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forestry support for agriculture



FOOD AND AGRICULTURE ORGANIZATION
OF THE UNITED NATIONS ROME

**china:
forestry support
for agriculture**

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

11 august - 30 september 1977

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ITINERARY OF THE FAO STUDY TOUR TO CHINA ON FORESTRY SUPPORT FOR AGRICULTURE
11 August-30 September 1977

GIPE-E6298

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TABLE OF CONVERSION FACTORS

1 mu	=	0.066 ha
1 ha	=	15 mu
1 jin	=	0.500 kg
1.00 yuan	=	0.6 US\$ (1978)*
1.00 US\$	=	1.66 yuan (1978)*

*At the time of the study tour (August-September 1977) the exchange rate was approximately 1 yuan = \$0.5 or \$1 = 2 yuan. The figures for costs, revenue, etc. are in general given in this report in yuan only. However, on p. 37 (para. 4), where both yuan and dollars are given, the dollar figure is calculated according to the 1978 exchange rate shown above.

INTRODUCTION

Technical contacts between the Food and Agriculture Organization of the United Nations and the People's Republic of China, at various levels, were started after it became a member of the Organization on 1 April 1973. These contacts were developed into, among other things, organized group study tours in 1976 and 1977. Each group consisted of about 20 persons, including a team leader from FAO, and participants from Member Countries with expertise in the subjects to be studied. The Study Tour on Forestry Support for Agriculture, which started on 11 August 1977 and ended on 13 September 1977, was one of these tours. The group consisted of three FAO staff members, including the Team Leader, and 15 senior officers of 11 Asian and African Member Nations. The candidates from Malaysia, Uganda and Zambia had to cancel their trips at the last moment for various reasons. (For list of participants see Appendix I).

The main purpose of the study tour was to find out how forestry supports agriculture in the People's Republic of China. Its objectives were: to observe and analyse the Chinese approach to forestry development whereby it is integrated into and supports agriculture; and to examine how some aspects of the Chinese experience might be applied in the countries represented on the study tour.

The fields covered were rather general but well chosen to demonstrate the link between forestry and agriculture. In spite of a very heavy programme and the fact that it was followed by the participants with the utmost interest, it was not possible to cover all the fields indicated in the letter of instruction. The programme covered the following major fields: shelterbelts, coastal windbreaks and "four around" tree plantation, plantation of fast-growing tree species for timber production, afforestation of bare land, tree crops yielding immediate cash returns, intercropping, watershed management, integrated development planning and programme implementation.

The study tour consisted of (a) indoor briefing, (b) field visits, (c) exchange of ideas and experiences in concluding discussions whenever possible and (d) preparation of the draft report. The latter was done mostly after meals, sometimes late in the evenings, and finalized in Beijing (Peking) before departure. The report is based on the group's observations and explanations given to them during the four-week period.

Most of the participants assembled in Karachi between 8 and 10 August before proceeding to Beijing (Peking). The Team Leader gave a first general briefing in Karachi and a supplementary one in Beijing (Peking). Besides elaborating on the purpose of the study tour, he informed the participants that after a few days of field trips an outline of the report would be worked out and that members would be requested to prepare their contributions to relevant chapters according to their background.

General briefing was given by Mr. Li Shih-Kang, Director, Forest Resources Division, Ministry of Agriculture and Forestry. The broad itinerary of the study tour was also outlined. Details of the programme in the field were only given by the organizers on the arrival of the participants in each of the provinces visited. (For detailed itinerary see Appendix 2). Two special briefing sessions were arranged for the participants to obtain more information on forestry education and wildlife in Guangzhou (Canton) and Beijing (Peking) respectively.

The study group visited Liaoning, Henan (Honan), Hubei (Hupeh), Hunan and Guangdong (Kwangtung) Provinces and Beijing (Peking), and the tour covered ten counties, one commune, thirteen production brigades, one nursery, nine forest farms and bureaux, three water conservancies, three forest product manufacturing plants and two forest research institutes. The total distance covered was 3,900 km by air, 2,100 km by rail and 2,800 km by road. The organization was excellent and the organizers were very kind and receptive to our suggestions on programme changes that were possible within a programme already fixed and prepared well in advance.

Historical places were visited in Beijing (Peking) and Shenyang. The group had the honour of visiting Chairman Mao's birthplace and being the first group of foreigners to pay tribute to Chairman Mao in his memorial hall in Beijing (Peking).

A dinner of welcome was given to the group by the Director of the Bureau of Foreign Affairs of the Ministry of Agriculture and Forestry, Mr. Li Yung-kai, on the evening of arrival. A farewell dinner was given by the Team Leader to the Chinese authorities responsible for organizing the study tour, both from the Ministry of Foreign Affairs and the Ministry of Agriculture and Forestry, on the night before departure. During the course of the study tour, official dinners were given by the chairmen of the revolutionary committees and directors of the provincial forest and/or agriculture bureaux. Films and plays were shown to the group for their entertainment in the evening and were greatly appreciated by everyone.

The group enjoyed and felt greatly honoured by the warm welcome and hospitality extended by the Chinese people and the excellent care and courtesy of their colleagues.

Chapter 1

BACKGROUND INFORMATION

1.1 GENERAL

China is the world's third largest country with 9.6 million km² of land and a population of about 950 million. It shares the highest mountain, Mt. Everest, at 8,848 m, with Nepal. The major landscapes are mountains, high plateaux, deserts and extensive river plains. The climate ranges from arctic at the higher elevations to monsoon along the sea coasts. Inland areas are mainly affected by continental air masses. Tree and shrub species are varied and at least 7,000 have been recorded. According to information given to the study group in Peking, about 10 percent of the land is covered with forest.

Most of China has four distinct seasons. Rainfall ranges from less than 100 mm annually in the desert areas to 2 790 mm in the monsoon belt south of the Yangtse River. Maximum temperatures range from over 45°C in the desert to 10°C in the plateaux and mountains; minimum temperatures range from 13°C in the monsoon belt to -30°C and lower in the mountains and northern temperate parts. Frost-free days range from 45 on the high plateaux to 365 in the tropical monsoon area.

Soils are as varied as the climate, vegetation, topography and geology. Wind has played a very large part in the formation of loess-derived soils in the lower sections of most basins, particularly in the northern part of the country. There is a wide range of fertile soils, the most fertile land being in the valley plains. Water-logging, salinity and alkalinity problems exist primarily in the eastern parts of China on the broad, flood-prone plains. Those areas which would normally be considered natural areas for forestry have a high proportion of exposed bedrock. Because of extensive land degradation, precious surface soils in the mountain areas have been eroded.

On the journey southwards from the most northern province visited, Liaoning, through Beijing (Peking), Henan (Honan), Hubei (Hupeh), Hunan and Guangdong (Kwangtung), it was noted that the general landscape features showed great variations:

1.1.1

Liaoning

Situated in north-east China, the province lies between 116° 20' and 125° 46' E and 38° 43' and 45° 00' N and has an area of 225,000 km². Elevation ranges from 200 to 2,000 m above sea level. About 60 percent of the land is mountainous, 30 percent is farmland and 10 percent is occupied by water.

The climate is temperate, with the monsoon influencing the easternmost part. The average temperature varies between 5° and 11° C and there is a maximum temperature of 30° C and a minimum of -30° C. Precipitation ranges from 400 to 1 200 mm, the higher precipitation being near the east coast. The frost-free period is about 150-180 days.

The soils in the western part of the province are loess, derived from wind funnelling down the river valleys from the western mountains. These soils tend to be deep and sandy with little organic matter. Plantation forests in the province cover 4,154,666 ha.

The group was told that formerly shifting sand-dunes affected agricultural areas and protective vegetation cover was sparse. Moreover, data presented by the Taipingtí People's Commune indicate low soil fertility before afforestation took place. In 1958, organic matter was 0.5 percent, nitrate 5 ppm, effective phosphorus 10 ppm and potassium 20 ppm in a very fine sandy loam.

Since improved crop practices have been adopted and shelterbelts have been planted for sand-dune fixation, soil nutrients have increased to the following levels: organic matter 27 percent, nitrate 45 ppm, effective phosphorus 20 ppm and effective potassium 50 ppm. Organic matter has been added at the rate of 30,000 to 75,000 kg per hectare per year, supplemented by 300 to 375 kg of chemical fertilizer. In almost 30 years a surface soil 0.37 cm deep has been created.

1.1.2 Beijing (Peking)

No extensive field trip on forestry was made from this municipality.

Rainfall ranges from 500 to 700 mm and occurs mostly between June and September. The maximum temperature reaches 30°C and the minimum falls to -13°C and there are about 150-240 frost-free days.

1.1.3 Henan (Honan)

The group concentrated its tour on the alluvial plain south of the Yellow River. A short visit was made to the hilly area in Yu County, about 70 km south of Zhengzhou. The province is strongly influenced by the Yellow River. Its floods both deposit sediment and erode away top soil. The province includes 167 000 km² of land, is located in the east plain and is surrounded by mountains rising in the western part to 1,000 m. There are four major river systems, the Yellow River being the largest. Altogether there are 200 rivers that tend to flow from the northwest to the east. Two-thirds of Yu County is mountainous or hilly, while one-third is covered by plains.

The climate and its effects have played a large part in the development of the area. It has a history of both floods and droughts.

The province is located between 118° and 120°E and 30° and 40° N. The mean annual rainfall is from 500 to 700 mm with some monsoon influence. The temperature reaches 30°C in summer and falls to -10°C in winter in the mountains. In the mountains frost-free days may be about 150 and in the plains 240.

The soils in the mountains are moderately deep and medium-textured. They are slightly acid with pH 6.0-6.5. The soils in the plains are deep, being derived from alluvial action. There are waterlogging, salinity and alkalinity problems. Soil drainage and irrigation programmes are being carried out to improve the soils. Fertility data were not provided. There is no question, however, but that, owing to intensive practices of drainage and the addition of fertilizer, soils are being physically and chemically improved. Approximately 73,333 ha were previously considered waterlogged. Since 1949 this acreage has been greatly reduced. As in most areas, there are few secondary stands in the province. Because of the wide

latitudinal range, tree species vary from pines in the north to warmer-climate species such as Paulownia spp. in the south. Before 1949, 667,000 ha were under forest, while in 1976 2,200,000 ha of land were under forest.

1.1.4 Hubei (Hupeh)

This province is a hilly/mountainous area dotted with many villages. The ridges and slopes have a rounded profile. The famous Yangtse River flows through the province. The south part is considered mountainous with rounded peaks rising to 1,500 m. In the north the alluvial landscape along the Yangtse is about 50 m above sea level.

In general the climate is temperate with some monsoon influence. Precipitation ranges from 1,200 to 1,700 mm; evaporation may be as high as 1,500 mm. The maximum high temperature reaches 30°C and the minimum drops to -5°C. The frost-free period ranges from 200 to 280 days.

Soils are considered fertile and depth varies with topography. Varying degrees of erosion have taken place. Locally the soils are yellow-brown. The mountainous area around Puqi County, located in the southern part of the province, is largely underlain with limestone. Other areas are commonly underlain with shale. Surface soils have a pH of around 5.5-6.5. Textures are in the medium range, in one case of sandy clay loam.

The forest cover situation has changed since 1949. The total acreage of land in Xianning County is 1,421,533 ha. In 1949 the forest cover was 186,666 ha; today it is 386,664 ha, resulting from massive planting efforts. Most planting is with Pinus, Cunninghamia and bamboo.

1.1.5 Hunan

Located in south-eastern China, Hunan is the home province of the late Maō Tse-tung. Of the 210,000 km² of the province 90 percent are hills and mountains, 8 percent plains and 2 percent water. The western part of the province is more rugged than the eastern part, although the whole of the province is mountainous, with small sinuous valleys. It is located within 110° and 115°E and 30° and 35°N. Highest elevations seldom rise above 1,500 m.

The average annual rainfall ranges from 1,000 to 2,000 mm. The mean maximum temperature is about 31°C and the minimum -6°C. Frost-free days are from 225 to 300, depending on the elevation. The summer storm period is from April to June. Taoyuan County in the west has a rainfall of about 1,467 mm.

Soils are derived from slates, shale, limestone and conglomerate. Old alluvial deposits are also often found at the upper elevations and soil profiles frequently have a high percentage of gravel. In the mountains, where most forestry work is done, the soil pH is about 5.5-6.5. Profiles are mainly moderately textured. It was mentioned that in Taoyuan County 38 percent of the main river drainage had eroded which indicated that the fertile topsoil had moved downstream, leaving behind less fertile conditions for forest growth.

Within Taoyuan County forest cover increased from 24.5 percent in 1949 to 41 percent in 1977 as a result of an accelerated reforestation programme.

1.1.6

Guangdong (Kwangtung)

This province in the south-eastern part of the country lies between 108° and 117°E and 18° and 26°N and has a long jagged coastline. Most of the province enjoys a mild sub-tropical moist climate. Soils in the areas visited are red and mostly sandy. Owing to high-intensity rains and typhoons, soil erosion and gullying are problems, which are being taken care of by extensive tree planting. Shifting sands along the sea-shores pose a problem which is being solved by coastal windbreak plantations of Casuarina. Soils are mostly acidic, with pH of 4-5 in the areas visited.

The annual average temperature in the areas visited varies from 22.7°C to 23.6°C. The absolute maximum temperature is 37°C and the absolute minimum 2.0°C. Annual average precipitation varies from 1,400 mm to 1,600 mm, distributed mostly from May to September. Typhoons and strong winds are frequent.

1.2

CONDITIONS RELATED TO FORESTRY SUPPORT FOR AGRICULTURE BEFORE 1949

The year 1949 marked a significant turn of events in China. Reference is always made to conditions prevailing prior to 1949. In this year a complete change in national life occurred which has influenced the utilization and development of natural resources. They are now conducted in accordance with the concept of collective ownership and accountability. The interdependence of different land uses like forestry, grazing, animal husbandry and agriculture was recognized and emphasized by Chairman Mao. He issued instructions in this regard which are always observed during planning.

According to the facts presented, agriculture and forestry were not integrated in the pre-1949 period. Forest cover was sparse and in a poor condition. The area under forest was only 5 percent of the total land area. Not only was yield from forests low, but the watersheds, sandy tracts and coastal areas were devoid of suitable protective vegetation. The combination of these factors resulted in soil erosion, loss of soil fertility, insufficient soil moisture for crops and progressive reduction in cultivable areas due to shifting sand-dunes and gullying and frequent damage by floods and droughts. The yield from agricultural areas was low. It was often reported that natural calamities struck in about nine years out of ten and that crop yields were insufficient to support the population. Failure to invest in land development and to improve agricultural practices worsened the situation. The ultimate result was the frequent occurrence of famine and the shifting of population.

1.3

ACHIEVEMENTS SINCE 1949

A massive programme of afforestation and forest improvement was initiated after 1949. Well-defined policy lines and guidelines in this connection were issued. Once the interdependence of forestry and agriculture was realized, protective tree planting in the form of shelterbelts was started in four locations, i.e. on roadsides, on riversides, around houses and around villages. This work has for many years received strong political support at the highest level. Moreover, the people themselves have realized its importance. The economic gains and the indirect benefits of earlier plantings have given them concrete proof of its significance and have also provided them with the means and experience to develop it still more.

The magnitude of the afforestation work required a massive labour input to match. This was obtained by mobilizing large masses of people. (In China, the "masses" means the people of the communes, state forestry farms, etc.) Mass mobilization was achieved by collectivization of resources and, more important, by participation of the masses in the planning procedure which has been described as "from the people, to the people", and "three-in-one and three-way planning". (See Chapter 3). The involvement of the masses in the execution of the plan and the maintenance and protection of plantations was the decisive factor in the success of the programme, which has resulted in the raising of the initial 5 percent forest cover to the present 10 percent.

It was observed that a considerable diversity exists among the tree species used for planting. These vary not only according to the site and climate but also according to the people's requirements. For example, in Liaoning Province, willows and poplars are used for sand-dune fixation and shelterbelts respectively. Amorpha fruticosa has been planted extensively to serve as a low-level soil binder and as a source of green manure and fodder. Orchards of apples and peaches have also been raised. In Henan (Honan), Paulownia, poplar and plane are the species planted on four sites; while Paulownia is used for intercropping, Amorpha is extensively planted. Apple and walnut are common fruit trees. In Changlou Production Brigade apple trees were being planted on reclaimed gully beds. Hubei (Hupeh) has Cunninghamia as the main tree species. Pinus massoniana was planted extensively in the past and did not perform well. Bamboo is now being extended on sites suitable for it. In Hunan extensive areas are under Cunninghamia; Pinus elliottii and P. taeda are also being used, along with Sassafras, as the main timber species. Aleurites is planted on roadsides and is mixed with pine plantations as it is fast-growing and completes its rotation before the pines are suppressed; moreover, it is a source of industrial oil. Thea oleosa is a source of edible oil; its old plantations have been improved and new plantations are being raised. Tea plantations are also being improved and extended. In Guangdong (Kwangtung) Province multipurpose eucalyptus plantations have been raised in addition to coastal shelterbelts of Casuarina. The fan palm (Livistona) has been planted on terraced hills and efforts at large-scale planting of star fruit, mango, litchi and black pepper are being made.

It has been realized that the success of planting work depends upon dedicating the right proportion of effort to the various operations involved. The success rate of the plantations visited depended on the rigid application of the principle that 30 percent of the efforts should go towards establishment, while 70 percent should go towards tending and protection. An intensification of all work has therefore been undertaken on this basis. It involves the practice of complete land preparation, proper planting according to the species, manuring and fertilizing, weeding and soil working, intercropping, mechanization of work wherever possible and adoption of soil and water conservation measures.

As this massive programme of tree planting with intensive management requires a large number of technical, skilled and semi-skilled personnel, a system of education, training and research has been developed. Education and training facilities are provided at the state, province, county, commune and production brigade levels. A fair measure of autonomy exists at the four lower levels. This system has helped not only in planning and execution but also in problem identification and solution at all levels.

To improve the old situation and develop the rural economy, a new system of ownership of, and right to, the forests/trees and income therefrom has been adopted. According to this system, ownership of the forests rests with the unit which is responsible for their formation and maintenance (and ownership of the trees planted within the proximity of his house with the individual). The income realized from the supply of forest products, therefore, belongs to the unit concerned. This income goes into a fund which is utilized for investment in improved inputs, mechanization and general development.

The post-1949 programme of work has resulted in a progressive improvement of agricultural yields along with an increase in forest cover. The following few examples illustrate this improvement.

The Tungfanghung Production Brigade in Liaoning covers 676 ha of variously sandy alluvial plains in a sub-humid temperate region. Before 1949 it had very few trees and agriculture was poor owing to shifting sand-dunes. Yield from food grains was about 450 kg/ha. Since 1949 trees in the form of shelterbelts and some compact blocks have been planted over 36 percent of the area. Owing to the protection thus afforded and other improvements, the average yield since 1973 has consistently been over 7,500 kg/ha.

The Paichuang Production Brigade of Chaochuang People's Commune in Henan (Honan) includes 103 ha of land in the old course of the Yellow River and has a sandy-silty soil. Before 1949 it had very few trees and sandstorms and shifting sand-dunes impoverished the land and the people. Yields of foodgrains at that time were only 210-240 kg/ha. Since 1949, 40 ha have been planted with apple orchards in addition to shelterbelts. As a result of tree planting and other land improvement measures, an average yield of 5,160 kg/ha was realized in 1976.

The Kung Yu People's Commune in Echeng County, Hubei (Hupei), covers 611 ha in a temperate, sub-humid climate. Previously the area was denuded with patches of degraded vegetation. Soil erosion, gullying and insufficient soil moisture resulted in low yields. Afforestation was initiated after 1966 and 7,766 ha have been planted. Intercropping is practised in the plantations. Through erosion control, the agricultural yield, which used to be less than 600 kg/ha, has risen to an average of 900 kg/ha.

Taoyuan County in Hunan covers a total area of 470,000 ha in a moist subtropical climate. Mountains and hills cover 300,000 ha. The county was subject to floods in the past and watersheds were denuded or had a poor, degraded vegetation. The total output of foodgrains was 182,000 tonnes in 1949, while cotton output was 575 tonnes. Work for improvement of watersheds and for water development was started after 1949. Output of foodgrains and cotton rose to 317,000 and 2,323 tonnes respectively in 1969. Efforts to increase the timber supply and to improve conditions for agriculture were started in 1970. These have increased the area under forest from 24.5 percent in 1970 to 41 percent at present. This has been accompanied by a further increase in food and fibre output, which stood at 461,500 and 6,221 tonnes respectively in 1976.

Nanshan Island in the south of Guangdong (Kwangtung) Province consisted of a group of ten small islands before 1949. The total area of 122 km² had almost no tree cover at that time, sand and sand-dunes destroyed a major portion of the area, people used to import firewood from other parts of the province and agricultural

output stood at 1.4 tonnes/ha. After 1949, the planting of coastal windbreaks with Casuarina was started, which now total 57 km in length, over a total area of 4,034 ha. Drainage and soil building linked the islands, shifting sand was arrested and agricultural land was developed. As a result, the island is not only self-sufficient in timber and firewood but it supplies more than 10,000 m³ of timber annually to the state. Foodgrain output has risen to 4.8 tonnes/ha.

Chapter 2

ORGANIZATIONAL STRUCTURE, EDUCATION, RESEARCH AND EXTENSION AFFECTING FORESTRY SUPPORT FOR AGRICULTURE

2.1 ORGANIZATIONAL STRUCTURE

2.1.1 Political Framework

The People's Republic of China is divided into 26 provinces and autonomous regions and three autonomous municipalities having the status of a province, namely Beijing (Peking), Tianjin (Tientsin) and Shanghai. A province is divided into prefectures and a prefecture into counties. In some areas where national cultural minorities reside in large numbers, leagues are constituted covering several counties each, in order to give special attention to these areas. Leagues have the status of prefectures. One of the leagues visited by the study group was Chao-u-ta League in Liaoning Province in the north-eastern part of the country.

A county is further subdivided into several people's communes. In cases where the county is large, it is subdivided into districts to facilitate administration, but this is the exception rather than the rule. A people's commune has units within itself which are the production brigades, and the production brigades are subdivided into production teams. While the commune may be the basic political unit, by all accounts the production brigades form the backbone of planning, implementation and, in fact, the entire economy, and may cover a few villages each. Generally, in the areas visited, a commune has a population of 10,000-80,000, a production brigade of 500-5,000 and a production team of 30-500 people. There is no uniformity as regards the area of operation of communes and production brigades.

2.1.2 Administrative Structure

At the national level, the central Government has a Ministry of Agriculture and Forestry in which there is a Department of Forestry. The Department of Forestry is responsible for the policies and guidelines on afforestation, forest management, forest industry and other forest development activities. At the province, prefecture and county level there may be a department of forestry or a department of agriculture and forestry responsible for forestry activities. As explained in chapter 3, this responsibility is not discharged through the hierarchical organization structure, but by an integration of "top and bottom" levels. In some provinces and prefectures there may be a department of forest engineering responsible for logging and transport of industrial wood and also a department of afforestation responsible for the management of state forests. In some cases, for example in Echeng County, Xianning Prefecture, Hubei (Hupeh) Province, a professional team or plantation committee oversees the management of the Cunninghamia forest plantation. While there is a specific department responsible for forestry at each level down to the county, below that level only specific personnel or groups remain responsible for it. Under the Ministry of Agriculture and Forestry of the central Government are also the Academy of Agriculture and Forestry Science and the Institute of Forestry Research. Provinces, prefectures

and counties may have specific research branches, and forestry research institutes with experimental stations under them may be established, depending on the need for, and importance of, the work.

2.1.3 Revolutionary Committees ^{1/}

At every level, province, prefecture, county, commune and production brigade, there is a revolutionary committee, mainly charged with executive functions. The revolutionary committee acts like a cabinet and is composed of a chairman, several vice-chairmen and other representatives. In Taoyuan County, Hunan Province, one of the counties visited by the group, each vice-chairman was responsible for a certain area of work, one of which was forestry, and was in charge of a sub-committee. This also occurs in some other counties. For the provinces, prefectures, counties and even communes, in other cases, one of the committee members is assigned to, of specifically charged with, all matters connected with forestry. In a county the revolutionary committee may consist of six to eight persons and at other levels correspondingly more or fewer. Specified units at the commune and production brigade levels may be set up to carry out certain work. Each committee or specified unit will be a combination of workers, professionals, and party cadres. For instance, for shelterbelts and sand-dune afforestation in Tungfanghung Production Brigade in Chifeng County, Liaoning Province, the forestry unit consists of three professionals (technicians) and some commune members and party cadres. In Hsiaoling State Forestry Farm for Cunninghamia plantation in Hubei (Hupeh) Province, the administrative group consists of the director, deputy director, accounts technicians and two representatives of the workers.

2.1.4 Ownership Pattern

Forestry ownership in China may be classified as follows:

- (i) state ownership: this extends to the natural forest areas and those established or planted by the state.
- (ii) collective ownership: extends to those forests established or trees planted through the collective efforts of the members of the communes, production brigades and production teams:
- (iii) individual ownership: extends to those trees planted by individuals or commune members around their houses through their own personal effort.

In the case of planted trees or established forest plantations, the general policy of ownership is that whichever agency is responsible for the planting of the tree or establishment of forest plantations also owns the said tree or plantation. This policy accordingly finds support in the state laws. The trees planted are maintained and managed by the agency that has jurisdiction over the area where the trees are planted. For instance, trees planted along roads and highways are maintained by the Department of Highways; those along railways by the Department of Railways, etc.

^{1/} Since mid-1977, the revolutionary committees have either been dissolved or transformed into regular management committees.

2.1.5 Implementation of Field Activities

In accordance with the policies set, the state continues to bear the major responsibility for carrying out the tree-planting programme. The revolutionary committees are responsible for implementing state laws, rules and regulations within their area of jurisdiction. The programme is mainly implemented by mobilizing the people of the communes, production brigades and production teams. It is China's experience that no tree-planting programme can be undertaken in any area unless the people can be included and educated. If this is done, the task can be easily achieved and protection is not a problem.

Special teams, composed of professionals and commune members, may be set up for the implementation of the programme, and a team leader is elected and ratified by the revolutionary committee of the production brigade concerned, with whom most of the responsibility for field work rests. It is the team leader who has to see to it that the plan is properly implemented. Professionals combine with the masses in performing jobs which require their skill, such as seed collection, nursery practice, protection against insects and diseases, etc.

Implementation procedures may include the conduct of propaganda work by conveying to the masses Chairman Mao's directions on forestry through radio, newspapers, films, exhibitions, songs and dances, and other mass media. Demonstration sites or models may be set up to serve as an example of proper forestry activities and techniques.

In coordination with the revolutionary committee concerned a professional team at the prefecture or county level, which had the responsibility for the initial preparation of the integrated land use plan (for further information on the plan see Chapter 3), is also charged with the responsibility for checking and monitoring its implementation.

2.2 EDUCATION

2.2.1 General

Forestry education and training in China may be conveniently divided into four distinct levels of training, as outlined below:

- (i) formal forestry training, which is divided into two levels, i.e. higher technical level of training and lower-level technical training;
- (ii) training by demonstration where communes, production brigades and teams may learn from the experience gained in state farms established for the purpose;
- (iii) training by way of visits of farmers to some identified model farms or communes, or tours of technicians, researchers and political cadres to communes where they discuss and exchange information on problems facing the individual communes visited;
- (iv) spot training programmes for individuals in the field normally accompanied by seminars or workshops.

Each of the above levels of training will be elaborated on separately and examples given from the places visited by the study group. Before going on to describe in detail the above levels of training, there are a few points which should be discussed so as to give proper background information and to make it easy to understand the training procedures discussed. The points in question are:

2.2.2. Selection Criteria for Training Candidates

There are generally three main criteria for the selection of an individual for training. This applies for all levels of training. The three criteria are:

- experience in forestry work;
- aptitude for, or interest in, forestry work
- high level of political consciousness.

2.2.3. Relationship between Forestry Training, Extension and Research Programmes

The study group found that, because of the mass nature of forestry training, it is difficult to draw a line between forestry training and extension programmes in China. Research is closely linked to these programmes.

The training system is related to the ownership patterns of forestry in China, as has been outlined in the relevant section dealing with ownership (Section 2.1.4). As explained in that section, most of the forests, other than those owned by highway and railway authorities and the state-owned demonstration farms, are owned and managed, and their products sold, by the masses. This explains why such an extensive training programme is undertaken in China.

As explained in the section on forestry research programmes (section 2.3 below), research in China is very practical and usually production-oriented. For example, in all state demonstration forestry farms visited research plots had been established, which were used for the solution of problems as well as for teaching new forestry techniques to the masses. Moreover, research is included in the curricula of all forestry training institutions. The staff of both training and research institutions visit communes from time to time to give on-the-spot training or carry out research programmes. There is thus close coordination between research workers and the grass-roots level, where much of the research is taking place.

With the above background information it will now be in order to follow up the four levels of forestry training as outlined below.

2.2.4. Formal Forestry Training for Higher-level and Lower-level Technicians

(i) Higher-level Technician Training

This is a three-year training at university or college level. In all the places visited by the group there were few of this cadre of people and in most cases such people were those in charge of state forestry farms, forestry research institutes and county forestry sections.

In the initial briefing received in Beijing (Peking) before starting the tour, we were informed that the central Government ran an Academy of Agriculture and Forestry Science which was possibly the highest institution offering both forestry and agricultural scientific training in China. Besides this academy, the state also ran a number of colleges of agriculture and forestry in various provinces. The study group was unable to learn their exact number.

The study group was not able to visit such an institute during their tour, but in Guangdong (Kwangtung) Province they were very fortunate in being given a detailed briefing by a director of such an institute and his professors.

The account in this section is based entirely on the briefing received in Guangzhou (Canton), and may serve as an example of how forestry and agricultural colleges are administered and managed in China.

The College of Agriculture and Forestry in Guangzhou (Canton) runs a multi-disciplinary training programme. It has eight departments, subdivided into twelve faculties. The eight departments and their faculties are as follows:

Agriculture Department	-	Three Faculties:	(i) Agriculture
			(ii) Seed Improvement
			(iii) Tea Culture
Soil Chemistry Department	-	One Faculty	
Plant Protection Department	-	One Faculty	
Forestry Department	-	One Faculty	
Agricultural Mechanization Department	-	Two Faculties:	(i) Agricultural Machinery
			(ii) Design of Agricultural Machinery
Veterinary Department	-	One Faculty	
Horticulture Department	-	Two Faculties:	(i) Fruit
			(ii) Vegetables
Silk Culture Department	-	One Faculty	

The main task of this college is to train technicians for the whole country, to carry out research programmes geared to solving problems facing the country and to boost production of agricultural and forestry products. Research programmes undertaken are either assigned by the state or are based on the needs of the people.

This college has an enrolment of 1,500 students with some 600 teaching staff, of which 55 are professors in various fields. The college also runs an agricultural farm, an agricultural machinery factory and a physics and chemistry research laboratory for radiation research work in agriculture.

The college administers mainly two types of training programmes. These are the normal three-year undergraduate training and a refresher course of one year's duration.

Besides the two types of training, the college has other special training programmes; for instance, it offers special training programmes for students intending to work abroad under Chinese technical assistance programmes in developing countries. The college also offers short-term courses, ranging from periods of one month to six months; such short-term courses are usually given on specific subjects. They are usually given to people selected from the communes who are involved in work related to the kind of training they will receive, and who will go back to their respective communes skilled in the new methods they have learned to continue the work they were doing previously.

Members of the teaching staff of the college sometimes go to the communes to give on-the-spot training or carry out research programmes so as to solve some of the problems facing the people there. We were informed that, through the short-course programmes and the teachers carrying out on-the-spot training in the communes, they were able to train some 20 000 people every year.

For recruitment to the college, students have to meet the three selection criteria mentioned under section 2.2.1. When the students graduate, they are assigned throughout China, in accordance with the unified plan of the Government, to carry out their work.

With regard to the teaching content at the college, it is based on Chairman Mao's instruction that a person has to be educated morally, intellectually and physically. Consequently, besides being trained in their area of specialization, the students have to take political science subjects throughout the three years. They also have to take part in physical fitness programmes.

There are normally three types of subject studied, depending on the area of specialization, but forestry students have to take the following subjects:

- basic background subjects, e.g. mathematics, physics, chemistry, botany, biology and one foreign language;
- professional subjects, e.g. forestry mensuration, forestry vegetation, silviculture, dendrology, soils, biology, survey, etc.;
- specialized training in various forestry disciplines, e.g. forest entomology, forest pathology, forest engineering, forest economics, etc.

With regard to the teaching methods, there is an integration of both theory and practice. Much emphasis is placed on research and practice. For example, with regard to research, students are required to participate in research programmes right from the very first year. This participation in research is done with the help of the teachers. The students are required to participate in research work in the field for a period of two to three months in each year they are at the college. Consequently, by the time they are in their third year, they are well versed in research methods. In fact, as a requirement for graduation, each student has to carry out a field research project, for which he is supposed to plan and carry out the research work, analyse the project results and give recommendations as to what measures should be taken. Besides the academic work, each forestry student is supposed to participate in some productive work in the forest farms with the commune members, actually carrying out all the manual work and at the same time teaching the commune members new forestry management practices.

(ii) Lower-level Technician Training

This is normally a one- to two-year training programme. On 7 May 1966, Chairman Mao stated that scientific experiment, together with class struggle and the struggle for production, were the three great revolutionary movements which were of theoretical and practical significance in implementing policies oriented towards socialism. Institutions in every discipline were set up which laid emphasis on all three in the instruction given. As in other disciplines, forestry schools were established to produce lower-level forest technicians who would be going simultaneously through the three movements in their learning. These schools came to be known as the 7 May forestry schools.

The 7 May forestry schools run short courses covering a period of one year. The study group was informed, during their visit to Zhuzhou County, Hunan Province, that there was such a school at the county level. They were also informed that the students in such an institution spent one day a week in the classroom and the rest of the days in the field doing productive work as well as carrying out some research or observation work.

The group was informed that a number of counties administered forestry training not only in the 7 May forestry schools but also in what are called secondary forestry schools. These secondary forestry schools offer two-year courses in forestry. Again, recruitment is based on the three major criteria described earlier.

When students graduate from these secondary forestry schools they are usually assigned duties within the county in the various communes.

2.2.5

Training by Demonstration on State Forestry Farms

Training of the masses by way of demonstration was noticed to be a widely used and effective training method in China; this was particularly so in the provinces of Hubei (Hupei), Hunan and Guangdong (Kwangtung), visited by the group. It was noticed that in a county where forestry was important and commune members were supposed to carry out large afforestation programmes, the state selected a representative place and established a forest farm there. Most of such farms visited were state-managed farms, but there were a few instances where they were administered by a commune for the purposes of demonstration and research.

The group was told that these forestry demonstration farms were not only meant for training the neighbouring production brigades and teams, but were also production-oriented, carrying out a number of experimental research programmes, and were supposed to be self-sufficient. In fact, all such farms visited had already an accumulated fund paid to the state after meeting all their expenses.

Examples of forestry demonstration farms run by the communes were mainly seen in Taoyuan and Zhuzhou Counties in Hunan Province. In Zhuzhou County, for instance, there were 61 forest farms run by the communes and production brigades comprising a total of 10 000 ha and a total of 2 900 workers. These farms had a total of 176 permanent and 1 600 temporary experimental plots and had developed through their research plots some 20 or more new methods of forest management.

The group visited an experimental forest farm at Xianning, which was established in 1964 to promote new species and new planting and tending methods after the general failure of propagating Pinus massoniana in the county. After trying out over 50 species and using different methods, the farm demonstrated through actual establishment of plantations the better growth conditions of Cunninghamia and Pseudosassafras grown and intercropped with legumes in the first three years. Proper thinning techniques of this species have also been worked out at this farm. Soon afterwards, planting of Cunninghamia was commenced in this county (Puqi) and in seven other counties.

The state forestry farm at Xianning had served as a centre to spread the propagation of Cunninghamia to surrounding communes, so that in 1966 13 500 ha of hills and mountains had been planted around this farm with this species.

Another example of a state-run forestry demonstration farm is in Leichow County in Guangdong (Kwangtung) Province. The state Forestry Bureau in Leichow County was established in 1954 and at present administers ten forestry farms scattered throughout the county with a total area of 69 000 ha. This bureau also runs a forestry research institute. Through the initiative of this bureau and the research programmes carried out by it, the surrounding communes and production brigades have been able to learn and copy new methods of afforestation and soil and water conservation and, as a result, forestry and its role in water and soil conservation has become a major contributory factor to the agricultural and general economy of the whole county. As a result of integrated planning and improved agro-forestry practices, the yields of the land have almost doubled, leading to increased revenue and greater prosperity for once impoverished areas.

2.2.6 Training by Means of Visits and Tours

Following the saying of Chairman Mao "In agriculture learn from Tachai", this method of learning from the experience of others through the arrangement of visits of farmers to identified model farms and communes has come to be very widely used, not only in agriculture but also in all fields of development.

For example, a group of workers engaged in afforestation programmes in one production brigade will arrange to visit another county or commune which has been identified as carrying out better forestry practice in one way or another. Such a group will try to learn the new technique practised in the area visited so as to apply it themselves.

In addition, through the three-in-one method, groups of technicians, researchers and political cadres carry out tours to particular communes and production brigades where they review the progress of forestry programmes and teach the members new management methods.

2.2.7 Spot Training Programmes

The spot training method differs from that of demonstration in that it mainly involves fewer individuals and it concentrates on specific items or subjects encountered in the field. Moreover, the people involved in spot training methods are those carrying out specific types of work in the field.

A good example of this spot training method was elaborated to the study group when it toured Tungfanghung Production Brigade in Chifeng County in Liaoning Province. Here it was explained how a group of unskilled workers engaged in either nursery work or planting of Paulownia root cuttings was given on-the-spot training in the best nursery and planting techniques. This was usually followed by discussion seminars or practical workshops where the technicians and the workers discussed the problems concerning the new techniques. This method, we were told, normally turned unskilled workers into very skilled personnel in the particular line of work in which they were engaged.

On the whole, the study group ended its tour with the general impression that, comparatively speaking, the average Chinese was much more knowledgeable about forestry than the average person in any other country. It was the feeling of this group that this general awareness had only been possible through the integrated nature of their training programmes and also through the interdependent nature of agriculture, forestry and animal husbandry which, in fact, forms the basis of the Chinese economy and way of life.

2.3 RESEARCH

2.3.1 General

Chairman Mao told the Chinese people, "Man has to summarize his own experiences in order to improve his practices". In the conduct of research, the direction was that research work should serve industry, agriculture and the military and should be combined with production. Thus, forestry research in China is one of the main scientific activities, as evidenced by the existence of the Institute of Forestry Research under the Department of Forestry of the Ministry of Agriculture and Forestry and forest research institutes and experimental stations and farms in the provinces, prefectures and communes respectively.

The orientation of forestry research in China is practical, that is, it is directed to solving the problems the people are facing or encountering during their work. Research work is integrated with teaching and training, and more particularly with production.

The Forest Research Institute in the Ministry of Agriculture and Forestry, based in Beijing (Peking), appears to be the umbrella which coordinates the formulation and implementation of research programmes.

After Liberation when large-scale plantings had been initiated, both tree planting and agricultural work went ahead. The people soon came to understand that some improvements had to be made in forestry and agriculture. This, then, was when research began and was carried out in conjunction with tree planting and agricultural cultivation.

As a broad policy line was established that research work should serve all levels, research projects were set up at county, commune and production brigade levels. The people engaged in research were assigned to carrying out work at these three levels, in formulating programmes, management of research stations and guidance and training of researchers, workers and party leaders.

A county-level research institute was visited in Yanling County in Henan Province. This institute covers 85 ha of land, and has 37 research units in various parts and 1 253 established plots. The research workers at county, commune and production brigade levels work in the farms and gain experience from the field workers. They work together and exchange their experience with each other. Regular courses, which are attended by selected representatives of communes and production brigades, are set up either in communes or production brigades. Meetings too are held regularly at different centres when research work is allocated to each. Seminars are also held for exchange of views and discussions and at these the results of any research completed may be either published or put forward.

Selection of species was explained at one of the forestry farms, a commune research institute, where they are selecting poplars and other fast-growing tree species for different localities. There is also an experiment in progress with Paulownia for better quality, faster growing, resistance to disease as well as for cross-breeding. They are also introducing bamboo from South China to grow in North China, and trees as cash crops, such as apples and others. The contribution of the institute to production is by way of demonstration planting sites and raising tree nurseries for the supply of suitable and strong seedlings.

There is also another forest farm experiment which covers 540 ha of land near the prefecture rest house in Xianning in Hubei (Hupeh) Province. A large part of this area has been covered with Cunninghamia lanceolata and C. chinensis. This is mainly for development and demonstration of techniques for the introduction of Cunninghamia into the region. Demonstrations are made of the following techniques:

- (i) plantation thinnings;
- (ii) intercropping;
- (iii) pest and disease control.

This experimental farm serves as a base for training technical people from communes and production brigades. Since research work became a major priority, together with forestry, agriculture and animal husbandry, China is reported to have achieved better and higher yields each year. As seen in nearly all the places visited, at brigade, commune and production team levels, there is always some kind of research work done, e.g. organic manuring of tree crops, animal breeding, upgrading of tree crops by grafting, e.g. apple trees and Thea oleosa from stems, bud grafting and root budding etc. Research work has gradually been developed not only by the professional people but also through the field work and the experience gained at different levels by the field workers. Although many good results have been obtained through hard work by the research workers, the country is still not yet satisfied with these.

2.3.2 Botanical Research Institute, Guangzhou (Canton)

In the final round-up of the tour, the Botanical Research Institute in Guangzhou was visited. During the briefing, information was given on the many tasks undertaken by it.

One of these tasks is to make available as many research workers as possible for research work outside in the county, communes, production brigades and so on down to the lowest level. They are charged with:

- (i) undertaking complete work in research;
- (ii) helping communes etc. to carry out their own work.

The purpose of this field work is to get better research results and to bring research work to the grass-roots level.

The headquarters of the institute has a total of 49 research specialists and has the function of training and sending out as many research workers as are required. Research has become such an important factor in increasing productivity that all students have to study in their first year such things as:

- (i) tree improvement;
- (ii) management of man-made forests;
- (iii) introduction of exotic species;
- (iv) cultivation of oil-bearing plants;
- (v) shelterbelts and windbreaks;

- (vi) control of pests and diseases;
- (vii) minor products;
- (viii) wood science and technology.

The central Government's directive is that the graduates should become teachers in forestry research institutes or leaders at various levels from the top down to the grass-roots level.

Several research projects have been undertaken for upgrading not only the agricultural crops but also the forest plantations.

2.4 EXPANSION

Extension as a means of achieving increased production through mass participation, and thereby raising the social and economic well-being of the community and of the entire nation, is very well illustrated by the example of China. The study group observed several interesting features of extension techniques, some of them unique in themselves, as follows:

2.4.1 Political Line

All spheres of work and activity have been given political content in China. Chairman Mao's thoughts on forestry and its interdependence with agriculture and animal husbandry, enunciated by him in 1958, have been disseminated to the masses through a system of mass communication, using particularly radio and public address systems which are much in evidence in practically all the production brigades visited and perhaps available throughout the country. Loud-speakers are noticeable not only in commune and production brigade areas, but also in the fields and factories. Thus, there is a smooth and effective flow of information between the people at the top levels and the masses. The recent stress given by Chairman Hua to the need for "four-around" integrated planting of trees along roads, along rivers and canals and around houses and villages, together with the call to modernize China scientifically before the end of the century, have without doubt permeated the masses by creating public awareness of the important role of trees for water and soil conservation, timber and industrial and domestic needs, as evidenced by the ubiquitous presence of trees in all the areas visited.

Besides the sayings of the late Chairman Mao and Chairman Hua, referred to above, there are also regulations governing the protection of trees promulgated by the State Council, which are made known to the masses by the revolutionary committees. Additionally, the people's committees at all levels may make their own regulations in consultation with the masses, to meet local needs. All these regulations are brought home to the masses by vigorous propaganda through mass media such as radio, newspapers, posters, billboards, films and other media like theatre, plays, exhibitions and public meetings. There is also a system of mass education at grass-roots level whereby classes are conducted for the benefit of members by party cadres and appropriate forestry department personnel.

Through these means, the people are not only made aware of the need to love and care for trees, but also of awards, and punishments for forest felonies that may be committed by them. This has a twofold effect in promoting the cause of forestry. Persons committing minor misdemeanours are subjected to a process of criticism by the commune, production brigade or production team members and rehabilitation is attempted by re-education of the errant member.

2.4.2 Motivation

This factor, although important in extension work, is probably the least problematic. For a people who had, by all accounts, suffered intolerable hardships, the new lines of policy and large-scale implementation set them on the road to national reconstruction. Motivation, therefore, was born out of a will to get away from the past. This tremendous motive force has compelled the Chinese people at all levels physically to move mountains as exemplified by Chairman Mao's story of "The Foolish Old Man who Moved Mountains". Notable examples of enormous progress were observed throughout the study tour.

All along, from the beginning, the accent has been placed on self-reliance and hard work and because of this agricultural production is reported to have progressively increased and almost doubled the targets set by Chairman Mao in 1956 in nearly all the production brigade areas visited. Forestry has played no mean role in achieving this goal and the masses have become fully aware of the interrelationship between forestry and agriculture. The revolutionary zeal has been kept up or renewed by the Great Proletarian Cultural Revolution of 1966.

2.4.3 Mass Mobilization

Unity is strength, as the saying goes, and in China this strength has been fully utilized in mass mobilization to accomplish gigantic tasks which cannot but amaze an outside observer. Through extension, the shoulders of all the able-bodied, whether party cadres, militia, technicians, commune members, production brigade members, men, women, the young or old, at whatever level have been harnessed in accordance with Chairman Mao's teaching, to "go all out to mobilize the masses". A notable example was cited when the group visited the Ming Reservoir, where it was learned that the late Premier Chou En-lai joined the masses in reconstruction work. The group was privileged to witness actual mass action being done on a few hills and mountains, where terracing, intensive land preparation, cutting of shrubs, movement of earth and boulders, etc., were in progress, under the banner of the red flags.

In response to Chairman Hua's call to modernize China, extension work involves the semi-mechanization or mechanization of forestry operations. The group was able to see the use of a crawler tractor for ploughing hills in the Kung Yu People's Commune. Transport of planting materials etc. is now largely motorized in many areas. It was mentioned that this trend would free some people to devote greater attention to other types of work.

Chapter 3

POLICY AND PLANNING

3.1 GENERAL

Generally, the national policies of China are formulated by the National Congress of the Communist Party of China, which is the ruling and sole party of the People's Republic. Such policies are announced in the form of instructions. The Ministry of Agriculture and Forestry gives shape to the policies and formulates regulations within its sphere of work in line with such general policy instructions. These policy instructions are sent down to the provincial, prefecture, county, commune and production brigade leaders, who may also formulate through their revolutionary committees specific regulations, plans and guidelines in consultation with the masses and in accordance with the general policy instructions, to suit the conditions peculiar to their respective areas.

3.2 POLICIES AFFECTING FORESTRY SUPPORT FOR AGRICULTURE

As mentioned earlier, before 1949, China had hardly five percent of its total area of 9.6 million km² under forests. Centuries of denudation of forests, which continued virtually up to the middle of the twentieth century, led to soil erosion, frequent flooding, formation of sand-dunes near the rivers, sand casting on fertile lands, wind damage to agricultural crops, etc. This in turn led to an accelerating process of impoverishment of agricultural lands and consequently seriously affected food production.

Immediately after 1949, emphasis was laid on the following aspects of forestry development:

- protection of forests, for which guidelines and policies were enunciated to make it a mass movement;
- afforestation on a large scale;
- full utilization of forest products by setting up forest-based industries wherever possible;
- wildlife protection;
- forest education and research;
- forestry support for agriculture.

The key to the acknowledgement of forestry's role in agricultural production and to the success of forestry support for agriculture is to be found in the teachings of Chairman Mao. Even as early as 1934 Chairman Mao laid the foundation of forestry support for agriculture with his view that forestry and animal husbandry were important parts of agriculture. One of his most significant instructions on the subject of agriculture was "Take grain production as the key link and ensure an all-round development in agriculture", which included forestry. Further

elaboration was given in his directives to cover the country with trees and to do farming as meticulously as gardening. He also said that agriculture, forestry and animal husbandry should be interdependent and should be placed on an equal footing, as none of them could dispense with the others.

During the study tour, these guidelines were repeatedly stressed to explain how the large-scale plantation of trees along roads and water areas and around houses and villages, the establishment of shelterbelts and windbreaks and the afforestation of bare hills and mountains came to be recognized as a support for agriculture. In general, the policy was to practise forestry wherever the land was suitable for it. Leaves and undergrowth provided fodder for animal husbandry, which again was an important source of organic manure for the agricultural fields. The afforestation of bare hills reduced soil erosion, run-off and flood and provided a stable means of irrigation. The sand-dune afforestation and farmland shelterbelts afforded protection to agricultural crops, improved soil and allowed modern agricultural practices to be adopted. Thus, close links between agriculture, forestry and animal husbandry were forged and it was acknowledged that without the support of forestry it might not be possible or advisable to adopt Chairman Mao's Eight-Point Charter for Agriculture: improve soil, apply fertilizer, ensure irrigation, improve seed, plant close, protect crops, organize implementation and put stress on field management.

In recent times, the concept of an integrated plan for mountains, rivers, forestry, croplands and roads has been introduced to implement the policy guidelines enunciated above. Shelterbelts are integrated with agriculture, and forestry both for production and protection is practised wherever possible. As a result of the combination of timber forestry, shelterbelts and tree plantations yielding quick cash returns (e.g. those of Thea oleosa - an oilseed-bearing plant), the forestry cover has been increased from 5 percent of the total area of China in the pre-1949 period to about 10 percent at the present time.

The shaping of the policy was conditioned by China's dependence on self-reliance and hard struggle. Its aim was self-sufficiency in foodgrains through self-reliance, mass mobilization of human resources and improved practices. It was realized that forestry could contribute to the achievement of this aim and was also a labour-intensive activity. Moreover, forestry development could bring about self-sufficiency in timber and fuelwood production, while giving support to agriculture.

A policy cannot end in enunciation only. While the procedures for planning and implementation are elaborated in the latter paragraphs of this chapter, it may be stated that the general acceptance by the masses of the fact that forestry supports agriculture is a pre-condition for undertaking large-scale afforestation work in China. There are various ways, explained previously, in which mass education is undertaken but mention should be made of the importance attached to examples in China. For agriculture, "Learn from Tachai" is a byword. Similarly, in every province or county, or even in communes, a successful example is first established to demonstrate the key aspects of the policy. In fact, the visits of the study group were mostly to representative areas which could be set up as examples for others to learn from or to follow. This does not, however, imply that other areas are far behind. The policy in China is to study the work already done, in order to discern the drawbacks and mistakes and, in the words of Chairman Mao, it is always to "aim high and get better, quicker and more economical results".

3.3 PLANNING PROCEDURES

When Chairman Mao issued instructions in 1958 to cover the country with trees and to make agriculture, forestry and animal husbandry interdependent, large masses of people were mobilized and their participation obtained in various types of tree planting, as mentioned earlier. Mistakes were made in the matter of techniques, selection of species, etc., and growth conditions and survival were very often poor. The Cultural Revolution, which started in 1966, underscored the need for a different approach to planning and implementation. More recently, the Party Central Committee, led by Chairman Hua, called for an integrated use of mountains, rivers, forestry, roads and field plots to give proper effect to Chairman Mao's instructions for a planned forestry support to agriculture.

There are various components of the forestry programme under the recent integrated plan. Detailed information on each component is given in Chapter 4. The procedure adopted for preparing the integrated plan is outlined in general in the present chapter, and particular reference has been made to the places visited by the group.

It may be said that in general the success of integrated planning and its implementation is largely due to the three-in-one formation, consisting of technicians, commune members and party cadres, of the units concerned at each stage of the process.

The criteria for planning, choice of crops, etc., are as follows:

- (i) site conditions, i.e. suitability of land for agriculture, forestry or animal husbandry;
- (ii) national targets;
- (iii) people's needs.

Technical factors are duly taken into consideration, but the decision is ultimately taken on political lines and is based on the people's needs and reflects the national targets. The three-in-one combination at each stage seeks to keep the planning firmly based on practical considerations at the grass-roots level.

As stated earlier, the integrated use of agricultural resources and infrastructure has grain production at its heart - the "key link". It is interesting to note that a basic consideration in the planning is the productivity of agricultural land. In fact, even forestry practices are oriented towards higher productivity. Immediately after 1949, Chairman Mao set national targets for agricultural yield or productivity on a regional basis. There were three regions: north of the Yellow River, the tract between the Yellow River and the Yangtse River and south of the Yangtse River. It appears that broadly the national targets are still set on this basis. The national target increases from the northern part of the country to the south. The establishment of three-in-one units or groups at each stage makes it easier for the commune members to understand the national targets and the importance of the role of forestry as a support to agriculture.

The planning procedure embraces the following four main elements:

- (i) investigation and study;
- (ii) integration of top and bottom levels;
- (iii) integrated planning; and
- (iv) site suitability.

For investigation and study, there could be a three-in-one planning group at the county level or even an investigation and design team at the prefecture level. It appears that, generally, the responsibility lies with the county. However, the forest farms run by the state could cover more than one county, or more than one commune or production brigade. Before a plan is finalized, there are three up and three down movements, as the Chinese say. First, a draft plan is made by the planning group of the county, based on the three criteria mentioned earlier: site conditions, national targets and people's needs. The draft plan is sent down to communes and production brigades, where the commune members offer their comments and suggestions. After that, it comes up again to the group at the county level, who make changes as called for in the plan, in the light of the comments and suggestions made by the commune members. The revised plan is then sent down again to the grass-roots level for final examination and comments. The proposed plan comes to the county planning group level for the third time with further comments and suggestions of commune members. The group assists the revolutionary committee of the county to take a final decision. The plan, finalized according to the committee's decision, is then sent down to the communes/production brigades for implementation.

The finalized plan sets out not only the targets and other technical details, but also the flow of resources. The resources - funds, machinery, trained manpower, etc. - that may have to be contributed at the commune/production brigade level are clearly spelt out. The provincial administration or the central Government makes the necessary arrangements for making additional resources available according to the plan.

The plan takes into consideration the integrated use of mountains, rivers, forestry, roads and farms contained within the county and production brigades. The soil, climate, altitude, availability of communication facilities, labour, etc. are the factors which determine the suitability of any land for agriculture, forestry or animal husbandry, and within each the appropriate crops, species or practices. Intercropping in forest plantations is an important component of the plan. In most places the intercropping will be for production of cash crops, such as soybean, water melon, sweet potato, peanuts, etc., and also of green manure. Only in one case, in Leichow Peninsula in Guangdong (Kwangtung) Province, did the group find that no intercropping was planned and that was for the eucalyptus plantations, as such plantations are unsuitable for the purpose.

Though the general approach appears to be as outlined above, there may be variations in the levels of decision-making or procedures. In Xianning Prefecture in Hubei (Hupeh) Province (population 3.28 million, area 3,554 million ha, 25 per cent of which is under forestry) the study group was informed that there was an investigation and design team at the prefecture level, consisting of 20 technicians, for investigation of resources and drawing up of the land use plan for the whole prefecture. At the county level in the prefecture, there were teams of 5-6 technicians only where forestry was an important form of land use in the county. The investigation and design team would cover every county and assess the forestry resources, incidence of waste lands and bare hills, soil conditions, vegetation cover, etc. They would put forward an initial report and ideas to the Revolutionary Committee of the Prefecture. There would be the usual "up and down" movements, after that, for finalization of the plan. It appeared that maps in the scale 1:25 000 were preferred as a part of the finalized integrated plan which the communes/production brigades were to implement. The same investigation and design team had the responsibility of monitoring the work. Monitoring might be done twice a year: the first time in April (for trees) or in May (for bamboos), to verify if the work had been done according to the planned target, and the second time in October, to determine its success. The monitoring at the second stage was also done to assess

quality of work and survival rate, to select any location as a model for demonstration or example, to sum up experiences and hence to suggest any necessary changes in the next year's plan.

Taoyuan County in Hunan Province has a population of 880 000 on its 470 000 ha of land, 41 percent of which is under forest. Mountains and hills cover a total area of 300,000 ha. In this county, the revolutionary committee takes the lead in the preparation of the integrated plan, and its finalization after the "up and down" movements. The revolutionary committee is assisted by a three-in-one integrated planning team. There is no specific team for forestry planning in the county, but in the prefecture there is a specific forestry team to offer assistance and guidance. For the county planning team, May to August is the busiest period for preparation of next year's plan. There are 300 persons in the team during the busy season, of which roughly 100 are technicians, 150 commune members and 50 party cadres. Normally, however, there are only 50 members in the team, in a similar three-in-one combination. There is one chairman and there are ten vice-chairmen of the revolutionary committee of the county and one of them is responsible for the planning team and its activities. In the phase of implementation, the vice-chairmen go to live with the commune members and one of them becomes responsible for each sector. The monitoring work also devolves upon them. There is a directing committee for the preparation of farmlands according to the integrated plan, and one of the vice-chairmen remains responsible for the implementation of this work.

Zhuzhou County in Hunan Province has a population of 490 000 and a total area of 435 000 ha of which 70 percent is mountainous, 10 percent a water area and 20 percent irrigated farmland. There is a three-in-one planning group in the county consisting of 70 members, including six leading party cadres, 25 technical personnel and 39 commune members (or peasant technicians). Some of the latter have gone through short-term forestry training courses. The planning group goes to the communes/production brigades for investigation and to obtain ideas and suggestions from the people on the plan. This part of the work is generally completed in six months and a draft plan is prepared by the group. The draft is then again discussed at the commune/production brigade level, and is recast by the group in the light of the comments and suggestions received. The proposed plan is then ratified and approved by the department concerned at the county level, and the finalized plan is sent down to the communes/production brigades for implementation. At present there is a target for achievement by 1980, which coincides with the national Fifth Five-Year Plan. This target is kept in view in preparing the integrated plan. The group has so far decided that 35 percent of the mountainous area will be used for timber and tree crops yielding quick cash returns and 5 percent for fuelwood plantations and pasture, while 10 percent will be reserved for agriculture. There will be no agriculture on slopes above 15°. The 10 percent reserve will be only such areas as are below 15° slope with better conditions of soil and agriculture.

Even though grain production is the "key link", there is no attempt to put every kind of land under agriculture. The farmland per caput is quite low. The study group found the following ratio of farmland to population in different places visited, higher in the north and gradually declining as one goes south:

Table 1

RATIO OF FARMLAND TO POPULATION

Area	Total Population	Total Land Under Agriculture (Mu*)	Agricultural Land Per Caput (Mu*)
<u>North of Yellow River (Liaoning Province)</u>			
Chifeng County	480 000	1 800 000	3.75
Taipingti Commune	20 000	70 000	3.75
Tungfanghung Production Brigade	1 957	4 650	2.38
<u>Between Yellow River and Yangtse River, Henan (Honan) Province</u>			
Yu County	880 000	1 200 000	1.36
Tanghung Production Brigade, Yu County	1 231	2 520	2.05
Chachia Production Brigade, Yanling County	1 800	2 400	1.33
Yuankuei Production Brigade	1 835	3 128	1.70
Laochuang Production Brigade	1 500	2 700	1.80
Pengchuang Production Brigade	1 190	2 650	2.23
<u>South of Yangtse River</u>			
Hsiennung Brigade, Hubei (Hupeh) Province	670	220	1.07
Taoyuan County, Hunan Province	880 000	1 350 000	1.53
Chuting District of Zhuzhou County, Hunan Province	490 000	550 000	1.12
Yutien Commune, Taoyuan County	13 000	20 000	1.54

*15 Mu = 1 ha

Several results were seen of the acceptance in planning of the interdependence of agriculture, forestry and animal husbandry laid down by Chairman Mao. In Chairman Mao's Eight-point Charter for Agriculture, one important point is irrigation. In the mountainous counties of Taoyuan and Zhuzhou in Hunan Province, 100 percent of the agricultural land is irrigated. There is an elaborate network of reservoirs, storage dams, weirs and dams across rivers for control of flood, pumping stations for supplying water to high-level irrigation channels from which water flows by gravity, etc. These irrigation channels are also used in the extensively reforested high elevations. In fact, 60 to 65 percent of the total land area is under forestry, trees yielding quick cash returns, fruit orchards, etc. This has been done for the support of agriculture - for moderation of run-off, to reduce silt load, to prevent floods, etc. Intercropping is done for three years or so in forest plantations, thereby increasing agricultural production and offering employment in the slack agricultural season. Many of the forest farms, or forest plantation units, have pig farms alongside, so that fodder is easily available for the pigs and pig dung can be used as organic manure in forestry and agriculture. Chairman Mao's Eight-point Charter for Agriculture could not be practised in many areas without shelter-belts and "four around" tree planting. Thus, forestry support for agriculture has been taken good care of in the planning procedure in order that Chairman Mao's policy instructions may be carried out.

3.4 PLAN IMPLEMENTATION

The implementation of the integrated plan rests mainly with the communes and production brigades. Self-reliance is the key word - and it is not just a slogan. Since machines are few and the human population is a plentiful production resource, it is necessary to use this resource to the best advantage. The organization of farmers in communes permits the easy mobilization of manpower and the most effective utilization of this resource. Motivation and direct participation of the masses is one of the most important elements in the Chinese success, as seen in the example of Taoyuan County mentioned above, where a network of irrigation channels was constructed, backed by reservoirs and dams of the Paiyang River catchment, for irrigation and afforestation which was undertaken on bare mountains, roadsides, canal sides, etc. In accordance with the anecdote of the "Foolish Old Man Who Removed the Mountains", frequently quoted by Chairman Mao, most of the work on dams, terracing, irrigation channels, etc., was done by the mobilization of human resources. At one stage, 100 000 people were mobilized for 70 days to complete the straightening of the river on a 20 km stretch, the plugging of the old river courses and the development of the sandy and pebbly plugged river beds for agriculture. Generally, all the people in the commune/production brigade in whose area work is to be done, are mobilized for doing the work, as these people will be reaping the benefit. When required, persons from other areas are also mobilized. It was learned that those who work in another area are entitled to more work-points for similar work than those earned by commune members working in their own locality. The work-points are, however, transferred to the home commune, from which such members get the income distribution to which they are entitled.

So far as the forestry aspect of the integrated plan is concerned, the state has in many cases taken the responsibility for supplying the foodgrain requirement of those communes/production brigades which are mainly engaged in raising tree crops yielding quick cash returns, such as Thea oleosa. An example seen was in Zhuzhou County, where old scattered plantations were improved in the initial stages of development of Thea oleosa.

A few words on commune/production brigade forest farms may be said here. Such forest farms could be commune forest plantations worked and managed jointly by several communes and production brigades or production brigade forest plantations worked and managed jointly by several production brigades and production teams. In accordance with Chairman Mao's instructions, 30 percent of the effort is directed to raising seedlings and planting and 70 percent to tending them. The ownership of forests is not changed, even if they are jointly managed. The work force has to be mobilized by production brigades and teams in joint effort on the basis of the amount of their land and their population. The advantages of setting up forest farms, with three-in-one management groups, are:

- (i) they demonstrate the advantages of coordination between people's communes and contribute to the integrated use of mountains, rivers, forestry, roads and field plots;
- (ii) they promote forestry and mass involvement in large-scale planting by providing a model;
- (iii) they expand the collective economy by bringing in income from forestry and sideline occupations and thus providing a source of funds for purchase of machinery for agricultural operations;
- (iv) they provide good conditions for training educated youth from towns and cities, who can acquire appropriate skills and settle down to do forest plantation work in communes/production brigades.

The following are the factors which contribute to the success of rural development, including forestry development, in China:

- (i) Strong leadership: Above all, Chairman Mao's far-sighted and clear instructions, which have resulted in the establishment of carefully selected leading cadres, with almost life-time tenure of office, at every level, and the constant and continuing nature of the development strategy.
- (ii) Public education: This is done through all the known methods of mass media, but the most effective of all are the posters, which are the instructions of Chairman Mao and simple technical messages in slogan form posted or painted on the walls of the houses, in the fields, on terraces, on the roadsides and on the river banks, etc. These are repeated frequently in the form of formal speeches or friendly chats at school, on radio and television, in films, and in group and professional plays and performances, etc.
- (iii) Actual field demonstrations: Any new programme is introduced to the ordinary people by actual demonstrations in the field. The importance of the activities, the needs of the country and the benefits to be derived are demonstrated. The whole thing is discussed with the people and popularized before going into large-scale implementation.
- (iv) Three-in-one combination: Since party cadres who set the targets and development policy, technicians who have the knowledge to implement the policy and the masses who carry out the actual work are all involved in planning, once the plan has been finalized they all work together in harmony until the completion of the work. At this stage everyone's aim is the same: to achieve the goal as quickly and perfectly as possible.
- (v) Mass mobilization: As already explained, the people of the communes, production brigades, etc. can be mobilized on a vast scale for implementing large-scale agriculture and/or forestry projects.

In addition to the above-mentioned factors, research and training, which are discussed in detail in Chapter 2, have also contributed to integrated rural development including forestry.

Chapter 4

HOW FORESTRY SUPPORTS AGRICULTURE

4.1 EFFECT ON FORESTRY OF CHINA'S AGRICULTURAL POLICY

China's economy is predominantly agriculture-oriented, with more than 700 million of its people living in the countryside. The strategy adopted is to "take grain production as the key link and ensure an all-round development in agriculture"; the expansion in agriculture will in turn motivate and promote a new upsurge in the development of almost every sector in the national economy. A consequence of this strategy on the forestry sector is that it has not only served as a support to agriculture but, in the process, has developed into a strong and viable segment within a system of integrated planning which characterizes China's approach to development. Stricken by a series of natural calamities throughout history, China appears determined to tame rivers, regulate water systems, reverse soil erosion, establish a favourable climatological balance and thus banish the feeling of helplessness against natural disasters. Forestry has played a major role in achieving these objectives. Moreover, through replenishing forest stocks, China has not only attempted to create a physio-biotic environment favourable to agriculture but has also ensured a steady stream of income to strengthen its collective economy and to enable procurement of capital goods to bring about technological advancement. This task of forestry development is one which has utilized the labour of large masses of people, whose productive energies have been directed towards the creation of a land and water conservation system which is also a source of income.

"Four around" plantation; shelterbelts, sand-dune stabilization, coastal wind-breaks, watershed management, afforestation of bare mountains, plantation of fast-growing species for timber production and forestry for food and non-wood products are dealt with as major elements of forestry support for agriculture.

4.2 "FOUR AROUND" PLANTATION ("FOUR SIDES" FORESTRY)

4.2.1 General

In the year 1958, which marks the beginning of the Great Leap Forward, Chairman Mao issued two significant instructions to the nation, both of which proved to have far-reaching consequences for the forestry situation in the country. One of them was to "cover the country with green trees" and the other, probably directed more towards the planners, was that "agriculture, forestry and animal husbandry should be interdependent and none of them can dispense with the others; these three should be placed on an equal footing". Another explicit directive was that forestry should be carried out wherever it was possible to do so. The question of where to carry out one type of forestry has been very concisely answered by a phrase which, when transliterated from Chinese, reads "FOUR AROUND PLANTATION". By "four around plantation or forestry" is meant: Planting along roads; along rivers and canals; around houses and around villages. It is possible to think of this type of forestry activity as something similar to either "environmental forestry" or "amenity forestry".

Although national figures to indicate the magnitude of work done in this sector were not given, a few examples were obtained:

In Liaoning Province	16 million trees
In Zhongning County, Hubei (Hupeh) Province	27 " "
In Xianning Prefecture, Hubei (Hupeh) Province	520 " "
In Hunan Province	1.9 billion "
In Taoyuan County, Hunan Province	50 million "

The team left with the impression that the achievement of the People's Republic of China in environmental tree planting would lie beyond the capacity of any organized forest service if such work were to be carried out in a system where labour had to be compensated directly by money wages. In every commune, "four around" tree planting is an integral part of the commune's economic activity and tree planting is everybody's business. This is reflected as one of the national aims which is popularly referred to in the country as the "five ones". These are: one man - one hundred trees, one pig, one mu of irrigated land, one thousand jin* increase in food production and one mu - 100 jin* of food grains.

"Four around" tree planting, besides helping in consolidating the river banks, restoring land, decreasing evaporation, providing shade etc., has directly contributed to the strengthening of the collective economy of the communes. Timber, fuelwood, fruit and other products obtained from these trees not only meet their local consumption requirements but are also the sources of external cash income for them. Litter and green leaves for preparation of organic manure and fodder for livestock are additional benefits of great significance.

Thus it is this programme which cuts across the rural and urban sections of the whole country and has persuaded 950 million Chinese that tree planting will, in due time, contribute to their collective and individual well-being. As a result, today the Chinese-people in general are the most tree-conscious among the peoples of the world.

4.2.2 Roadside Planting

(i) Roadside Planting in the Countryside

The group travelled by road some 3 000 km, including state highways, secondary roads and dirt roads, in the hills and in the plains, and was invariably struck by the amount of tree planting that has taken place everywhere. Although the trees planted along state highways belong to the Department of Highways, many roads within a commune and the trees lining them, belong to the communes themselves. Even the state highways are constructed by the members of the communes, that portion of the highway which passes through their commune being their specific responsibility.

Nearly all the communes that the team visited have had all their roads lined with trees. For example:

- in Yanling County of Henan (Honan) Province, some 3 900 km of roads are lined with trees;
- in Taoyuan County of Hunan Province, about 2 905 km of highways and 2 300 km of secondary forest roads have been planted with trees on both sides.

* 1 jin = 0.5 kg

Although planting of one row of trees on either side is more commonly seen, two or more rows on each side are also planted. The team observed several instances where complete belts of trees six to ten rows deep have been planted.

The most common spacing observed is 2 m within rows and 2 m between rows or a minor variation of it, like 1.5 m x 1.5 m and 1.3 m x 1.3 m. The spacing on highways is, however, sometimes more than 2 m x 2 m. Close planting even along roadsides appears to be a common practice. Planting of seedlings - strong and well-grown - in pits is the most common planting practice.

As regards species, the team observed that planting of willow, poplar and Pinus massoniana was most common in the northern parts of China. For example, on the way from Chifeng to Tungfangnung Production Brigade, three rows of trees were planted on either side of the road; the inner row of trees was of Pinus massoniana and the outer two rows were of poplars. Between pine and poplar rows the spacing was 2 m, whereas between poplar rows it was only 1 m.

Poplar is a much favoured tree for roadside planting in the countryside, since it grows fast and straight and provides timber, fuelwood, fodder and substance for organic manure. At many places the team saw five- to six-year old poplars planted along roads, reaching a height of 15-20 m and an average depth of 15 to 20 cm.

Paulownia fortunei is more commonly seen in Henan (Honan) Province. The other roadside trees observed in the central provinces of China are: Robinia pseudo-acacia, Sassafras tsumu, Platanus orientalis, Pseudosassafras spp., Thea oleosa, Aleurites fordii, Melia spp.

In southern China, the roadside trees are generally in one or two rows and are mostly Casuarina equisetifolia and Eucalyptus spp.

In some areas it was observed that underplanting the tree belts on either side of the road with a green manure crop like Amorpha fruticosa had been practised.

(ii) Roadside Avenues in Cities

During its tour the group visited the urban centres of Beijing (Peking), Shenyang, Zhengzhou, Changsha and Guangzhou (Canton); in all these cities they observed impressive roadside avenues raised after 1949. In fact, as the visitor drives into the city from Beijing (Peking) Airport he does so on a completely shaded road of some 25 km, with long belts of mixed forest running on either side of the road - willow, poplar and Pinus massoniana are planted three rows deep with Amorpha fruticosa forming the shrubby layer.

An outstanding example of roadside avenues in cities is seen at Zhengzhou City in Henan (Honan) Province. The main species planted is Platanus orientalis. Trees are planted two to four rows deep. The branches of the trees on either side of the road are trained towards the centre of the road till they nearly touch each other. There is complete shade on the road; sometimes it appears as if an arched canopy of overhead foliage has been constructed all along the length of the road.

Another example seen by the group is tree planting in Changsha City in Hunan Province, where 114 km of city roads have been provided with avenue trees. One central park and four other parks have been created, which cover an area of 614 ha. It is reckoned that every citizen of Changsha has 8 m² of green land to meet his aesthetic needs.

The group visited the provincial tree nursery in Changsha, situated 8 km outside the city. The nursery covers an area of 58 ha and is under the management of the Bureau of City Construction. It was started in 1960 and has 114 persons on its staff. The nursery is located on undulating terrain; therefore bench terracing was extensively carried out. An irrigation system with gravity canals some 12,000 m long and a network of roads were constructed. An originally shallow compact red soil of low nutrient content has been improved by deep soil working (40 cm depth) and application of some 225 tonnes of organic manure per ha. The staff has been divided into seven operational groups: four for raising tree seedlings, one for ornamental plants and the others for sideline occupations and administration.

A production plan, linking production with the requirements of the city, has been made for the nursery. Priority is given to raising seedlings for roadside planting. Raising ornamental tree seedlings and experimenting with new species have been accorded lower priority.

Since 1960 the range of species raised has been widened from 60 to 159. So far, 3.6 million seedlings have been supplied by this nursery. No charge is made for seedlings supplied for planting in school grounds and on roadsides (the Bureau of City Construction, under whose management the nursery has been established, is also responsible for tree planting of the former category). However, when seedlings are supplied to others, they are priced. The price depends on the species and the length of time it has been tended in the nursery.

Generally, three-to-four-year old seedlings 2 to 4 m tall, are supplied for planting out. The more common species seen in the nursery are: Cinnamomum camphora; Platanus (various species), Acer spp.; Metasequoia spp.; Sophora spp.; Taxodium spp.; Paulownia spp.; Cedrus spp.; Magnolia spp.; etc.

The nursery has experimented with 34 species to find tree seedlings resistant to toxic air and also those that are sensitive and therefore can be used as indicator species. It is found that Pittosporum tobira, Magnolia grandiflora and Poncirus trifoliata are resistant to sulphur dioxide; Ligustrum lucidum, Photinia and Nerium indicum are resistant to chlorine fumes; and Cedrus spp. are good indicators of sulphur dioxide and chlorine.

The practice of planting tall and fully grown plants is common. Even plants 8 m high have been planted out. While the plants are being lifted from the nursery, roots are generally pruned and root ends wrapped in straw. Evergreen trees are lifted with soil around the roots; others are transported with naked roots. Winter planting in pits 2 m in diameter and 1.2 m in depth is carried out. Shading of trees and sprinkling of water after planting out are practised. The survival percentage is reported to be 95 percent.

4.2.3 Riverside and Canal-side Planting

One of the more important examples of riverside planting that the group saw was along the Yellow River. The Yellow River is the second largest in China and has a catchment area of around 74 million ha. In a long span of 2,500 years, the Yellow River broke its banks 1,500 times causing untold human misery. Some 1.6 billion tons of silt are deposited by the Yellow River every year; a dam of one cubic metre in volume made of this silt would go round the world 27 times. Every year the river-bed is rising by 10 cm and in some places the river is even 10 km wide.



Fig. 1 Plantation along river, Hubei (Hupeh) Province



Fig. 2 Plantation along canal, Hubei (Hupeh) Province

After 1949, top priority was given to training the Yellow River; soil conservation measures were undertaken in the catchment area and some 100 000 people living along the river downstream were mobilized to construct supplementary dykes over some 700 km at intervals of 200-500 m and to plant trees on the banks and on reclaimed soil. The group visited the Yellow River site near Zhengzhou in Henan (Honan) Province and observed the bank consolidation work. The main species planted here was willow. Out of the 1.9 billion trees planted under the "Four Around" forestry programme in Henan (Honan) Province, a large proportion is along the Yellow River. It was reported that as a result of this work there had been no damage due to floods in recent years. Even in the peak flood year of 1958 (some 22 000 m³/sec of water flow) no breaches occurred.

The group also visited the riverside planting activities in Chifeng County, Liaoning Province. In this one county, people have planted trees over 920 km along six rivers and 21 irrigation canals.

In Xianning Prefecture of Hubei (Hupeh) Province, people have planted trees 10 to 50 rows deep on either side of the Yangtse River over 324 km.

Another example of riverside and canal-side planting seen by the group was in Pengchuang Production Brigade, Yanling County of Henan (Honan) Province. This production brigade of only 1 190 persons has planted 40 000 trees along 12 irrigation canals of 6 km in length. Taoyuan County of Hunan Province offers another example of integrated measures taken to carry out water and soil conservation in which tree planting along rivers and canals is an important element.

The main species planted along rivers and canals are: willow, poplar and Paulownia spp.

4.2.4 Planting Around Houses and Villages

Emphasis has been given to tree planting around individual dwellings in the communes and around villages and in almost every commune the group visited the ubiquitous presence of trees was observed.

While visiting Taipingti Commune, the study group had an opportunity to visit some of the houses. Most houses have large compounds generally enclosed in a compound wall of mud. Inside the compound there is space not only for growing trees, mostly poplar in this area, but also for raising poultry, rearing a few pigs and growing either sunflower or sorghum. The trees planted inside compounds belong to individuals.

The group particularly observed "around village" planting at Pengchuang Production Brigade in Yanling County, Henan (Honan) Province. In 1975, the people of this village removed the 400-metre-long mud wall around the village, moved 38 000 m³ of earth and planted 50 000 trees around the village. Mainly poplar was planted with 2 x 2 m spacing. Trees were even irrigated and soil working by ploughing was done under the tree belts. A thinning after three years and a ten-year rotation are planned. Such examples of planting and tending of trees around houses and villages are numerous.

4.3 SHELTERBELTS

Shelterbelts, or farmland shelterbelts as the Chinese call them, are grown in many parts of China but especially in the north-west, to stop sand-dunes and desert encroachment. In Chifeng County, Liaoning Province, the group was told that shelterbelts extended over 2 771 km in the county and consisted of 2 510 main belts and 2 670 secondary belts, which protected about 57 700 ha of farmlands.

4.3.1 Planning

Shelterbelts, like all other forestry practices in China, are an integral part of agricultural, animal husbandry and water conservancy planning. Thus, tree belts have been established on farmlands, along roads and rivers and in front of sand-dunes to protect the land and the people from wind and sandstorm damage.

Main belts normally run at right angles to the irrigation canals and at 45° (or 26° as in Taipingti Commune) to the prevailing winds. The width varies from 8 to 22 m (4-13 rows of trees).

Secondary belts run along the irrigation canals and at right angles to the main belts, with a spacing of about 400 m, to form a network of squared farm plots each about 400 x 400 m (16 ha). The maximum distance between main belts was given as 500 m. At the same time, roads and irrigation canals are arranged in such a manner that they lie between shelterbelts. However, in Chachia Production Brigade Henan (Honan) Province, belts are spaced much more closely, 100-200 m apart, to give adequate protection against the loose sandy soils of the area.

Successive belts are planted adjacent to the old shelterbelts at a distance of about 8-10 m, eight to ten years before clear-felling of the latter for utilization. The successive belts will take over the protective function of the old belts. This type of belt was introduced as a means of practising clear-felling instead of selective fellings within the belts.

Structure of belts varies according to the damage caused by wind-blown sands. Three types of structures are described as follows:

- Ventilated structure where area is very windy.
- Thin structure for belts close to the river, where sand damage is serious.
- Close structure for fruit gardens and for protection from sand-dunes.

4.3.2 Establishment

Site preparation for poplar planting in shelterbelts is usually done one year before planting. Deep ploughing (13-20 cm) is followed by harrowing. Planting stocks are raised from cuttings taken from selected parents. After one or two years in the nursery, the rooted plants (0.40 cm diameter) are planted. Various methods of planting tree seedlings in shelterbelts are described as follows:

Slip planting - Normal cuttings of branches of poplar are planted underneath the soil, with only the tip emerging, at an acute angle to the soil surface. This is suitable for sandy areas subject to strong winds.

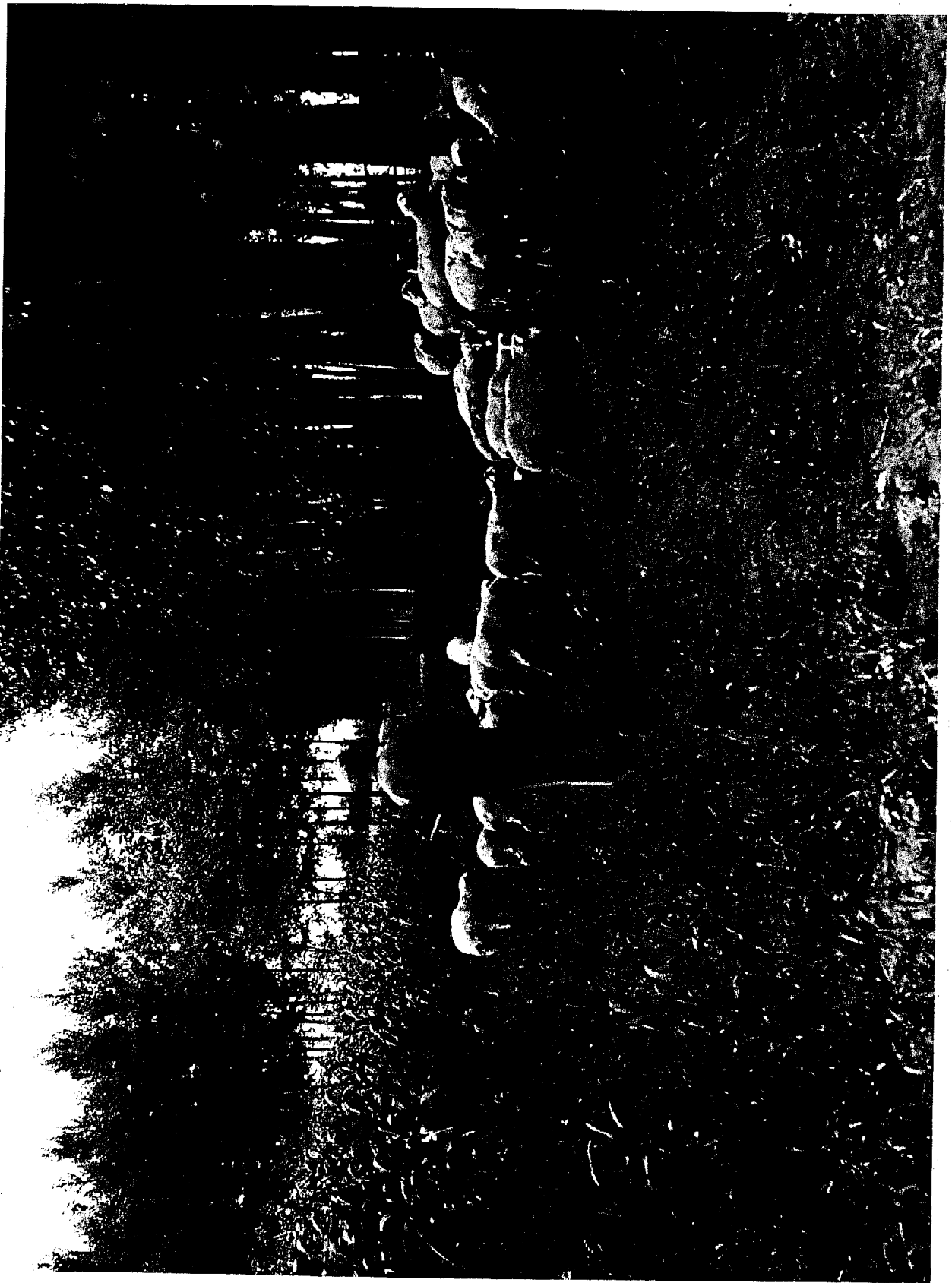


Fig. 3 Shelterbelt: crop protection and fodder production, Liaoning Province

Pit planting - Two pits are dug, the soil from one pit is put into the other, the plants are planted and the soil is then firmed.

Furrow planting - Rectangular furrows are dug; seedlings are planted and buried.

Open-hole (pit) planting - This is a common method for planting farmland shelterbelts. A pit 30 x 30 x 60 cm is dug and planted with seedlings.

At first, the planting distance for poplars was very close (1.3 x 1.3 m) but this has been changed to 2.5 x 2.5 m and 2 x 2.5 m (rows are 2 m apart) to allow for mechanization of tending operations. For Paulownia shelterbelts in Henan (Honan) Province, single rows are used. These are spaced 50 to 70 m apart and plants 4 m apart in the rows. In multi-row belts plants are normally staggered to give triangular-shaped compartments.

Poplars constitute the main species for shelterbelts in Chifeng County (Liaoning Province). The following broad-leaved and coniferous species are also used: Populus simonii, P. pekinensis, P. pyramidalis, P. canadensis, P. nigra, Salix spp., Ulmus pumila, Amorpha fruticosa, Robinia pseudo-acacia and Pinus tabulaeformis. In Henan (Honan) Province, Paulownia fortunei is the main species, spaced very widely.

The cost of establishment of a belt of 1 km with a spacing of 2.5 x 2.5 m (approx. 1 ha) was given as 15-20 man-days or 15-20 yuan (\$ 9 to \$ 12). This includes labour costs for digging of holes and weeding three times during the first year. It does not include land preparation before planting and tending operations after the first year, which are all done by machines, nor does it include nursery costs.

For machine costs (using a 15 h.p. tractor) the figure given for cultivation and weeding is 0.20 man-days/ha.

4.3.3

Tending

The Chinese say that in plantation work 30 percent of the efforts should be devoted to planting and 70 percent to tending operations. Hence weeding is done three times during the first two years and once or twice during the third and fourth years of the plantation. The rates of survival are therefore usually very high (90-95 percent).

Intercropping of shelterbelts has largely replaced such intensive weeding operations. The belts are intercropped with agricultural crops, usually legumes (sweet potato, peanuts, etc.) for the first two or three years. The system has two advantages: weeding becomes unnecessary and food is produced.

Farmland shelterbelts are usually irrigated at the same time as the crop fields, normally three times a year. The amount of irrigation water given per unit of belts is not known. Organic manure is applied at the rate of 2-5 tonnes/ha of belts; normally when the crop fields are manured.

Shoot pruning is done to favour the strongest leading shoots. Buds are also removed from the shoot to produce a strong leader stem.

Protection against pests and diseases is carried out when necessary.

4.3.4

Benefits of Shelterbelts

The Chinese emphasized the importance of shelterbelts on several sites by saying that shelterbelt forestry was a pre-requisite for the increase of agricultural crops. Other factors like irrigation, fertilization, improved seeds, mechanization, etc. came next in importance. This appears to be true, if one considers the benefits reported from shelterbelts, as follows:

(i) Supply of Timber and Fuelwood Requirements

The problem of firewood is solved in many parts of China by the establishment of shelterbelts (and other forms of forestry). Between 1966 and 1976, the Tungfanghung Production Brigade harvested 3 000 m³ of firewood from shelterbelts for its own requirements and also supplied some other brigades. Thus dung, used previously for fuelwood, is preserved for manuring the farmlands. The firewood is sold to the members of the production brigade at one-third of the market price.

Between 1966 and 1976 the income from forestry of the Tungfanghung Production Brigade was 319 000 yuan, mainly from the sale of timber to the state. This made it possible for them to purchase agricultural machinery, fertilizers, irrigation equipment and other implements.

Growth rates for ten-year-old poplars grown in a shelterbelt were given on site at the Taipingti Commune, Chifeng County, Liaoning Province. They are as follows:

Table 2

GROWTH RATES OF POPLARS IN A SHELTERBELT

Planting date: 1966
Measurement date: 1976

Species	Average Height (m)	Average Diameter at Breast Height (DBH)(cm)
<u>Populus canadensis</u>	18.8	20.2
<u>P. pekinensis</u>	16.4	19.3
<u>P. pyramidalis</u>	16.1	17.1
<u>P. simonii</u>	11.3	13.5

In another belt of P. canadensis planted in 1966 and measured in 1976, average height was 21 m and average DBH was 21.5 cm. The total volume of 1 km of this belt 10 m wide (equivalent to 1 ha) was 563.3 m³ or an increment of 56.33 m³/ha/year.

The rotation for poplars has been fixed at 20 years, after which the belts are clear-felled.

The measurements for Ulmus pumila in the former belt were 11.2 m and 14.5 cm for average height and DBH respectively.

(ii) Improvement of the Microclimate

Shelterbelts can help regulate the microclimate and improve the environment for agricultural crops, thus increasing their yields. Behind shelterbelts wind speed is reduced, thus affecting all microclimatic factors to the benefit of the growing crops. The following figures compare some effects in two sites visited:

Table 3

EFFECTS OF SHELTERBELTS ON MICROCLIMATE

Effects of Shelterbelt	Chifeng County, Liaoning Province 4 rows, 8 m wide, 20 m high Populus spp.*	Yu County, Henan Province 1 row, 40 m apart, 20 m high Paulownia spp.
Wind speed reduction	58%	14-30%
Temp. reduction (spring and summer)	1°C	0.4-2.2°C
Temp. increase (autumn and winter)	1°C	0.4-2.0°C
Evaporation reduction	38%	12-25%
Relative humidity increase	7%	13-20%
Grain yield increase	30-50%	13-17%

(iii) Protection of Seeds and Fruit and Lengthening of Season

Shelterbelts protect seeds and seedlings from burial by sands. Moreover, seed broadcasting in spring can be done earlier, and the growing season for crops can thus be extended. Harvesting in autumn is done without shattering of fruits and seeds.

The following figures were given for grain production in Chifeng County, Liaoning Province:

<u>Year</u>	<u>Yield</u>
1950	460 kg/ha
1965	3 020 "
1971	6 382 "
1972	6 765 "
(This was said to be a very dry year)	
1973-76	7 500 kg/ha

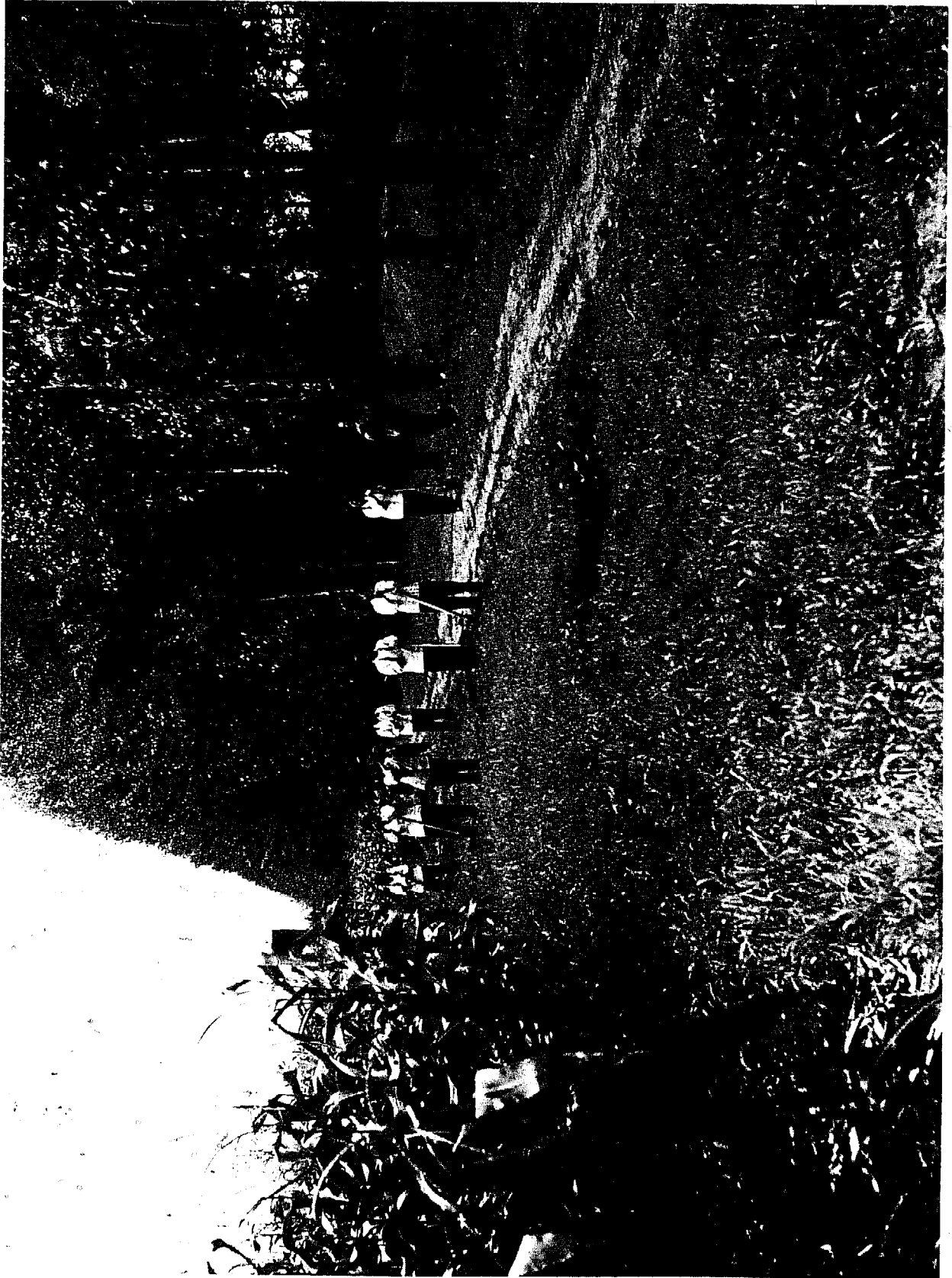


Fig. 4 Shelterbelt: Protection and Increased Yield, Liaoning Province

No doubt factors other than shelter contributed to the increase shown above. However, shelterbelts can have a major effect especially in severe climatic conditions, as in 1972, which was said to be a very dry year.

(iv) Protection of Canals

Shelterbelts protect irrigation canals from sand burial. River banks are protected and stream flow is regulated. Thus river floods are smooth and can be used for irrigating the farm lands.

(v) Promotion of Animal Husbandry

In the Tungfanghung Production Brigade, there were only a few animals (one mule, three horses and a few pigs) before the establishment of shelterbelts. Today there are 670 head of animals, or three per household.

(vi) Promotion of Side-line Occupation

Under shelter, fishing was improved. In the Tungfanghung Production Brigade, a pond 1.5 ha in area was supporting about 50 000 fish.

4.3.5 The Disadvantages of Shelterbelts

The Chinese claim that until now only two disadvantages of shelterbelts have been encountered. The first is that shelterbelts occupy part of the farmlands and this is inevitable as they are a pre-requisite to farming practices. The second is that shelterbelts shade crops, thereby decreasing yield in shaded areas. This, we were told, is a very secondary harm and can be solved by realignment of roads and canals.

4.4 SAND-DUNE STABILIZATION

The group saw two distinct types of sand-dune stabilization activities, i.e. levelling of inland dunes and establishment of coastal windbreaks.

4.4.1 Levelling of Inland Dunes

These activities were observed in one commune and one production brigade in Chifeng County and one production brigade in Yu County. These areas were examples of the general sand-dune problems that are commonly found in the desert sands of the north and north-western interior of China. The dunes are formed by the sands blown from the desert which cover the cultivated land, canals, roads, etc., owing to lack of protection and proper land use practices.

The two separate places visited in Chifeng County, Tungfanghung Production Brigade and Taipingtí Commune, were known for their poverty in the past. The precipitation is very low, ranging from an annual average of 300-400 mm (maximum of 490 mm and minimum of 204 mm); the evaporation rate is about four times as much as the annual precipitation. South-west winds in summer and north-west winds in autumn and winter are the prevailing winds, with a speed of 4 m/sec annual average up to 29 m/sec as a maximum; in any particular year there are 100-150 days of very strong winds, out of which 45 to 71 days are days with maximum wind speed. As a result, thousands of sand-dunes were formed. For example in Tungfanghung Production Brigade alone there were 20 000 sand-dunes and some of them covered an area of between 0.1 to 0.5 ha each.

The people of Tungfanghung Production Brigade were mobilized to level the dunes by moving two million m³ of sand, thereby turning the sand-dunes into land suitable for agricultural crops. After being levelled, the land was flooded with water in order to be enriched with silt deposits. Thus, man-made soil reached a depth varying from 0.30 to 1 m within ten years; nitrogen increased 4.1 times, phosphorus 1.3 and potassium 1.4 times. This development was completed by establishing shelterbelts around the fields and linking the land with irrigation pumps and a canal system. The grain yield was more than tripled. Wind damage was completely eliminated; in fact, in 1963 very strong winds occurred in the neighbourhood, covering the land with six inches of sand, but thanks to these development measures Tungfanghung Production Brigade was not affected at all.

Similar climatic and environmental conditions, producing the same effects, existed in Paichuang Production Brigade in Yu County. Here 800 000 m³ of sand were moved and the dunes converted into land suitable for agricultural crops in the same way.

In all three places visited small areas with the original dunes were kept as a reminder of old disasters, to serve as part of public education on proper land utilization.

4.4.2

Coastal Windbreaks

The group visited Nanshan Island, Guangdong (Kwangtung) Province, where 57 km of coastal windbreaks have been established in the last 20 years to protect the island from the north-east winds which blow sands onto the farmlands, from typhoons in summer and from the sea which used to destroy the arable land and houses annually. It was said that before the establishment of coastal windbreaks the island suffered badly from heat and typhoons.

Nanshan Island was originally composed of ten islands (as mentioned earlier in chapter 1, section 1.3) which have now been linked together by the people. It has an area of 122 km² with a population of 51 000 people.

Before 1949, this island was characterized by shifting sands and sand-dunes and the area was barren and without trees. Agricultural production was likewise extremely poor and the area was often struck by typhoons and very strong winds which blew almost all year round. Between 1929 and 1949 the sea came in about 2 km and 120 ha of crop-land were covered by sand.

The soils are sandy and the climate sub-tropical, with an average annual temperature of 23.6°C, an absolute maximum temperature of 37°C and an absolute minimum temperature of 2°C. Average annual rainfall is 1,400-1,600 mm and there are two distinct seasons, a dry season from October to April and a rainy season from May to September.

Tree planting started in 1953. By 1954, 19 300 trees had been planted, even though the survival rate was low because of lack of experience. By 1956 large-scale plantation had been initiated through mass mobilization and by 1964 some 3,933 ha of land had been planted with Casuarina. This rate of planting continued and by 1976 the island had a total of 57 km of coastal windbreaks covering 4,034 ha of land.

The width of the coastal windbreaks runs from 1 to 5 km, thus giving total inland protection from sand and tidal water. As a result wind speed has been reduced by 60 percent, daily average temperature by 0.2-8.3°C, ground surface temperature by 1.3-2.0°C and evaporation by 12.5 percent. Relative humidity has increased by 7 percent.

Yield of agricultural crops increased from 1.4 tonnes/ha before 1949 to 4.8 tonnes/ha in 1976. Furthermore, 2,200 ha of land have been reclaimed by linking the islands, 1,200 ha of which have been used for agriculture.

Before the establishment of the windbreaks firewood had to be transported to the island. After 1964, the windbreaks began supplying wood; timber was sold to the state and timber for 20,000 new houses was also made available. At present, more than 10,000 m³ of timber are supplied to the state and 2,100 tonnes of firewood to neighbouring cities annually.

The revenue of the island from forestry is about 700,000 yuan annually.

The species used is Casuarina equisetifolia. It is grown from seed, which is sown in January and February. The seedlings are transplanted in March-April into soil blocks covered with straw. Tap roots are cut when they are transplanted.

The seedlings are planted out in July-September. Before planting, the roots are pruned. The spacing is 2 x 2 m and pits are of 40 x 40 cm. No manuring is applied. Every year five rows are planted toward the sea.

The cost of establishing one ha of coastal windbreaks (including nursery) was given as 120 yuan.

The rotation period ranges from 10-15 years depending upon growth conditions and plan requirements. The yield is 45 m³/ha, which is about 4-5 m³/ha/year. Each year 40 ha are cut and the area is immediately replanted. The wood is mainly used for constructing houses as well as large-sized boats and furniture.

4.5 AFFORESTATION OF BARE MOUNTAINS

4.5.1 General

Afforestation of bare mountains forms part of the integrated land-use plan at all levels. This type of activity is undertaken either in the context of protection or production forestry.

Since afforestation of bare mountains was classified as a separate activity from watershed management and plantation of fast-growing species for timber production by the Chinese organizer of the study tour, it is distinguished from them here and they are dealt with separately in the following paragraphs.

Production plantation is carried out either to enrich existing secondary forest areas with species producing timber or edible oil or to replace old, unsatisfactory Pinus massoniana plantations. Especially in the first case, the land is clean cultivated, old stumps are uprooted and the existing vegetation is completely eliminated. This clean cultivation, with or without terracing, causes a lot of soil erosion, especially during the early years of establishment. In most cases paths to the top of the hill are so straight that they encourage soil erosion and deep gully formation. Most of this plantation is carried out on land which is unsuitable for agriculture and it serves to produce timber or fuelwood to meet national and local requirements. Furthermore, trees are planted around pastures and grazing land for the same purpose.



Fig. 5 Dense and ill-pruned Pinus massoniana plantation, Hubei (Hupeh) Province

4.5.2 Main Species Used and Observed

The following species are used in all kinds of plantations:

In Liaoning Province: Populus chifungensis, P. simonii, P. nigra, P. pyramidalis, P. canadensis, P. pekinensis, Salix spp., Ulmus pumila, Amorpha fruticosa, Robinia pseudo-acacia, Pinus tabulaeformis.

In Henan (Honan) Province: Paulownia fortunei, Populus spp., Salix spp., Ulmus pumila, Platanus orientalis, Diospyros kaki, Ziziphus jujuba, Melia azedarach, Toona sinensis, Populus tomentosa, Populus dakuanensis, Paulownia lankanensis.

In Hubei (Hupeh) Province: Cunninghamia lanceolata, Pinus massoniana, Larix koreana, L. sibirica, L. principis, Pseudosassafras laxiflora, Glyptostrobus pensilis, Pterocarya stenoptera.

In Hunan Province: Paulownia spp., Populus spp., Salix spp., Cunninghamia lanceolata, Pinus elliotii, P. massoniana, Pseudosassafras latifolia, Toona sinensis, Aleurites montana, A. fordii, Camptotheca acuminata, Osmanthus fragrans, Sapindus mukurosi, Cinnamomum camphora, Podocarpus macrophylla, Acer davidii, A. mono, Platanus orientalis, P. acerifolia, Taxodium distichum, T. ascendens, Ligustrum lucidum, Sassafras tsumu, Magnolia grandiflora.

In Guangdong (Kwangtung) Province: Alstonia scholaris, Michelia alba, Acacia confusa, Aleurites moluccana, Bombax malabaricum, Melaleuca leucadendron, Chukrasia tabularis, Ficus retusa, F. lancor, Casuarina equisetifolia, Eucalyptus exserta, E. citriodora, E. leichow no. 1, Artocarpus heterophylla.

4.6 WATERSHED MANAGEMENT

Although watershed management is not used as a common term, land utilization in accordance with the principles of soil and water conservation is explicitly covered in the integrated planning procedure in China. In the hilly areas, hydrological effects of afforestation are recognized in regulating the stream flow. Improvement of water quality and erosion control are the main objectives of this type of activity. As water is the key to food production, many projects centre around the development of irrigation systems which, along with the massive tree-planting programme and management methods and techniques, will have a long-term effect on the hydrological regime of the watersheds.

A land capability classification is adopted for delineating areas for agriculture and permanent vegetation cover (it includes forests and forest plantations). All lands with a slope of up to 15° and a suitable soil are reserved for agriculture, while those with a slope of over 15° are reserved for forests, as are lands with a slope of up to 15° and poor soil. Tree planting over areas with a serious erosion hazard is emphasized.



Fig. 6 Integrated watershed development (farm ponds and rice fields at the bottom, Thea oleosa on the right, and Cunninghamia on the left hills), Hunan Province

Although complete soil working before afforestation is prescribed, the methods adopted vary for different slopes and soil conditions. For example, complete land preparation is done on slopes of up to 15° at suitable sites; terracing is done on slopes from 16° to 35°; planting in pits is done on slopes of over 35°. The planting terraces and trenches are shaped to ensure better water conservation, and drainage of excessive water is also provided for.

However, complete weeding and hoeing in the early stages does not seem to be conducive to soil protection. But the shape of the planting pits and trenches and terraces may retard down-slope movement of the loosened soil. Construction of small reservoirs, ponds and dams, wherever possible, has been done. These structures help to retain soil within the watersheds as well as to reduce flood occurrences and improve subsoil water movement. The practice of inter-cropping with legumes and other crops does provide a considerable, if not complete, soil cover.

The result is that floods and droughts, which alternated frequently in the past, have been controlled. For example, in Taoyuan County, 21 floods and eight droughts occurred from 1949 to 1958. Starting in 1959, a programme of practices, combining the control of rivers and mountains with afforestation, was undertaken to control waterlogging and droughts. To date, 70 percent of the mountainous area has been protected and the water is comparatively clear. This has been accomplished through a combination of the following measures: the closure and protection of the upper catchment reaches, the construction of five multi-purpose dams and one reservoir, the planting of 105 000 ha of trees, the building of 132 small impoundments and 15 small reservoirs, the construction of 23 000 small farm ponds, the straightening of the river course in 45 places and the strengthening of the embankment along 40 km.

The effect of this work has been to reduce sediment from 7 480 tonnes/km² to 3 700 tonnes/km². There is now a storage capacity of 620 000 000 m³ of water which can provide irrigation for a drought of 110 days. Foodgrain output has increased from 132 000 tonnes in 1970 to 199 000 tonnes in 1976.

The example given above is only one of a multitude taking place as watersheds are changed from flood producers to regulated flow suppliers. There is no question but that forestry support for agriculture in China also means watershed management.

4.7 PLANTATION OF FAST-GROWING TREE SPECIES FOR TIMBER PRODUCTION

The basic principle behind tree plantation in China is to organize the masses and encourage them to act in a spirit of self-reliance, that is to collect seeds, raise the seedlings and do the planting themselves. Tree planting is, however, part of integrated land-use planning, on the same footing as agriculture and animal husbandry.

The aim of this type of plantation is to provide timber for industry, housing, various uses in factories and agriculture and coal mines. In spite of the great number of species encountered, the most important quick-growing species used for timber production are: poplars in North China, Cunninghamia lanceolata, Paulownia spp., Sassafras and Pseudosassafras spp. in Central and South China, and eucalypts and Casuarina in Southern China, especially in Guangdong (Kwangtung) Province. These species are discussed below (except for poplars, for which reference should be made to Section 4.3).

4.7.1 Paulownia spp. (fam. Scrophulariaceae)

Paulownia fortunei is mainly used in Henan (Honan) Province as a windbreak species or as individual trees in agricultural diversification with a row spacing of 50 m to 70 m apart. The total area effectively occupied by Paulownia fortunei in Henan (Honan) was in the order of 600 000 ha in 1977. According to plans, by 1980 the total area occupied by Paulownia planted under varying schemes should reach the target of 1 380 000 ha.

Seedlings are raised in the nursery from cuttings and planted after one year. A quick-growing species with a deep rooting system which can go as far as 2 m deep, Paulownia does not cause any harm to food crops whose root system is localized in the upper 50 cm of soil layer.

Soil preparation for planting is similar to that for poplar plantations.

Growth rate: On irrigated sandy soil, a four-year-old Paulownia fortunei may have a girth of 70 cm, a height of 10 m and 5 m of clear bole. On a favourable site, an eight-year-old Paulownia may have a girth of 170 cm. A specimen of this growth was observed at the Yu County administrative headquarters. At the age of ten years, it is usual to obtain a diameter of 45-50 cm. At the places visited, a rotation of 8 to 10 years was applied and production with this rotation can be in the order of 12 m³ ha/year.

It is a species with a wide range of adaptation to varying climatic conditions. It can stand a temperature of -18°C and can thrive at locations where summer temperatures may be as high as 40°C. It can also thrive at 10 m above sea level as well as at an altitude of 1 600 m. However, it requires a deep and friable soil and a low water table which should be at least 2 m below the soil surface.

Importance of Paulownia in rural areas: Paulownia timber is good for building and furniture manufacturing. The leaves are used as animal feed. The bark and flowers are utilized in traditional medicine. With a production of 12 m³ ha/year, Paulownia is a cash crop widely used in agricultural diversification. However, a disease assumed to be caused by a virus affects a large number of Paulownia trees. The research station of Yanling County, Henan (Honan) Province, has succeeded in controlling the disease, either by physical operation which consists in cutting the attacked branch and burning it, or by injecting an antibiotic solution. Prevention is now possible by dipping the rooted cutting into an antibiotic solution before planting.

4.7.2 Cunninghamia lanceolata

C. lanceolata is the most prized species for reafforestation, used in a large number of eastern provinces in China. The study group's first acquaintance with the "miracle" Cunninghamia occurred in Hubei (Hupeh) Province, in Tungzu Commune, where over 50 percent of planted areas consist of C. lanceolata. In Hubei (Hupeh) Province C. lanceolata is planted on red soil deriving from secondary volcanic mother rock. In places, this soil is covered by a thick layer of alluvial soil deposited by the Yangtse River over a million years ago when the river changed its bed. The soil in upper elevations is poor in humus and in N, P and K content. It is very dry in summer and compact in the rainy season. Soil acidity is high, pH 5 to 5.4.

Site preparation: Site preparation has undergone several improvements since the first plantations were created. Initially, shallow ploughing was done and holes were dug 0.40 m long x 0.40 m wide. Since then site preparation has been



Fig. 7 Large-scale Cunninghamia plantation, Hubei (Hupeh) Province



Fig. 9 A ditch is dug between rows of Cunninghamia, Hubei (Hupeh) Province



Fig. 10 Grass and legumes are buried in the ditch, Hubei (Hupeh) Province



Fig. 11 The ditch is then recovered, Hubei (Hupeh) Province

the subject of serious research work because of the low rate of survival. At present, all over China, the method of "three deep" is adopted, i.e. the site is deeply ploughed to a depth of at least 40 cm from the soil surface, a hole is dug 60 cm long and 40 cm wide, and the seedling is then planted deep with two-thirds below the soil surface. Hole planting is, in some locations, replaced by trench planting. Instead of a hole, a trench 50 cm deep is dug. This method is said to preserve the soil moisture better. Deep planting promotes a good development of the root system and prevents sprouting from the root collar which occurs in most cases where shallow planting is done. After planting, intercropping is practised in place of weeding. Shallow ploughing takes place in the second or third year after planting and deep ploughing to a depth of 0.40 m or 0.50 m is undertaken in the fourth or fifth year. In the meantime, a ditch is dug between rows 50 cm away from the root collar wherein grasses or legumes are buried to increase the soil's organic content. Such a ditch is 67 cm wide and 70 cm deep.

At the beginning, close density was adopted. This density might be as high as 6 000 plants per ha. Several spacings have been tried: 1.3 x 1.3 m (5 800 plants/ha), 1.5 x 1.5 m (4 350 plants/ha), 2 x 2 m (2 500 plants/ha) and 1.3 x 2.6 m (3 000 plants/ha). The high density affects tree growth, which was quickly acknowledged by the Chinese foresters. At present, a spacing of 1.3 m x 2.6 m is most favoured, as it allows a quick canopy closure at year six or seven which in turn permits a thinning of 50 percent intensity so that the definitive stand has only 1 500 trees/ha.

Hereunder are some findings concerning the relationship between density and tree growth.

Table 4

EFFECTIVE DENSITY ON TREE GROWTH OF CUNNINGHAMIA LANCEOLATA

	Average Height (m)	Average Diameter (cm)	Standing Volume/ha (m ³)	Remarks
<u>Plot 1:</u> Before thinning in 1974 Measurements in 1976 Increase in volume in 2 years	7.1 8.5	8.9 10.6	74.25 110.25 36.00	Planted in 1965 - density 6 000 plants/ha in 1974 before thinning to 2 650 plants/ha.
<u>Plot 2:</u> Measurements before thinning in 1974 Measurements in 1976 Volume increase in 2 years	7.4 8.5	9.0 10.9	62.85 111.60 48.75	Planted in 1965 - same density of 6 000 plants/ha, thinned in 1974 to 2 200 plants/ha.
<u>Plot 3:</u> Measurements in 1974 Measurements in 1976 Volume increase in 2 years	4.9 6.6	6.5 8.5	44.80 82.80 38.00	Planted in 1976 - density 6 000 plants/ha. In 1974, trench dug along contour line 0.70 m wide and 0.70m deep. 75 t of green manure applied + 2.250 t P ₂ O ₅ + 750 kg calcium/ha in trench and covered with soil. Thinned to 2 250 plants/ha.

The above experiments show that a density of 2 000-2 500 plants seems to favour a better growth and can enhance Cunninghamia timber production. Depending on the intensity of cultivation methods, total production per hectare of C. lanceolata varies from 250 m³ to 350 m³ (including the volume of thinning products estimated to be of 40-50 m³/ha) for a 20 years' rotation.

It can be assumed that C. lanceolata makes up one-third of the afforested area in China, to judge by its importance in the reforestation schemes.

Management: Rotation is given as about 20 years. Clear-felling is adopted and regeneration is by planting. Clean weeding by intercropping is generally practised for the initial two or three years, depending on canopy closure. Legumes (peanuts, soybeans) are the preferred crops. Rate of survival, in general about 80-85 percent, is 5 percent higher where intercropping takes place.

In Zhuzhou County (Hunan Province), C. lanceolata planted in 1965 on the Huanglung People's Commune thrives well. An abundant natural regeneration is observed there at a density of 4-5 young seedlings (of one year old) per m².

Such a natural regeneration is thought to be very satisfactory. It may perhaps be considered in future management practice, but it is doubtful that attention will be given to using this natural regeneration potential.

Problems arising from intensive management of Cunninghamia are several:

- (i) Although there is some fertilization in some plots, fertilizer is not systematically applied to all areas planted. Intercropping with legumes is useful, but without a good amount of green manure and some chemical fertilizers, the second-generation crop may give a lower yield.
- (ii) Early flowering of five- or six-year-old trees indicates difficult growing conditions. What will the quality of the second generation crop be on these poor sites?
- (iii) Irregular growth and high mortality rate in some cases indicate that a tree improvement programme needs to be set up as early as possible to secure a supply of good seeds. It appears that a vast expansion of Cunninghamia planting is planned, to meet a growing demand.
- (iv) The risks of monospecific plantations should not be ignored even though no diseases or insects are at present regarded as a serious threat.
- (v) In the opinion of the study group, mixed plantations should be considered. Two broad-leaved species perform very well: Robinia pseudo-acacia (Legum.) and Sassafras tsumu and Pseudosassafras spp. (all designated as Sassafras by local foresters) (Laur.). Mixture by strips seems to be the best combination as both broadleaves and Cunninghamia can be managed on 20- to 25-year rotation. In the second generation, Cunninghamia will be planted on strips previously occupied by broadleaves and vice versa.

4.7.3 Sassafras spp. (Lauraceae)

Under the name of Sassafras, local foresters designated Sassafras tsumu, Pseudo-sassafras laxiflora and Pseudosassafras latifolia. Phenotypically they look alike. The difference is in the shape of the leaves.

Sassafras are local species found at high elevations in Hubei (Hupeh) and Hunan Provinces. Adapted to lower altitude, they perform very well. In the experimental station in Xianning Prefecture, Hubei (Hupeh), Pseudosassafras laxiflora planted in 1963 reached a height of 16-20 m and a diameter of 10-15 cm after 14 years. In Cheichia Commune, (Taoyuan County, Hunan), Sassafras tsumu planted in 1973 had a 7-8 m straight bole and a diameter of 8-10 cm. Maximum growth per year may be 4 m in height and 1.5 to 2 cm in diameter. In Shuting Production Brigade (Huanglung Commune, Zhuzhou County, Hunan) an eight-year-old Sassafras had reached 14 m in height and 18 cm in diameter.

Despite its good performance, Sassafras is not yet used in any large-scale plantation, except in Hunan Province, where large blocks of hundreds of hectares of Sassafras have been observed.

Management practices: Site preparation includes ploughing, digging a deep hole 1 m wide and 1 m long and planting one-year-old nursery seedlings. Planting is done in spring. Spacing is usually 2 m x 3.3 m. Density at planting is 1 500 plants/ha. Thinning is done at 4-5 years of age, which leaves 900 plants/ha. At 15 years of age, Sassafras may reach 25 cm in diameter and have a straight bole of 15 m. Rotation is given as 15 years. Production at felling may be as high as 400 m³/ha which is a production of 30-35 m³/ha/year. Clear-felling is adopted and subsequent regeneration is by planting. After planting, Amorpha fruticosa (Legum.) is intercropped as green manure.

Amorpha leaves are harvested two or three times a year and buried in the stand itself to increase soil organic content and improve soil structure.

Thinning products are all utilized to meet the people's requirements for small-diameter woods. All trees thinned are uprooted and roots used as stumps for further planting.

4.7.4 Pinus massoniana

After 1958, when Chairman Mao instructed that China should be covered with trees, P. massoniana was the very first species used in reafforestation. From Liaoning to Hunan, it covers large patches of mountains and hills. However, it became noted for its poor form and poor growth. Existing stands are still preserved for soil and water conservation and for providing some fuelwood to the people's communes. Its role in "timber forestry" is being taken over by other pine species (P. elliotii and P. taeda) which are now introduced still on a small scale for trials. Conversion of P. massoniana plantations is now a pending problem.

4.7.5 Eucalyptus spp.

Their importance in timber production equals that of Cunninghamia in the northern provinces. Leichow Peninsula can be cited as an illustration. Out of the 69 000 ha of land under its administration, the State Forestry Bureau has planted 52 000 ha with eucalypts. More than 60 species have been tried, but only three are actually used in large-scale plantation: E. exserta, E. citriodora and E. leichow no. 1.



Fig. 12 Eight-year-old Sassafras plantation, Hunan Province



Fig. 13 Replacement of Pinus massoniana with P. elliotii and P. taeda (foreground), Hubei (Hupeh) Province

Other species such as E. tereticornis, E. grandis and E. saligna perform well in diameter growth but the bole is not as straight as the three former ones. Other species such as E. botryoides, E. argophlora, E. toriellana and E. pilularis are only of marginal interest.

Under the particular conditions of Leichow Peninsula, where there is no rain for eight months of the year and where the compact, sandy, red soil is subject to severe erosion, E. exserta, E. citriodora and E. leichow no. 1 now constitute a highly profitable undertaking with their excellent growth and their full utilization.

Managed under a 25-year rotation and three commercial thinnings at years five, seven and ten or twelve, eucalypts provide poles, fuelwood, building material and foliage for oil and tannin extraction.

One-year-old seedlings raised in the nursery are planted at a density of 4 500 plants/ha and are thinned to 3 000 plants/ha at age five, to 1 500 plants/ha at year seven and to 900 plants/ha at year 10 or 12. Volumes harvested at each commercial thinning are respectively 24 m³/ha, 21 m³/ha and 24 m³/ha, leaving a standing volume of 120 m³/ha. Thus at twelve years old, total production is 189 m³/ha, i.e. a mean annual increment of 15.75 m³/ha/year. It is expected that by the end of the rotation, growing stock per ha will be in the order of 300 m³/ha.

Actually, total growing stock of 52 000 ha of eucalypts is 1.84 million m³, of which 150 000 m³ are exploited annually. Two-thirds of the exploited volume is timber and one-third thinning products which provide also 7.5 tonnes of leaves/ha to be used in oil and tannin extraction. Oil content of eucalypt leaves is 0.7 per cent for E. exserta and 1.2 percent to 1.7 percent for E. citriodora. Tannin content is generally eight times higher than that of oil. After oil and tannin extraction, what remains of the leaves is used as organic manure.

The plan for 1986 fixes the target to be reached for growing stock at 3 million m³ of which 400 000 m³ will be exploited every year. Of the 400 000 m³ cut, about 250 000 m³ will be timber. Such a plan implies that eucalypts will be planted on the remaining 17 000 ha still to be used by the Leichow State Forestry Bureau and also on the expanded forest areas on waste and barren lands.

Though the reforestation with eucalypts in Leichow Peninsula is impressive and successful, the problem of insects, especially of Phorocantha, should not be overlooked. Up to now all the stands have been healthy but as the prosperity of the whole area depends mainly on eucalypts, increased attention to the problem of insects can only be profitable.

4.7.6

Casuarina equisetifolia

On Nanshan Island, C. equisetifolia is planted on 4 034 ha as a coastal wind-break 57 km long varying in width from 1 to 5 km. The area planted with Casuarina thus represents one-third of the total land area of the island. Raised in nursery beds, the young seedlings are transplanted after two months to a basket of 10 cm diameter x 0.15 m in depth. After four or five months in the basket, the seedlings are planted. The roots are dressed before planting in holes of 0.40 m x 0.40 m x 0.40 m. The rate of survival is high, about 80 percent. July, August and September are the best months for planting as the young seedlings will have the benefit of the rains during these months. C. equisetifolia grows very well on coastal sand, as a four-year-old plantation shows an average diameter of 5-7 cm and an average height of 7-8 m.



Fig. 14 Coastal sand-dune fixation with Casuarina, Guangdong (Kwangtung) Province

C. equisetifolia plantations are managed under a 10-15 years' rotation. The yield is about 45-50 m³/ha, which is a production of about 4 m³/ha/year. Plantation cost, including tending, amounts to 120 yuan/ha.

As regards the wood harvest from C. equisetifolia plantation, every year 2,100 tonnes of firewood are marketed outside Nanshan Island and more than 10,000 m³ of timber are sold to the state. The total income from forestry was 700,000 yuan in 1979 in addition to the increased income from food grain production under windbreak protection (1.4 tonnes previously; now 4.8 tonnes).

Nanshan Island is now proceeding to implement a tree improvement programme for C. equisetifolia. Plus trees are selected from which seeds are to be collected for further plantation. Coppice from stumps is no longer allowed to develop, as the people prefer to uproot stumps and replace coppice by good races of Casuarina.

The so far successful example of Casuarina in its role both in timber production and in support of agriculture has made of this species a cash-crop species to be grown in harsh, windy conditions.

4.8. TREE CROPS YIELDING IMMEDIATE CASH RETURNS

4.8.1 Fruit Trees

Apple trees, Citrus spp., pear trees and Chinese date trees are used in forestry as well as in agriculture.

The Paichuang Production Brigade, Henan (Honan) Province, removed 32 sand-dunes and levelled 27 waterlogged areas between dunes, thus gaining 630 ha of cultivable land. As soon as the land was levelled, the people planted trees. "If we don't plant trees", they said, "the sand will come back". On their newly conquered land, one-third of the area is under forest trees, one-third is cultivated with fruit trees and one-third is reserved for agricultural crops.

In Yu County, Henan (Honan) Province, plans have been made to plant 6 300 ha with apple trees and another 6 300 ha with walnuts.

In Taoyuan County, Hunan Province, chestnut is now considered as one of the several species envisaged in what is termed "industrial forestry", aiming at producing non-wood products of quick, perennial and high return.

In central and north China, only Juglans mandshurica is planted. As regards Castanea spp., C. mollissima is preferred over the other two (C. henryi and C. seguinii) as it grows very well on deep soil on lower mountain slopes and thalwegs.

Figures on production are unfortunately not yet available as the plan for using walnut and chestnut as "cash" plantations has only just been implemented.

The Chinese "date" was a special product used in traditional medicine and in cooking as a delicacy. It was regarded as a "bourgeois" foodstuff, but is no more considered so, as it is widely planted on newly conquered sand-dunes. Throughout many provinces in central China, the Chinese date tree, Ziziphus jujuba, is seen everywhere. As an example, mention is made hereunder of the Chachia Production Brigade, Yanling County, Henan (Honan). This production brigade started planting Z. jujuba in 1964 on about 55 ha of new land levelled from sand-dunes. A thirteen-year-old "date tree" measures 10 m in height and 10 cm in diameter. Z. jujuba is



Fig. 15 Fruit Tree Plantation, Henan (Honan) Province



Fig. 16 Chinese date (Ziziphus), Henan (Honan) Province

planted with a spacing of 10 m x 5 m, at a density of 200 plants per ha. The average yield in dried dates is about 240 kg/ha, usually sold to the state for processing and export. The production brigade received an income of about 150 yuan per ha from only 200 plants. It is to be remembered that, in addition to the income from "date trees", agricultural intercropping of peanuts and/or maize may easily produce five or six tonnes of food, which is the norm established in Henan (Honan) Province. Income from Z. jujuba and connected forestry activities represents 25 percent of the total income, which includes return from foodcrops, pig-raising and sideline activities. The total area planted with Z. jujuba is not known with accuracy, but it can be estimated to be one-third of the cultivated area in Henan (Honan) Province.

Diospyros kaki is another fruit tree prized in Chinese forestry. Dried D. kaki fruits are an export item. All over China, D. kaki is planted in the same way as Z. jujuba. The land between rows is intercropped with maize and pulses. D. kaki is also planted along roadsides and as shade trees in the city streets. Information on output and income per ha is not available but, to judge by the area covered and the great care with which D. kaki plantations are tended, there is no doubt of the importance of the role it plays in rural economy. D. kaki is also frequent, though not abundant, in natural forests. Some trees were seen in the natural forest area of Huawen People's Commune, Hubei (Hupeh) Province. The fruit from natural forest trees is not large in size, but the trees are preserved to provide supplementary items in the diet of the local people.

4.8.2 Oil-bearing Trees and Shrubs

These are Aleurites fordii, A. montana, Sapium sebiferum (Fam. Euphorbiaceae) and Thea oleosa (Fam. Theaceae).

At locations visited, A. montana and A. fordii are planted along roadsides, canals or dwellings for family needs. Small plantations of S. sebiferum were observed in Taoyuan County (Hunan). These plantations are still young, so that information on yield and return of Aleurites spp. and of S. sebiferum is not available. A. fordii was seen interplanted with pine as a special intercrop for a period of eight to ten years, which is the life span of A. fordii. After ten years of age, A. fordii is cut. At the same age, pines would have their crown sufficiently developed to cover the soil against erosion. In rural zones, electricity may not be available everywhere; tung oil will then be used for lighting.

Thea oleosa is widely adaptable and has been planted over thousands and thousands of hectares of land. It can be planted between 98°40' and 121°40' E longitude and 22°42' - 34°34' N latitude, where there is an annual average temperature of 15-22°C, annual average precipitation of 700-2,400 mm and relative humidity of 70-85 percent. It grows better on hilly areas at an elevation of 800 m above sea level. It prefers sunny sites with 4.5-5.5 pH and deep soil; however, it can thrive almost anywhere provided the soil is deep and annual rainfall is above 700 mm.

It is a slow-growing small tree but has a long life and excellent cropping capacity up to 200 years. Fruit-bearing starts at the age of eight and goes on as long as 80-100 years. Leaves are alternate and of a leathery nature; each branch bears fruit. Flowers are bisexual and white in colour and flowering takes place in October and goes on up to February. The fruit contains 1-6 seeds of which the under part is concave and the inside irregular. The seeds contain about 33 percent edible oil with great variation. The oil can be stored ten years. It represents 70 percent of total edible oil consumption in China. It can be used as a lubricant, is rust-resistant, and is also used in the treatment of skin diseases. The outer part of the seed can be used as tannin, or as active carbon, whereas the remaining part is used as a fertilizer. Constant flowering is good for bee-keeping. The timber is solid, with good grain, and is largely used for agricultural tools.



Fig. 17 Stand improvement in Thea oleosa natural growth, Hunan Province

Thea oleosa has been planted in China for more than 300 years, but before 1949 there were about 10 000 ha of scattered plantations mixed with weeds and shrubs. The yield was only 20-30 kg of oil per ha. Since 1949 the development of Thea oleosa has undergone three stages:

- (i) Up to 1958: Existing plantations were improved and consolidated so that with proper management quality could be improved and yield increased. Soil preparation was carried out and the gaps were filled through regeneration. During this operation, after the fruit had been picked, the land was prepared and formed into strips, and gaps were planted with young seedlings, the old trees being kept for shade. Furthermore, the old stems were coppiced for regeneration and selection purposes. Through these operations alone the oil production was doubled.
- (ii) From 1958 to 1960: Thea oleosa cultivation received strong support from the party and the Government, which provided subsidies and foodgrains to communes and production brigades engaged in planting Thea oleosa. During this period the area of Thea oleosa was substantially increased. In Zhuzhou County (Hunan), Thea oleosa acreage was doubled.
- (iii) The third stage started in 1970. During this period Thea oleosa was treated as a horticultural crop with all rational management practices: farming of the consolidated plantations in big blocks (900 permanent personnel were assigned in Zhuzhou County to 34 plantations); intercropping with agricultural crops; intensive cultivation consisting of one deep ploughing every three years and one shallow ploughing every year; siting of Thea oleosa plantations on terraces to preserve soil, water and fertilizer (3 000 ha of plantations in Zhuzhou County are reaching this stage); fertilizing, pruning, pest and disease control and grafting for quality and yield increases.

As a result of this intensive management, the oil output has been increased by as much as 100-120 kg per ha, as against an output of 20-30 kg per ha before 1949. This represents a twofold increase against even the 1965 yield.

In addition to oil, an average of 225 kg of oil cake are obtained per ha. The total oil and oil cake bring in an income of about 160 yuan/ha/year.

The importance of Thea oleosa in integrated land use management is manifold:

- (i) As an economic cash crop, T. oleosa, once established, can grow and thrive for 100 years or more. Sustained income is thus ensured.
- (ii) As a shrub which can thrive in a wide range of climatic conditions, its use in watershed management is beneficial to local people, who can only profit by protecting it.
- (iii) During its early years, T. oleosa can grow under the shade of P. massoniana, thus allowing progressive conversion of the stands at present occupied by the latter species without any uncovering of the soil.
- (iv) T. oleosa contributes oil cake for the development of animal husbandry (pig raising) which in turn provides refuse (dung) as agricultural fertilizer.
- (v) The fact that T. oleosa flowers during five months in winter (October to February) makes it a valuable forage for bee-keeping.

- (vi) By pruning and trimming, which are necessary cultural operations to develop maximum crown, which in turn develops maximum fruit-bearing capacity of T. oleosa, or by rejuvenation by coppice, a certain amount of fuelwood or wood for handicrafts can be provided.

The cultural practices for Thea oleosa are as follows:

Seed selection - Chairman Mao's statement that "better yield can be obtained by careful seed selection of improved varieties even without increasing labour and fertilizer" has been carefully applied to T. oleosa. There are two distinct varieties of T. oleosa, i.e. a small-fruit variety and a big-fruit variety. The small-fruit variety has small leaves and dense foliage, a very thin pericarp round the seed and 1-3 seeds in each capsule, maturing in early October; the oil content is 30 percent, with high resistance to disease. The big-fruit variety has bigger leaves and each fruit consists of 5-6 seeds, maturing at the end of October; the oil content is 25 percent, with medium resistance to pests and disease. Plantations of the big-fruit variety occupy 95 percent of the total plantation, but because of cross-pollination and site differences, the oil content of individual trees shows great variation. For this reason, great emphasis has been put on selection of plots, fruit, seeds and, above all, plants. In this connection, the following criteria have been laid down for plus trees:

- vigorous growth condition between the ages of 15 and 60 years;
- spreading crown with dense foliage and even fruit bearing of each branch;
- yield should be 20 percent greater than that of the surrounding ten trees;
- yield should be constant with less than 30 percent variation;
- red fruits with an average of 3 cm in diameter and less than 0.25 cm thickness of pericarp;
- seed portion should be more than 45 percent and dry fruit 2 percent;
- high resistance to pests and diseases.

Plus trees should be selected for each site. Besides, the seeds of the plus trees, the branches are also used in nurseries, for grafting purposes.

Planting Practices: Careful site selection, land preparation and close planting are the major rules to be followed. Being a light-loving species and deep rooted, T. oleosa requires red and yellow soils with pH of 4.5-5.5. Clean land cultivation at 30-40 cm depth with inversely sloped terraces is essential. On land with a slope of more than 15 percent the width of terraces is 2-3 m, while on slopes less than 15 percent they can be as wide as 4-5 m. The general practice is to plant the trees with a spacing of 3 x 3, 4 x 4 and 5 x 5 m distance, which gives between 500 and 900 trees per hectare.

Planting Season: Nursery-grown and carefully selected seedlings are used in plantation for higher survival rate and fast growth as well as greater yield. January to March are the best months for planting. Direct sowing is also practised.

Maintenance and Care: Intercropping is used as a care and maintenance practice, to give the plantation a better structure and to provide better soil moisture, at the same time reducing the planting cost by increasing income. During the last two years, 1 000 ha of plantations have been intercropped, which have produced 4 000 tonnes of food grains and other crops. Apart from soybean and sweet potatoes, a special grass has been grown, whose rhizomes contain additional edible oil. To increase and maintain the soil fertility, the dead leaves of these crops are mixed with manure, especially pig manure. Most forestry farms raise pigs to obtain the required manure.

Pruning of the lower branches is started 3-4 years after planting to increase the height. At a height of 60 cm the tree is topped off, keeping three main branches. The following prunings aim at training the remaining branches to spread at an angle of about 60° and making them even and uniform. After three years, a second pruning is carried out with the same objectives and ultimately to form the tree into an umbrella shape with a hollow inner part, in order to expose it to proper sun and air penetration when it is at the optimum fruit-bearing stage. Dead, diseased, overgrown, lower and slanted branches should be pruned.

Colletotrichum camelliae, caprodium theae, Eupractus pseudoconsersa and Chremonia adsitarsis are the major pests and diseases of T. oleosa.

For its multiple use and high return the study group paid exceptional attention to T. oleosa, which can be regarded as another "miracle tree" in Chinese forestry.

4.8.3

Other Non-wood Products

The Chinese people are known for their skill in making use of everything. Their skill has also been observed in finding many non-wood products of forest trees. Hereunder are a few examples:

Cinnamomum camphora: In Hunan Province, large-sized C. camphora trees were observed in remote places where the group happened to pass by. They were isolated trees, usually wounded and decaying. Their diameter was estimated to be 0.70 m to 1 m. This is a clear indication that C. camphora grew well in more or less pure stands which were decimated because of their timber, which is very prized in Chinese tradition as "coffin wood". For centuries, the Chinese have known how to extract camphor from young leaves, twigs and resin, for use in traditional medicine and cosmetics. C. camphora is now returning to Chinese forestry as a plantation species along roads and canals but not yet as a full-scale plantation species. As a matter of fact, only small patches of C. camphora were observed in full plantations.

Sapindus mukurosi^{1/}: A species frequent but not abundant in tropical and subtropical forest formations, S. mukurosi is an under-storey species neglected by conventional foresters, who look down on tree species not prized for timber or fuel-wood, in most countries; but not in China. S. mukurosi is one of the 149 species raised in the Changsha city nursery, which produces some 3.8 million plants per year. Out of this number, S. mukurosi and Osmanthus fragrans represent 10 percent of the seedlings produced. S. mukurosi is known as a "soap fruit tree". In fact, the fruit provides a liquid detergent when it is macerated in water. Clothes soaked in this water can be washed as they are with soap.

As regards Osmanthus fragrans and Hovenia dulcis, they provide raw material for wine making. O. fragrans is utilized for its flowers and Hovenia dulcis for its berries. In natural forests, all the above trees are preserved.

^{1/} Called S. mukorossi by Alex. Rodger in the Handbook of Forest Products, Burma, p. 99.

Finally, a word should be said on the use of some tree species for detecting air pollution. Cedrus deodara, Pinus massoniana and Cunninghamia lanceolata may be planted individually or along roadsides for their role as indicators of air pollution by sulphur dioxide or chlorine. The Changsha city nursery has evidence that they are sensitive to the presence of sulphur dioxide and chlorine, whereas other species such as (i) Pittosporum tobira, Magnolia grandiflora and Poncirus trifoliata are resistant to sulphur dioxide and (ii) Ligustrum lucidum, Photinia serrulata and Nerium indicum are resistant to chlorine.

Livistona: An illustration of the Chinese skill in the diversification of non-wood production is given by the Soil and Water Experimentation Station in Dianbai County. The soil there is a compact, yellow, sandy soil subject to heavy erosion. E. exserta and Casuarina equisetifolia, which perform very well elsewhere, do not grow healthily on this type of soil. Traces of gully erosion can be seen in several places. The climate is dry and it rains only with the typhoons. Eucalyptus and Casuarina show a very poor growth with a thin stem and a diameter of 4-5 cm after ten to twelve years of age. After several years of research, Livistona chinensis was introduced on 1 300 ha of land. Livistona chinensis is a palm with fan-shaped leaves arranged in a rosette. This palm is planted from one-year-old seedlings raised in a nursery. Density at planting is 1.5 x 1.5 m. However, in places where it is interplanted with other non-wood products, spacing is 5 x 1.5 m. Leaf exploitation begins after six years. A full hectare of L. chinensis can yield 60 000 leaves per year. L. chinensis is used as a fibre source in rope-making, mat-making, basket handicraft, etc. Income from leaves amounts to some 4 000 yuan/ha/year, which is very high. The life span of L. chinensis is about 100 years or more. L. chinensis is thus seen not only as a suitable species for covering the soil entirely for a long time, but also as a species which ensures a continuous and sustained income. L. chinensis is interplanted with three other species: Piper nigrum, Litchi chinensis and Averrhoa carambola. In addition to interplanting, intercropping with cassava, soybean and peanuts is also practised during the first two years. Yield of Piper nigrum at year six is about 800-900 kg/ha, whereas the yield of Litchi chinensis can be 9 tonnes/ha and Averrhoa carambola (star fruit) 30 tonnes/ha. Other fruit trees have also been tried, such as jackfruit and mango. Mango yields only 1.5 tonnes per ha in a good year and jackfruit 6 tonnes. The most interesting combination seems to be Livistona chinensis and A. carambola. After six years of age, A. carambola will be dominant and a two-storey stand is formed with Livistona chinensis as the under-storey. L. chinensis can grow under shade without diminishing its yield in leaves.

The Chinese seem to favour the combination of Livistona and Averrhoa as this provides the highest income. A. carambola is a popular fruit, rich in juice and vitamins, which can be used as a preserve or in pastry.

4.8.4

Bamboo

Two species of bamboo are widely planted in the provinces visited: Phyllostachys pubescens and P. edulis. Bamboos are cultivated on good sites where the soil is deep and pH is 6. These two species are single-stem and not clump-forming bamboos. Exploitation is thus easy, as stems are cut at soil level, which is not the case with clump-forming bamboos.

In the Hsiennung Production Brigade (Suiyang Commune, Puqi County) bamboos are cultivated on 500 ha of land which represent two-thirds of their total land acreage. The growing stock is 1.2 million stems, i.e. a density of 2 400 stems/ha.

In the nearby Hsiensien Production Brigade, another 300 ha of bamboos are planted with the same density.

Cultivation methods are the same in both production brigades. The site is cleared of shrubs and existing vegetation. Stumps are dug out and stones removed. The soil



Fig. 18 Livistona as a cover crop, Guangdong (Kwangtung) Province

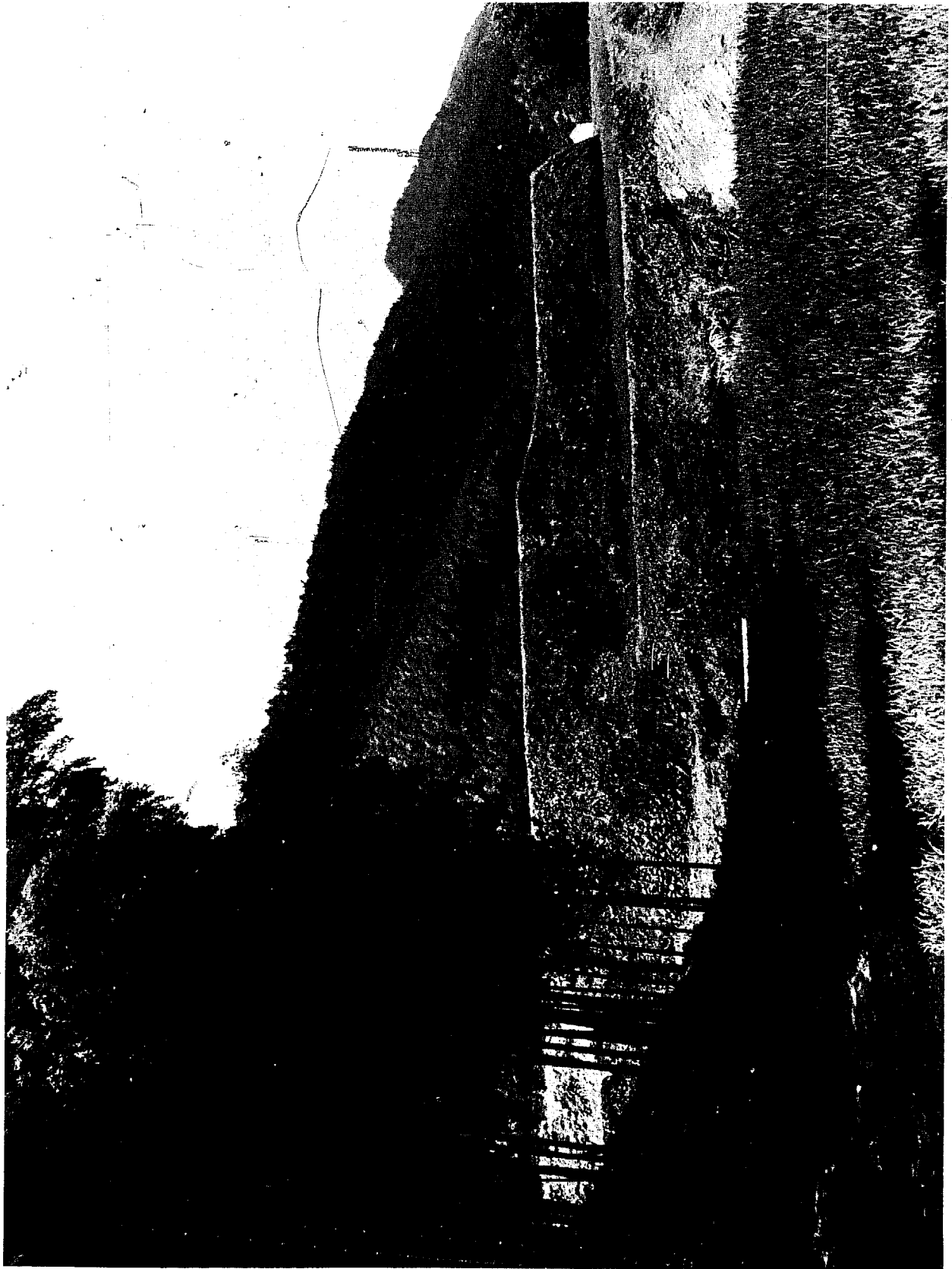


Fig. 19 Bamboo, Cunninghamia and Sassafras plantation, Hubei (Hupeh) Province



Fig. 20 Bamboo Stems, Hubei (Hupeh) Province



Fig. 21 Top Pruning of Bamboo, Hubei (Hupeh) Province

is then fertilized with 150 tonnes of organic manure per hectare. Then deep holes are dug and bamboo rhizomes planted. After seven years, exploitation begins. Exploitation is by selection. Stems under five years old are not exploited, except in thinning operations. Exploitation intensity usually does not exceed one-third of the stand density.

Shooting capacity: In one place, average shooting capacity is 1 500 shoots/year in stands five or six years old. In another place, the total number of shoots counted during spring this year was 2 340. The average shooting/stem ratio is about 0.8 shoots per bamboo stem after five years. It is interesting to mention the case of an experiment carried out in the Huanglung People's Commune, Zhuzhou County, Hunan, where 24 stems of Phyllostachys pubescens were planted in 1965. No exploitation nor removal of shoots were allowed. The twenty-four-stem bamboo stand was thoroughly protected, tended and fertilized. The number of stems counted in spring 1977 was 3 200. From the above information, it was calculated that the shooting/stem ratio in Huanglung Commune was 0.6 shoots per stem up to nine years of age and became only 0.5 beyond nine years. It is very likely that the ratio will further decline with bamboo age.

In the places visited, the practice with regard to shoot removal is very conservative, as the production brigades prefer to thin stands only when they are too dense. In the group's opinion, the practice could be modified to allow a reasonable shoot removal for food.

Exploitation and replacement: On the assumption of a density of 2 400 stems/ha, exploitation in Hsiennung as well as in Hsienhsien Production Brigade removes only 800 stems/ha. On the assumption of a conservative shoot/stem ratio of 0.6, there is a recruitment of 1 400 shoots per hectare. It appears reasonable to allow a removal of 540 shoots/ha for food, the remaining 900 shoots becoming established stems three or four months later, and still allowing a thinning of 100 stems at a later stage. The average weight of a shoot is 2 kg. It can be conservatively assumed that with an exploitation of one-third of the density of one ha of bamboo containing 2 400 stems/ha, it is still possible to produce 1 to 1.2 tonnes of food/ha/year.

Bamboo is one of the major cash crops planned for planting widely. An indication of the potential of bamboo cultivation is found in Chairman Mao's instruction to research stations to carry out research on the acclimatization of southern bamboo species to the ecological conditions of northern China.

To return to the case of Hsiennung Production Brigade, where 500 ha of bamboo were planted, the potential resources in shoots used as food could be in the order of 600 tonnes/year. Total population of the Hsiennung Production Brigade is 620 persons; the ratio of shoots that could be distributed to each person is in the order of one tonne/year.

This indicates the possibility, under intensive cultivation, of combining stem and food production in the management practices of bamboos.

4.9 INTERCROPPING

This is a tending operation which promotes good growth of young plants and which brings in some income. In general, during the first two or three years after planting, land between rows is cultivated. Depending on population needs, on soil conditions and also on silvicultural requirements, intercrops may be watermelon, soybeans, peanuts, sweet potatoes, oil-seeds or green manure. This practice replaces weeding, which is normally carried out several times between planting time and canopy closure. Whether trees are planted in shelterbelts, around villages, along canals or on roadsides, with spacing of 1.3 x 1.3 m, 2 x 2 m or 1.3 x 2.6 m, the land between rows of trees is always cultivated. The multiple land use concept has found its application in this agri-silviculture system which is reported to be applied throughout China to provide supplementary sources of food, fodder and green manure. At the same time, weeds are eliminated. Not only will competition with young seedlings not occur, but also there will be no build-up of fire hazards. Total forest cover is now 10 percent of the total land area of China. It was only 5 percent in 1949. Between 1950 and the present time (1977), forest areas have increased by another 5 percent, which is roughly 48 million ha, i.e. an average annual acreage of new plantations of 1.78 million ha. As intercropping is assumed to be practised for at least two years in any plot, the total area intercropped in China is estimated to be 3.56 million ha per year.

The amount of food yielded by ha of intercropping varies, depending on soil quality, cultivation intensity and availability of irrigation. Output per ha may be 7-8 tonnes (sweet potatoes, maize, peanuts) if ideal conditions are met. It may be only one or two tonnes on average soil combined with medium skill in management. In Zhuzhou County (Hunan), intercropping in Thea oleosa plantations gives 4 tonnes of food/ha. On the assumption of a reasonable average production of 1.5 tonnes/ha of food, total acreage intercropped would provide:

1.5 tonnes x 3.56 million ha = 5.31 million tonnes of food.

In one of the production brigades in Echeng County, Xianning Prefecture, 413 ha of Cunninghamia plantations were intercropped in 1976. Total output was 2 700 tonnes of grains, watermelon and vegetables, bringing in 50 percent of the production brigade's total income. Output per ha in this case was 6.5 tonnes.

The Xianning State Forestry Farm in 1976 intercropped 76 ha of new plantations. Food output was 90 tonnes of grains, i.e. 1.3 tonnes/ha. In another farm, 335 ha of Cunninghamia were intercropped. Total output in grains and oil seeds provided an income of about 20 000 yuan (to give a comparative idea of the value of the yuan, it may be mentioned here that an average workman's wage is 1.50 yuan/day).

Not only did intercropping bring in a substantial income, but the survival rate of Cunninghamia was 5 percent higher than that of non-intercropped plantations and plant height was one-third higher. In Xianning Prefecture as a whole, every year about 7 300 ha of Cunninghamia are intercropped. The resulting yield in 1976 was an average of 1.4 tonnes/ha of food.

The case of Taoyuan County (Hunan Province) deserves a special mention. Integrated land use planning was implemented there thanks to a gigantic, successful erosion control project which included the building of a network of water reservoirs integrated into a comprehensive irrigation system, to bring water to lands at different elevations, and the reforestation of 52 000 ha of watersheds. In this county, grain output per ha is very high, as three crops a year are grown: two crops of rice from May to September plus one crop of wheat from October to the beginning of May. The grain output reached 22 tonnes/ha in 1975 and 25 tonnes/ha in 1976. In this county, intercropping aims at producing more green manure than

food. A yield of 20 tonnes/ha of green manure is usual. Some of this green manure will be used for feeding pigs and some to fertilize the soil. Refuse from pigs will fertilize crops and fish ponds. Taoyuan is known for its integrated activities in agriculture, forestry and animal husbandry, which all support each other.

For the 20 years that intercropping has been practised in forest plantation, not a single forest fire has been recorded, as complete weeding through intercropping has been achieved. There has been no build-up of fire hazards. On the contrary, the soil has become more friable and capable of retaining more moisture and thus of ensuring a better tree growth and a higher survival rate.

Chapter 5

POSSIBLE ADAPTATION OF PRACTICES TO OTHER COUNTRIES

After studying the major activities included in the study tour and reviewing the conditions in the participating countries, the group was of the opinion that it might be worthwhile for the countries represented on the study tour to follow up the following selected subjects. Of course, these are only technical suggestions, which have to be worked out according to each country's social structure, organizational set-up and financial resources.

5.1 SHELTERBELTS

Shelterbelts of fast-growing species could be established in Central Burma where wind speed is fairly high. In the north-eastern part of Kenya there are plans to settle people along the Tana River, under an irrigation/farming scheme where the establishment of a shelterbelt would be greatly needed; in the other parts of Kenya windbreaks could also be established around private farms, mainly for fuelwood supply and poles for building. In western Nepal, especially in the Dang, Surkhet and Mustang areas the shelterbelts could contribute greatly to farming by minimizing the ill-effects of strong winds. In Pakistan, although some work is being carried out in this field, it should be expanded on both irrigated and rainfed agricultural land for water conservation and to increase the crop yields; indigenous species will be preferred in rainfed areas, while fast-growing exotic species may be added for irrigated land. In Sri Lanka the wind is a damaging factor in the central highlands as well as in the north-east, north-west and extreme south-east. Shelterbelts should be an integral part of any large-scale development, especially around tea plantations, homesteads and agricultural fields both in the highlands and lowlands. In Sudan shelterbelts have already been started on a small scale, and may be expanded as an integral part of agriculture from the beginning and should be managed by the people for their own benefit. In Tanzania, since big farms are owned either by the state, parastatal organizations or Ujamaa villages, the introduction of shelterbelts will be easier and will prove very useful.

5.2 COASTAL WINDBREAKS

Casuarina equisetifolia has been successfully used for coastal shelterbelts in the typhoon-affected areas of South China. This is a fast-growing species with spreading roots and grows easily on sandy soil. The Chinese technique of raising successive series of shelterbelts on the sandy sea-shore and also planting series of windbreaks at regular intervals in the in-shore area may be adaptable to many countries affected by typhoons. The trees thus grown as shelterbelts will not only provide protection to the agricultural crops, the population and property against natural hazards, but will also produce timber and firewood for the coastal community.

5.3 "FOUR AROUND" PLANTATION

In Bangladesh forest extension programmes could be extended up to union level to include homestead and village plantation activities. The chairman and members of the union council could take the responsibility for raising their own nursery and the Forest Extension Service could act as technical cadres. As regards roadside and water-side plantations, the respective government departments could undertake the work in collaboration with local union council chairmen. In Burma this type of plantation has already been undertaken partly (on roadsides and water-sides) but it could be expanded together with homestead and village plantations, in order to provide fuelwood and timber as well as being an amenity to the countryside. In India plantation for fuelwood production could be undertaken by roadside planting with big trees from special nurseries, particularly in areas susceptible to grazing or other protection problems, as well as by plantation in villages and homesteads. In Kenya "four around" plantation has already been started by rural afforestation extension schemes with the exception of roadside and railroad planting, which may be included in future activities. In Nepal roadside and water-side plantation work has recently been taken up; homestead and village plantations could be included to provide fodder and fuel. In Pakistan planting along roadsides and water-sides is already in practice but it could be expanded to include homestead and village plantations. In Papua New Guinea homestead plantation, especially in the highlands, which are mainly grasslands, is already in progress; villagers are also encouraged to carry out community plantings but they are not yet in full force and could be intensified. Owing to immediate natural regeneration along roads and water-sides very little can be done there. "Four around" plantation may be highly desirable and very applicable to the Philippines, especially within the framework of the new five-year tree-planting law which has just been promulgated, requiring all able-bodied citizens of ten years and over to plant one tree per month for five years. Tree planting by citizens in compliance with this law may be done around houses and villages and on roadsides and water-sides, etc. In Sri Lanka homestead plantations have already been started but could be stepped up simultaneously with an intensification of mass education. Village plantations could be undertaken along the same lines, but mostly of big trees in order to minimize animal browsing damage. Although some roads are lined with natural vegetation there are long stretches of roadsides and water-sides which could be planted. In Sudan tree plantation by people around houses and public places, and on roadsides, etc. is carried out during Arbor Day but this could be carried out on a large scale. In Tanzania small-scale activities could be enlarged and organized, especially in Ujamaa villages.

5.4 INTERCROPPING

The intercropping up to the third or fourth year in Bangladesh is adaptable to the Taungya system of afforestation or reafforestation practices. It could, however, be expanded to the Shorea robusta forests of Dacca, Mymensingh, Tangail and the northern district. Intercropping in plantation areas has been practised in Burma since 1918 in Taungya areas. It may be worth investigating whether intercropping cannot be further expanded and intensified with the use of manure and fertilizer and better tending practices. In Kenya the land to be afforested is usually given to forest workers or other individuals to cultivate for one or two years before ploughing. After plantation the same people are allowed to continue farming in the area for another two or three years until the canopy closes; during that period they weed the forest trees, and then they move to another area. The method might be improved and intensified by giving some incentives to the people engaged in these activities to improve yield and maintenance. Intercropping in plantations has just been introduced in Burganj forest district in Nepal and could be extended to all the areas of plantation,

especially in the Terai and valleys; the practice of intercropping of trees on cropland could also be introduced. In Pakistan, intercropping could be adopted especially in the irrigated plantations in the plains as well as in the uplands under intensive forest management. In view of the fact that the Bureau of Forest Development of the Philippines under the "Kaingin Management Programme" has started a scheme of intercropping for shifting cultivators and some of the private companies have successfully implemented it among the squatters and nearby homestead owners, this could be intensified and expanded. In Sri Lanka intercropping is practised on about 4,000 ha. of teak under Taungya cultivation. Intercropping is on an extensive scale but could be intensified by manuring, irrigation (wherever possible) etc. and arranging for more organized marketing of produce. The intercropping of food crops in the hill country with pines and eucalypts has not been practised so far for soil and water conservation reasons. It could be tried out on an experimental scale with the adoption of more intensive land preparation and the cultivation of soybean or any crop other than tubers, which involve disturbance to the soil. Intercropping is already practised in Sudan in the Acacia senegal (gum tree) plantations in the sands of western Sudan. Perhaps species such as Paulownia and Sassafras could be introduced to the heavier-rainfall areas of southern Sudan, to be intercropped with local agricultural crops. Although intercropping is practised in some parts of Tanzania, it could be expanded to the other parts of the country.

5.5 PLANTATION OF FAST-GROWING SPECIES FOR TIMBER PRODUCTION

In Bangladesh, in hill afforestation using fast-growing species for timber production, intensive soil working and terracing could be carried out in the unclassed state forests of Chittagong Hill Forests, the protected forests and the barren hills of Sylhet, Chittagong and Comilla. In Chittagong Hill Forests government agencies may be able to motivate the shifting cultivators through the village headman. The forest administration in these districts, in collaboration with the divisional development authorities and Chittagong Hill Forest Development Board, could undertake pilot forestry farms immediately. Although in Burma this type of activity has already been started, there are still large areas that could be planted with fast-growing species. In India fast-growing species in combination with fruit trees could be tried in large-scale plantations; an introduction trial of Cunninghamia in the lower hills of the western Himalayas might be successful. Plantation for timber production has been going on for decades in Kenya and the present afforestation methods are quite adequate. However, what could be adopted is a modified land preparation method, particularly in afforesting hills with very poor site conditions and with serious erosion problems. In such places, in spite of the high cost of labour, some trenching or terracing with application of organic manure would certainly pay dividends, particularly if intercropping were encouraged, to offset the high cost of digging trenches. Most of the hills in Pakistan are suitable for growing timber species and the naturally occurring forests are being used for the purpose. However, most of the areas suitable for forestry have been encroached upon by subsistence agriculture. Afforestation with timber species over this area could be taken up according to the capability classification of the land. In Sudan an introduction trial of Cunninghamia in the hills might be undertaken with proper land preparation and terracing.

Almost every member of the group expressed great interest in introducing, at least for trial purposes, the following species into their respective countries: Cunninghamia, Paulownia, and Sassafras.

5.6 TREE CROPS YIELDING IMMEDIATE CASH RETURNS

Because of its wide range of suitable growing areas, its fast growth, multiple use and economic value, great enthusiasm was shown by all participants for introducing Thea oleosa either in pure plantations or on barren hills or as an enrichment of natural pine forests or plantations. Improvement of natural bamboo stands, expanding bamboo plantations to ecologically suitable places either with indigenous or exotic species, might be undertaken because of their fast-growing nature and multiple use.

5.7 INTEGRATED PLANNING

The key to China's success in its forestry support for agriculture programme is its integrated approach to overall planning. China has taken grain production as the "key" but has placed agriculture, forestry and animal husbandry on an equal footing, since they are considered to be interdependent. Even within the sectors the planning process is integrated in such a way that many of the forestry farms visited were found to have been planned so as to be completely self-reliant up to the end product. The integration of planning also includes the integration of involvement at various levels. Such integration of involvement provides assured support at the time of implementation and results in the overall success of the programme.

Such integration may not be adaptable to many countries, but involvement of locally elected bodies at the planning stage might be possible and this would ensure integration of planning processes with the implementation stage, as these local bodies are, in many cases, able to mobilize the local masses. Integrated planning of rural development in most of the countries could adopt the Chinese practice and take forestry as a major supporting programme for overall village development.

5.8 RESEARCH, TRAINING AND DEMONSTRATION

In China, research units are operating down to production brigade level with link-up support and control at commune, county, prefecture, province and country level. This helps in undertaking research not only at laboratory level, but also at grass-roots level. The system of research at field level is in practice in many countries, but due to absence of link-up coordination between field workers and research workers most of the research results end up as theoretical findings. The sending of research workers to the grass-roots level, both for research and application, as practised in China, could be adopted in many countries.

China's forestry education and training is oriented towards the integration of theory and practice. To ensure forestry support for agriculture, China trains its grass-roots workers at the forestry colleges where they gather theoretical knowledge and during their training also work in the field for practical study of problems and their solutions. For mass education and training, teachers are also sent to communes and production brigades for local training of grass-roots workers and for on-the-spot findings and solution of problems at the field level. Such integrated training of technicians and grass-roots workers could be adopted in different countries and forestry colleges and the department of forestry could organize such training of technicians and grass-roots workers, with physical and material support from the local bodies.

Demonstration forestry farms as established in China in pilot areas under government sponsorship could be established in different participating countries. These farms could act as laboratories for the training of grass-roots workers.

Chapter 6

RECOMMENDATIONS

On the basis of its studies and observations as well as exchange of ideas among its members and discussions held with Chinese colleagues, the study group made the following recommendations which are given under follow-up projects and other suggestions. The follow-up projects are divided into multilateral and bilateral projects according to their scope and objectives.

6.1 MULTILATERAL FOLLOW-UP PROJECTS

(i) FAO/UNDP/China cooperation in the field of forestry in general, and forestry support for agriculture and forestry for local community development in particular, should be continued.

(ii) A study tour on wildlife management with particular emphasis on domestication and game cropping should be organized.

(iii) FAO should establish seed exchange for the fast-growing species (Cunninghamia, Paulownia, Sassafras, Thea oleosa and others) between the People's Republic of China and interested Member Nations.

(iv) The Forestry Support for Agriculture Study Tour should be repeated for Spanish- and French-speaking countries.

(v) A study group consisting of foresters, agriculturists, animal husbandry experts and planners should be organized to study forestry for local community development. This should include the following topics: eradication of shifting cultivation in China, and the impact of commune forestry work on the overall employment.

(vi) Selected project managers of the UNDP/FAO and/or Trust Fund/FAO projects in integrated watershed and forest land use and representatives of Forestry Operations Service should visit the People's Republic of China for three weeks to study the mobilization of the masses, education, training and integrated planning and development as a background in reformulating development strategy in forestry.

(vii) A two-man team (professional forester and professional photographer) should visit the People's Republic of China either in April or in October to prepare a filmstrip on various steps and aspects of forestry support for agriculture.

(viii) A China/FAO monograph should be published, covering: techniques of land preparation and tending forest plantations; education, training and extension methods with reference to forestry; research methodology. China may be requested to prepare the text in Chinese, with illustrations, and FAO should get it translated into other working languages; selected Chinese books and other literature on forestry support for agriculture should also be treated along the same lines.

(ix) Joint study should be organized between Bangladesh, the People's Republic of China and Nepal with the aim of formulating integrated watershed development projects for the selected watersheds of the rivers which flow through these countries.

6.2 BILATERAL FOLLOW-UP PROJECTS

This group includes the projects which can be implemented through bilateral arrangements between the People's Republic of China and the respective countries, with or without FAO participation and assistance.

(i) A selected group of Chinese foresters should visit Italy and Turkey for three weeks to study both research on, and large-scale plantation of, poplar, which is widely used in the north-east of China.

(ii) Study tours to the People's Republic of China should be organized for field- and policy-level officials of the Bangladesh Forestry Department:

(a) Mid-level and field-level study tour with following composition:

Conservator of Forests	1	(Team Leader)
Divisional Forest Officers	3	
Forest Rangers	3	
Foresters	3	
	<u>8</u>	
Total	20	

There could be two such teams and the duration of this study tour could be three to four weeks.

(b) Study tour at policy level:

- Secretary, Forests, Fisheries and Livestock Division (Leader)
- Chief Conservator of Forests
- Chief Engineer, Roads and Highways
- Director-General, Integrated Rural Development Programme
- Two high-level policy officials of Water and Land Resources Departments

The tour could be of two to three weeks' duration.

(iii) A multidisciplinary study tour to the People's Republic of China should be organized for specialists from the Ministry of Agriculture, Kenya. The group should include an agriculturist, a soil and water conservationist and foresters to study integrated development with reference to forestry support for agriculture; duration three weeks.

(iv) An integrated watershed management project should be formulated and implemented in Nepal, consisting of: (a) construction of a rural reservoir to utilize water resources and to control floods; (b) construction of a small hydro-power plant for village electrification which would promote their interest in forestry; (c) plantation on the slopes for construction, fuelwood and fodder production; and (d) integration of pig raising and conservation farming.

(v) A joint study team, consisting of Nepalese and Chinese experts should be formed to study the watersheds along the Nepal-China border and recommend various watershed management projects.

(vi) In Sudan, two units should be selected, one in the Gezira and one in the Rahad irrigation scheme, for pilot experimental integrated development projects covering agriculture, forestry, animal husbandry and water conservation. A study tour should be organized for selected farmers from these two units to visit the People's Republic of China for four weeks.

6.3 OTHER SUGGESTIONS

(i) One country in Africa and one in Asia should be selected to serve as examples of integrated planning and development which could eventually be used as training centres for the regions.

(ii) Participants in the study tour should send to FAO an annual report on activities in their countries as regards forestry support for agriculture.

Appendix 1

LIST OF PARTICIPANTS IN THE STUDY TOUR

COUNTRIES

Bangladesh	Mahbub Uddin Chaudhury Assistant Chief Conservator of Forests and Officer-in-Charge, Planning Cell, Forest, Fisheries and Livestock Division and Chief Investigator ERTS (LANDSAT) Programme Block -F, Forest Colony Bailey Road Dacca -2
	Bahauddin Chowdhury Conservator of Forests Forest Extension Circle Forest House 'E' Bailey Road Dacca -2
Burma	Hoke Lin Deputy Director, Forest Department Shwebo Forest Division Shwebo
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	Sudhakara Rao Forest Economist Ministry of Agriculture B109 Sastri Bhavan New Delhi - 110001
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Papua New Guinea	Lionel Bunari Provincial Forest Officer Eastern Highlands Province
Pakistan	M. Amjad Mahmood Cheema Watershed Management Specialist Pakistan Forest Institute Peshawar

COUNTRIES

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Sudan

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Tran van Nao
Forest Resources Division
Forestry Department, FAO Headquarters

Mervin E. Stevens
Project Manager of UNDP/FAO Project
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Nepal
c/o UNDP
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Kathmandu

Appendix 2

ITINERARY

9 August 1977

Study tour participants assemble in Karachi.

10 August

- 11:00 - First briefing by Team Leader Eren
- 21:15 - Leave Karachi by flight CA 932

11 August

- 06:30 - Arrive BEIJING (PEKING)
- 10:00 - General Briefing by Mr. Li Shih-kang, study tour host, and discussion of schedule
- 14:00 - Tour of Beijing (Peking) Timber Processing Factory
- 18:30 - Dinner hosted by Mr. Li Yung-kai

12 August

- a.m. - Visit to Great Wall and Ming Tombs
- p.m. - Discussion of situation in countries of participants

13 August

- 08:00 - Briefing on study tour details * * *
- 13:45 - Leave Beijing (Peking) by Flight CA165
- 15:00 - Arrive Shenyang City, LIAONING PROVINCE
- 16:00 - Liaoning Province briefing
- 20:00 - Leave Shenyang by train

14 August

- 07:45 - Arrive Chifeng
- 09:30 - Briefing on Chifeng County
- 14:00 - Field visit to Tungfanghung Production Brigade
- 19:45 - Song and dance performance

15 August

- 08:00 - All day field visit to Taipingti Commune, Chingfengti Production Brigade
- 14:30 - A general briefing was given

16 August

- 08:00 - Final discussion of Chifeng County visit
- 15:00 - Visit to carpet factory
- 17:00 - Dinner hosted by friends
- 19:00 - Leave Chifeng by train

17 August

- 07:00 - Arrive Shenyang
- 09:00 - Visit Ching Dynasty Palace and Tomb
- 16:10 - Leave Shenyang by flight CA362
- 17:15 - Arrive Beijing (Peking)
- 21:45 - Leave Beijing (Peking) by train

18 August

- 08:45 - Arrive Zhengzhou, HENAN (HONAN) PROVINCE
- 09:30 - Briefing on study tour schedule
- 11:15 - Tour of city streets observing plantings
- 14:00 - Field visit to Chaochuang Commune, Paichuang Production Brigade
- 17:00 - Visit to observe Yellow River
- 18:30 - Dinner hosted by friends

19 August

- 07:30 - Drive to Yu County
- 10:00 - Yu County briefing
- 11:00 - Field visit to Chungkao Commune, Changlou Production Brigade
- 14:30 - Field visit to Tsuho Commune, Kechien Production Brigade
- 16:45 - Leave for Yanling County
- 21:00 - Yanling County briefing

20 August

- 07:30 - Field visit to Pengtien Commune, Chachia Production Brigade
- 10:30 - Field visit to Pailing Commune, Yuankuei Production Brigade
- 11:00 - Field visit to Laochuang Production Brigade
- 14:00 - Field visit to Pengchuang Production Brigade
- 16:00 - Field visit to Yanling County Research Institute
- 18:45 - Leave Yanling County
- 22:00 - Arrive Zhengzhou

21 August

- 00:20 - Leave Zhengzhou by train
- 10:30 - Arrive Xianning Prefecture, HUBEI (HUPEH) PROVINCE
- 14:00 - Briefing on prefecture
- 16:00 - Field visit to forestry farm

22 August

- 08:00 - Field visit to Echeng County
- 13:00 - Field visit to Tuchen Commune, Liangtze Cunninghamia
Forestry Farm Plantation
- 20:00 - Film show at the hotel

23 August

- 08:00 - Field visit to Puqi County, Suiyang Commune, Hsiennung Production Brigade
- 12:30 - Picnic Lunch
- 14:00 - Field visit to Huawen Commune, Hsienhsien Production Brigade
- 19:30 - Theatrical entertainment

24 August

- 09:00 - Field visit to Xianning County, Hsiaoling Forestry Farm
- 14:15 - Final discussion on Hubei (Hupeh) Province
- 19:00 - Dinner hosted by friends

25 August

- 03:00 - Leave Xianning by train
- 07:45 - Arrive Changsha, HUNAN PROVINCE
- 08:00 - General briefing
- 09:45 - Field visit to Changsha City nursery
- 15:00 - Detailed briefing on the nursery
- 18:30 - Dinner hosted by friends

26 August

- 07:00 - Leave Changsha by bus
- 12:00 - Arrive Changde for lunch (rest stop)
- 15:45 - Arrive Taoyuan County
- 16:30 - General briefing on the county and visit to the exhibition about the water development projects
- 19:30 - Film show

27 August

- 08:30 - Field visit to Yutien Commune
- 09:30 - Field visit to Cheichia Commune
- 14:30 - Detailed briefing on Taoyuan County
- 19:30 - Theatrical entertainment

28 August

- 08:00 - All day field visit to Paiyang River system

29 August

- 08:00 - Field visit to Huping Commune, Hsilung "March Eighth" Forestry Farm
- 10:45 - Field visit to Lungtanchiao Commune Forestry Farm
- 14:00 - General briefing and discussion on Paiyang River system
- 18:30 - Dinner hosted by friends

30 August

- 07:00 - Leave Taoyuan by bus
- 09:30 - Rest stop at Changde
- 13:00 - Arrive Shaoshan, birth place of Mao Tse-tung
- 18:30 - Dinner hosted by friends

31 August

- 07:30 - Leave Shaoshan
- 08:00 - Field visit to Shaoshan irrigation system
- 11:00 - Lunch at Zhuzhou Municipality
- 16:45 - Field visit to Kantien District, Kantien Commune,
Tzewu Production Brigade
- 18:30 - Arrive Chuting District
- 19:00 - Dinner hosted by friends

1 September

- 07:30 - General briefing on Zhuzhou County
- 08:15 - Field visit to Shihkow Production Brigade Forestry Farm
- 08:45 - Field visit to Huanglung Commune, Chungching Forestry Farm
- 11:00 - Field visit to Huangshi Production Brigade
- 14:30 - Briefing on eastern part of province

2 September

- 07:30 - Final discussion on Hunan Province
- 13:30 - Leave Chuting
- 17:15 - Arrive Changsha

3 September

- 13:30 - Leave Changsha by Flight CA231
- 14:45 - Arrive Guangzhou (Canton) GUANGDONG (KWANGTUNG) PROVINCE
- 16:00 - General briefing on province
- 19:45 - Dance-opera entertainment

4 September

- 07:30 - Leave Guangzhou by Flight CA333
- 08:45 - Arrive Zhanjiang Prefecture (Programme delayed due to typhoon)
- 18:15 - Dinner hosted by friends
- 20:00 - Film show

5 September

- 07:30 - Field visit to Dianbai County, Dianbai Water and Soil
Conservation and Experiment Station
- 09:30 - Field visit to Shatuan Commune, Musu Production Brigade
- 12:00 - Lunch at research station
- 13:00 - Briefing about station
- 19:30 - Film show

6 September

- 07:00 - Field visit to Suikai County, Leichow Forestry Bureau
(Stop at Thread Spool Manufacturing Plant)
- 11:30 - Lunch at Forestry Bureau
- 15:45 - Visit to Eucalyptus Products Manufacturing Factory,
Jangcha Forestry Farm
- 18:00 - Briefing at Forestry Bureau

7 September

- 07:00 - Field visit to Nanshan Commune, Nanshan Plantation
(this is an island)
- 14:15 - Leave Zhanjiang by air
- 15:30 - Arrive Guangzhou (Canton)
- 18:45 - Dinner hosted by friends

8 September

- 08:00 - Field visit to Institute of Botany and Botanic Gardens
- 09:45 - Field visit to Guangdong (Kwangtung) Forestry Research Institute
- 14:00 - Briefing on College of Agriculture and Forestry of
Guangdong (Kwangtung) Province, Guangzhou (Canton)
- 18:30 - Leave Guangzhou (Canton) by Flight CA132
- 21:00 - Arrive Beijing (Peking)

9 September

- 08:00 - Working on draft of report
- 16:30 - Team discussion on report

10 September

- 08:00 - Continuation of team discussion on report
- 09:45 - Mr. Eren meets with Mr. Li Yung-kai and Mr. Li Shih-kang
to discuss report findings
- 16:45 - Tour of the Forbidden City
- 18:00 - Dinner hosted by Mr. Eren and study team

11 September

- 08:00 - Working on draft of report and free shopping time
- 11:00 - Visit to Memorial Hall of Chairman Mao
- 19:30 - Music-dance show at Beijing (Peking) Stadium given on the
anniversary of the death of Chairman Mao

12 September

- 08:00 - Work on report and free shopping time
- 14:30 - Visit to Beijing (Peking) Zoo

13 September

Team members return to respective countries.

Appendix 3

PEOPLE MET

<u>Date</u>	<u>Location</u>	<u>Name</u>	<u>Position</u>
29 July	Rome	Li Yung-kai	Director, Bureau of Foreign Affairs, Ministry of Agriculture and Forestry
11 August	BEIJING (PEKING)	Li Shih-kang	Director, Forestry Resources
		Chang Shih-chan	Director, International Conferences
13 August	Beijing (Peking) Timber Processing Factory	Tung Ching-sung	International Affairs, Department of Forestry
		Miss Kung Tsien-ying	as above
		Hsu Kuo-chang	as above
		Cheng Yu-chai	Vice-Chairman, Revolutionary Committee
14 August	Shenyang, LIAONING PROVINCE	Yang Teh-hsi	Chief of Factory Office
		Pa Ru-yu	Technician of Factory
		Shen Liu	Director, Forestry Department
		Li Chai	Deputy Director, Forestry Department (Reforestation)
15 August	Tungfanghung Production Brigade	Hwang Cheng-li	Technician, Forestry Department
		Liu Chao-hsing	as above
		Hsiu Hung-wen	Vice-Chairman, Revolutionary Committee of Chao-u-ta League
		Hsing Chen-tsao	Deputy Director, Forestry Department
		Pao Hsi	as above
		Li Wen-cheng	Head of Foreign Affairs Division of Chao-u-ta League
		Sui Han-yu	Vice-Chairman, Revolutionary Committee of Chifeng County
		Chao Hsiu	Director, Forestry Department of the County
15 August	Taipingti People's Commune	Ching Tao-tsa	Technician of Forestry Department of the County
		Wan Chen	Vice-Chairman, Revolutionary Committee
15 August	Taipingti People's Commune	Miss Luai Hsiu-hsia	Director of Production Brigade
		Lu Chan-san	Chairman, Revolutionary Committee
		Tung Ye-fi	Vice-Chairman, Revolutionary Committee
		Tsai Chuang-fi	Forestry Technician

<u>Date</u>	<u>Location</u>	<u>Name</u>	<u>Position</u>	
18 August	Zhengzhou, HENAN (HONAN) PROVINCE	Liu Yung-fu	Deputy Director, Department of Agriculture and Forestry	
		Cheng Fa-chen	Director, Forestry Division, Department of Agriculture and Forestry	
		Wang Tin-hsuen	Staff Member, Department of Agriculture and Forestry	
		Li Tao-lin	Section Chief, Foreign Affairs Office	
		Liu Hsia-wu	Staff Member, Foreign Affairs Office	
		Tu Fu-teh	Staff Member, Foreign Affairs Office	
		Paichuang Production Brigade	Pai Hsi-chuan	Chairman, Revolutionary Committee
		Tsao Kai-hsiou	Vice-Chairman, Revolutionary Committee	
		Pai Ming-hsuen	Vice-Chairman, Revolutionary Committee	
		Pai Yua-chi	Forestry Technician	
19 August	Yu County	Liu Fen-ming	Vice-Chairman, Revolutionary Committee	
		Ma Kang-chuan	Chief of Office of the Revolutionary Committee	
		Tin Chung-pu	Section Chief, Foreign Affairs Office	
		Liu Hsi-tang	Deputy Director, Forestry Department	
		Wang Yu-chin	Forestry Technician	
		Kechien Production Brigade	Chu Hung-hsin	Chairman
			Li Cha-hsin	Technician
			Chang Shih-kang	Director of Forestry Farm
Chang Mu-shen	Deputy Director of Forestry Farm			
20 August	Yanling County	Lin Chi-tien	Vice-Chairman, Revolutionary Committee	
		Sung Teh-ming	Chief of Office of the Revolutionary Committee	
		Li Kuo-ching	Deputy Director, Forestry Department	
		Chai Shih-teh	Forestry Technician	
		Li Kuo-chen	Staff Member	
		Chu Chung-chian	Staff Member	
		Xuchang Prefecture	Yang Kung-cheng	Director of Forestry
	Chai Chung-yu		Section Chief of Foreign Affairs Office	
	Liang Ta-chuan		Staff Member	
	Chachia Production Brigade	Liu Feng-an	Chairman	
		Cha Shu-li	Technician	
	Yuankuei Production Brigade	Cheng Kuo-pao	Chairman	
		Liu Yuan-pu	Technician	

<u>Date</u>	<u>Location</u>	<u>Name</u>	<u>Position</u>	
20 August (cont.)	Laochuang Production Brigade	Wang Shu-ming	Chairman	
		Chang Tien-chi	Technician	
	Pengchuang Production Brigade	Tsao Hsiao-en	Chairman	
		Chang Tung-ching	Technician	
	Forestry Research Institute	Cheng Ken-fa	Director	
		Chang Chien-ye	Technician	
		Shen Hwang-chi	Technician	
21 August	HUBEI (HUPEH) PROVINCE	Hsu Yi-lin	Deputy Director, Forestry Department Vice-Chairman, Revolutionary Committee, Xianning Prefecture Division Leader of Foreign Affairs Director, Forestry Department, Xianning Prefecture Division Leader, Forestry Department, Hubei (Hupeh) Province	
		Hsung Kuan-ming		
		Yuan Ye-yung		
		Li Ji-kwang		
		Hsian Hua-fang		
22 August	Echeng County	Yao Hwei-chi	Vice-Chairman, Revolutionary Committee	
		Yang Tzu-hu	Chairman, Revolutionary Committee	
		Li Hui-cho	Head of Liangtze Cunninghamia Plantation	
		Yu Huow-yung	Technician of the Plantation	
		Hu Ya-liang	Technician of the Plantation	
23 August	Puqi County	Wan Hueng-hsan	Vice-Chairman, Revolutionary Committee	
		Hsiennung Production Brigade	Chang Min-chin	Head of Production Brigade
			Ye Wen-kwang	Deputy Leader of Production Brigade
			Fang Hsuen-yu	Technician of the Production Brigade
			Mei Shen	Team Leader
		Xianning County	Chang Hai-shan	Vice-Chairman, Revolutionary Committee
		Huawen People's Commune	Tung Yung-ping	Vice-Chairman
		Hsienhsien Production Brigade	Yan Huan-hen	Head
		Wang Chi-huai	Deputy Leader	
		Mrs. Wang Tung-hui	Technician	
		Cheng Yuan-hsing	Team Leader	

<u>Date</u>	<u>Location</u>	<u>Name</u>	<u>Position</u>
24 August	Hsiaoling Forestry Farm	Hsi Liang-yuan	Head
		Chei Ta-chuan	Deputy Leader
		Li Pao-yuan	Technician
		Hang Chi-hsien	Team Leader
25 August	Changsha HUNAN PROVINCE	Lei Lung	Deputy Director, Forestry Department
		Liu An	Leader of Afforestation Division, Forestry Department
		Hou Chao-an	Technician
		Miss Wang Hsiang-ling	Foreign Affairs Department
	Changsha City Construction Department	Li Tai-ji	Deputy Director
		Liu Fu-huei	Director of Park and City Tree Planting Board
		Hsien Hsu-fan	Director of Nursery
		Yang Chen-ji	Deputy Director
		Kung Ku-hsiang	Technician
		Chang Huan-ming	Staff Member
26 August	Taoyuan County	Chui Hai-ching	Vice-Chairman, Revolutionary Committee
		Lu Chiao-sung	Director, Agriculture Department
		Tang Hsien-yi	Director, Forestry Department
		Li Mei-chang	Technician, Water Conservancy Department
		Li Ken-chi	Technician, Forestry Department
27 August	Yutien People's Commune	Chang Chung-hsiang	Vice-Chairman, Revolutionary Committee
	Cheichia People's Commune	Chang Chei-chen	Vice-Chairman, Revolutionary Committee
28 August	Huang Shih Reservoir	Liu Ching-yi	Deputy Director of Management Unit
	Chou Chi River Dam	Ni Wen-huan	Head of Work Site
	Li Lin River Dam, Fangsha Commune	Chou Yang-yuan	Vice-Chairman of Commune
29 August	Huping People's Commune	Kao Yung	Vice-Chairman, Revolutionary Committee
		Miss Lei Lu	Head of March Eighth Forestry Farm
	Lungtanchiao People's Commune	Chiang Chin-chien	Vice-Chairman, Revolutionary Committee
30 August	Shaoshan District	Liao Mao-hsu	Leader of Foreign Affairs Division of Revolutionary Committee
		Miss Wan Teh-chen	Staff Member
		Miss Hsu Fu-yuan	Staff of Exhibition

<u>Date</u>	<u>Location</u>	<u>Name</u>	<u>Position</u>
31 August	Kantien District (and Commune)	Hu Hsiao-chai Ku Wen-chai	Leader Chairman, Revolutionary Committee
	Tzewu Production Brigade	Hu Chi-tze	Head
	Zhuzhou County	Hu Yu-hsiang Yu Hsu-sung Hsen Chen-chu	Director, Agriculture Office Technician Technician
3 September	GUANGDONG (KWANGTUNG) PROVINCE	Mu Kao-yiao	Chairman, Revolutionary Committee
		Fang Hsu	Deputy Director, Forestry Department
		Lin Mi Chu Chi-sung	Head, Afforestation Division Deputy Director, Forestry Research Institute
4 September	Zhanjiang Prefecture	Yuan Hi-ching	Section Leader, Forestry Farm Division
		Hsiao Chi-kuei	Vice-Chairman, Revolutionary Committee
		Chei Chin-ming Wei Seng-hui Chen Tiao-chai	Member of Revolutionary Committee Director, Forestry Department Director, Foreign Affairs Division
5 September	Dianbai County	Chi Chung-chen	Vice-Chairman, Revolutionary Committee
		Lei Ching Chai Liang-chen	Director, Forestry Department Head, Soil and Water Conservation Research Station
		Pi Yung-fung	Technician of the Station
6 September	Leichow Forestry Bureau, Suikai County	Liu Min	Deputy Section Director
		Lo Chi-yen	Section Leader
		Chi Su-hsiang	Technician
7 September	Nanshan People's Commune	Chan Chiang	Vice-Chairman, Revolutionary Committee
		Liang Ya-wen Hse Ku-hao	Head of Casuarina Plantation Technician
8 September	Guangzhou (Canton) College of Agri- culture and Forestry	Lu Jen-hsiang	Vice-Chairman, Revolutionary Committee
		Ysu Ye-chen	Professor
		Lu Hsin	Teacher
		Wang Chuang	Professor
		Ching Tzao-shang	Teacher
		Liu Yu-mei	Teacher
		Chen Tien-hsin	Teacher
		Han Hung-kuang	Teacher
		Ho Tien-hsiang	Professor
		Chen Kang	Teacher
		Fang Tse-jiao	Teacher
		Oh Yueh-han	Teacher
Lu Hsi-hsiang	Teacher		
Lin Wen-tao	Teacher		

Appendix 4

LIST OF SELECTED TREE SPECIES FOUND IN CHINA
WITH INDICATION OF MAJOR DISTRIBUTION PATTERN AND USES

Species	Distribution Areas			Major Uses in Planting						
	North	Central	South	Timber Forestry	Fuel-wood	"Four Sides" Forestry	Shelter-belts, wind-breaks	Urban Forestry	Industrial Forestry	Coastal Afforestation
<i>Acacia confusa</i>			X		X	X		X		
<i>Acer davidii</i>		X		X				X		
<i>Acer mono</i>		X						X		
<i>Acer negundo</i>	X	X						X		
<i>Ailanthus altissima</i>	X	X	X	X						X
<i>Aleurites fordii</i>		X	X		X	X			X	
<i>Aleurites moluccana</i>			X					X		
<i>Aleurites montana</i>		X	X		X	X			X	
<i>Alstonia scholaris</i>			X					X		
<i>Amorpha fruticosa</i>	X	X	X		X				X	
<i>Artocarpus heterophylla</i>			X					X	X	
<i>Arundinaria</i> spp.		X	X			X	X		X	
<i>Averrhoa carambola</i>			X			X			X	X
<i>Biota orientalis</i>		X		X				X		
<i>Bischofia javanica</i>		X		X						
<i>Bombax malabaricum</i>			X					X		
<i>Camptotheca acuminata</i>		X		X	X	X		X		
<i>Canarium album</i>			X						X	
<i>Castanea henryi</i>		X	X	X					X	
<i>Castanea mollissima</i>		X	X						X	
<i>Castanea seguinii</i>		X	X						X	
<i>Casuarina equisetifolia</i>			X	X	X	X	X	X		X
<i>Cedrela sinensis</i>	X	X				X		X		
<i>Cedrus deodara</i>	X	X		X				X		
<i>Chukrasia tabularis</i>			X	X	X					
<i>Cinnamomum camphora</i>		X	X	X				X	X	
<i>Citrus</i> spp.	X	X	X						X	
<i>Crataegus pinnatifida</i>		X								X
<i>Cryptomeria japonica</i>		X		X				X		
<i>Cunninghamia lanceolata</i>	X	X		X						
<i>Cupressus funebris</i>		X		X				X		
<i>Dendrocalamus</i> spp.		X	X	X					X	
<i>Diospyros kaki</i>		X	X			X		X	X	
<i>Elaeagnus angustifolia</i>	X									X
<i>Eucalyptus citriodora</i>			X	X	X		X		X	X
<i>Eucalyptus exserta</i>			X	X	X		X		X	X
<i>Eucalyptus grandis</i>			X	X	X	X	X			
<i>Eucalyptus leichow</i> No.1			X	X	X		X		X	X
<i>Eucalyptus saligna</i>			X	X	X	X	X			
<i>Eucalyptus tereticornis</i>			X	X	X	X	X			
<i>Ficus lancor</i>			X					X		
<i>Ficus retusa</i>			X					X		

Species	Distribution Areas			Major Uses in Planting						
	North	Central	South	Timber Fores- try	Fuel- wood	"Four Sides" Fores- try	Shelter- belts, wind- breaks	Urban Fores- try	Indus- trial Fores- try	Coastal Affores- tation
<i>Fraxinus chinensis</i>	x			x	x					
<i>Fraxinus mandshurica</i>	x			x						
<i>Ginkgo biloba</i>		x	x					x	x	
<i>Glyptostrobos pensilis</i>		x	x	x						
<i>Haloxylon ammodendron</i>	x						x			
<i>Hovenia dulcis</i>	x	x							x	
<i>Juglans mandshurica</i>	x	x		x					x	
<i>Juglans regia</i>	x	x				x		x	x	
<i>Keteleeria davidiana</i>		x	x	x				x		
<i>Larix dahurica</i>	x			x				x		
<i>Larix koreana</i>	x			x				x		
<i>Larix principis ruppr.</i>		x		x				x		
<i>Larix sibirica</i>		x		x				x		
<i>Ligustrum lucidum</i>		x		x	x					
<i>Liquidambar formosana</i>		x	x				x	x		
<i>Litchi chinensis</i>		x	x						x	
<i>Livistona chinensis</i>			x					x	x	
<i>Magnolia grandiflora</i>		x	x					x		
<i>Mangifera indica</i>			x			x			x	
<i>Melaleuca leucadendron</i>			x	x	x			x		x
<i>Melia azedarach</i>		x	x	x	x		x			x
<i>Metasequoia glypto- stroboides</i>	x			x						
<i>Michelia alba</i>			x	x			x	x		
<i>Morus alba</i>		x	x			x			x	
<i>Nerium indicum</i>		x						x		
<i>Osmanthus fragrans</i>		x	x					x	x	
<i>Paulownia fortunei</i>	x	x		x		x	x	x		
<i>Paulownia lankanensis</i>	x	x		x		x	x	x		
<i>Photinia serrulata</i>		x						x		
<i>Phyllostachys spp.</i>		x		x		x			x	
<i>Pinus armandii</i>			x	x						
<i>Pinus elliottii</i>		x	x	x						
<i>Pinus massoniana</i>	x	x	x	x	x					
<i>Pinus sylvestris</i>		x		x				x		
<i>Pinus tabulaeformis</i>		x		x	x					
<i>Pinus taeda</i>	x	x	x	x	x					
<i>Pinus yunnanensis</i>			x	x						
<i>Piper nigrum</i>			x						x	
<i>Pittosporum tobira</i>		x						x		
<i>Platanus acerifolia</i>		x		x				x		
<i>Platanus orientalis</i>		x		x				x		
<i>Podocarpus macrophylla</i>		x	x	x				x		
<i>Poncirus trifoliata</i>		x						x		
<i>Populus canadensis</i>	x	x		x		x	x			
<i>Populus chifungensis</i>	x	x		x		x	x			
<i>Populus dakuanensis</i>	x	x		x		x	x			
<i>Populus nigra</i>	x	x		x		x	x			

Species	Distribution Areas			Major Uses in Planting						
	North	Central	South	Timber Forestry	Fuel-wood	"Four Sides" Forestry	Shelter-belts, wind-breaks	Urban Forestry	Industrial Forestry	Coastal Afforestation
<i>Populus pyramidalis</i>	x	x		x		x	x			
<i>Populus simonii</i>	x			x		x	x			
<i>Populus tomentosa</i>	x			x		x	x			
<i>Populus yunnanensis</i>			x	x		x	x			
<i>Prunus spp.</i>	x	x				x		x	x	
<i>Pterocarya stenoptera</i>		x	x	x	x	x		x		
<i>Pyrus spp.</i>	x	x				x		x	x	
<i>Quercus acutissima</i>		x	x	x						
<i>Quercus mongolica</i>	x			x						
<i>Quercus variabilis</i>	x			x						
<i>Robinia pseudo-acacia</i>	x	x	x	x	x	x	x			
<i>Salix spp.</i>	x	x	x			x	x	x		
<i>Sapindus mukurosi</i>		x	x			x			x	
<i>Sapium sebiferum</i>		x	x						x	
<i>Sassafras spp.</i>	x	x		x	x	x		x		
<i>Schima confertiflora</i>			x			x				
<i>Sophora japonica</i>		x	x			x	x	x		
<i>Tamarix chinensis</i>	x				x					x
<i>Tamarix pentandra</i>	x				x					x
<i>Taxodium ascendens</i>		x	x	x				x		
<i>Taxodium distichum</i>		x	x	x				x		
<i>Thea oleosa</i>		x	x				x		x	
<i>Thea sinensis</i>		x	x						x	
<i>Tilia mandshurica</i>		x		x		x		x		
<i>Ulmus laciniata</i>	x	x		x			x	x		
<i>Ulmus pumila</i>	x	x		x			x	x		
<i>Ziziphus jujuba</i>		x							x	
<i>Ziziphus spinosa</i>		x	x						x	

Appendix 5

ENGLISH NAMES OF SELECTED TREE SPECIES FOUND IN CHINA

<i>Acacia confusa</i>	Acacia
<i>Acer davidii</i>	David's Maple
<i>Acer mono</i>	Mono Maple
<i>Acer negundo</i>	Ash-leaved Maple; Box Elder
<i>Ailanthus altissima</i>	Tree of Heaven; Ailanthus
<i>Aleurites fordii</i>	Tung-oil Tree
<i>Aleurites moluccana</i>	Candle-nut Tree
<i>Aleurites montana</i>	Chinese Wood-oil Tree
<i>Alstonia scholaris</i>	Scholar Tree; Devil's Tree
<i>Amorpha fruticosa</i>	Bastard Indigo
<i>Artocarpus heterophylla</i>	Jackfruit
<i>Arundinaria</i> spp.	Bamboe; Cane
<i>Averrhoa carambola</i>	Carambola; Star Fruit
<i>Biota orientalis</i> (syn. <i>Thuja orientalis</i>)	Chinese Arbor-Vitae
<i>Bischofia javanica</i>	Java Bishopwood; Red Cedar
<i>Bombax malabaricum</i>	Silk-Cotton Tree
<i>Camptotheca acuminata</i>	Camptotheca (anti-cancer tree)
<i>Canarium album</i>	Chinese White Olive; White Almond
<i>Castanea henryi</i>	Henry's Chestnut; Henry Chinkapin
<i>Castanea mollissima</i>	Chinese Chestnut
<i>Castanea seguinii</i>	Seguin Chestnut
<i>Casuarina equisetifolia</i>	Horsetail Casuarina or Beefwood; She-Oak; Australian Pine
<i>Cedrela sinensis</i> (syn. <i>Toona sinensis</i>)	Chinese Mahogany; Toona Cedar
<i>Cedrus deodara</i>	Deodar Cedar
<i>Chukrasia tabularis</i>	Indian Red Wood
<i>Cinnamomum camphora</i>	Camphor Tree
<i>Citrus</i> spp.	Citrus Fruits
<i>Crataegus pinnatifida</i>	Chinese Hawthorn
<i>Cryptomeria japonica</i>	Japanese Cedar; Cryptomeria
<i>Cunninghamia lanceolata</i>	Chinese Fir; China Fir
<i>Cupressus funebris</i>	Chinese Weeping Cypress; Mourning Cypress
<i>Dendrocalamus</i> spp.	Giant Bamboos
<i>Diospyros kaki</i>	Chinese Persimmon; 'Kaki' Persimmon
<i>Elaeagnus angustifolia</i>	Oleaster; Russian-olive
<i>Eucalyptus citriodora</i>	Lemon-scented Gum
<i>Eucalyptus exserta</i>	Bendo Gum
<i>Eucalyptus grandis</i>	Rose Gum
<i>Eucalyptus Leichow</i> No. 1	<i>Eucalyptus</i> Leichow No. 1
<i>Eucalyptus saligna</i>	Saligna Gum; Sydney Blue Gum
<i>Eucalyptus tereticornis</i>	Forest Red Gum
<i>Ficus lancor</i>	Spotted Fig
<i>Ficus retusa</i> (syn. <i>F. microcarpa</i>)	Chinese Banyan; Malay Banyan
<i>Fraxinus chinensis</i>	Chinese Ash
<i>Fraxinus mandshurica</i>	Manchurian Ash
<i>Gingko biloba</i>	Maidenhair Tree; Gingko
<i>Glyptostrobus pensilis</i>	Chinese Swamp Cypress; Chinese Water-Pine
<i>Haloxylon ammodendron</i>	Common Dulse; Dulse
<i>Hovenia dulcis</i>	Japanese Raisin Tree
<i>Juglans mandshurica</i>	Manchurian Walnut
<i>Juglans regia</i>	Common Walnut
<i>Keteleeria davidiana</i>	David Keteleeria

Larix dahurica
Larix koreana
Larix principis rupprechtii
Larix sibirica
Ligustrum lucidum
Liquidambar formosana
Litchi chinensis
Livistona chinensis
Magnolia grandiflora
Mangifera indica
Melaleuca leucadendron

Melia azedarach
Metasequoia glyptostroboides
Michelia alba
Morus alba
Nerium indicum
Osmanthus fragrans
Paulownia fortunei
Paulownia lankanensis
Photinia serrulata

Phyllostachys spp.
Pinus armandii
Pinus elliotii
Pinus massoniana
Pinus sylvestris
Pinus tabulaeformis
Pinus taeda
Pinus yunnanensis
Piper nigrum
Pittosporum tobira
Platanus acerifolia
Platanus orientalis
Podocarpus macrophylla
Poncirus trifoliata
Populus canadensis
Populus chifungensis
Populus dakuanensis
Populus nigra
Populus pyramidalis (syn. *P. italica*)
Populus simonii
Populus tomentosa (syn. *P. pekinensis*)
Populus yunnanensis
Prunus spp.
Pterocarya stenoptera
Pyrus spp.
Quercus acutissima
Quercus mongolica
Quercus variabilis
Robinia pseudoacacia
Salix spp.
Sapindus mukurosi (or *mukurossi*)
Sapium sebiferum
Sassafras spp.
Schima confertiflora

Dahurian Larch
Korean Larch
Prince Rupprecht's Larch
Siberian Larch
Glossy Privet
Sweet Gum; Formosan Gum
Litchi
Chinese Fan Palm
Laurel Magnolia; Bull Bay
Mango
Punk Tree; Cajeput-oil Tree; River
Tea Tree; Paper-bark Tree
Persian Lilac; Chinaberry
Dawn Redwood
White Jade Orchid Tree; White Michelia
White Mulberry
Indian Oleander
Fragrant-Olive; Kwai-Fah
Fortune's Paulownia or Fox-glove Tree
(Variety of Paulownia or Fox-glove Tree)
Chinese Photinia

Bamboo
Armand's Pine
Slash Pine
Masson's Pine
Scots Pine
Chinese Pine
Loblolly Pine
Yunnan Pine
Black Pepper
Japanese Pittosporum
London or European Plane
Oriental Plane
Japanese Yew; Kusamaki; Buddhist Pine
Bitter or Trifoliolate Orange
Hybrid Black Poplar; Carolina Poplar
Chifung Poplar
Dakuan Poplar
Black Poplar
Lombardy Poplar
Simon's Poplar
Chinese White Poplar
Yunnan Poplar
Stone-fruits (Plums, Cherries, Peaches)
Chinese Wing-nut
Pome-fruits, including Pears
Sawtooth Oak
Mongolian Oak
Oriental Oak
Black Locust
Willows
Chinese Soapberry
Chinese Tallow Tree
Sassafras
Gugertree

Sophora japonica

Tamarix chinensis

Tamarix pentandra

Taxodium ascendens

Taxodium distichum

Thea oleosa (syn. *Camellia oleifera*)

Thea sinensis (syn. *Camellia sinensis*)

Tilia mandshurica

Ulmus laciniata

Ulmus pumila

Ziziphus jujuba

Ziziphus spinosa

Pagoda Tree

Chinese Tamarisk

Tamarisk

Pond Cypress

Bald Cypress

Tea-oil

Tea

Manchurian Linden

Manchurian Elm

Dwarf or Siberian Elm

Jujube Tree; Chinese Date

Thorny Jujube (wild)

Note: English names of tree species vary in many cases from one country to another. In the above list an attempt has been made to select those names most widely used, but it is not intended to be a comprehensive or definitive list.

Appendix 6

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