industry has responded well to the new incentives and output figures for the wood-processing industry have greatly increased. Thus in 1977, production of wood-based panels had increased by 20 percent compared with 1976 and output during the first six months of 1978 showed a further increase of 38 percent as compared with the same period of 1977. All mills visited claimed an increase in production for the current period. Most mills described far-reaching plans for further production increases over the next few years. It appears that this will be achieved mainly through increased utilization of presently unused or inadequately used residues.

Fig. 7 Simple plant for blockboard production at Harbin, Heilongjiang Province

2.3 THE CURRENT SITUATION OF THE WOOD PROCESSING PLANTS

The Chinese wood processing industry through restructuring and expansion along the lines described in the above paragraphs, has come a long way since the days before liberation. Based on a relatively limited supply of raw materials and a great internal demand for wood-based products, the wood processing industry has evolved into a viable and dynamic industry which is fulfilling its task well in the national economy. The plants visited were characterised by high utilization rates. Most of them are integrated with units that are designed to utilize the residues generated from felling and milling. Due to the policy of residue utilization from sawmills and plymills, there is a proliferation of small fibreboard, particle board and paper mills, utilizing the wood residues. Currently, the wood processing industry of China is characterized by a more rational and stabilized distribution of plants to cater for the national needs. Without exception, all mills visited claimed that their operations were profitable over the current period. But there is still scope for improved utilization of residues both in quality and quantity.

2.3.1 Location of the Wood Processing Plants

As a result of the restructuring programme, the current wood processing plants can now be grouped into two broad classes. There are those which have been formed from the amalgamation of groups of smaller workshops with varying degrees of reconstruction, and those which have been newly constructed closer to the source of raw material.

Mills of the first category are usually located in and around the bigger coastal cities where old established wood factories existed in the days prior to 1949. They can be found in Beijing (Peking), Tianjin (Tientsin), Shanghai and Guangzhou (Canton). They can also be found in the north-eastern provinces of Heilongjiang, Kirin and Liaoning, built up mainly from old Japanese-owned mills.

Mills of the second category are usually found in places where forest resources are available and where no previous mills existed to process the logs. For example, irthe western part of the province of Heilongjiang, six new processing plants were set up to process the forests of that area. These plants are established along branch railway lines (designed to carry forest and agricultural products from the zone) laid north and south from the main Chinese north-eastern railway. The forests supplying these plants are close by and can continue to supply them for a period sufficient to amortize the investment. It is also not unusual for a processing complex to raise food crops on agricultural land surrounding it. The complex at Nancha is a good example of this integration, where the industrial plant supports a new township of about twenty thousand people. In addition to growing food crops on its own farms, the complex, essentially a wood processing one, utilises beet molasses from the surrounding area to produce alcohol and pharmaceutical-grade yeast products for part of the year.

2.3.2 The Operational Scale of the Wood Processing Plants

Integrated wood processing plants in China range downwards in size from large complexes, such as the sawmill and wood hydrolysis plant at Nancha, to the small plywood and sack paper mill seen at Fanglin Forest Farm. In addition there is a complete range of sawmills with a lower degree of residue utilisation ranging from large down to tiny enterprises under communal ownership where the main or sole use of residues is for fuel. The resource on which these industries are based is

Fig. 8 Hand glue spreading on furniture panels in Guangzhou (Canton) Wood Processing Complex

Fig. 9 Chair making from Manchurian Ash at Harbin Furniture Factory

predominantly the forests of Heilongjiang Province. Fortunately, the main species from this forest, Korean pine (P. koriaensis) can be transported in log form without serious deterioration. This has made it possible to supply quite large sawmills operating in Harbin, Beijing (Peking) and Shanghai, for example, with adequate supplies of logs and to process the residues into wood-based panels, such as fibre-board and particle board. While this log supply remains available it is logical to maintain, though not expand, these processing plants in the large coastal cities.

If expansion is to occur then the logical sites would be in certain parts of the north-east forests, possibly new areas becoming accessible in the south-west of the country and in any areas where industrial plantations are beginning to yield significant volumes of wood.

If the Chinese economy is to expand, then more processed wood is needed,but it is not clear what the resource possibilities are for this expansion. From a long-term point of view, it seems that the forests of the north-east are being overcut, while the rate of development of new forest resources in the south-west was not spelled out during our visit. Industrial plantations will be called on to provide an increasing future share of the wood supply.

Chapter 3

DESIGN AND DEVELOPMENT POLICY FOR THE INTEGRATED WOOD PROCESSING INDUSTRY

The team were fortunate to attend a symposium organized by officials of the State Administrative Bureau of Forestry (SABF) in Harbin, where the guidelines and policy for design and development of the integrated wood processing industry in China were outlined. The information, which is of general interest, is summarized below.

3.1 GENERAL

The following general principles are applied to the design and location of the enterprises. Where possible, the aim is to process the log close to the point of production. This saves 30 percent of the raw material and half the transport costs. It is also easier to integrate the operations.

A policy often followed is to combine small and medium sized enterprises with large ones. Large enterprises may show lower production costs but have heavier investment costs and their construction time is longer. Small and medium sized enterprises have a lower production and a higher unit production cost, but need less investment and the pay-back time is shorter. For example, a fibreboard mill of a 2 000 t /year capacity has an investment cost of 2.5 million yuan and takes one to one and a half years to build but the cost can be paid back in three years. A 15 000 t/year fibreboard mill requires an investment of 9 million yuan, takes four to five years to build and eight to nine years to pay back. Thus, they find medium-scale mills more advantageous. Although foreign techniques may be useful, unless they are adopted with enthusiasm and great care they may not be beneficial.

New plants are planned to utilize fully the available raw material, but old factories near the cities require to be transformed and rebuilt even to make full use of their already installed equipment. There is a need for bigger fibreboard and particle board plants and waterproof grade products are the most important. These products should have priority in residue utilization. The production of chips for pulping should be done only at the forest farms. Full attention is given nowadays to the handling of liquid, solid and gaseous wastes to reduce pollution and protect the environment.

The development of the wood processing industries is considered from an overall national point of view and plants are set up in a regular sequence according to national priorities.

The following details were given at the seminar on the process technologies used by various types of wood processing plants.

Fig. 10 Assembling sewing machine cabinets at Guangzhou (Canton) Wood Processing Complex

3.2 PLANT DESIGN

3.2.1 Sawmills

Sawmills are grouped in three sizes. Large mills have outputs of about 200 000 m^3/year. Medium mills have outputs of 100 000 to 200 000 m^3/year and small mills have outputs less than 100 000 m^3/year. These outputs are calculated on the basis of two shift operation. Three sawing technologies are utilised: a) band saws; b) gang saws and c) circular saws.

In the province of Heilongjiang, where most of the wood processing industry is located, the sawmills are mainly band mills. Although it is possible to combine sawmilling with chip production, this is not practised in Heilongjiang, but such enterprises exist in the south of the country. In Heilongjiang there are mills combining band saws and gang saws and there are also some mills using multiple band saws of twin and quad types. A new sawmill, using a twin band saw as main headsaw, is now under construction in Heilongjiang province and the trend is to favour multiple band sawmills.

Some details were given of the specification of this new sawmill. Its annual output is 50 000 m^3/year per shift and it works 360 days per year. Log input per shift is 72 000 m^3. The main equipment comprises 11 sawing units in total. Power is 840 KW and there are 61 workers, i.e. 13.8 KW per worker. The sawmill's covered space is 4 300 m^2. Production is 820 m^3 per worker per year, or 2.7 m^3 per worker per shift, reckoned on the basis of workers within the sawmill shop. The total investment for this sawmill is 2.43 million yuan, of which 650 000 yuan was for construction and 1.5 million yuan for equipment. The pay-back period for this investment was estimated to be two years.

3.2.2 Fibreboard Mills

Fibreboard mills are classified for size as follows. Large mills have outputs greater than 15 000 t/year. Medium-sized mills have outputs of between 5 000 and 15 000 t/year and small mills have outputs of less than 5 000 t/year. There are wet, dry and semi-dry process mills in China and they produce hardboard and softboard. A medium-density dry process fibreboard plant is at present inthe design stage. Fibreboard was first made in Heilongjiang province which has the longest experience in its production.

Most of the mills are small and medium-sized enterprises, but there is one large mill of a 15 000 to 18 000 t capacity which was not visited. All the mills in Heilongjiang are wet process mills, but in future there will also be dry process plants. The following design details were given for a standard 2 000 t/year nominal capacity plant for making fibreboard by the dry process. Sheet size is 925 mm by 2 134 mm. Output is achieved in 300 working days of three shifts each per year. The raw material input is 6 000 m^3 of scrap wood, 22 t of paraffin, 3.2 t of sulphuric acid, 2 t of 25 percent ammonia, 60 t of alum and 2 600 t of coal. Steam supply is 3.5 per hour and 20 t of water are required per hour. Electric energy consumption is 700 KWh per ton of board and the power consumption is 768 KW for the plant. Factory space is two hectares of land, of which 2 340 m^2 is covered space. Ninety-eight workers are needed of which 92 are production workers. Electric power per worker is 8.3 KWh.

The total investment for such a plant is 1.79 million yuan, of which 1.3 million yuan is for construction and 1.28 million yuan is for equipment. The value of production is calculated as 245 yuan per ton. Total annual value of output is assumed to be 900 000 yuan. The pay-back period is four years.

3.2.3 Particle Board Plants

Some details were given of the small particle board plants which the team had seen. Typical figures were as follows: Annual production is 2 300 m^3/year of particle board in 300 working days of three shifts each. Raw material consumed is typically 3 680 m^3 of wood, 150 t of glue, 1.5 t of hardener and 15 t of paraffin wax There are 53 workers, of which 50 are production workers. Power requirements are 292 KW and 1 t of steam is required per ton of production. Floor space needed is 1 100 m^2 and the plant costs 860 000 yuan.

3.2.4 Plywood Plants

Plywood plants in China are classified for size as follows. Large plants have a capacity of about 10 000 m^3 per year, medium-sized plants of from 5 000 to 10 000 m^3 and small-sized plants have a capacity of 5 000 m^3/year of plywood or less. The small plants have one peeler and a small hot press. The medium-sized plants have two peelers and two presses. The large plants have three or more peelers and three presses. The team saw a range of plywood plants during its visit exemplifying the three capacity types.

For a large plant having a capacity of 10 000 m3 per year, the following data were given. The log input is 25 000 m^3/year in 306 working days of two shifts. The total work force is 403, of whom 349 are production workers. The installed power is 395 KWh and 1 200 t of glue are required per year. A water supply of 10 t/hour and a steam supply of 5.7 t/hour are needed. Covered floor space is 7 080 m^2. Power per worker is 1.1 KWh and productivity is 29 m^3 per worker per year. Total investment required is 2.68 million yuan of which 1.1 million yuan is required for construction and 1.49 million yuan for equipment.

A small plant of 1 000 m^3/year output on the other hand requires the following: 2 700 m^3 of raw material per year, 280 working days of one shift per day and a work force of 40 people, of whom 38 are production workers. The power requirement is 70 KWh and annual glue usage is 130 t. A water supply of 2 t /hour and a steam supply of 0.8 t/hour is required. The covered floor space is 670 m^2. Productivity is 26 m^3 per person per year and the installed power is 1.8 KWh per worker. An investment of 135 000 yuan is needed, of which 68 000 is for construction and 61 000 is for equipment.

It was pointed out that the precise future of plywood manufacture in China was not clear, because of technological changes in the demand by industry for wood-based panels and an increasing shortage of conventional plywood raw material. No information was given on whether the Chinese are planning to utilize plantation-grown wood such as pine and poplar in plywood manufacture, especially for construction grade plywood.

3.2.5 Wood-based Pulp Mills

Most paper in China is, of course, made from straw produced by agriculture. Wood, though important, plays a minor part as a paper-making raw material. There are more than 1 000 paper mills in China based on straw. The smallest has a capacity of less than 1 000 t/year and there are some large ones of a capacity of more than 100 000 t/year. To utilize fully wood raw material resources in Heilongjiang Province a number of small paper mills have been installed. Paper boards are also made. A need for more rayon pulp production is foreseen for the province.

The team saw two pulp mills based on wood as raw material in Heilongjiang. Both were small. One made rayon dissolving pulp and the other made sack paper from unbleached semi-chemical pulp. The following data were given in regard to the rayon dissolving pulp mill. Nominal output is 2 000 t of bleached dissolving pulp per year. Actual annual production is 3 000 t in 330 working days per year of three shifts each. The wood consumption is 15 000 m^3/year. The consumption of caustic soda is 1 050 t/year, of sodium sulphite 250 t, of sodium bisulphite 33 t and of chlorine 300 t. The installed power is 977 KW. A water supply of 260 t/hour and a steam supply of 3.3 t/hour are required . The work force is 254 people, of whom 243 are production workers. The factory requires 5 913 m^2 of covered floor space. The total investment is 2.67 million yuan. The production cost is reckoned as 900 yuan per ton giving an annual output value of 2.87 million yuan. The pay-back period of the mill is about five years.

3.3 PRODUCTION PLANNING AND MANAGEMENT

At the symposium a description was given of the way production planning is organized.

3.3.1 Production Planning

First of all quotas are established for inputs and for quantity and quality of production. The quota for raw material use covers both logs and all other needed raw materials. In the case of logs, since these are produced from the forests under the control of SABF and then transported and allocated to various enterprises, also mainly under SABF control, the planning of the log quota must involve both output quotas from the forests and input quotas for the various enterprises. Other raw materials, not generally being the responsibility of SABF, are viewed as input quotas.

Labour inputs are also planned in detail and quotas fixed for the various enterprises. Finally, a quota is established for enterprise working capital. All of these quotas must be approved by the central administration.

3.3.2 Production Management

Plans are made on a daily, monthly and annual basis for the management of production. The progress in the fulfilment of plans is followed up by meetings and checking procedures in the enterprises. Each factory works to a financial plan which functions at two levels.

At the level of the factory floor, attention is concentrated on the cost of production and normal cost accounting procedures are used. At the management level, control is also applied to the utilization of quotas for working capital, for raw material costs and so on.

3.4 DISTRIBUTION

The products of enterprises are distributed by the state, according to the volume produced under the production plan. The producing factories themselves do not sell their production, they merely deliver it for credit as scheduled to the state distribution organization. The supply of raw materials is managed in the same way. Deliveries are made in the quantities and according to timing laid down in the factory plan. Naturally, fulfilment of the deliveries is not the responsibility of the factory which needs the raw material; they must depend on plan fulfilment by the distributing organization.

3.5 TECHNICAL MANAGEMENT

The technical management plan envisages management at the technological level in the enterprise, to ensure that raw material and labour power are allocated and used in the most rational way. Problems of production may also be overcome by changes in the technology of production. This sector of the management plan also schedules the overhaul and maintenance of machinery.

3.6 FORESTRY MANAGEMENT

In addition to the information on Forest Management given in Chapter 1, a fairly clear picture was given at the symposium on the management structure of forestry in China.

At the centre of forestry in the country, stands the State Administrative Bureau of Forestry (SABF). It leads the whole country in organization of forestry and forest industries. It draws up both the long-term plans and the yearly plan, as it is in charge of both the forests and the industry which processes the wood they yield.

Some provinces with significant forest resources have provincial administrative bureaux of forestry or the forest administration may be combined with the agricultural bureau, if forestry is not of great importance in that province. Where forestry is an important activity in a province, there will be sub-bureaux of forestry from the provincial level down to the level of the commune.

An example was given for Heilongjiang province where there are eight sub-provincial bureaux of forestry which control districts where important production enterprises exist. These sub-bureaux operate forest farms which are equivalent to forestry districts and also control forest industries in the area.

The formulation of the forestry plan starts at grass-root level in the sub-provincial bureaux. Each large enterprise and forest farm district determines its production plans and these are sent up to the provincial level and finally on to the SABF for approval. At the grass-root level, all planning is focussed on production. Detailed questions of raw material procurement and allocation of product are not dealt with. These two aspects are dealt with on the national and to some extent on the provincial level.

Chapter 4

TECHNICAL DESCRIPTIONS OF SOME WOOD PROCESSING PLANTS

In all, the team visited twenty wood processing plants all of which presented special features of interest to developing countries. A complete description of all these plants in a report of this nature is not necessary or even possible, so four representative plants were selected by vote amongst team members and detailed descriptions of them are given in this chapter. The plants were selected for their technical interest and relevance to the needs of other developing countries. The plants selected were:

1. Fibreboard Plant of Guangzhou (Canton) Wood Processing Complex, Guangzhou (Canton), Guangdong Province.
2. Particle Board Plant of Nancha Wood Processing Complex, Nancha, Heilongjiang Province.
3. Rayon Pulp Plant of Mudanjiang Wood Processing Factory, Mudanjiang, Heilongjiang Province.
4. Hsing Fang Timber Mill, Harbin, Heilongjiang Province.

In addition to the detailed description of these plants, a brief summarized description of the twenty wood processing and machine building plants visited is given in Appendix 3.

4.1 THE GUANGZHOU (CANTON) FIBREBOARD MILL

4.1.1 Location

The mill is located on the banks of a tributary of the Pearl River about 25 km upstream from Guangzhou (Canton). This gives the plant a number of advantages. The site is on a gently undulating to hilly terrain unsuited for agriculture - an important point in China where no arable land can be wasted. The location on the riverside solves transport problems since the road network in the zone is not well developed. River transport by sampan and barge is well developed, enabling the plant to receive raw material from forest areas up river and from associated factories in Guangzhou (Canton) and to distribute its production to Guangzhou (Canton) and to smaller towns and villages along the river system. Coal for boiler fuel is also delivered by river transport. A high tension power line, providing electric energy for operations, passes by the plant.

4.1.2 Raw Materials

Wood is received as offcuts, edgings and slabs from sawmills in Guangzhou (Canton) and in the form of green hardwood chips, produced by using mobile chippers in forested areas about 75 km up river from the plant. These chips arrive in barges where they are unloaded by crane using wire mesh measuring boxes. The plant buys the chips at this point. Wet slack coal from local deposits is used as boiler fuel for steam raising. Other raw materials used in minor amounts are paraffin wax emulsion and aluminium sulphate.

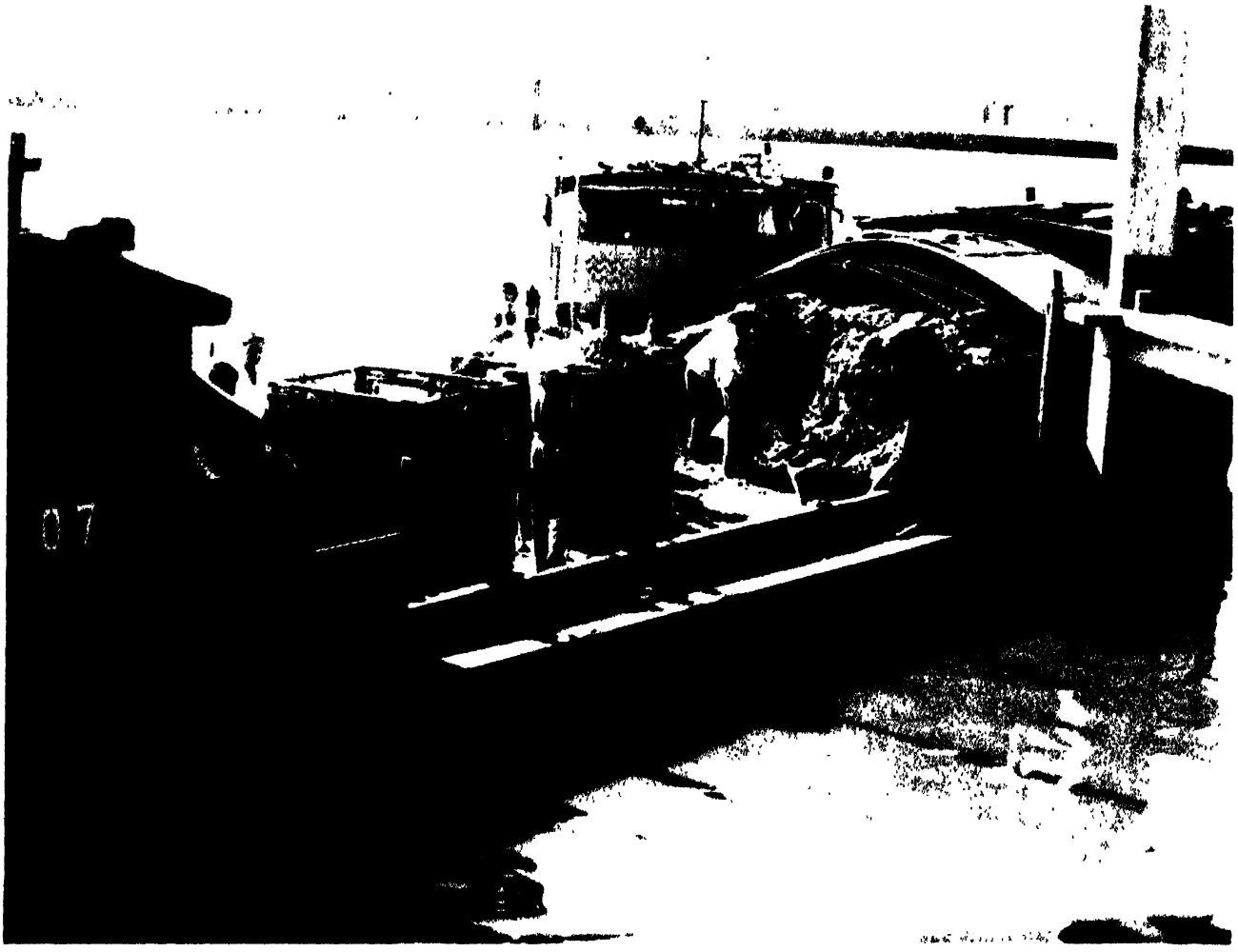


Fig. 11 Delivery of green hardwood chips by barge to Guangzhou (Canton) Fibreboard Factory near Guangzhou (Canton)

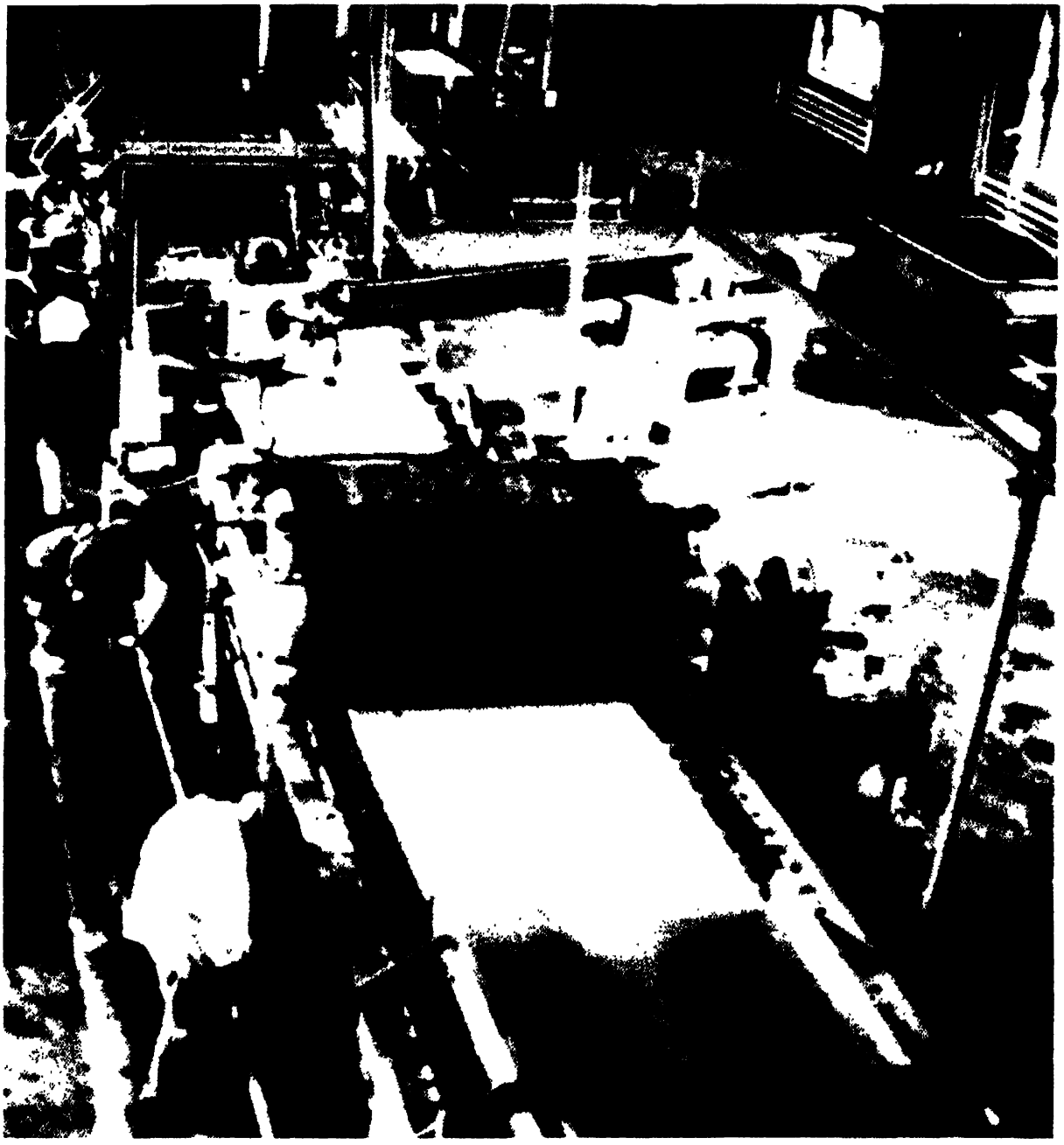


Fig. 12 Sheet formation line in small fibreboard mill, Harbin

4.1.3 Equipment

This plant is of special interest in that it shows how normal production capacity of a standard fibreboard plant can be raised by carefully studying the capacities of the various plant units and judiciously eliminating the bottlenecks through the enlargement and duplication of critical items of equipment.

This plant was originally equipped with a standard fibreboard line of 2 000 t/year nominal capacity produced by the Shanghai Artificial Board Machinery Plant (visited by the team whilst in Shanghai). Over the years from 1970 to 1978, the plant's management, technicians and workers have steadily raised its output to reach 6 500 t/year. It was stated that more than 140 significant modifications to the plant had been made in the eight year period.

Major changes were: building a new defibrator to run in parallel with the original one; installing a new boiler plant of higher operating pressure and evaporative capacity; reducing the daylight opening of the press from 10.3 cm to 9.1 cm; replacing the original 18 cm cast iron head of the press with a cast steel head 9 cm thick. These last two changes enabled the press size to be increased from 15 daylights to 17 daylights. The use of chipped raw material produced in the forest enabled the original chipper to cope with increased production. Steam of higher pressure and temperature enabled the pressing cycle to be shortened and output raised.

This high output of fibreboard demands a high-output boiler plant, which was not always available in other plants visited, which were equipped with the same standard plant of 2 000 t nominal annual capacity.

An advantage of this plant from the developing countries' point of view is that it is built up from units of orthodox design and the control system is based on well-understood microswitch/relay technology, thus avoiding the need for sophisticated maintenance.

The achievements of this Guangzhou (Canton) factory in raising the output of this standard plant had not gone unnoticed by the Shanghai machinery plant that produced it. They were developing an improved higher-capacity defibrator and were making other improvements to their plant to enable the potential excess productivity of their sheet-forming machine and hot press to be used to advantage.

4.1.4 Process

Wood residues approximately in the ratio of sixty percent offcuts and slabs with bark to forty percent green woodchips are conveyed by belt into the plant. Unchipped material passes to a standard horizontal spindle disc chipper with screens to separate over- and under-size material. Chipper capacity was stated to be 13 t/24 hours. Absence of ear protection for chipper operators was notable here as in all the other fibreboard plants visited. Chips are stored in hoppers above two defibrators operating in parallel. Steam supply is 210°C (16.5 atmosphere gauge) to the defibrators.

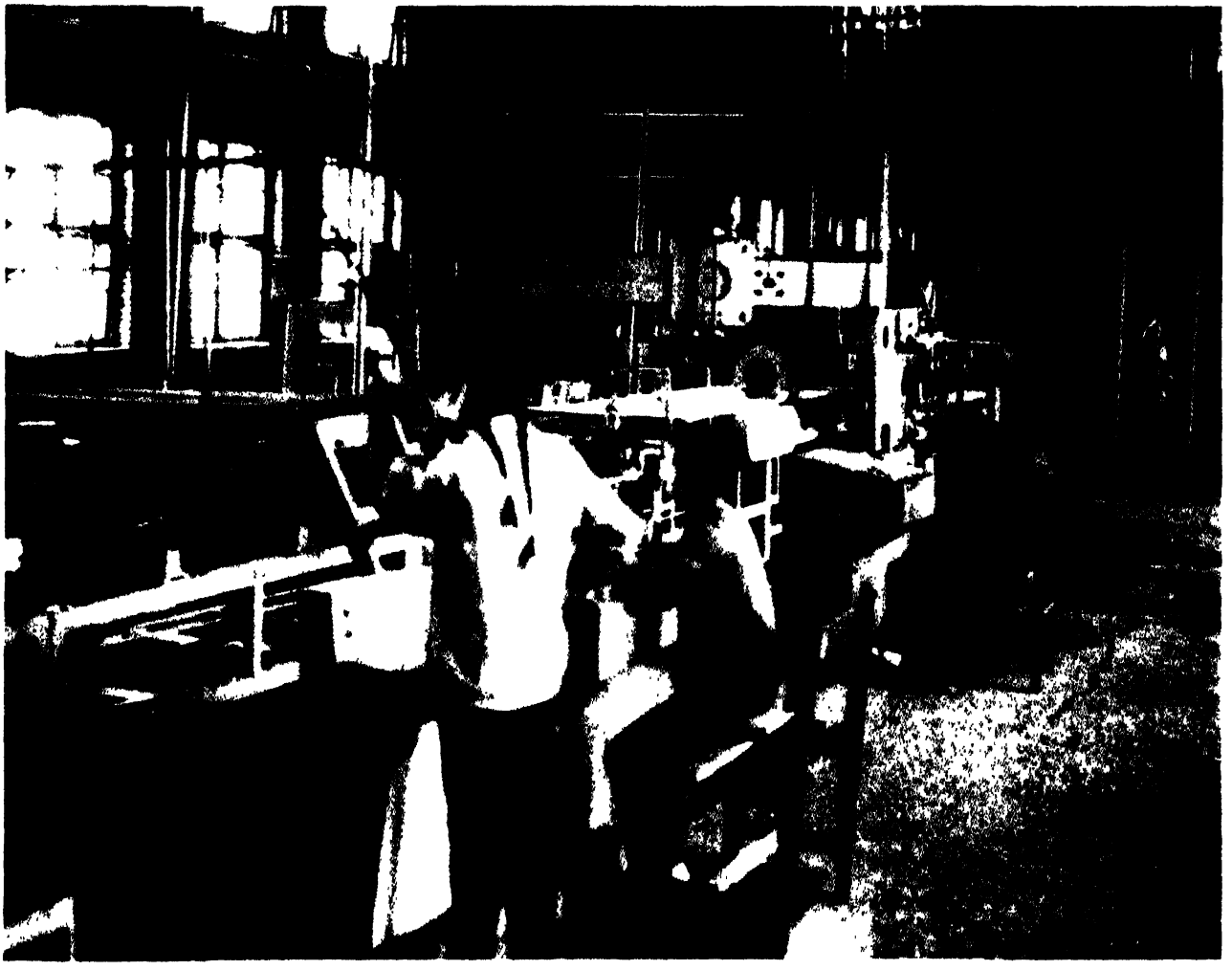


Fig. 13 Press and loader control console in small fibreboard mill, Harbin

Output from the defibrators is passed through a disc refiner and then to concrete stock tanks where it is blended and mixed with alum and paraffin wax emulsion. No resin adhesive is added. Prepared stock at correct consistency flows under manual control to the head box of the foudrinier type board-forming machine. At the time of visit a sheet approximately 0.9 m wide was being produced. Maximum width possible would be about one metre. Formed sheets were trimmed to length using rotary wet saws but water jets, as seen in other plants, were being installed.

The hot press was of 17 daylights with drilled steel steam-heated plattens. Conventional screens and tee-headed cauls were used, with normal loading/unloading equipment.

The platten temperature was 200-210°C and the press cycle was as follows for 3 mm board.

Loading	60 secs	
Pressing water	44 secs	
Drying	180 secs	
Final pressing	94 secs	
Unloading	60 secs	
Total cycle time	438 secs	= 7.3 minutes

After pressing, boards were separated from cauls and screens with air suction lifters and transferred to a standard-type trim saw line. Finished sheet size was approximately 2.13 m by 0.81 m and 3mm thick. Heat treatment of boards after pressing to improve properties has been tried and not found necessary.

Defective sheets were sorted after trimming and consisted mainly of a small percentage of blistered face sheets which would be saleable for second class uses.

Board quality is controlled by a government standard specification which, it was stated, the board easily meets. Further, it was claimed that this board, based on hardwoods and including some bark, was superior to that of other plants using softwood. This agrees with experience in other parts of the world.

Effluent water from the plant was discharged without treatment into the adjacent river. It was stated that, in view of the ecological problems which this may pose, research was being done on treatment methods.

The steam supply for the plant is provided from a single water tube boiler fired with wet coal slack from nearby coal mines. Boiler pressure was 16.5 atmospheres gauge (242 psi or 17.05 kg/cm2). Boiler output is approximately 4 t of steam/hour.

Fig. 14 Sorting sawmill waste at a sawmill for use in particle board and packaging, near Harbin

4.1.5 Labour

The average crew was as follows:

Raw material preparation	15 per shift
Defibrators	2 " "
Refiner	1 " "
Size additions	1 " "
Forming line	1 " "
Hot press	2 " "
Trim line	1 " "
Miscellaneous	4 " "

The plant works seven days of three shifts each. In addition, there are employed:

Packing and storage	7
Maintenance	19
Electricians	8
Boiler room	10

The plant works the whole year, but in practice about two to four weeks each year has been needed for alterations and maintenance. Most workers do not get annual leave but workers who perform well receive 12 days (two weeks) paid annual leave. The average wage paid in the plant was stated to be normal for the industry.

4.1.6 Maintenance

The plant has well-equipped machining, fitting and welding shops for maintenance, production of spare parts and construction of new and modified machine units.

4.1.7 Technical and Economic Data

Annual Production	6 500 t/year
Annual Consumption of wood	14 - 15 000 m^3/year
Raw material haulage distance by water	20–25 km for slabs and offcuts
	100 km for chips
Transport of finished products to market by water	20–25 km
Total plant investment	2.86 million yuan
Annual profit	0.5 million yuan
Cost of green chips free alongside (FAS) factory	100 yuan/bone dry tonne
Cost of slabs and offcuts	transfer price from other enterprises of group plus river haulage to plant

Production cost of fibreboard	280 yuan/t
Selling price of fibreboard	400-450 yuan/t depending on quality
Electric power used	380 kWh/t of fibreboard
Water consumption	60-70 t/t of fibreboard

4.1.8 Comment

This mill was impressive. Factory housekeeping is good and the use of raw material, labour and machines is very rational. It is a good example of how output can be increased by careful improvement of process techniques and machine units. Plant location in relation to raw material, markets for finished products, electric power and availability of suitable industrial land is noteworthy.

4.2 PARTICLE BOARD PLANT OF THE NANCHA WOOD PROCESSING COMPLEX

The particle board plant of the Nancha Wood Processing Complex illustrates a number of factors relevant to the production of particle board as seen during the visit of the team to China.

One of the most interesting features of the integrated forest industry plants of China is the coexistence within the one complex of relatively high-technology, capital-intensive processes alongside simple labour-intensive ones. Although the economic return from both types of process can be widely different, they continue to operate successfully since there is a need for the product they produce and their existence is not threatened by the normal forces of capitalist market competition. Furthermore, because the morale of the work force is high, productivity even of rather primitive plants can be quite reasonable.

4.2.1 Raw Materials

Wood raw material for particle board production at Nancha consists of softwood slabs and offcuts from the sawmill of the complex and a certain amount of branch wood. Korean pine would be the most common species in the mix. Urea resin locally made is used as binding resin and paraffin wax emulsion is added to improve board stability and resistance to humidity.

4.2.2 Equipment

The equipment is all Chinese made, mostly in Harbin but some in the Nancha plant workshops.

"Honibak" type flakers are used for primary chipping and then a ring flaker mill is used to reduce the chips to flakes of suitable size.

The gluing equipment consists of a simple batch-operated spray chamber made in the works. A forming station was still under construction in the plant and appeared to be designed to produce a graded layer board.

A prepress was installed but it was not clear if caulless operation was intended as sheet steel cauls were in use in the plant.

The press had 12 daylights. Its hydraulic system operated at a pressure of 140 kg/cm2 (2000 psi) and steam-heated plattens at a temperature of 140-150°C were used. Tee-headed cauls with conventional loading and unloading equipment are fitted to the press. The Nancha plant is able to make hot presses in its own workshop and drilled plattens of high strength cast iron were being made at the time of the visit.

Vacuum arms are used to separate panels from cauls and standard transfer and trim saw lines follow the press. Plain saws without carbide tippings were used as trim saws.

4.2.3 Process

Offcuts, slabs and branch wood, all with bark, are cut by two operators into lengths to suit the primary flakers using a 24 inch circular saw bench. About three operators feed this prepared wood into the flakers. The chips are transferred by belt to a ring flaker and then elevated to screens. Undersize and dust from screens is used as fuel.

Flakes which are relatively coarse, being more like waferboard flakes, are fed to a rotary drier. Dried flakes are elevated to a storage hopper.

Glue application is a batch process using an applicator spray chamber made at the factory. A pre-weighed quantity of flakes is placed in the bin and stirred while urea resin, wax emulsion and hardener are sprayed in.

At the time of our visit the forming line unit was still under construction but to enable production to continue without it, sheets were being hand formed using a deckle box made of wood. Baskets of flakes were carried from the pile of spread flakes beside the glue applicator, tipped into the box and hand levelled. The spread sheet on a caul after removal of the deckle box was placed in the press loader.

Pressing was normal though the low press temperature made the pressing time long, being 20 minutes for 18 mm board.

The surface of the boards was relatively rough, rather like flakeboard and there was considerable variation in thickness. It was not clear if this was merely due to an uneven hand spread of board furnish or also partly due to inadequate stiffness in the press. Similar uneven thickness boards of a similar type were seen at the Sung Chiang plywood factory in Harbin which was making an identical product with identical equipment, except that the boards were machine formed. The finished sheet size was about 1.80 x 1 m and 18 mm thick.

4.2.4 Labour

The plant employed a mixed labour force of women, men and juniors of both sexes. Three shifts were worked for about 300 working days per year.

4.2.5 Maintenance

Since the plant forms part of the Nancha complex, its maintenance requirements are handled as part of the overall maintenance of the plants of the complex. Because of the very extensive engineering workshops of the complex, which comprise machine, welding and foundry shops with a complete professional engineering staff, the plant must be considered self-sufficient in all maintenance aspects even including construction of complete new items of plant.

Because of the reconstruction work in progress, it is impossible to give any comment about general housekeeping and safety except to note the absence of noise protection for operators near the chippers.

4.2.6 Technical and Economic Data

The investment in the particle board mill was stated to be 1.2 million yuan and and the value of production per year as 0.52 million yuan.

Wood residue consumption was given as 4 000 m^3/year. This is a relatively minor outlet for the sawmill residues of the complex which total 120 000 m^3/year Of these, the wood hydrolysis plant used 75 000 m^3 and the fibreboard mill 10 000 m^3.

Full technical data was not available for the particle board plant but data for a rather similar plant at the Sung Chiang Plywood factory is given below.

4.2.7 Production Information and Technical Data (Sung Chiang Plywood Factory Mill)

Capacity of mill	2 300 m^3/year
Input (wood)	3 680 m^3/year
Number of workers	53
Average wage rates	56 yuan
Annual production	1 300 m^3
Number of work days	300 year
Number of shifts	3
Glue consumption	150 t/year
Hardening agent	1.5 t/year
Water-proofing agent (wax)	15 t/year
Water consumption	8 t/hour
Steam consumption	1 t/hour
Electric power installed	292 kW

4.2.8 Comment

The special interest of this particle board plant is to show that in the Chinese situation the existence of a local need for a particular product, the determination of an enterprise to produce it, and the availability of small-scale unsophisticated equipment at relatively low capital cost enables that local need to be met. In other words, the criterion of whether a product will be made is not simply economic in the narrow financial sense but includes social factors, such as a local need for that product, the desire to provide useful employment for local people and the availability of suitable raw material or residues for which higher-grade users are not immediately available. Developing countries can conclude from this example that sophisticated plant is not needed for viable particle board production in the technical sense.

4.3 RAYON PULP PLANT OF MUDANJIANG WOOD PROCESSING COMPLEX, MUDANJIANG, HEILONGJIANG PROVINCE

This plant is a small-capacity, high-grade, special-purpose pulping plant which demonstrates integration at the level of the individual complex and integration of product within the industry as a whole. The type of equipment used for pulping, namely spherical digesters, was found also in other small-sized pulp and paper plants visited by the team.

The rayon pulp plant was established in 1965 with a design capacity of 2 000 t/year. Its present production is 3 000 t/year, and it employs 254 people. It forms part of a larger complex producing sawnwood (150 000 m^3/year), joinery, fibreboard (2 000 t/year), activated charcoal (200 t/year) and carboxymethyl cellulose (200 t/year).

4.3.1 Raw Materials

Twelve species of deciduous hardwoods are used, in the form of offcuts, slabs and branch wood. Hand debarking of this waste material is carried out in the wood yard of the mill before it is conveyed by belt to the chipper. The main species used are birch, ash, elm, linden and poplar. There is no selection of species, the actual mix varying with log supply.

4.3.2 Equipment

The plant was made in China and was commissioned in 1965. The main items of equipment are the chipper, four spherical digesters, two for prehydrolysis and two for alkaline kraft cooking, bleaching vats, rotary filters, centricleaners, hollander beaters used for bleaching, a fourdrinier-type sheeter and roll-type bone dryer. The final item is a sheet cutter and baler which was made in the factory itself.

4.3.3 Process

Because of technical problems in translation of chemical terms, some details of the pulping process were not available, but the following is an outline of the process used. Debarked mixed deciduous hardwood offcuts, slabs and branch wood are conveyed to the chipper, a conventional horizontal shaft disc machine. The chips were elevated to screens, the oversize chips were returned and fines were discarded.

Fig. 15 Sawn Korean pine structural timber produced at the Hsing Fang Timber Mill, Harbin

Prehydrolysis to reduce the pentosan content of the chips is carried out in two spherical digesters in parallel. They are of steel plate, lined with stainless steel. Cooking is carried out at a temperature of 165°C for six hours. The ratio of chips to liquid is 1 to 2.7.

After hydrolysis the chips are blown down into a concrete storage bay drained and transferred by conveyer to the two following spherical digesters which operate in parallel. The chip/liquor ratio is 1 to 3.5 and cooking is for six hours to a maximum temperature of 165°C. The cooking liquor was a mixture of caustic soda and sodium sulphide. There was no black liquor recovery system. Pulp is screened after cooking to remove knots and washed. It is bleached in tanks and hollander beaters with chlorine, sodium hypochlorite, and caustic soda, but precise details were not available. The bleached washed pulp is passed through centricleaners and then to the fourdrinier-type sheeter, followed by a drum-type bone dryer. The finished pulp is cut and baled for dispatch to rayon factories. Bales were tied with vegetable fibre cordage. A quality control laboratory carried out simple control testing of the finished product.

4.3.4 Labour

The total labour force in the mill is 254 distributed over three shifts.

4.3.5 Maintenance

This is carried out as part of the normal maintenance of the whole enterprise which possesses extensive well-equipped workshops. The level of housekeeping in the plant was below average. There were numerous unfenced holes in floors and there appeared to be no noise protection for operatives in the chipper room. Employee morale appeared to be good and the accident rate was stated to be low.

4.3.6 Technical and Economic Data

8 m^3 of wood chips yields	1 t of pulp
1.07 t of pulp yields	1 t of rayon
Investment cost of plant and machinery	2.67 million yuan
Investment cost of steam boiler plant	1.38 million yuan
Investment cost of site works	1.89 million yuan
Investment cost of miscellaneous items	1.38 million yuan
Total investment cost	7.32 million yuan
Capacity of mill	2 000 nominal 3 000 actual t/year
Wood input	24 000 m^3/year
Number of workers	254
Cost of production	900 yuan/t
Selling price	1,100 yuan/t
Annual profit	600 000 yuan
Number of shifts	3
Caustic soda	1 050 t/year
Electric power installed	977 kW
Water	260 t/hour
Steam	2.3 t/hour

4.3.7 Comment

This plant shows that under appropriate conditions a very small-scale pulp mill can be technically viable. The sales price given, namely 1 100 yuan/t, (US$ 647 is in the range of normal present world mill net prices for dissolving pulp). The mill is operating profitably as indicated in the data above. But the total investment cost per daily ton of production at US$ 520 000 is high for a mill built in 1965 without black liquor recovery or bleach chemical plant. Perhaps the mill was constructed for a special reason such as to provide some cellulose pulp for nitration as an alternative to cotton which does not grow in the zone.

4.4 THE HSING FANG TIMBER MILL

This mill is located in Harbin, a city of 2.5 million people, and the capital of Heilongjiang Province. This province is the major producer of logs and sawnwood in the country, the logs of its principal species, Korean pine (P.Koriaensis) being found even in sawmills in Guangzhou (Canton) in the far south of the country. The forests which once surrounded Harbin at the turn of the century have long disappeared and the log supply for this mill comes from present logging areas located east, north and west of Harbin.

This mill also includes, in addition to its large sawmill, a plymill, furniture workshops, a plastic laminates plant, a fibreboard mill and a plant for production of wood adhesives.

The factory was established in 1951 and expanded in 1952 and 1955. Its technology is basically European and various machines of European manufacture are in use in the sawmill and two plymills.

Log supply is from the pooled system operated by SABF and it is not possible to say exactly where they originate within Heilongjiang Province.

The mill has a sawn production of 40 000 m^3 and is, therefore, classed by the Chinese as a medium-sized mill. Plywood production from its two plants totals 15 000 m^3/year of hardwood plywood. Manchurian ash plywood produced is of very good quality.

In addition to its production facilities, the mill has constructed more than 50 000 m^2 of housing for its work force which numbers 2 800. There is also a canteen for hot meals, a kindergarten, a community centre for 1 000 people and a school for 3 500 pupils.

4.4.1 Processing System

The sawmill is elevated and logs from the log yard are roughly sorted for size and grade and elevated by a bull chain conveyer running the length of the log yard to the mill floor. Logs of different sizes are sawn serially, for which the mill is adapted. The log diameter being cut was mainly in the range 0.2 to 0.4 m centre diameter.

On arrival at the live log deck on the mill floor kickers push the logs to one of two band head saw and carriage lines. The band mills have saws about 12 cm wide and wheels about 1.20 m diameter. Carriages have riders who control settings of logs by push button. The first head saw slabs the log and feeds cants to a gang saw which produces square edge boards and two roundbacks, but some larger or faulty cants are passed to the second head saw and carriage where they are cut so as to produce wide sawn boards and planks.

There are three band resaws in the mill again having saws 12 cm wide. The band resaws are conventional with an infeed and outfeed operator. Roundbacks from the head saws are resawn on the band resaws though there is also a small circular bench where some roundback slabs are resawn.

After passing the band resaw, boards requiring edging pass to a two saw edger of conventional design.

Belt conveyers then carry the sawn boards and planks down to a green chain running at right angles to the axis of the main mill where they are end trimmed and graded. Graded and sorted material is lifted from around the end of the green chain by a gautry crane to the stockholding area.

4.4.2 Stacking and Seasoning

This is organized in a rather elementary way in this sawmill. Sawn timber stacks are spread over a large area of the mill site with little or no attempt to save space by making stacks taller. Sawnwood stacked for air seasoning is piled without stickers or protection from weather.

Fortunately Korean pine is quite durable in this climate and provided the sawnwood moisture content is reduced to a "shipping dry" condition (about 20–25 percent moisture content) no problems in transport or handling appear to be encountered. In tropical developing countries severe decay and deterioration would occur if similar conditions of seasoning and storage were to be used.

4.4.3 Waste Utilisation

The average sawn timber recovery is fairly high at this sawmill. Some of the residues are used for fibreboard production within the complex and the remainder, including bark and sawdust, is used for fuel. Some of the residues, mainly slabs, provide fuelwood for workers. It is not clear if sawdust from this mill is utilised except as fuel, but in some other mills, for example at Nancha Wood Hydrolysis Plant (north-east China,) it is processed into alcohol and at Guangzhou (Canton) Wood Processing Complex (South East China) it forms the principal raw material for production of activated charcoal.

4.4.4 Production Information and Technical Data

Total investment in the sawmill	2.43 million yuan
Capacity of mill	40 000 m^3/year
Number of shifts	2
Input (logs)	72 000 m^3/year
Number of workers	190
Number of work days	306/year
Annual profit	2 million yuan
Electric power installed	840 kW
Production cost per m^3	135 yuan
Selling price for Korean pine per m^3	150 to 220 yuan
Average haulage distance for logs to mill	400 km
Average log haulage cost to mill, per m^3	25 yuan

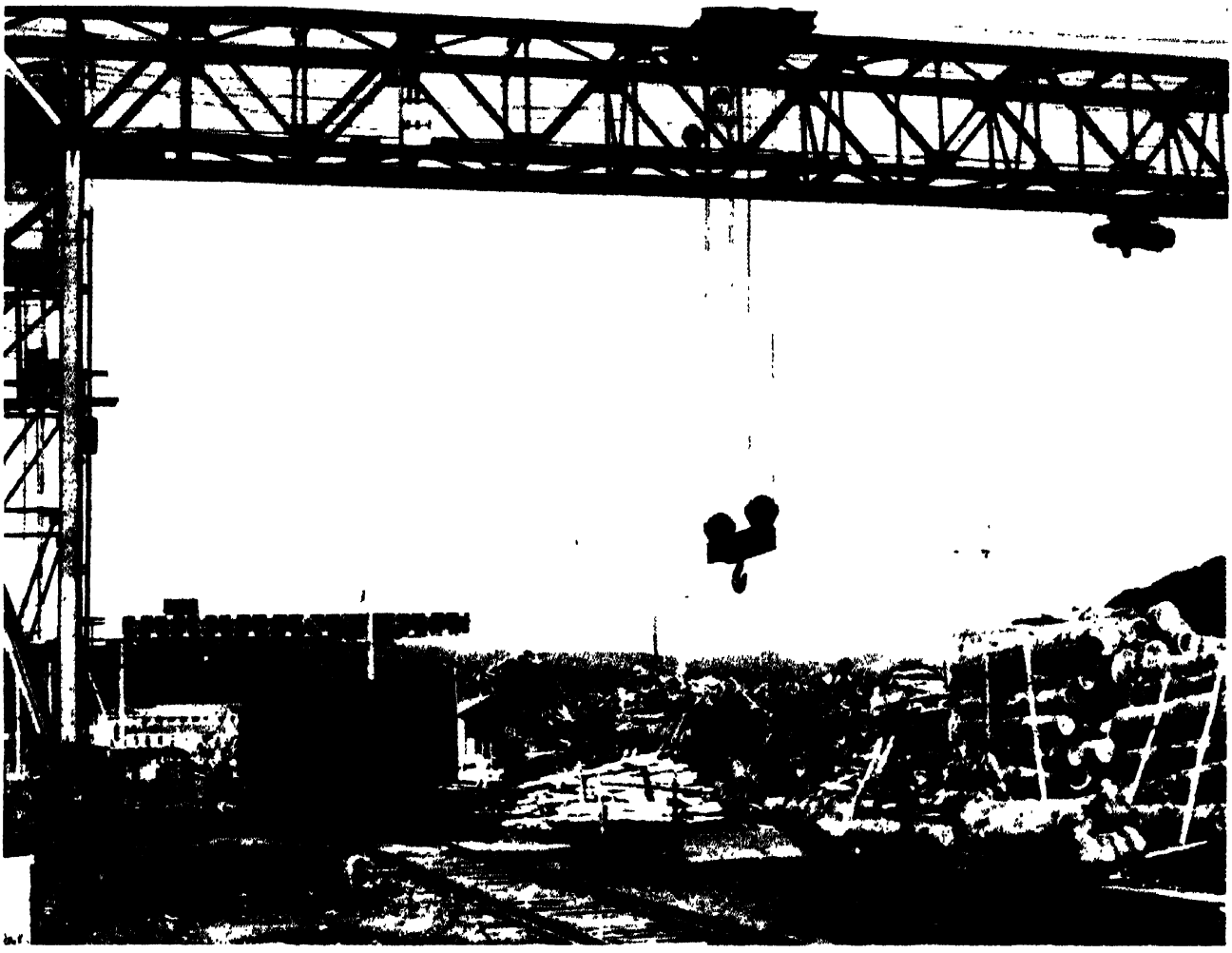


Fig. 16 The log yard of the Nancha wood hydrolysis complex, Nancha, Heilongjiang Province

4.4.5 Comment

This mill is a typical example of softwood sawmilling technology from the early fifties. The team were told that the mill would be rebuilt in two or three years' time, but the machinery of the mill, though well-worn, has been carefully maintained. In the labour and raw material supply situation prevailing in Harbin, there seems little incentive to re-equip this mill with up-to-date machinery apart from perhaps installing a debarking line. Rebuilding could have the effect of eliminating workers for whom there may be no immediate alternative work. Investment in improved utilization of residues, e.g. particle board, could be a better option if it is considered that Harbin is the correct long-term location for this sawmill in relation to supply of logs. The sawmill and plymill of the complex together must produce each year around 28 000 m^3 of residues, of which about 8 000 m^3 is probably sawdust, leaving 20 000 m^3 of high-grade residues.

Unless this wood is utilised efficiently by other neighbouring enterprises having no other local source of raw material, then it would seem that investment in plants such as particle board by the complex should be closely considered.

Chapter 5

LABOUR AND WORKING CONDITIONS IN INTEGRATED WOOD INDUSTRIES

The People's Republic of China sets as its priority task the needs of the people above all else. Nowhere is this more clearly expressed than in the field of labour relations.

The team had an opportunity to observe at close hand in the forest products industries many aspects of these relations and to see to what degree it has been possible to give effect to the aims of the People's Republic of China in this field.

Overwhelmingly the picture that emerged was one in which the welfare of the workers was placed first, though there were some aspects such as worker safety and annual holidays which still seemed to lag behind.

China is an egalitarian society and the strong impression obtained in all the factories visited is that workers, technicians and management work hard in close partnership with the aim of raising by their labour the standard of living of all the Chinese.

The team was told on many occasions in factories of the problems of the past, the excesses of the "Gang of Four", the mistakes which occurred during the Great Leap Forward, and how all these factors had affected output. All managements spoke confidently about the new conditions prevailing and the rise in output and worker morale which had occurred following the crushing of the "Gang of Four".

Labour conditions were not a prime object of the team's study; the main interest was technology. For this reason the amount of information collected was limited and the picture presented below is lacking in some particulars.

5.1 RECRUITMENT AND TRAINING

5.1.1 Recruitment

There are two main ways by which the wood processing industries can recruit new workers. The first one requires the industries to lodge with the central government a formal application, showing their labour requirement. This system is normally followed when the industries want to recruit graduates from such institutions as universities, technical colleges and other training schools.

The central government or province then proceeds with the actual recruitment from the institutions mentioned above. In addition, it distributes young workers entering the labour force to the various mills according to their respective requirements and the jobs available.

It must be mentioned here that some new graduates, who have had some years of working experience before enrolling at the university or technical colleges return automatically to their previous employer. They may, therefore, not be affected by the distribution process as carried out by the state.

Most people recruited under the system described above are usually qualified technical or professional employees and are therefore placed in responsible positions when they return to or take up employment with the industries.

Fig. 17 Sorting and debarking by hand of Korean pine sawmill slabs and roundwood at Fanglin Forest Farm paper plant

The second system of recruitment, unlike the first one, is operated by the individual mills or plants themselves. However, before they can do this a formal permission must be sought from the state. They need to advise the state on the number of people they want to recruit. If approval is granted the mills or plants then go ahead and recruit the approved number of people. Generally speaking, workers recruited by this system are unskilled people. They come from nearby communes and, on actually taking up employment, they are given jobs initially which do not require much skill or qualifications.

One has a strong impression on visiting plants that the social aspect of job creation is important. Many enterprises seem overstaffed at the factory floor level. In addition, because the welfare of the workers is a priority objective of enterprises, there are large numbers of employees who work in the canteens, medical clinics, kindergartens and cleaning, sanitation and gardening services of the enterprises. Since everybody is employed in productive work with a visible purpose, the morale of the work force is high. The relatively low cost of labour power also enables an overall lower level of productivity per employee to be accommodated by the enterprise without financial strain.

5.1.2 Training

That the productivity, efficiency and quality of any staff can be improved by further training is fully appreciated in the Chinese system. In the wood processing industry there are two main ways of doing this. The first is by running short courses from time to time. These are usually arranged and conducted by the various mills at the mill site. The courses aim at increasing the knowledge of the employees in the various aspects of their job. In addition, they help them to understand better the role each and everyone is required to play in order to attain the objectives of the mill and of society.

The second way is to send capable and promising employees for further training to institutions such as universities and technical colleges. Institutions, for example, like the North-East Forestry Institute, Harbin, usually give priority to such people in their enrolment.

On successful completion of their training, the graduate returns to employment and may take up a more responsible position either immediately or after some time. There is also apprenticeship training available in the wood processing industries. Under this scheme people who join the industries after completing their secondary school or tertiary institution studies, are employed for a period of three years as apprentices. At the end of the three-year period the apprentices sit for an examination. Those who succeed in the examinations become permanent employees, while unsuccessful ones have a chance to repeat their apprenticeship courses. Pay scales are also linked to training results and provide a strong incentive to workers to improve their knowledge on the job.

5.2 WAGES AND OTHER SOCIAL BENEFITS

5.2.1 Wages

The wage structure is based on an eight-grade scale. All employees ranging down from the manager or factory chairman are included in the scale. The manager/chairman may be, but is not necessarily, paid at the eighth grade, which is the highest level.

Salaries or wages of employees are based on the scale. They differ from mill to mill and from province to province. However, the difference is not very significant. The average salary is between 65 and 75 yuan/month. The lowest salary range is around 35 to 45 yuan/month, while the highest salary ranges are around 100 + yuan/month. These are normal salaries and do not include bonuses which can be awarded to employees whose output and work quality are outstanding during the month. An example of the scale taken from data given for Shanghai is as follows:

Step 1	38 yuan
" 2	44 "
" 3	51 "
" 4	59 "
" 5	68 "
" 6	78 "
" 7	90 "
" 8	104 "

It is not unusual, for example, for a technician of a factory who is highly skilled to be paid at a higher level than the manager and this does not seem to interfere with the management structure of the enterprise. The working day is normally eight hours and six days are worked per week. Cost of transport for workers to and from the job is subject to various kinds of subsidy equalization. Workers who live close by in apartments owned by the factory receive slightly less than workers who live at a distance and may need to use public transport. In other instances, assistance may be given to acquire a bicycle and an allowance to cover its maintenance may be paid. As far as is know, the amount paid as wages is net and is not subject to any levy or tax deductions.

5.2.2 Housing

The wood industries, like other industries, provide some housing for their employees. Rent for these houses is either free or is so low that it does not exceed 5-10 percent of the monthly earnings of the family occupying the apartment.

In addition, some plants, located on large areas of land, make land available near the factory for those employees who want to build their own houses. Lighting for houses is provided by the factory's power supply. Water supply may also be provided by the factory.

5.2.3 Medical Care

The provision of health services by factories for their employees and their families is a prime task of the management. This is done by the establishment of health clinics on the mill sites. Such clinics are staffed by trained and qualified people and the services are free of charge.

Some mills also have an agreement with big hospitals in their locality where an employee with serious sickness can be taken and cared for, also free of charge. It is also to these hospitals that pregnant women employees go for delivery.

Fig. 18 Unguarded veneer guillotine at Guangzhou (Canton) Wood Processing Complex

Fig. 19 Kindergarten children and team members at the kindergarten of the Nancha wood hydrolysis complex, Nancha, Heilongjiang Province

5.2.4 Education

As with the health services, many factories provide education facilities for for the children of employees. These include kindergarten, primary and secondary schools. Education is compulsory and is provided free of charge.

Trained, qualified teachers are responsible for the management and teaching of the school children.

The factories located in the city area, which do not run their own schools, send their employees' children to schools run by the Ministry of Education.

5.2.5 Leave

There are three main types of leave to which employees are entitled. These include vacation leave, sick leave and maternity leave for female employees.

As regards vacation leave, workers who qualify by meeting output and attendance norms, etc., are granted up to 12 days' leave on full pay as decreed by the state. At present most workers do not get annual leave but one of the present objectives of the Government is to extend the provision of annual leave. It must be recognised that provision of facilities to enjoy annual leave are required as well and since these are limited at present, the granting of annual leave is also restricted.

Sick leave is given to employees who are sick and must stay away from work. All employees are entitled to a maximum of six months' sick leave on 100 percent salary. After this, they are entitled to 80 percent of their monthly salary.

Maternity leave is given for females. The maximum allowable duration for this leave is 56 days, commencing with the first day after the time of delivery. In addition, expectant mothers are given about two weeks' rest before the expected time of delivery. During all these times the woman enjoys full pay. Furthermore, she is given free treatment and free medical services while in the hospital.

Another type of leave from which employees can benefit is that granted for attending to family problems. It was not possible to obtain details of the allowable duration of this leave and whether employees taking this leave are given reduced pay or leave without pay.

5.3 SAFETY

The forest product industry throughout the world is by its nature a dangerous one and the team was interested to see how worker safety is ensured in the industrial plants and forest operations visited. It must be said that the impression received by a visitor to China experienced in these types of industrial operations is an uneven one and, at times, even disturbing.

In many aspects of safety the Chinese industry lags behind the developed and even some of the developing world's industry, in provision of protective clothing, boots, gloves, eye protection and protection against industrial noise. In many plants the guarding of machine elements and building hazards such as floor openings is inadequate by standards accepted outside China. This is especially true of the guarding of guillotines and circular saws. There was also inadequate ventilation in some areas of plants using toxic solvents. On the other hand, operatives seem to handle their machines carefully and groups of workers operating unguarded guillotines without any interlocked safety controls appear to move carefully to avoid injury. Good worker morale, a high interest in work output and the absence of pressure from overseers must also contribute to minimising the accident rate which otherwise would be much higher.

The reasons why safety protection is lagging in most enterprises visited are probably due to a combination of factors. First is the traditional one. Chinese industry in colonial pre-revolutionary days was notorious for its almost total disregard of its human operatives' welfare and safety. Many enterprises are reported to have functioned under conditions of callous semi-slavery. The present enterprises visited represent a giant step forward and they must seem to older workers to be almost idyllic.

A second factor is the simple lack of the necessary equipment owing to the present level of development of Chinese industry. Footwear of factory workers, for example, in China is elementary and gives next to no protection against falling objects. Thus, provision of hard boots for sawmill workers has not yet received much attention from management. Safety helmets (hard hats) are used to a minimal extent and the few that were seen were of a woven bamboo basket construction which seemed inadequate by modern standards. Eye protection glasses and screens were also rarely seen, possible because of a shortage of these items.

A third factor is probably the isolation of factory management and technical staff which existed under the "Gang of Four" policy, from world developments in industrial safety. (This applied not only to safety, of course, but to the whole gamut of technology). This must explain the lack of cognizance of the danger of high noise levels around chippers and circular saws.

Despite the fact that a number of minor factory accidents were seen by the team, the factories did not seem to have a particularly dangerous atmosphere and this is explained mainly by the interest shown by the workers in their work. The cramped layout of a number of furniture and cabinet workshops was not conducive to safe working but the willingness of operatives to "make do" in cramped and unsuitable surroundings and their belief in the usefulness of their work were undoubtedly important factors in reducing the effect of a sub-standard environment on the workers' health and safety. Another important positive factor in the situation is the provision of adequate first aid and health clinics in the factories. These seem to be well staffed and of clean, if sometimes spartan, appearance.

Furthermore, in discussions on safety with management it was stressed that an important factor in reducing accidents is the training which operatives are given in safe working and ways of avoiding accidents. While this does not overcome the problem of unguarded circular saws, guillotines and so on, it undoubtedly must reduce the incidence of accidents in these hazardous situations.

5.4 INCENTIVES

There is a complicated incentive system of bonuses in the wood processing industries. It includes material and moral motivations.

The material incentive involves the payment of extra money to those employees whose work during the month has been up to or above the standard set by the mill management. The appraisal is based on: (i) production, and (ii) the quality of the product, and is carried out at the end of each month. This incentive sounds like a good one and can encourage many employees to become more effective and productive. However, it was not clear if the system is being implemented on an industry-wide basis or only in some plants. The system was described by the management of the Kwang Hua Timber Mill in Beijing (Peking) and was stated to be effective. The bonus is a comprehensive one based on quality and quantity of production and is calculated each month. The average wage for the factory was 61 yuan/month within a range of 33 to 95 yuan. The typical bonus per month was stated to be 7 yuan/month for production workers, 6 yuan/month for maintenance workers and 5.5 yuan/month for management.

Fig. 20 Factory bulletin board where outstanding achievements by workers are mentioned

Management of some other plants referred to material incentive schemes but did not give details. Often the material incentive was given a minor role compared to the moral or prestige incentive, which is more a commitment to the welfare of society as a whole. Its operation is described in the following section.

5.5 COMMITMENT

The moral incentive, unlike that described above, does not involve any money payment at all to the individual. It is a motivation that encourages the employees to work harder, as it means publicity on notice boards and/or announcements on the radio for outstanding workers ("industrial heroes") etc. Photos of people whose work has been outstanding in previous months are displayed in show windows at the factories. All these things create an atmosphere in which everyone can strive to be among the advanced or outstanding workers and a few can succeed. It is the fact that not everyone can win the moral bonus which demands in addition a material bonus for the system to be effective.

No statistics were available to show how the above-described incentive systems affect such things as output, labour productivity, etc., in the wood processing industries. However, the following table taken from the Beijing (Peking) Review No. 34 illustrates how an aluminiumware factory in Beijing (Peking) experienced an increase in labour productivity, output and firstclass products, as a result of the implementation of the incentive system (material and moral) in the factory.

1st Quarter of 1978	Compared with State Quota	Compared with 1st Quarter of 1977
Output	31.5 percent higher	109 percent higher
1st class products	7.8 percent higher	11.2 percent higher
Labour productivity	11.8 percent higher	100 percent higher

To judge from the above statistics, the incentive system encourages the workers to work hard and improve their efficiency.

5.6 PRODUCTIVITY

Labour productivity was a point about which little information was given by the wood processing industries. Apart from two factories, all others visited gave no direct information on the productivity of the labour force. Because of this, the figure given below may not be a true reflection of how productive the labour force in the industries is.

Productivity naturally varies from mill to mill and from one product to another (e.g. particle board to fibreboard) but a range between 20 m^3/year/worker and 45 m^3/year/worker may not be a bad guess for particle board and fibreboard mills.

In sawmills productivity per worker per year seems to range around 150 m^3.

The above figures are certainly low compared to figures of the so-called developed world, being of the order of one-quarter or one-fifth of the average productivity of the latter. But there are a number of reasons for this. First of all, there is the typically small size of the wood-based panel plants. Then there is the large proportion of workers employed on "non-productive" activities such as canteens, health clinics, sanitation, etc. These are usually not counted in conventional estimates of labour productivity, whereas generally in the figures

given in China they seem to be included. Furthermore, there is the large number of extra workers who are employed in almost every plant as learners and apprentices and in the maintenance and construction workshops. These latter workers play an important role in the Chinese small-scale forest industries. They are employed to a large extent in extending, improving and mechanizing the plant installed in the factory - in other words raising the factory's potential labour productivity through mechanization. As workers are released from the production process by this means they will probably find new jobs in new or expanded factory operations.

The conclusion remains, however, that the labour productivity of the Chinese small-scale wood industries is low but is not as low as it may at first appear. Decisive increases in this productivity must probably await the successes of the modernization campaign. Meanwhile, the low productivity is socially acceptable since it means that most of the available labour force finds meaningful, socially rewarding work. This is certainly better than in those situations where one finds high productivity in modern mechanized plants embedded in a matrix of chronic regional unemployment.

Fig. 21 Machine shop attached to wood processing factory, Mudanjiang, Heilongjiang Province

Chapter 6

POSSIBILITIES FOR TRANSFER OF TECHNOLOGY

6.1 GENERAL

China is, as one so often hears in China, a developing country. However, it is a developing country with at least one very big difference from developing countries in general. That difference is that China has solved many of the problems of economic and social under-development which still bedevil many other developing countries. It is only natural, therefore, for some of these countries to see China's solutions as providing, almost ready-made, the answers that they have been seeking. The tendency has, however, been less pronounced in forestry and the forest industries, than in some other fields.

One of the main reasons why China has not been regarded as seriously offering a model for forest industries development has been the belief that China has concentrated on small-scale and apparently technologically backward plants (the backyard industries). In other words, it has adopted a line which has little relevance to situations other than its own. More recently that view has been undergoing some revision. Developing countries generally (and some developed countries for that matter) have become enthusiastic about the possibilities of specially designed small-scale, labour-intensive forest industry plants. The prospect of plants which could match the more technologically advanced plants of the industrialized countries economically and technically, without straining the marketing, financing and managerial capacities characteristic of developing countries, has an obvious appeal. The performance of China's small-scale forest industries has thus become a matter of real interest.

In this respect the study tour was both timely and of immense value. It gave people associated with forest industries in a number of developing countries an opportunity to investigate, at first hand, the actual operation and performance of China's small-scale integrated wood processing industries. The outcome was impressive. Small scale labour-intensive wood processing and manufacturing industries do work and work well. Integration of manufacturing processes utilizing wood residues from the forest and from previous processes and other processers is possible with low-level capital investment. In fact, some of the industries operate most successfully on a much smaller scale, with much more intensive use of labour and with much lower capital investment than would have been thought possible. It is therefore almost an under-statement to say that the ultimate result of the study was an enthusiastic endorsement of almost every aspect of the industry.

It would be tempting, therefore, to go from endorsement of the results of the Chinese efforts to acceptance of the methods by which those results have been achieved. But such a step is possible only to a very limited extent.

In considering the transfer of technology in the forest industries from China to other developing countries two very major differences in conditions have to be borne in mind. One of these differences is purely technical. The forests on which this very impressive organization of small-scale integrated wood processing industry is based are in the main typical of the temperate zone. The raw material supply thus has a very large coniferous component and is made up of a much less heterogeneous mixture of species than is found in tropical forests so that a relatively uniform log supply with respect to size, quality and composition is obtainable under virtually any system of forest management. The technologies for the full range of products from this type of raw material are well established and widely known. They are also

readily adaptable from country to country, while most of the advances in technology and product development are tailored to this type of raw material. The tropical forests which provide the typical resource base in most developing countries are, in almost all respects, quite the opposite.

The second difference is not at all technical, but perhaps more crucial. The success of this path to industrial development is almost completely the outcome of the socio-political philosophy and system developed since Liberation. In this respect, the gap between socialism as it is applied in China and socialism as it is professed in a number of developing countries is enormous. For one thing, China really has mobilized the masses for development in the national interest - not just physically but morally - and this certainly makes it much easier to implement a policy of industrial development largely for social purposes. But equally important is the corresponding economic system which enables small, medium-sized and large-scale plants to co-exist efficiently in the same industry and in the same locality without destructive competition for a share of the market. There are nevertheless aspects to which these limitations do not apply. Where the possibilities exist for beneficial transfer of technology from China to other developing countries can be judged from the following summary under the various product categories.

6.2 SAWMILLING

The majority of sawnwood production is from coniferous logs of the north-eastern forest zone. These logs are similar in properties to European redwood (Pinus sylvestris) and the technology which is used in China is similar to that current in the European industry in the early fifties, which is when most of the Chinese sawmills were established. This same technology is used for the processing of plantation-grown softwoods and, in fact, for practically every other type of softwood log.

It appeared that the Chinese had nothing novel to show in this field and there are ample opportunities for developing countries in various parts of the world to master this technology. In fact, this technology, in a more advanced form, has already been adequately transferred to countries such as Argentina and Chile. Nonetheless, China could offer training for this kind of sawmill operation and possibly also in the planning and construction of new sawmilling enterprises.

The team saw little of note in timber drying or preservation or in handling and packaging of sawnwood. The joinery plants seen were rather orthodox. The prefabricated house units seen may have relevance for some developing countries. However, there are satisfactory examples of the transfer of technology of prefabricated house construction to be found in Chile, Guyana, Nigeria, Surinam and Venezuela. In addition, the house types developed in these countries are adapted for use in tropical areas which are typical of most of the developing countries.

6.3 PLYMILLS

The plymills visited were not of special interest or novelty in a technical sense but they were instructive in the way that they were producing products of good quality and making rational use of species of special value such as Manchurian ash. It would be of advantage if training could be offered to countries which are beginning the manufacture of plywood with simple or second-hand equipment. As far as the modern technology of plywood manufacture is concerned, there are good examples available in a number of other developing countries, for example, Korea, Singapore, Indonesia and Brazil. Many of the Chinese plywood factories manufacture their own adhesives and this may be an area where transfer of technology could be relevant. However, the adhesive technology which was seen was not advanced.

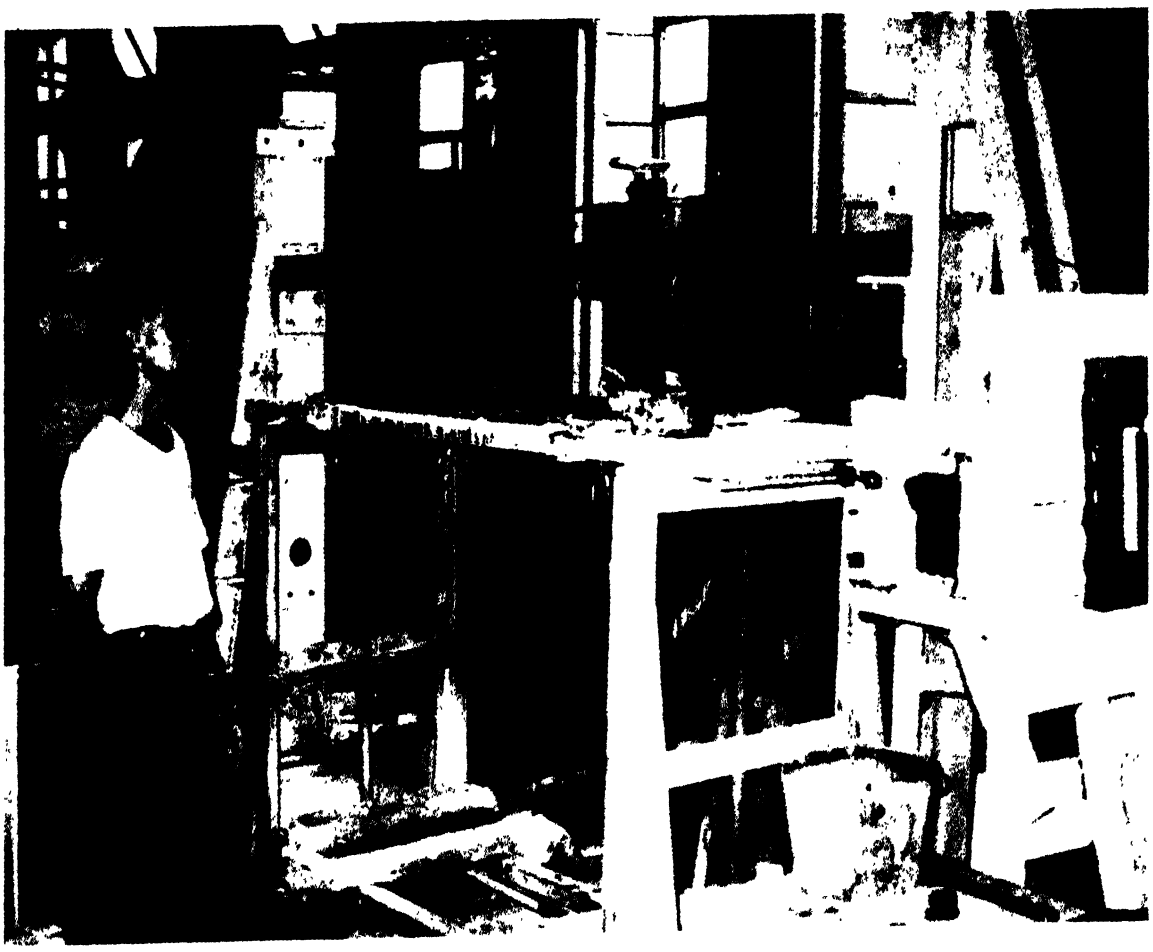


Fig. 22 Lacquer polishing machine built by workers at Jiefang Furniture Plant, Guangzhou (Canton)

Fig. 23 On the machine assembly shopfloor of the Shanghai Artificial Board Machinery Plant, Shanghai, where small fibreboard plants are produced

6.4 FIBREBOARD

Small fibreboard plants of special interest to developing countries were seen in operation in China and this is one area in which the possibilities for transfer of technology could be quite good. A detailed description of such a plant is given on pages 25-33.The plants are made in China and are available, at least to Chinese industries, at attractive prices.

The plants were seen operating on a variety of raw materials ranging from high-quality edgings of Korean pine down to mixed tropical sawmill waste and mixed tropical forest chips. The product produced in all cases was a quite satisfactory standard-grade hardboard for use in the furniture industry, utility-type door manufacture and packaging. The process was economical, since no resin binder was used and the maximum sheet size of approximately 0.9 by 2.15 m,whilst a little on the small size, is adequate for furniture and house doors.

The annual production capacity of the standard unit was 2 000 t/year, but it is possible by modifying the plant to push this capacity up to 6 000 t/year. This size fits adequately the waste volume of many small to medium-sized sawmills cutting tropical mixed forests in developing countries. A developing country could acquire the capability to produce its own hardboard from tropical species in this way, if it were prepared to provide protection to such a plant against unfair competition from the dumping of imported hardboard. It was not indicated whether the Chinese authorities are prepared to export these mills but, in principle, it should be possible. Good training for operatives, of course, could be given in the Chinese plants. The cost of Chinese plants is quite attractive, being equivalent to approximately US$ 200 per annual tonne of production.

6.5 PARTICLE BOARD

To judge from the plants producing particle board which the team saw, there is not very much to offer in this field. The operating plants were using mainly softwood waste arising from sawmilling or joinery and furniture operations. Most plants seen were of the horizontal extrusion type which produces a board with inferior properties and requires a high resin consumption. Some other mills were either single-layer or graded-layer types producing only moderate quality board from normal raw material. Urea resins for binder were mainly made by the plants themselves and, as in the case of plywood, there may be some possibilities of technology transfer in this field.

6.6 MACHINE BUILDING AND MAINTENANCE

This area was one of the most interesting aspects in all the plants visited. Many developing countries could learn much from a study of the methods used in China to develop production capabilities through construction of their own plants, careful maintenance of existing plants and production within the plant itself of spare parts for equipment. It is often a problem in many developing countries to obtain even simple spare parts to keep imported equipment functioning. It is felt that the Chinese system of producing, within the plant, as many of their spare parts as possible, could well be followed by developing countries who have this kind of problem. Of course, the success of this system requires a skilled and enthusiastic work force, supplied with good basic workshop facilities. An important ingredient of the Chinese success is the enthusiasm for production which has been generated in the work force by the social conditions prevailing in China. Moreover, it must be recognised that some of the spare parts undoubtedly do not perform as well as those produced to original manufacturers' specifications. Nevertheless, the results speak for themselves and almost without exception the machinery and equipment in the Chinese factories, though in many cases old and obsolete, still function well.

It could also be argued that the economics of maintaining and operating the extensive workshops attached to many factories is doubtful, but the advantages of having plants operating and producing, instead of being shut down waiting for spare parts, is obvious and overrides some of the fine details of the economics. There is no doubt that the Chinese can contribute technology in this field to any developing country which is prepared to make the effort to follow their example. Of course, without enthusiasm and dedication on the part of the work force the system is doomed to fail and no effective transfer of technology will occur.

Essential to the Chinese success are three factors: firstly, the adequate supply of trained technicians at all levels, secondly the adequate supply of simple orthodox machine tools and workshop equipment of all types and then the use of the trained technicians to train others. The existence of these well-equipped workshops, attached to factories in the wood processing sector, itself contributes to the supply of machine tools, since many of them build such equipment when not engaged in repair or expansion of their own plant facilities. Some of these aspects may be difficult for many developing countries to emulate, but there is no doubt that at least a part of the Chinese approach could be copied by many developing countries.

6.7 PLANNING AND PLANT DESIGN

The team had only a limited opportunity to see this aspect of the Chinese wood processing industry. The lesson that can be learned, however, is interesting for some developing countries. The Chinese have emphasized small and simple plants at the expense of more complex, sophisticated and costly ones. This approach is economically beneficial for them, given their plentiful supply of low-cost labour and a market capable of absorbing products of almost any specification.

The system succeeds for them, despite its economic limitations when compared to sophisticated processes of higher productivity, because the social conditions prevailing in China shield their factories from the destructive aspects of competition and ensure that the production of every plant, providing it is not obviously anti-economic, will find some use somewhere in the economy.

Developing countries interested in developing plant design and construction capability consistent with their own need and aspirations may well benefit by making use of Chinese experience in this field.

Appendix 1

LIST OF PARTICIPANTS

Afghanistan

Mahommad Farong KARANZAI
Deputy Chief of Planning
Forest and Range Department
Kabul

Mahommad KAZIM
Technical Officer
Forest and Range Department
Kabul

Ghana

Emmanuel Yaotse DJOKOTOE
Senior Assistant Conservator of Forests
Forestry Department
Accra

A.S.K. BOACHIE-DAPAAN
Senior Assistant Conservator of Forests
Forestry Department
Accra

India

T.V. SUBBA RAO
Managing Director
Andhrah Pradesh State Forest Development Corporation Ltd.
Andhrah Pradesh

B.K. SETH
Managing Director
Madhya Pradesh State Forest Development Corporation Ltd.
Madhya Pradesh

Malaysia

Mohd Nor YAACOB
Deputy Director General of Forestry
Kuala Lumpur

Tuck Meng WONG
Deputy Director of Research (Utilisation)
Forest Research Institute
Kepong

Nigeria

G.O. IGUGU
Asst. Chief Forest Management Officer and
Co-Manager of Sawmilling Industries Centre
Benin City

Nigeria (cont.)

A.A. AFOLAYAN
Senior Assistant Conservator of Forests
Forestry Division
Ministry of Agriculture and Natural Resources
Ibadan

Papua New Guinea

Oscar MAMALAI
Provincial Forestry Officer
Marobe Province

Misi HENAO
Provincial Forestry Officer
Central Province

Sierra Leone

Aiah Philip KOROMA
Assistant Chief Conservator of Forests
Department of Forestry
Freetown

Patrick Francis LAMBOI
Forester
Department of Forestry
Freetown

Sudan

M.E.A. MUKHTAR
Chief
Utilization Division
Forest Administration
Khartoum

K.A.B. MAHMOUD
Senior Sawmill Manager
Forest Administration
Khartoum

Eriasafa K. MWANGA
Chief Forest Officer
Ministry of Agriculture and Forestry
Kampala

Lawrence S. KIWANUKA
Senior Forest Officer
Ministry of Agriculture and Forestry
Kampala

FAO Participants

Team Leader: A.J. LESLIE
Director, Forest Industries Division
Food and Agriculture Organization of the United Nations
Rome, Italy

H.E. BOOTH
Mechanical Wood Products Branch
Forest Industries Division
Food and Agriculture Organization of the United Nations
Rome, Italy

Appendix 2

PROGRAMME

1978

20 August	Arrival of team members in Beijing (Peking)
	Introduction and discussion of programme with Mr. Li Shihkang, Division Director of State Administrative Bureau of Forestry (SABF) and Mr. Chao, Director of Division of SABF concerned with foreign relations
	Visit to the Imperial Palace and Museum
21 August	Visit to Kwang Hua Timber Mill, Beijing (Peking)
	Visit to Beijing (Peking) Timber Mill
22 August	Address by Mr. Li Shihkang, Division Director of SABF, on the structure of the wood processing industry, followed by discussion
	Visit to Summer Palace and gardens
23 August	Travel by air to Harbin in Heilongjiang Province
	Discussion of detailed programme for industry visits in Heilongjiang Province with local officials of SABF
	Address by Mr. Li Wangyu of SABF on forest industries of Heilongjiang Province, followed by discussion
24 August	Visit to Hsing Fang Timber Mill
	Visit to Sung Chiang Plywood Factory
25 August	Visit to Cheng Yang Ho Wood Processing Factory
	Visit to Harbin Furniture Factory
26 August	Travel to Mudanjiang
	Visit to Mudanjiang Machinery Plant for Wood Industries
	Visit to Mudanjiang Wood Processing Factory
27 August	Travel to Harbin by train
	Visit to Harbin Horticulture Research Institute
28 August	Travel to Wuyiling and Yichun City
	Visit to Wuyiling Forest Farm
	Visit to Paper Mill at Fanglin Forest Farm
29 August	Travel to Nancha
	Visit to Nancha Wood Processing Coomplex
30 August	Discussion on Nancha Complex
	Travel by road to Tailing
	Visit to Tailing Machine Maintenance Plant of SABF
	Visit to plantations and regeneration areas
	Visit to forest farm factory (collective ownership)

31 August	Visit to Tailing Forest Farm, forest operations, seed orchards, plantations
	Visit to Lanxi Provincial Forest Research Institute
	Visit to Forestry Research Institute of the Forestry Bureau of Tailing
1 September	Discussion on forestry activities in Tailing
	Return to Harbin by train
2 September	Visit to the North-east Institute of Forestry, Harbin
	Visit to Sung Wah River Tractor Plant, Harbin
3 September	Rest day
4 September	Symposium meeting on Integrated Forest Industries held at North-east Institute of Forestry, Harbin
5 September	Return by air to Beijing (Peking)
6 September	Depart from Beijing (Peking) for Shanghai
	Discussion of programme for Shanghai area
7 September	Visit to the Shanghai No. 1 Wood Processing Combine which included a seminar on operations of the plant
8 September	Visit to Shanghai Industrial Exhibition
	Visit to Shanghai Artificial Board Machinery Manufacturing Plant
9 September	Visit to Shanghai Furniture Factory
10 September	Visit to Shanghai Chiangnan Paper Mill
11 September	Visit to Hero Fountain Pen Plant
	Travel to Guangzhou (Canton)
12 September	Visit to Guangzhou (Canton) Fibreboard Mill
	Visit to Jiefang Furniture Factory, Guangzhou (Canton)
13 September	Visit to Guangzhou (Canton) Wood Processing Complex
	Visit to South China Botanical Gardens
14 September	Meeting in Guangzhou (Canton) on management of state and collective enterprises and on reforestation policy
	Return to Beijing (Peking) by air
15 September	Rest day and report writing
16 September	Visit to Great Wall and Ming Tombs
17 September	Rest and report writing
18 September	Team members begin departure to home countries

Append 3

LIST OF PLANTS VISITED AND BRIEF OUTLINE OF THEIR PRODUCTS

Name	Products	Remarks
g Hua ing (P	Sawn timber (15 000 m^3/year), plywood (11 500 m^3/year), particle board (4 000 m^3/year), sewing machine cabinets, window frames, resins (phenol and urea resins), toys and decorative melamine plastic laminates.	The factory was said to possess a wood hydrolysis p ant but this w s not visited. Logs for sawn timber and plywood are supplied from N.E. China. Wood residues from the sawmill and plywood mill are used for particle board and for some of the products listed.
Beijing (Peking) Timber Mill, Beijing (Peking).	Sawn timber, plywood, particle board, fibreboard, blockboard, furniture, synthetic resin adhesives.	Raw materials used and waste utilization are as for Kwang Hua Timber Mill. Established in 1952.
Hsing Fang Timber Mill, Harbin, Heilongjiang Provinc[1/]	Sawn timber (40 000 m^3/year), plywood (15 000 m^3/year), hardboard, furniture, adhesives.	Some furniture items exported. Established in 1951.
Sung Chiang Plywood Mill, Harbin, Heilongjiang Province	Sawn timber (5 000 m^3), plywood (12 000 m^3) and particle board (910 m^3) - for first six months of 1978.	Some plywood is for export, especially fancy-face Manchurian ash and clear-face alder. Established in 1924.
Cheng Yang Ho Wood Processing Plant, Harbin, Heilongjiang Province.	Sawn timber (40 000 m^3/year), fibreboard (2 000 t/year), particle board (600 m^3/year), chips (10 000 m^3/year) and prefabricated houses (600units/ year.	Wood residues from the sawmill provide raw material for the fibreboard and particle board plants. Established in 1956, from 17 existing small mills.
Harbin Furniture Factory, Harbin, Heilongjiang Province	Sawn timber, furniture, sewing-machine cabinets (80 000/year) and prefabricated houses (1 200/ yea:	Veneer produced is for blockboard manufacture. The blockboard is used for furniture and cabinet work. Some of the sewing-machine cabinets are for export. Established in 194

1/ Part of the operations described deta in Chapter

Mudanjiang Wood Processing Machinery Plant, Mudanjiang, Heilongjiang Province [1]	Over 30 types, including machinery for sawmilling, planing, fibreboard making, and a variety of drilling machines, turning lathes and special wood-working machines	40 percent of total production for export to many parts of the world. Established in 1948.
Mudanjiang Wood Processing Factory, Mudanjiang	Sawn timber (160 000 m^3/year), fibreboard (2 000 t/year), rayon pulp (3 000 t/year), furniture (350 000 sets/year), activated charcoal (200 t/year), and prefabricated houses (1 500 units/year)	The complex was taken over before Liberation. The rayon pulp mill was established in 1964.
Pulp and Paper Mill, Yichun (a small town in Heilongjiang Province)	Brown paper (1 800 t/year and plywood (1 000 m^3/year)	Branch wood and residues from a sawmill provide raw materials for the pulp and paper mill.
Nancha Wood Processing Complex, Nancha, Heilongjiang Province [1]	Sawn timber (400 000 m^3/year), particle board (2 000 m^3/year) fibreboard (2 000 t/year), ethyl alcohol (4 000 t/year), furfural, methanol, ammonium sulphate, activated carbon, feed grade yeast, yeast tablets mononucleic acid and adenosine triphosphate	The wood hydrolysis plant uses slabs, sawdust and offcuts from the sawmill. For part of the year the fermentation plant processes purified local beet molasses to produce alcohol and medicinal grade yeast tablets, mononucleic acid and adenosyn triphosphate, etc. Maintenance workshop produces spare parts for machinery of the mill complex, e.g. plattens for hot press, shafts, bolts, etc., as well as complete plant items and machine tools for sale.
Tailing Forest Farm Factory	Tool handles (using [illegible]ngs	Owned collectively but located on a farm of the Forestry Bureau of Heilongjiang Province. School and simple household furniture, pallets and crates.
Machinery Maintenance Plant of State Administrative Bureau of Forestry, near Tailing, Heilongjiang Province	Rebuilt machinery	The plant repairs and overhauls logging and transport equipment and vehicles used in operation in the area. Many spare parts are made in plant workshops, including tapered roller bearings, axles and other parts for tractors and trucks.
Sung Hua River Tractor Manufacturing Plant, Harbin, Heilongjiang Province	80 h.p. articulated wheeled skidders (200/year) with blade infront and winch at rear, 50 h.p. crawler tractors with winch (800/year) and spare parts for these tractors	Established in 1950. These tractors are for use in the forest industry throughout the whole of China for haulage. Some are exported, notably to East and West African countries.
Shanghai Wood Processing Complex No.1, Shanghai	Plywood (20 000 m^3/year), fibreboard (6 000 t/year) and sewing-machine cabinets (250 000 sets/year)	Founded before 1949. Expanded with production of fibreboard in 1958. The attached sawmill is part of the sewing-machine cabinet workshop, converting flitches into smaller dimensions, and sawing 7 500 m^3/year of wood for this purpose.

[1] Part of the operations described in detail in Chapter 4.

N e	duc	Rem ks
Shanghai Art ficial Board Machinery Manufacturing Plant, Shanghai	Complete standardised fibreboard plants with nominal capacity of 2 000 t/year, excluding chippers and trim saws. Production target = 15 plants/year.	Commenced production in 1958. They plan to produce plants with a nominal capacity of 5 000 t/year.
Shanghai Furniture Factory, Shanghai	Household furniture (120 000 sets/year), particle board (780 m^3/year), sawn timber (11 000 m^3/year) and plywood are produced in this factory mainly for furniture production.	Factory was formed in 1960 by amalgamating 100 craft factories. 55 percent of the furniture items are exported annually, mainly to Hong Kong. Some of the plywood used is imported from Romania and the United States.
Shanghai Chiangnan Pulp and Paper Factory, Shanghai	Pulp (20 000 t/year) and paper (30 000 t/year of fine printings and some toilet tissue).	Established in 1926. Long-fibre bleached kraft pulp is imported from Canada and other countries to blend with straw pulps. Raw materials for pulp making are rice and wheat straw and cotton stalks. The latter is used only for toilet tissue.
Guangzhou (Canton) Fibreboard Mill near Guangzhou (Canton), Guangdong Province	Fibreboard (6 600 t/year)	Established in 1970 as one of the units of the Wood Processing Complex of Guangzhou (Canton). Raw material, as slabs and offcuts, is brought in from the other mills of the complex. Branchwood and chips come by boat from upstream forest areas.
Jiefang Furniture Factory, Gu ngzhou (Canton)	Household furniture (26 500 pieces/year) of which 80 percent is for export, mainly to Hong Kong.	Established in 1968 by combining many small factories. It is one of the units under collective ownership control. 40 900 m^2 of plywood and 2 200 m^3 of sawn timber are used annual annually in the furniture factory.
Canton Wood Processing Complex.	Sawn timber (150 000 m^3/year and fibreboard (hardboard 5 000 - 8 000 t/year; softboard 1 150 t/year). Plywood (for cabinet work only), sewing-machine cabinets, radio and TV cabinets, plastic-surfaced panels, activated charcoal (500 t/year) and wood wool cement boards.	Established in 1951. This enterprise is the headquarters of the complex consisting of ten small factories within the Guangzhou (Canton) area.

1/ Described detai Chapter

Appendix

BIBLIOGRAPHY

Richardson, S.D. 1966 — Forestry in Communist China, Baltimore, John Hopkins Press. 237 p.

U.S. National Academy of Sciences 1975 — Plant Studies in the People's Republic of China, Washington D.C., National Academy of Sciences. 205 p.

Wang Chiwu. 1961 — The Forests of China - With a Survey of Grassland and Desert Vegetation, Cambridge, Mass., Harvard University. 275 p

THE FAO TECHNICAL PAPERS

FAO CONSERVATION GUIDES:

1. Guidelines for watershed management, 1977 (E* F* S*)
2. Hydrological techniques for upstream conservation, 1976 (E* F* S*)
3. Conservation in arid and semi-arid zones, 1977 (Ar* E* F*)
4. Special readings in conservation techniques, 1977 (E* F* S*)
5. Manuel de contrôle des avalanches, 1979 (F*)

FAO FORESTRY PAPERS:

1. Forest utilization contracts on public land, 1977 (E* F* S*)
2. Planning forest roads and harvesting systems, 1977 (E* S*)
3. World list of forestry schools, 1977 (E/F/S*)
4. World pulp and paper demand, supply and trade, Vol. 1, 1977 (E* F* S*)
   Vol. 2, 1978 (E* F* S*)
5. The marketing of tropical wood in South America, 1978 (E* S*)
6. National parks planning, 1978 (E* F*** S***)
7. Forestry for local community development, 1978 (E* F* S*)
8. Establishment techniques for forest plantations, 1978 (Ar*** E* F*** S*)
9. Wood chips, 1978 (E* S*)
10. Assessment of logging costs from forest inventories in the tropics, 1978
    1. Principles and methodology (E* F*** S***)
    2. Data collection and calculations (E* F*** S***)
11. Savanna afforestation in Africa, 1978 (E*)
12. China: forestry support for agriculture, 1978 (E*)
13. Forest products prices, 1979 (E/F/S*)
14. Mountain forest roads and harvesting, 1979 (E*)
15. Agris Forestry world catalogue of information and documentation services, 1979 (E/F/S***)
16. China: integrated wood processing industries, 1979 (E* F*** S***)

FAO PLANT PRODUCTION AND PROTECTION PAPERS: 14 titles published
FAO ANIMAL PRODUCTION AND HEALTH PAPERS: 15 titles published
FAO FOOD AND NUTRITION PAPERS: 10 titles published
FAO AGRICULTURAL SERVICES BULLETIN: 36 titles published
FAO IRRIGATION AND DRAINAGE PAPERS: 33 titles published
FAO SOILS BULLETINS: 43 titles published

Availability: May 1979

Ar - Arabic
E - English
F - French
S - Spanish

*Available
** Out of print
*** In preparation

The FAO Technical Papers are available through the authorized FAO Sales Agents or directly from Distribution and Sales Section, FAO, Via delle Terme di Caracalla, 00100 Rome, Italy.

M-38
ISBN 92-5-100770-5