

CHINESE-AMERICAN
JOINT COMMISSION ON RURAL RECONSTRUCTION

Forestry Series : No. 1

FOREST CONDITIONS IN TAIWAN

By

Paul Zehngraff,
Forestry Consultant



TAIPEI, TAIWAN, CHINA

JUNE 1951

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Forest Condition in Taiwan

Introduction

Forests have played a most important role in human welfare since the early days of civilization. They have given food, fuel and shelter; and they have protected and increased fertility of the soils. They have provided the necessary raw materials for ships, dwellings, cities, railroads, telephones, electric power and innumerable other needs for human welfare in the development of civilization. These needs are still increasing. Nevertheless, forests always have been considered wild lands, the products they provide have been taken for granted and, they have been forced to yield space in favor of increased food production and immediate profits.

Looking back, it is evident that the human race throughout the world has been, and still is, shortsighted in regard to self preservation through conservation of natural resources. In heavily populated areas of the world, over-exploitation of the earth and its resources has been most severe.

Unless conservation measures are taken before the land is denuded, the population either must move or be fed. When neither is done, nature develops its own control measures, all of which are aimed to reduce the number of "parasites" so as to maintain a balance between production and consumption. Nature's most common weapon against over-population are diseases, slow starvation and wars. Scientific efforts thus far have proven fairly successful against diseases and, as a result, the populations are increasing at a steadily accelerating pace. Against the roots of the evil: human nature, over-exploitation and lack of foresight, civilization still seems to be helpless.

Conservation is an all embracing term. It implies the maintenance of a certain balance of all phases necessary for human welfare, now and for the future. Forestry is but one phase of conservation, but the maintenance of a proper balance between cleared land and forested land is recognized by conservation leaders of the world as the basis for all soil conservation and general human welfare.

The effects of deforestation are well demonstrated in many parts of the ancient world. When the protective forest cover for various reasons is removed, the micro-organic life which has been created in the soil over centuries, quickly disappears due to exposure and leaching and the soil undergoes certain undesirable physical and chemical changes. With the controlling factors of forest cover removed, the climate itself is drastically changed. Temperature ranges become sudden and severe; precipitation becomes sporadic, and drought periods alternate with flash rains which carry away organic matter and soils, depositing them in stream-beds, and causing flood and destruction. Winds whip up the dust, and air composition is changed to the

detriment of human health. The rate of certain diseases increases, formerly fertile land loses its productive capacity, and the population subsists in poverty on drugs, commercial fertilizers and borrowed time. Unless the root of the evil is attacked, other measures will prove of only temporary value.

In order to plan for and accomplish an effective conservation program, it is essential that the overall needs and capabilities of a nation be thoroughly recognized by its leaders and that all efforts be pooled to achieve a desired balance.

Forestry is but one phase of conservation, but as populations increase and other natural resources diminish, the remaining forests become increasingly important. They supply the only renewable natural resource, a resource for which numerous new uses are being continually developed, thus resulting in rapidly increasing per capita consumption of wood.

The purposes of forestry are to keep to a minimum the ill effects of over exploitation and denudation and, to maintain a balance between growth and drain of forest resources through protection, management, proper utilization and reforestation of cut-over areas. Since the ill effects are intangible and forest crops are long range crops, public understanding and support is most frequently inadequate. In most places, therefore, effective programs of forest capital conservation and management for full future production are started too late and, consequently, the costs of repair measures become disproportionally high.

Taiwan is among the few fortunate countries which, despite heavy past exploitation, still contains a significant forest capital of virgin timber and because of early foresight, a fair volume of young timber in artificially established forest stands. In addition, she possesses large areas of idle, but formerly productive forest land which, due to favorable climatic conditions, is still fertile and of high potential value when reforested. Repair measures in Taiwan, therefore, are not yet beyond justifiable expenditures and the returns on the investments will be high. However, if conservation and reconstruction measures are neglected, catastrophe within a foreseeable future is inevitable.

Summary of Past History*

During the former Chinese rule of Taiwan there was little concern for the forest except for the production of camphor on which the government established a monopoly in 1714. When the Japanese took over the island in 1895 they were immediately interested in its forest resources. The first step towards a forest exploitation program was one of land acquisition which was carried out by the newly established Forestry Section under the Industry Division. Farmers who owned forest land were required to show documentary proof of ownership. Lacking this, the government took possession of their forest. Likewise, large areas were acquired from the natives of the interior through a program of resettlement. The territories

*This chapter primarily is summarized from "Forestry in Formosa" by D. J. Haiback and K. Yamada, Forestry Division, SCAP.

thus gained were classed as national forests in the sense of being government owned.

In 1897 the Forestry and Exploitation Sections were combined under the name of the Forestry Branch, mainly to deal with the natives in camphor production and land acquisition and to establish forest ownership boundaries. In 1899 it began to administer the newly established government camphor industry. When the Exploitation Division was established in 1901, it took over the duties of the Forestry Branch and also began to sell government standing timber to private loggers. In 1905 the name was changed to Forestry Division.

Many changes in forest administration took place during the following 40 years. In general, however, the Regional Forest Office of the Governor General was the sole administrator of the so called special national forest areas on which the government operated three branch stations for the purpose of logging. The Forestry Division set the overall forest policy for the prefectural forestry sections which were responsible for the control of all regular national and prefectural forests and for encouragement of private forestry. In 1942 the Regional Forest Office was abolished, and the branch stations of the special national forests were transferred to the Forestry Division. The logging and milling equipment was transferred to the Taiwan Development Company, over bitter opposition by the government foresters. The following year, in line with the war time policy of decentralization, all of the national forests were transferred to the prefectural forestry sections which continued to follow the policy laid down by the Forestry Division.

By 1942 the national forests contained 89.1% of the forest area and 95.6% of the timber volume of Taiwan. Private forests covered 10.1% of the forest area and 4.1% of the timber volume, while communities and prefectures owned the insignificant balance. About 470,000 ha. of national forests has been designated as special national forests by 1942. They included the three principal government timber producing areas, the Ali-shan, Taiping-shan, and Paksien-shan. These areas produced most of the timber in Taiwan, primarily coniferous sawlogs. There were several private operations of government owned timber, but all were on a smaller scale than government operations.

Three national parks were reported in 1942 as covering about 470,000 ha. Like those in Japan they were not separate ownerships but were superimposed over other ownerships. Practically all were on national forest land.

Forest management plans existed only on national forests. In 1936 such plans, covering about 900,000 ha., were being followed. Plans were developed for an additional 1,000,000 ha. by 1943, but these were never followed. A protection forest system, similar to that of Japan, covered 364,000 ha. in more than 500 units by 1942.

In spite of the rapid development of the logging industry, production never came up to consumption, and large scale wood import was resorted to. The average domestic production for the period 1926 to 1941 was only 40% of consumption. Of the imported materials, 87% came from Japan. By 1940, production had nearly tripled, but so had consumption, and the import rate remained the same. Wood export which amounted to 15.4% of the production, or 6.1% of the consumption, was mostly in form of logs to Japan. A maximum timber production

of about 470,000 m³ was reached in 1941. The average timber production for the 16-year period 1926-1941 was about 245,000 m³. This volume was in addition to fuel production which averaged 465,000 M/T of fire wood and half-charcoal, and 55,000 M/T of charcoal annually. The total wood drain, including all forest products, reached 1,870,000 m³ tree volume in 1941. Two thirds of this came from the national forests.

From 1900 to 1941 a total of about 307,000 hectares had been reforested, more than three fourths of which was in private and prefectural forests. Most plantations were established of pure stands, and Formosan Acacia was the chief species planted. Cryptomeria and Cunninghamia were the most extensively planted conifers. Many exotic species were also introduced. Nurseries were small, mostly less than one half ha. each. By 1942 there were about 700 nurseries with a total area of 270 ha. Private nurseries numbered more than 300 and prefectural nurseries 240. The regional forest office maintained 35 nurseries of more than 2 ha. each. The Industry Bureau operated 19 nurseries for production of specialty trees and erosion control stock. It also had the prefectures operate 42 of its nurseries to provide stock for windbreaks and reforestation on private forests. The Monopoly Bureau operated 17 nurseries for production of camphor planting stock. The universities and experiment stations also operated nurseries for their own use. Prefectural nurseries were subsidized by the government (50% of stock production costs). Community nurseries received subsidies from both the prefecture and the government (1/3 of cost from each).

Present Situation

1. GENERAL

Taiwan, with its present population of somewhat over 9 million inhabitants, is primarily a forest country of extremely rugged topography. Of the total land area of 3,596,121 hectares, approximately 64% are now classed as forest land. This includes the entire mountain range which divides the island and extends from north to south, covering most of the central and eastern parts. To the east, the mountain range parallels the coast line and drops sharply into the ocean, while on the west the terrain slopes into broad alluvial plains extending along most of the coast. The mountains are high and steep, with the two highest peaks, the Chi Kao Shan to the north and Mt. Morrison in the central part, both reaching altitudes of slightly under 4,000 meters.

The principal mountain range is composed of slate, schist, gneiss and intrusive igneous rocks. The foothills are underlain by sandstone, limestone, shale and conglomerates.

Because of inaccessibility, topography and geological composition, the forest areas are largely unsuitable for agricultural purposes. The interior and high mountain areas are sparsely settled by natives (aborigines) who make a precarious existence, primarily from hunting,

supplemented by spot-farming on the mountain sides, handicraft and, in some localities, lumbering.

2. LAND USE

In the past, rather strict land-use policies were rigidly enforced. In line with the more democratic attitude of the Chinese Government such policies and enforcement have been largely abandoned since the restoration. Lack of enforcement of existing policies has increasingly encouraged unwise and short-sighted land-uses to the permanent detriment of public welfare.

The unwise land-uses include indiscriminate clear-cutting and burning of steep slopes, regardless of ownership, for the cultivation of cash crops of which banana, citronella and pineapple are the most common. In the back mountains the same procedure is followed by the natives for production of other food crops. Fires started for land clearing and other purposes often "get away" and rage uncontrolled over large areas, causing waste and destruction which renders the land non-productive for generations to come.

The mountain soils as a rule are of poor quality and low fertility. The burning of forest vegetation is therefore done partly to obtain the temporary fertilizer benefits from the ashes. After a few growing seasons this effect disappears and the user moves on to a new area, leaving the worn out area idle. This practice is used on national and other public lands as well as on private lands. Land-uses on national lands are under the control of the Bureau of Land Administration which is empowered to grant permission for use of idle land on a rental basis. Land willfully burned over by the potential user however is often classified as idle land.

In comparison with the bulk of mountainous areas in Asia, most of the mountains of Taiwan are still green and productive. This is partly due to favorable climatic conditions and partly to moderate use and high degree of protection in the past. However, the mountains of Taiwan are steep and most of them are of compositions which invite trouble when the forest cover is removed and the land used unwisely. As a result of indiscrimination and unwise land-use practices the exposed soil is washed out during heavy rains and carried away by rapid mountain streams to be deposited elsewhere, causing flood and destruction, clogging of water reservoirs and irrigation systems and direct agricultural losses. Once the mountain side is broken, land slides and erosion continue at an accelerated rate. The costs of repair and artificial erosion control measures are high in comparison with the temporary financial gains from the cash crops. The financial losses to agricultural crops and lands below are considerably higher than the temporary gains from cultivation of mountain slopes, which afterwards are left non-productive, constituting a continuous threat to fertile lands below. Because of the steepness of topography and the violent nature of the rivers, certain areas already are beyond the possibility of economic repair and reclamation.

RECOMMENDATIONS:

There should be no objection to multiple land-uses, provided that such uses are properly directed and understood and, that the land is recovered with forest vegetation after it has served its temporary agricultural purposes. As part of the land rental, therefore, such reforestation must be stipulated. In this manner the land-use will serve a double purpose, the latter being a conversion to tree species of higher commercial value.

On public forest land, whether idle or not, no clearing or cultivation should be permitted until conditions have been examined by the local forest officer and such use approved by him.

At the present time some public agencies, such as the Power Company, are devoting more effort to protection through propaganda, etc., than others. It is suggested that all agencies interested in conservation coordinate their efforts and that these efforts be supported through necessary appropriations of public funds.

It is recommended that extension work in proper land-use be carried out cooperatively by agricultural and forestry specialists.

It is urged that forestry protection personnel be given full support by the Government in attempts to reduce illegal clearing and burning.

3. FOREST STATISTICS

FOREST TYPES

Because of the extreme altitude differences in Taiwan, the climate ranges from tropical to frigid with everlasting snow. The island, consequently, is divided into distinct climatic zones, as shown below:

Table 1. CLIMATIC ZONE RANGES IN TAIWAN*

Climatic Zones	Percent of area	Altitude in North		Altitude in South	
		From : meters	To : meters	From : meters	To : meters
Tropical	56	Sea level	300	Sea level	600
Subtropical	31	300	1,500	600	2,000
Temperate	11	1,500	2,800	2,000	3,500
Frigid	2	2,800	4,000	3,500	4,000

* From chart prepared by Taiwan Forestry Research Institute.

Due to the geographic location of Taiwan and the extreme climatic variations of the island, forest species are numerous. Of the 200 commercially recognized species, broadleaved species number 154, coniferous species 20, and exotic species 26. Except for *Chamaecyparis* in the high mountains and artificially established stands, pure forest types are not found. Forest growth and other vegetation, however, vary in direct proportion to altitudes and climatic zones and are broadly classed into three main categories as shown in table 2.

Table 2. FOREST ZONES AND TYPES *

Tropical	Sub-tropical	Temperate	Frigid
Broadleaved		Mixed	Conifers
PRINCIPAL COMMERCIAL SPECIES			
<i>Tectona grandis</i>	<i>Cinnamomum</i> spp.	<i>Quercus glauca</i>	<i>Abies kawakamii</i>
<i>Dalbergia sissoo</i>	<i>Zelkova formosana</i>	<i>Castanopsis uraina</i>	<i>Pseudotsuga wilsoniana</i>
<i>Swietenia mahagoni</i>	<i>Juglans formosana</i>	<i>Pinus armandii</i>	<i>Juniperus squamata</i>
<i>Cassia siamea</i>	<i>Keteleeria Davidiana</i>	<i>Pinus massoniana</i>	<i>Juniperus formosana</i>
<i>Eucalyptus robusta</i>	<i>Podocarpus</i> spp.	<i>Libocedrus formosana</i>	
	<i>Acacia confusa</i>	<i>Cunninghamia lanceolata</i>	
	<i>Schima superba</i>	<i>Cunninghamia Konishii</i>	
	<i>Machilus longifolia</i>	<i>Cryptomeria japonica</i>	
	<i>Quercus gilva</i>	<i>Taiwania cryptomerioides</i>	
	<i>Michelia formosana</i>	<i>Chamaecyparis formosana</i>	
	<i>Pinus luchuensis</i>	<i>Chamaecyparis Taiwanensis</i>	
		<i>Tsuga chinensis</i>	
		<i>Picea morrisonicola</i>	

* From chart prepared by Taiwan Forest Research Institute.

FOREST AREA

Of the total area of 3,596,121 hectares in Taiwan, approximately 64%, or 2,278,956 hectares are classed as forest land. Of this area, 78% or 1,788,116 ha. are classed as productive forest while the rest is denuded or otherwise not producing timber. Artificial forests constitute 15.5% of the productive forest area. Bamboo covers 2.6% of the total productive area.

FOREST CAPITAL

The productive forest land in Taiwan carries a total capital of about 206,742,000 m³. Of this, about 70,787,000 m³, or 34.2%, are classed as conifers, while 135,955,000 m³ or 65.8% are broadleaved species. Capital contained within artificial forests is 5.6% of the total. Bamboo volume is estimated at 487,000,000 pieces.

OWNERSHIP

The ownership of forest land has remained practically unchanged since the restoration. At present, national forests and other government forest lands constitute 89.7% of the total forest area. Private holdings come next with 9.5% while other public lands cover only 0.8%. Of the productive government forest land, constituting 77.6% of the holdings, 6.2% are artificial forests. Of the productive private forest land, covering 85% of the holdings, 93% are artificial forests. Of all artificial forests, 61.8% are privately owned, 35.8% government owned and 2.4% in other public holdings. Of the total forest capital, 95.3% are contained within the national forests. Private forests contain 4.2% and other public holdings 0.5%. Artificially established forests contain at present 6.0% of the total government forest capital.

Table 3 and 4 which follow, show the forest areas and forest capital by principal forest types and by ownership.

NOTE: Present statistics on forest area and forest capital are based upon old surveys of questionable accuracy. They are believed to be unreliable and considerably over-optimistic for the following reasons:

1. The proportion of burned, cleared and cultivated land has been greatly increased due to lack of control during the past decade.
2. Indiscriminate cutting and thefts have likewise increased.
3. Private plantations have been largely cut for fuel.
4. Reforestation during the past decade has been seriously neglected.
5. Volumes indicated, in proportion to areas, are too high. Dividing volume by area the following stockings are revealed:

Artificial forests=118m³ per hectare

Natural forests=125m³ per hectare

Productive forests, mean=124m³ per hectare

All forest land=96m³ per hectare

Based upon field observations in Taiwan and compared with similar conditions elsewhere, the average volumes indicated, particularly for the last three conditions, are believed to be impossible.

Table 3. FOREST AREAS, BY OWNERSHIP *

Classes of land	Principal Forest Types	Ownership (hectares)			
		Government	Private	Other public	Total
Artificial Forest	Conifers	18,254	6,746	917	25,917
	Mixed	14,122	7,274	330	21,726
	Broadleaf	64,696	128,559	4,831	198,086
	Bamboo	1,784	28,814	1,212	31,810
Sub-total		98,856 35.8%	171,393 61.8%	6,690 2.4%	276,939
Natural Forest	Conifers	151,371	3,679	1,101	156,151
	Mixed	241,940	34	65	242,039
	Broadleaf	1,082,590	8,951	7,153	1,098,694
	Bamboo	13,787	465	101	14,353
Sub-total		1,489,628 98.5%	13,129 0.9%	8,420 0.6%	1,511,177
Natural reproduction		38,919	2,704	197	41,820
Scattered trees		62,901	4,371	317	67,589
Grass land		187,471	13,025	945	201,441
Denuded		13,110	911	66	14,087
Cultivated		19,825	1,377	100	21,302
Rocks, cliffs, etc.		134,573	9,350	678	144,601
Sub-total		456,799 93.0%	31,738 6.5%	2,303 0.5%	490,840
Grand Total		2,045,283 89.7%	216,260 9.5%	17,413 0.8%	2,278,956

* Courtesy, Taiwan Forest Administration

Table 4. FOREST CAPITAL BY PRINCIPAL SPECIES *

Principal Species	Government			Total Private m ³	Total Other Public m ³	Total, all ownership m ³
	Natural Forest m ³	Artificial Forest m ³	Total Government m ³			
Chamaecyparis	29,837,887	974,479	30,812,366	97,582	36,171	30,946,119
Tsuga	15,852,449	745,360	16,597,908	145,698	29,016	16,772,523
Cunninghamia	846,606	364,517	1,211,123	51,553	1,910	1,264,586
Cryptomeria	566,582	407,232	973,814	18,995	1,474	994,283
Pinus	8,766,811	836,133	9,602,949	30,874	18,335	9,702,158
Abies	5,265,063	—	5,265,063	58,693	9,706	5,333,462
Picea	3,724,233	—	3,724,233	41,558	6,872	3,772,663
Libocedrus	393,343	244,551	638,394	74,342	6,718	719,454
Miscellaneous	545,837	512,016	1,057,853	206,048	18,014	1,281,915
Total Conifers	65,799,316	4,084,293	69,883,609 98.7%	775,343 1.1%	123,216 0.2%	70,787,168
Castanopsis	22,870,474	481,530	23,352,004	1,374,124	162,428	24,888,556
Machilus	20,850,377	512,723	21,363,100	1,231,467	145,925	22,740,492
Shiia	9,461,476	711,429	10,172,905	634,030	69,488	10,876,423
Quercus	381,947	12,253	394,200	245,690	2,693	642,583
Engelhardtia	143,779	16,531	160,310	10,303	1,129	176,742
Cinnamomum	360,313	756,557	1,116,875	277,739	53,040	1,447,654
Zelkova	174,575	16,167	190,742	11,888	1,303	203,933
Acacia	2,866,502	2,573,523	5,440,025	3,099,975	330,347	8,870,347
Michelia	74,339	14,624	89,013	5,548	608	95,169
Tectona	3,577	1,547,791	1,551,368	96,690	10,597	1,658,655
Miscellaneous	62,384,364	941,405	63,325,769	937,942	91,041	64,354,752
Total Hardwoods	119,576,773	7,584,533	127,161,311 93.5%	7,925,396 5.8%	368,599 0.7%	135,955,306
Grand Total	185,376,094	11,668,826	197,044,920 95.3%	8,700,739 4.2%	996,815 0.5%	206,742,474
Bamboo (pcs.)	96,399,813	17,011,733	113,411,551	365,185,710	8,403,955	487,001,216

* Courtesy, Taiwan Forest Administration

PROTECTION FORESTS

Included in the total forest areas are several areas which have been designated as protection forests for the purpose of conserving soils, water resources, river banks, etc. The protection forests are superimposed over the national forests as well as over other ownership, and cover a total land area of 367,107 hectares with an estimated timber volume of 46,160,000 m³, distributed as follows:

	Area (ha.)	Volume (m ³)
National forest working area	326,586	44,950,000
Total outside working area	40,571	1,210,000
Total	367,107	46,160,000

At present, no cutting whatever is allowed in areas designated as protection forests. Consequently, growth is stagnating and natural mortality is high. These stands, therefore, are approaching the time when they will no longer serve the purposes for which they are intended, unless they are properly managed through selective cuttings which will revive growth and vitality and actually increase their value.

AGE CLASS DISTRIBUTION

A normal forest, theoretically is one in which age classes are evenly distributed and which therefore may be managed on a sustained yield basis with an equal volume of similar quality to be cut every year, without depleting the forest capital and without losing volume due to mortality in overmature stands. Since natural forests generally are reproduced under conditions of catastrophes, tornado, fire, over-maturity, etc., which break down the parent stand or otherwise create conditions favorable to establishment or re-establishment of forest growth, natural forests seldom reach desirable age class distributions. One of the major aims of forest management is to attain this balance through wise cutting practices of existing age classes and progressive regeneration of clearcut areas. Because forests are long range crops, this goal can be accomplished only over a long period. Steps toward this goal have been taken in Taiwan, but since reforestation has not kept pace with cutting, the goal is still far away and the age class distribution is unsatisfactory for future sustained yield. The approximate age class distributions in Taiwan are shown below:

Table 5. AGE CLASS DISTRIBUTION OF PRINCIPAL FOREST TYPES *

Age Group	Broadleaved Percent	Mixed Percent	Conifers Percent	Total Percent
Over 100	—	—	70	7.5
81—100	—	10	10	2.5
61— 80	—	10	—	1.5
41— 60	10	20	—	14.0
21— 40	20	30	10	20.0
0— 20	70	30	10	54.5

* From "Report on Taiwan Forestry" by K. W. Woodward, J. G. White Engineering Corporation, 1950.

ACCESSIBILITY

At first glance—based upon statistics indicating high volumes of standing timber in natural and still untouched stands—the outlook for increased logging appears promising and the reasons for comparatively moderate exploitation in the past are puzzling. However, the greater part of the presently untouched timber volumes in Taiwan are located on mountains too steep for logging or, in localities of such inaccessibility that to get this timber out require investments of such an extent that the undertaking thus far has been deemed prohibitive.

The portion of national forest volume which may be classed as accessible within a foreseeable future is estimated to be but 35% of the total volume, as shown below:

Table 6. ACCESSIBLE TIMBER VOLUMES

Ownership	Forest Species	Total volumes standing (m ³)	Percent accessible	Accessible standing volumes (m ³)
Government	Chamaecyparis	30,812,400	31	9,552,000
	Other Conifers	39,071,300	25	9,768,000
	Broadleaved	172,161,300	35	44,506,000
Other	All species	9,697,000	100	9,697,000
	Total	206,742,000	35	73,523,000

ANNUAL GROWTH

Actual growth data for Taiwan is not yet available. A project on growth study now

being undertaken by the Forestry Research Institute is, however, progressing slowly. The present average annual growth of the total forest capital is estimated by the Forest Administration to be 1.6 million cubic meters. One of the reasons for this low growth estimate is the high volume of overmature timber in which mortality exceeds growth. For abnormal forests, such as are found in Taiwan, distinction must also be made between total growth and effective growth. The latter is based upon degree of utilization possible under prevailing practices. In Taiwan, according to table 5, 11.5% of the forest stands are over-mature and 54.5% still too young to produce merchantable materials, leaving 34% on which effective growth is taking place at present.

ANNUAL DRAIN

The present timber products requirements in Taiwan are estimated at 800,000 m³ and fuel 1,200,000 m³, based upon standing tree volumes. The present annual cut (1950) is about 520,000 m³; the planned future cut is 927,000 m³. Both figures are exclusive of fuel. The commercial fuel production for 1950 is shown as 166,000 m³. This, however, does not include the fuels cut directly by the users. The total drain of wood for fuel, therefore, cannot be determined. Based upon past consumption, however, it is believed to be at least 0.11 m³ per capita, or about 1,000,000 m³.

The reason for the much higher planned future production is partly due to sharply increased demands for military use. Of the 1950 production, 82% came from government land. Of the 1951 planned cut, 90% will come from the same source.

ALLOWABLE CUT

In the management of normal forests, under a policy of sustained yield, the annual allowable cut is that part of the growth which may be harvested each year, after deducting normal losses due to mortality.

According to the present forest statistics for Taiwan, as furnished by the Forest Administration the total annual growth on the forest capital is 1,600,000 m³, or 0.8%.

The total annual allowable cut is estimated by the Forest Administration at 60% of the total growth as shown below:

Table 7. PRESENT GUIDE FOR ALLOWABLE CUT, GOVERNMENT LAND

Species	Total forest capital (m ³)	Annual allowable cut (m ³)	% of forest capital
Chamaecyparis	30,812,400	111,000	0.33
Other Conifers	39,071,300	111,000	0.30
Broadleaved	127,161,300	733,000	0.53
Total	197,045,000	955,000	0.48

This, theoretically, would stretch the supply of *Chamaecyparis* for nearly 300 years and maintain a balance between growth and drain indefinitely, on the remaining forest capital, after deducting normal mortality.

Actually, this is not so. Unless reforestation is drastically stepped up to take the place of the natural stands, liquidation of the present forest capital will be accomplished within 1/6 of this time. Since *Chamaecyparis* is the most valuable wood in Taiwan and therefore most profitably logged, government operations center primarily around this species. Of the total 1950 cut, 161,942 m³ were *Chamaecyparis*. The total remaining standing volume of this species is estimated to be 30,812,366 m³, of which 31% or, 9,551,830 m³ are classed accessible. Based upon the present production, the supply of accessible *Chamaecyparis* in Taiwan will be liquidated in about 60 years. Considering expanding woods requirements due to normal population increases, which in Taiwan is 3.2% annually, the present forest capital will be liquidated in about 30 years unless drastic steps are taken to replenish it.

For the total forest capital, the situation is about as follows:

a. Total standing volume (Table 4)	=	206,000,000 m ³
b. Protection forest volume	=	46,000,000 m ³
c. Productive forest volume (a-b)	=	160,000,000 m ³
After deducting protection forest, the accessibility is 46%		
d. Accessible forest capital (46%)	=	73,500,000 m ³
e. Growth (present) = 0.8% annually	=	588,000 m ³
f. Present needs = 800,000 m ³ plus fuel	=	2,000,000 m ³ Approx.
g. Annual deficiency (f-e/2) *	=	1,706,000 m ³
h. Annual population increase	=	3.2%
i. Liquidation period = about 30 years.		

* Under a liquidation system of cutting, annual growth is reduced in proportion to capital reduction. Average annual growth for this period therefore is half of the present growth.

Actually, it is impossible to determine the annual allowable cut until more reliable information is available on capital and growth, and a future management policy has been determined. Theoretically, the drain should not exceed the growth. However, in Taiwan, due to a preponderance of inferior wood and a high volume in over-mature age classes, overcutting would be permissible, provided that (a) such cutting be confined to over-mature timber and inferior species; (b) all clearcut areas be planted progressively; (c) good management be applied to all forest stands of potential value; and, (d) utilization on present logging jobs be considerably improved.

In addition to these points it is recommended that more areas of valuable timber be made accessible, even at what may seem prohibitive costs, in order to stretch the supply until the young, artificial stands on accessible areas are ready to supply the demands. Since the growth rates in the younger age classes are considerably higher than the present average, which

includes the old timber, the total growth and allowable cut will progressively increase under management when the old stands have been cut and reforested.

In order to determine the annual allowable cut on a sustained yield basis it is strongly recommended that the present statistics on forest capital be revised, if possible through examination of aerial photos, otherwise, by field spot checks and that the present investigations on growth be brought to an early completion.

4. FOREST MANAGEMENT

ADMINISTRATION

Following the Japanese surrender in 1945, the new Taiwan Provincial Government took over the administration of national forest land and most of the larger logging operations on such land. Since 1945 several changes in administrative organization and responsibilities have taken place, as well as frequent shifting of administrators and personnel.

At present, the Taiwan Forest Administration is responsible to the Taiwan Provincial Government, through the Provincial Department of Agriculture and Forestry, for administration of national forest land and, for logging operations on such land. The role which the PDAF plays in forest administration is primarily of a token nature, however. The Provincial Government, in conformity with the present economic condition, determines the forest policy, the amount of timber to be cut, disposal of revenue and appropriations for current administrative expenditures.

The Forest Administration, with headquarters in Taipei, consists of divisions. It has under its jurisdiction a total land area of 2,045,280 hectares, including 367,000 ha. of protection forests and national parks, all classed as national forests. The national forest areas are divided into seven forest districts, each with a district office. The districts, which range in size from 113,000 ha. to 356,000 ha., are divided into 40 subdistricts, manned by semi-technical personnel.

The Forest Administration operates six logging stations on national forest land. Three of these were formerly operated by the Japanese Government while the three others were privately operated. Although the logging stations are located within the national forest districts, they operate independently of the forest districts and of each other. They are responsible directly to the Forest Administration for the volume of timber produced and for reforestation of cut-over areas. In addition to logging, the logging stations operate several sawmills, primarily for custom sawing and for sawing of products needed for logging station maintenance purposes. These sawmills, partly because of antiquated and inefficient equipment, mostly operate at a loss.

The Administration is charged for the stumpage value of the timber cut by the logging stations, as well as certain taxes. The profits left over after the sale of timber products, however, also are claimed by the government. The Forest Administration in return must seek appropriations for other functions not directly related to logging. Appropriations, which

constitute but a fraction of the income from timber sales, are entirely inadequate for maintenance of future forest production.

The hsien (prefectural) governments are responsible directly to the Provincial Government and indirectly to the Forest Administration for management and protection of other public forest lands and for encouragement of private forestry. A total of 113 forestry personnel, authorized to execute forestry laws, etc., are assigned to the hsien offices for these purposes. While these officials formerly were regarded as Forest Administration personnel, they now are employed directly by the hsien governments.

PERSONNEL

Following the restoration of Taiwan most of the supervisory positions were filled by technicians from the mainland and local personnel formerly in subordinate positions. Only a very few Japanese remained in an advisory capacity. Being unfamiliar for the most part with the local overall problems, functions and possibilities, this shift led to a certain degree of inefficiency in all phases of forestry.

The total number of administration personnel is 1,647. Of these, 241 are employed at the Forest Administration Office in Taipei and 1,405 at the logging stations and the forest districts. In addition, there are 5,477 laborers, 4,527 of which are engaged in logging.

Although there is now considerably more forestry personnel than during the Japanese occupation, there is a pronounced shortage of field personnel for protection, public relations, technical work, supervision and inspection. On the other hand, the various offices, central as well as districts, are overloaded with personnel. Hence, in spite of the higher total number of present personnel, the total production in the various phases of forestry work is considerably less than before. The chief reasons given for this undesirable and inefficient personnel distribution is lack of transportation facilities and shortage of travel funds. A more serious reason for inefficiency, however, is an acute shortage of properly trained technicians and personnel and, an over-abundance of half-trained personnel who lack the grasp of the overall problems and the remedies for their solutions.

Adding to this unfortunate situation are frequent shifts and transfers of district personnel, making it difficult for forestry officers to win the confidence and cooperation from the local population, to become familiar with local conditions and to apply their knowledge and experience to the problems.

PROTECTION

Following the restoration of Taiwan, formerly established and strictly enforced control and protection systems were largely abandoned, due to the more liberal attitudes of the new government. The results of this new freedom are detrimental, not only to the forest and the land, but to the general attitude of the population toward conservation as a whole. Realizing the lenient attitude of the government and lack of enforcement, the local residents take

advantage of the situation and are willfully disobedient to the existing laws. Illegal land clearing, fires and thefts are now rampant, and huge losses have been sustained by the country through cutting of young potentially valuable forest plantation for fuel, destruction of sea-coast windbreaks, uncontrolled fires started by the natives for the purpose of hunting and by others for land clearing.

The local forestry field personnel lack backing by the government in the enforcement of protection. When offenders are caught and brought to court, most frequently the courts dismiss the cases. This lack of cooperation is rapidly discouraging the protection personnel to the point where they are becoming less zealous in their tasks.

LOGGING

Notwithstanding its high forest capital, Taiwan never in the past has produced sufficient wood for her own use. The chief reasons for this are: (a) the timber resources are located in mountains of difficult accessibility, involving high production and transportation costs, (b) a low degree of efficiency in logging operations and (c) poor "on the spot" utilization practices of the timber cut. It has, therefore, in the past been deemed cheaper to import certain forest products, such as railroad ties, pulp, poles and even lumber.

The Japanese government invested huge sums of money in the construction of logging railroads and logging equipment in order to develop this industry. An example of the transportation difficulties is the Alishan logging station on which logging operations began in 1913. The 65 km. railroad which connects the station with the city of Chiayi has a slope of 5% with 74 tunnels, totalling more than 10 km., three spiral sections, two switchbacks and 2.8 km. of bridges. On their 35 km. journey from Taiping-shan to the sawmill at Lotung the logs are transferred seven times over three aerial cableways and 4 narrow gauge logging railways before they are re-loaded on flatcars for their final journey to the mill. Consequently, transportation constitutes more than half of the cost of log production. Because of topographic conditions and the violent nature of the rivers in Taiwan, river driving of forest products is not possible.

The Taiwan Forest Administration is regarded as a revenue producing government business agency. Since timber harvest is the main revenue producing function of forestry, the present primary efforts of this agency, consequently, are devoted to logging. The Forest Administration operates six logging stations which in 1950 produced 38% of the total timber cut. Since practically all high grade coniferous forest is located on national forests, and conifers are most profitably logged, government logging is principally concentrated on these species.

Private logging operations on government land are confined chiefly to hardwoods. Partly because of lack of capital and partly because private operations are subject to government allocations of stumpage, these operations are, for the most part, small and inefficient.

The relative volumes produced are shown in table 8, which follows:

Table 8. VOLUMES OF STANDING TIMBER CUT IN 1950 (m³)

Principal species	Government Land			All other land	Grand total
	By Government	By others	Total		
Chamaecyparis	148,569	13,373	161,942	—	161,942
Other Conifers	45,016	827	45,843	1,578	47,421
Broadleaved	6,841	214,864	221,705	88,857	310,562
Total	200,426	229,064	429,490	90,435	519,925
PLANNED FUTURE CUT STANDING VOLUME (m ³)					
Chamaecyparis	159,420	—	159,420	—	159,420
Other Conifers	15,330	132,442	147,772	1,578	149,350
Broadleaved	28,390	501,201	529,591	88,857	618,448
Total	203,140	633,643	836,783	90,435	927,218

In addition, the commercial fuel production is shown as 166,000 m³, exclusive of the cuts by direct user. The total volume cut for fuel cannot be determined.

UTILIZATION

In spite of the wood shortages in Taiwan, utilization on most logging jobs, whether public or private, is usually poor averaging less than 50% of the standing timber volume. It is claimed that it is not economically feasible to utilize top wood, inferior species or trees of inferior form because of high local transportation cost. These materials, therefore, are left in the mountains, while similar materials are imported.

The Forest Administration derives its main source of income from sale of timber, and the highest profits are made on high grade logs. Consequently government logging efforts are concentrated on these products, which are contained in *Chamaecyparis* and other conifers. The present logging utilization of coniferous species is only about 60% of the standing tree volume.

Private logging operations on government lands are confined chiefly to hardwoods. The sales contracts pertain to the net volume of products removed, only. There are no specifications in the contracts pertaining to degree of utilization, quality or silvicultural practices. The only penalty is for over-cutting of the specified volume. In addition, government supervision of such operations is for various reasons extremely limited, being confined primarily to measurements of volumes taken out. The operators, therefore, fill their allotments with the best part of the best trees only.

The wood products deficiencies in Taiwan are mostly in form of railroad ties, poles, pulpwood and, in some places, fuel. While *Chamaecyparis* ties are fairly resistant to rot and termites and therefore will last 8 to 10 years without treatment, the service life of hardwoods ties without preservative treatment is only 2-4 years. There are at present insufficient treating facilities in Taiwan. The demand for hardwood ties is therefore limited and the price offered is comparatively low. Furthermore, production of ties in Taiwan requires fairly heavy equipment and finance, neither of which is available in most private operations. Because of the high production costs and low profits in this product, the government logging stations produce but a small fraction of the total needs.

Most of the inferior wood species, as well as waste materials left in logging operations, are suitable for pulping. In some instances such as for hardwoods, this utilization will involve different manufacturing methods. Information on such methods, however, is available locally. One paper factory, which is located in the same city as a logging station, at the terminal of a government logging railroad, is operating at half capacity because the price of waste material from the local government logging operation is higher than pulpwood shipped in from private operations at far greater distances. Such privately produced pulpwood, which, to a great extent, consists of pine resulting from premature cutting of young plantations, is often of a quality inferior to local waste materials.

Logging stations, transportation facilities, paper mills, railroads and several other wood using industries are all government operated, each strictly on a profit basis and all more or less depending upon each other for such profits. One of the chief causes for poor utilization and subsequent shortages of wood, therefore, is lack of coordination. In the end the forest must pay the bill to the detriment of future production.

SALE OF TIMBER

Sale of logs and timbers produced by the government logging stations are made to private sawmill operators and other concerns upon application. Demands for these products far exceed production. Yet, as a measure to prevent inflation, it is the present policy of the government to sell these products at predetermined prices, which range from 20 to 30% below the average market value.

Sales of government owned standing timber are made to private operators on an allocation basis. The maximum allocation is 5,000 m³ annually for a single operation. Cases have been observed where these allocations, despite existing wood shortages, are insufficient for maximum operation capacity. The appraised government selling price for such timber is derived by deducting the average estimated operation expenses, plus 15% profit, from the estimated average selling price. The total sum obtained by the government is generally insufficient for reforestation of the cut-over area, which, therefore, is left denuded or in an undesirable condition for future production.

FOREST POLICY

The present forest policy, forest regulations and, forest laws are based upon general overall forest policies for China. While they contain many excellent points, several of these are vague and non-specific or do not fit the local conditions. The most serious deficiency, however, is that for the most part they are not taken seriously and that the present chief policy therefore is to produce revenue.

RECOMMENDATIONS

Logging is the chief revenue producing function of the Forest Administration. Since this agency, like all other government agencies in Taiwan, must show profit, logging is given the highest priority of all forestry functions. Other activities suffer accordingly, for not only is about half of the administrative personnel occupied in this phase of forestry, but the chief emphasis of the entire administration is placed upon producing revenue. Overcutting, poor utilization, inadequate protection, lack of coordination, inferiority complex and inefficiency of personnel not employed in logging, etc., all are results of this emphasis.

Continuous harvests of forest products are made possible only by good forestry. The purpose of forestry is to maintain an adequate supply of timber and a balance between growth and drain. In most places, including the U. S. A., this is done at a cost.

Timber production in Taiwan always has been the smallest of its five major industries. The revenues derived by the government from logging are so insignificant in comparison with total needs and with the ill effects derived from placing the main emphasis on this item, that they should be given no further consideration, except as investment in future forest production and the many other benefits derived from maintaining forest cover.

The Forest Administration must be left free to apply its technical skill to forestry, rather than to logging, and it must receive the necessary appropriations to carry out its purpose.

To serve the purposes of forestry and carry out the intended functions of the forestry organization, a reorganization of the Forest Administration is necessary. The reorganization plan recently submitted by the J. G. White Engineering Corporation* is recommended with some exceptions, one being that the logging division be completely separated from forestry.

A proposed plan for reorganization is presented in the appendix of this report.

The number of field personnel, particularly for management and protection purposes, should be considerably increased. To some extent this can be accomplished through reduction of excessive office personnel and transfer of the more suitable individuals to the field.

It is recommended that a one-year forest field personnel training course be established, particularly for personnel of the ranger, field assistant and forest guard type. The course should include basic principles of forest management, silviculture, utilization, forest policy, soils, surveying, protection and public relations. It should, however, center primarily around

* "Forestry and the Taiwan Forestry Administration" by Nelson H. Fritz, J. G. White Engineering Corporation

practical training and application. While at least part of the training course should be given to existing personnel on a rotation basis, it should be designed mainly for new personnel. Candidates of this type should be chosen by the local population among whom they would live and work as public servants the better to carry out both local and government interest.

It is strongly recommended that a number of qualified technical foresters be given training in U. S. A. This training should be primarily concentrated on practical aspects of forestry and the trainees therefore should spend most of their time in the field, working with the American foresters. Trainees selected for this purpose should be experienced foresters in responsible positions, rather than young graduates seeking further education.

It is recommended that the government gives forest protection personnel more authority and support in the performance of their duties. It is suggested that in addition to regular protection personnel, certain trustworthy local residents be designated as deputies. Their responsibilities should be suppression of fires when discovered and reporting of violations. They should be paid only for actual service, but should be given a badge of authority. It is also proposed that a sharply stepped-up propaganda program for forest protection be initiated. The propaganda program should include posters, radio, newspaper and public meetings, as well as constant personal contacts by the forestry personnel. When public sentiment and understanding has been established, efforts should be directed toward the formation of forest protective associations for permanent, voluntary protection.

Whether it pays to utilize certain indigenous forest products and waste materials or import similar products with foreign exchange is a matter of national economics rather than of individual profits. Furthermore, wood imports are becoming increasingly unreliable with the dwindling of this source of raw material in other countries. Taiwan, at a somewhat higher expenditure of local funds, which would remain in circulation, can utilize to good advantage the greater part of the 50% of waste materials now being left on the logging areas and at the same time assist in stretching the wood supply.

In order to obtain the full value of government timber it is suggested that the sale of both standing timber and government produced logs be made through auctions or advertised sale and closed bids. The additional price thus obtained should be invested in forest improvements.

It is recommended that sufficient stumpage be allocated to private operators for year round operation. The contracts should by all means specify silvicultural practices and utilization standards. These operations must be much more closely supervised than they now are. Where clearcutting is practiced, reforestation should follow within a year.

It is urged that top level government circles be impressed that maintenance of sufficient productive forest cover is essential to the future welfare of Taiwan, financially and otherwise. Further denudation, lack of reforestation and indiscriminate land uses will provoke precarious conditions within a foreseeable future in form of increasing land slides, erosion, silting, floods and water shortages; this, in turn, will result in decreased agricultural production and needs for increased imports of wood products at heavy expenditures of foreign exchange. This may still be largely averted if the importance of forestry is fully recognized and preventive steps are

continuously taken.

An understanding of the purposes of forestry is the basis for a sound forest policy and the forest policy is the backbone of forestry. It is recommended, therefore, that the present forestry and protection laws be revised in line with a long range forest and land use policy for Taiwan and that this policy and laws be given full official support.

5. TIMBER MANAGEMENT

Probably because of a former abundance of virgin timber and extremely difficult and expensive logging and transportation conditions, timber management in Taiwan is of a rather crude type. For virgin timber the management policy is clearcutting and planting at the maximum production capacity. For the virgin stands of *Chamaecyparis*, which range in age from 200 to 2,000 years and is the most abundant and valuable coniferous species in Taiwan, the policy is to stretch the supply until sufficient young timber is developed to take its place. A considerable amount of advanced reproduction is generally found under old stands. Most of this, unfortunately, is destroyed in logging.

Although it is recognized that *Chamaecyparis* is the only termite-resistant tree species in Taiwan and of the highest commercial value for construction and other purposes and that it, therefore, is essential to maintain an adequate future supply, it is the policy to reforest with faster growing species exclusively.

For young, artificial coniferous timber stands, consisting mainly of *Cryptomeria* and *Cunninghamia*, the policy is clearcutting and planting at an arbitrary rotation of 40 years, following one self-supporting thinning at the age of 25-30 years. Various observed thinnings give the impression of over-cautiousness which, because of the rapid growth of these stands and the long intervals between thinnings and harvest cutting, result in repeated over-density and loss of growth.

For hardwoods which constitute 65.7% of the forest capital, there is no management policy. The cutting of these stands amounts to high grading and culling. Since incomes from cutting these stands are too small for reforestation or other stand improvement work, the areas are left in culled-over conditions with little possibility of future yields of commercial products.

Management plans exist only on national forests. During the Japanese occupation, management plans covering some 900,000 ha. of national forest land were being followed. In 1943 management plans were completed for an additional million hectares. The latter plans, however, were never put into effect. Whether any of the plans are now actually being followed can not be ascertained. At any rate, the plans are all sketchy and in urgent need of revision.

RECOMMENDATIONS

The future of forestry and wood supply in Taiwan will to a great extent depend upon present timber management practices particularly in young stands. Quality development of

forest stands is equally as important as quantity. In the thinnings of young stands the work must not be confined to suppressed trees, but must remove all surplus growing stock, including wolfy trees and trees of poor form where these threaten to interfere with the growth and development of better formed growing stock. Inasmuch as old yield tables are based upon natural development of "fully stocked" unmanaged stands, they are invariably too high for the best growth and development of managed stands. For managed stands it has lately been determined that maximum growth will continue throughout the rotation when the basal area (square of wood surface at breast height) per unit area is maintained nearly constant or, slightly rising, after an optimum has been reached. In future thinnings this should be borne in mind, and the basal area should be kept well below that which is indicated in old yield tables. A study of past growth under various basal area levels in existing stands is necessary to correct the yield tables and for making practical growing stock guides.

It is strongly recommended that, where possible, thinnings be made at more frequent intervals so as to increase the growth. In silvicultural management, particularly where quality is involved, the question is no longer how short a rotation may be made but, rather, how long a stand will continue to give satisfactory returns on the investments. When more frequent thinnings are made, and to the correct degree, it will be found that satisfactory growth will continue far beyond the arbitrary 40-year rotation, and that quality increment will exceed quantity. In other words, the mean annual monetary yield per hectare will be considerably increased in a longer rotation under more intensive management.

It must be strongly emphasized that the purpose of forest management is to use the forest stands through progressive removal of surplus growing stock. Correct growing stock levels at all age classes, annual growth and periodic yields are closely interrelated. Upon this balance hinges the total yield, and it is therefore the determining economical factor in commercial forestry through artificial reforestation.

Inasmuch as a future supply of *Chamaecyparis* is essential to the economy of Taiwan, it is urged that more attention be given to the regeneration of this valuable tree species, in spite of its slower growth. In the logging areas of the high mountains it is suggested that the possibilities for natural regeneration be explored, at least on an experimental scale. Since most of the advanced reproduction is destroyed in logging, it is suggested that some sort of soil scarification be tried during the last year prior to logging so as to make the soil receptive to seed fall and germination shortly before removal of the mother stand. Seedlings thus established would be too small to suffer much damage in logging and would contribute considerably to a better stocking. Without scarification no germination can take place, due to the presence of a dense grass and sod cover of the forest floor. The present practice of clearcutting should be abolished in favor of selective cuttings which will leave the more vigorous trees and thus stretch the supply of this valuable timber species.

Management of hardwood stands should vary according to their quality. For stands containing mostly inferior or low grade species, absolute clearcutting is recommended, followed by artificial conversion to high value species. It must not be expected that income from

logging of inferior hardwood species will pay the entire cost of reforestation. Profits derived from other logging must be used for a part of this expenditure.

In hardwood stands containing valuable species, much can be gained through selective cuttings, both in growth and future quality. The cuttings should be designed to release young growing stock of valuable species through removal of mature trees and trees of inferior quality. This will result in gradual conversion to stands of good quality and growth. Trees to be removed from such stands must be marked by forestry technicians prior to cutting. Very little profit, if any, may be expected from the first improvement cutting of such stands.

In several localities there is a shortage of fuel and miscellaneous wood products for local use. Since it is a cumbersome procedure for local people to obtain small amounts of government wood for such uses, the shortages are remedied by stealing government wood. These thefts naturally are not confined to inferior wood, but often include species of high potential values, both natural and in plantations established at high cost.

Inasmuch as the government owns most of the forest land, it also must carry the responsibility of supplying local wood needs. Proper timber management in wood-poor areas will solve the stealing better than unenforceable laws. In order to accomplish this, it is urged that the number of semi-technical forestry personnel be somewhat increased and distributed in areas where their services are most urgently needed. Their functions must include determination of annual local fuel needs in cooperation with village leaders, marking or designating trees to be cut for fuel and supervision of actual cutting. The field personnel must be given authority to manage individual tracts and stands according to accepted silvicultural practices and to distribute the wood according to predetermined regulations. While the income from such operations should cover the foresters' wages during the time spent on this service, the actual profit to the government would come later in the form of more and better products.

It is recommended that the present management plans be scrutinized and revised to fit actual conditions. This will require the assistance of an American or Japanese management plan expert and should, logically, follow a re-survey of the forest resources.

6. REFORESTATION

GENERAL

Because of a preponderance of old, over-mature timber and difficult logging accessibility, forest management in Taiwan consist mainly of clearcutting followed by artificial reforestation.

For replacement of the old virgin *Chamaecyparis*, the most important commercial species in Taiwan, fast growing species exclusively are used, particularly *Cryptomeria* and *Cunninghamia*, both exotics. Both species thrive exceptionally well in Taiwan when planted at the correct altitude. *Cryptomeria* may be planted up to 2,000 m. but it reaches its optimum development around 1,500 m. *Cunninghamia* may be planted up to 1,500 m. but reaches its optimum development around 1,000 m. Neither species is planted below 700 m. The reasons for using these

species for replacement are that seed from the old *Chamaecyparis* stands is difficult to collect, and the species grows comparatively slowly. Neither of the replacement species, however, is endowed with the rot- and termite-resistance abilities of *Chamaecyparis*.

In altitudes lower than 700 m. broadleaved species primarily have been used. Most of these were imported because of their high commercial values.

Because of the climatic conditions in Taiwan denuded areas are quickly invaded by noxious vegetations particularly tall aggressive grasses which constitute serious competition for the planted trees. Plantation care, consisting of frequent removal of such competition during the first two or three years is of the utmost importance.

PAST HISTORY *

Forest planting in Taiwan dates back to the early part of the century and very large areas were planted for various purposes during the Japanese occupation, a total of more than 307,000 hectares during this period. Private planting was especially encouraged. Although the national forests contained most of the wasteland, private and prefectural forests contained about three fourths of all artificial forest area. The reasons for this were that these lands were the most accessible and that the government gave considerable encouragement to these programs in form of free distribution of planting stock and financial subsidies. By 1941, commercial plantings on private and other public lands had reached a total of about 220,000 ha., and various protection plantings about 14,000 ha. On national forest lands during the same period about 53,000 ha. of commercial plantings and 15,000 ha. of protection plantings had been established.

Broadleaved species were used more often than coniferous. As of March, 1942 a total of 252,000 ha. of broadleaved species, 47,000 ha. of conifers and 6,500 ha. of bamboo had been planted.

Acacia was used in nearly half of the total planted area. Because of its nitrogen fixing properties it is particularly well suited for denuded wasteland. This species is the most valuable for charcoal production.

Camphor tree plantings were always encouraged by the government. By 1941, 47,000 ha. had been planted. *Cryptomeria* and *Cunninghamia*, both exotics, totalled more than 12,000 ha. each.

Casuarina, originally from Australia, comprised a total area of 14,000 ha. This species, because of its nitrogen fixing ability and ability to withstand the effects of salt is particularly well suited for coastal windbreaks. It is highly treasured for fuel.

Many exotic broadleaved species were also planted. The most common were Teak, Sisso, Tung Oil tree, Laquer tree, and *Cinchona*. Formosan red pine was the only native conifer planted to any extent. The total area planted was about 8,000 ha.

* Past History is condensed from "Forestry in Formosa" by D. J. Haiback and Kinji Yamada, Forestry Division, NRS, SCAP.

PRESENT STATUS

Since restoration in 1945 the reforestation has continued, although on a much smaller scale than before. However, the greatest part of the newly established plantations, as well as large areas formerly planted, have been lost during the later years due to lack of plantation maintenance. In addition, with removal of the strict control formerly exercised, large areas of artificial forests have been indiscriminately cut for fuel by the local population during the past decade, including 80% or more of the seacoast windbreak forests. No reforestation data is available for the three-year period, 1943 to 1945. The total area planted from 1946 to 1951, however, is claimed to be 42,000 ha. The highest government reforestation was reached in 1948, a total of 6,100 ha. However, due to lack of weeding and poor timing, most of this has been lost. Areas planted by private and other public agencies are strictly an estimate, based upon planting stock distributed by the government and government subsidies for this purpose. Due to serious lack of government supervision and follow-up on private and other public lands, the success of these plantings is undetermined.

Reforestation of cutover lands lags seriously behind cutting. On the government logging stations alone, the areas in need of reforestation aggregate 8,700 ha.

Below is shown the total reported reforestation from 1946 to present and the remaining areas in need of reforestation :

Table 9. RECENT REFORESTATION

Year	Government land (ha.)	All other land (ha.)	Total (ha.)
1946	1,108	1,079	2,187
1947	4,320	714	5,034
1948	6,180	1,937	8,117
1949	2,307	3,094	5,401
1950	4,307	4,898	9,205
1951	2,141	10,000	12,141
Total	20,363	21,722	42,085
Balance (denuded)	220,410	16,420	236,830

The total denuded area yet to be reforested is still alarmingly high. Not only does this mean a very serious national annual loss in terms of wood products and labor, but unless the rates of successful reforestation are immediately and drastically increased, the past ten years neglect inevitably will result in an equal period of low lumber production some twenty years hence because of the resulting uneven age class distribution. It is feared that this future

period of low availability will, in turn, result in premature liquidation of the present young artificial coniferous stands in order to meet demands and thus create accelerated timber shortages in years to follow.

The past and present lack of reforestation is particularly unwise, considering that the denuded areas are now largely accessible as result of past construction for exploitation. The next logging of these areas, therefore, would involve considerably less construction expenditures than formerly and result in cheaper production costs. The latter is necessary to offset future logging costs in old virgin timber, as these costs will increase sharply in proportion to greater future distance and decreasing accessibility.

In the past, considerable efforts have been made to find and introduce new forest species of high commercial value. A number of these have proven successful. Currently, except for the academic aspects and demonstrations, this important phase of reforestation has been discontinued, and further propagation of the successful species is not being undertaken. Present reforestation is confined chiefly to *Cryptomeria* and *Cunninghamia* on old logging areas, Teak in the southern part, *Acacia* and bamboo on erosion control areas, and *Casuarina* for re-establishment of sea-coast windbreak forests and farm shelter belts.

The planting season coincides with the rainy season and extends from December to April or May in the north and from May to August in the south.

While *Cryptomeria*, *Cunninghamia* and *Casuarina* are planted as regular nursery stock, *Acacia* is generally seeded directly on the area in prepared spots. Bamboo is planted in form of cuttings. Because of the high degree of competition, particularly from aggressive grasses, large planting stock is preferred. A considerable amount of plantation care, in form of release from competing vegetation during the first 2-3 years is essential to prevent the young plantations from being overcome. This competition increases sharply in proportion to the lapse of time between removal of the old stand and reforestation. Total cost of reforestation increases in the same proportions. Correct timing of reforestation and weed cutting is of the utmost importance. One of the chief complaints from the field is that funds for these purposes are received too late for efficient and effective operation. Large losses of reforested areas have been sustained due to lack of funds for plantation maintenance.

Reforestation in Taiwan lacks planning and coordination. It is now done mostly in a spotwise fashion without much regard for site quality or suitability of species. It gives the impression that whatever species happen to be available are planted wherever most convenient. Several cases have been observed where the particular species were planted on sites unsuitable for their proper development. This constitutes a serious financial loss, for trees are long range crops and the loss of production due to unsatisfactory growth is cumulative throughout the rotation.

FOREST NURSERY

The number of nurseries has been drastically reduced since the Japanese occupation, and the total nursery area has been cut in half. Following is a tabulation of the present nurseries

by ownership :

Table 10. STATUS OF FOREST NURSERIES

Ownership	Number	Area (ha.)	Transplant stock*
Government	78	40.9	13,390,000
Public & private	196	86.4	5,840,000
Public & private **	17	4.3	5,350,000
Total	291	131.6	24,580,000

* Available for planting, fall 1951. ** Windbreak stock nurseries.

The species grown are primarily *Cryptomeria*, *Cunninghamia*, Camphor, Teak and *Casuarina*. The first two are grown both from seed and by vegetative propagation (cuttings). The latter method, although somewhat more expensive at the start, is very successful for these species. Rooted stock of superior quality may thus be grown in one season. The survival is high and the faster initial growth is maintained after field planting. The principal limitation to this practice is availability of vegetative materials. All other species are grown from seed and must be transplanted in the nursery prior to field planting 2-3 years following seeding.

Nursery practices are not standardized, but vary from one nursery to another and the practices are not always the most desirable. The most common fault is over-density in nursery beds. This is nearly always true for *Casuarina*. The result is spindly planting stock with low resistance to the more exposed conditions on the planting areas. Although production of planting stock is the most important phase of reforestation, nursery work in Taiwan is a stepchild of forestry.

RECOMMENDATIONS

It is urged that reforestation in Taiwan be considerably increased and coordinated, on private lands as well as on national, in order to secure the future indigenous supply of timber and fuel and to prevent erosion.

To provide for an expanded reforestation program it is suggested that immediate steps be taken to expand and coordinate planting stock production through standardized and efficient nursery practices, under closer supervision. It is urged that felling areas on national forest land be re-planted immediately following logging so as to reduce later expenses for maintenance and to obtain the best growth. Similarly, it is recommended that reforestation on national forest be done progressively in an orderly pattern, rather than in the present spotwise fashion, in order to obtain better efficiency, both in reforestation and in later management. The more accessible denuded areas along formerly established logging roads should be given highest priority. For the purpose of obtaining the best growth possible on the areas planted it is essential that pre-examination of areas prior to reforestation include soil tests and site determination in

order to select the species best suited. Likewise, several more species than are now planted are suitable for reforestation in Taiwan. It is suggested that further propagation of these species be given highest possible attention.

Timing of planting and weed cutting is extremely important. Funds for these purposes therefore must be available when needed.

In order to meet future timber demands, the area of economic forest needed in addition to the present artificial forest, based upon an average annual growth of 6m³ is estimated at 125,000 hectares. The total needed for adequate protection is 32,000 ha. and for fuel production 107,000 ha., a total of 264,000 ha., of which half is on government land. This does not include sea coast windbreak plantings. A summary of reforestation needs, as estimated by the Forest Administration, is shown below:

Table 11. DESIRABLE REFORESTATION, 1951 to 1960

Ownership	Planting		Direct seeding ha.	Total area ha.	Estimated total cost NT\$ *
	Conifers ha.	Broadleaved ha.			
National Forest	42,668	39,998	39,997	122,658	322,030,630
Logging Stations	8,707	—	—	8,707	23,683,040
Total Government	51,370	39,998	39,997	131,365	345,713,670
Public Land	2,640	2,640	7,920	13,200	1,320,000
Private Land	24,000	24,000	72,000	120,000	12,000,000
Total	26,640	26,640	79,920	133,200	13,320,000
Grand Total	78,010	66,638	119,917	264,565	359,033,670
Reforestation Classification, National Forest ****					
Economic Forest	44,970	27,198	—	72,168	196,296,960
Erosion Control	4,800	9,600	9,600	24,000	62,496,000
Water Conservation	1,600	3,200	3,200	8,000	20,832,000
Fuel Production	—	—	27,197	27,197	66,088,710
Total National	51,370	39,998	39,997	131,365	345,713,670

* These include all costs (per hectare) : Planting \$ 890, seeding \$ 600, replacements \$ 140, weeding \$ 1,290, miscellaneous \$ 400. Total planting per ha. NT\$ 2,790, seeding \$ 2,430, for national land. On other land a subsidy of NT\$ 100 per ha. is given for reforestation.

** This includes all land which will be clearcut for fuel in the next 10 years.

*** Planting on other than national land is primarily for fuel production.

7. COASTAL WINDBREAKS

The coastal areas of Taiwan, particularly along the west and south coasts, are exposed to almost continuous winds, often of high velocities. For many years the coastal sands, which are stirred up by the ocean waves, have been whipped up by the winds and deposited inland in form of sand dunes in the same manner as snowdrifts. As the dunes weather and dry out, the materials from the top and windward sides are carried over the top and deposited on the leeward side. The dunes thus develop a rolling effect, slowly moving further inland, where they gradually cover productive lands and even buildings and other constructions. In the rolling of the dunes the finer sand particles are picked up by strong winds and carried inland, often several miles.

High winds and sand-flight cause considerable annual damage to farm crops. The damage occurs through abrasion, whipping, evaporation and salt-spray. The abrasion and whipping cause injury and mortality to leaves, hence decreased photosynthesis. This, combined with high evaporation rates and deposits of saltspray reduce growth and yields very considerably over extensive areas.

The need for protection against the wind, in form of sea coast windbreak forests and frequent intermittent farm land shelter belts, has been long recognized and long practiced. In Taiwan the program was formerly strongly advocated and supported by the Japanese government, through 50% of cost subsidy, with the result that about 14,000 ha. of seacoast and windbreak plantations were progressively established. The sand dunes were stopped, the ill effects of wind were largely checked and reclamation of damaged or lost land was progressing rapidly.

Partly as a military measure during the past war and partly due to lack of control since the war, the farmland windbreaks and particularly the seacoast windbreak forests have been drastically reduced. Of the latter only about 20% remain. In certain areas in the southern part of the island, farm windbreaks were established under the auspices of windbreak associations. After the crops were protected, the windbreak associations were dissolved, and the farmers gradually forgetting the reasons for which the trees were planted have cut them down for fuel under the excuse that they consumed too much space, water and fertilizer. This was especially true of tenant farmers.

The cutting of windbreaks, however, seems to be most intimately related to local availability of fuel. The most pronounced destruction, therefore, has taken place along the west coast plains areas where no other fuels are available. Average annual crop damages due to wind in these areas are now estimated by the Sugar Corporation to be approximately 10%. It is believed that other crops suffer proportionally. The agricultural production losses in coastal areas were estimated by the Japanese to be 25 to 30%.

An example of recent damage is an area near the coast west of Hu-wei. This area of more than 1,000 ha. formerly protected by windbreaks and shelter forest and used for rice production, is now bare, non-productive and covered with salty sands and sand dunes among

which the local population is attempting to grow a few peanuts and sweet potatoes. Sand filled irrigation canals and windtorn, sand-covered constructions are the only remaining signs of former productivity. The effects of wind and salt may be observed several miles inland, and the dunes continue their inward march.

The local populations once more realize the importance of windbreaks and serious attempts are being made to restore them. This interest is being strongly encouraged by the Sugar Corporation as well as by the local governments. The species most frequently used for windbreaks is *Casuarina*. *Miscanthus* spp., *Ipomoea* spp., *Vitex* spp., *Loucaena*, *Pandanus* and *Agave* are used for stabilizing the sand.

RECOMMENDATIONS

Since the importance of windbreaks is again fully recognized by the local land users who are willing to contribute labor for their re-establishment and care, it is urged that the Provincial and local governments further encourage this work in form of technical advice and financial aid.

Because windbreaks are located chiefly on private lands, their establishment, maintenance and management must necessarily be the responsibility of the owners. However, since past experience has proven that recognition of windbreak needs will change from one generation to the next, it is imperative that this responsibility be undertaken by permanent, voluntary organizations composed of such owners and directed by the local governments. The individual local organizations should be members of one overall provincial organization that would review and scrutinize all applications for windbreak establishment and subsidies, and supply technical assistance in overall planning, establishment, management and coordination.

It is also suggested that a study be undertaken immediately to determine: 1) the adequacy of nursery facilities for growing of windbreak planting stock; 2) the technical advice needed in the production of proper planting stock; 3) the nature and extent of planting stock production coordination, and 4) additional species suited for this purpose in the various localities, particularly on ruined areas near the west coast.

The initial costs of organized re-establishment of windbreaks and windbreak forests would each year be returned several times in the form of increased agricultural production. Future management of the windbreaks would, to a great extent, alleviate the acute fuel shortage in these areas. It is recommended, therefore, that all possible efforts be made to reestablish the windbreaks during the next five years. An estimate of the total needs follows:

Table 12. DESIRED WINDBREAK RE-ESTABLISHMENT 1951 to 1955

Location (hsien)	Status of Windbreaks				Total cost * (NT\$)
	Originally forested (ha.)	Deforested (ha.)	Reforested 1946—1950 (ha.)	Requiring reforestation (ha.)	
Taipei	453	386	86	300	630,000
I-lan	880	771	176	595	1,249,500
Taoyuen	1,880	1,494	280	1,214	2,549,400
Miaoli	2,305	1,855	355	1,500	3,150,000
Hsinchu	469	371	71	300	630,000
Taichung	773	685	149	536	1,125,600
Changhwa	1,021	895	248	647	1,358,700
Yunlin	2,700	1,950	735	1,215	2,551,500
Chiayi	737	652	246	406	852,600
Tainan	855	754	272	452	1,012,200
Kaohsiung	176	121	39	82	172,200
Pingtung	355	324	68	256	537,600
Taitung	800	641	62	579	1,215,900
Hwalien	814	665	28	637	1,337,700
Penghu	66	59	33	26	54,600
Total	13,820	11,613	2,339	8,774	18,425,400

* Cost is estimated at NT\$2,050 per ha., namely, planting stock \$ 500; transport \$ 15; labor \$ 135; settling of land (grasses, fencing, etc.) \$ 950; replacements \$ 450. These figures do not include travel and supervision which are estimated at 15%.

8. RESEARCH

Forestry research in Taiwan has been in progress for a long time and is contributing considerably to the solution of certain problems and knowledge of forestry. Forestry research is carried out primarily by the Provincial Forestry Research Institute and by the Taiwan University, School of Forestry. Both agencies operate independently of the Forest Administration and of each other.

While there is a definite lack of information on many practical forestry problems in Taiwan, most forestry research is of an academic nature due to shortages of operational

funds. Both research agencies and the Forest Administration are in possession of facilities for the solution of practical problems but, because of the split authority and resulting competitive feelings, there is a certain amount of overlapping and a definite lack of coordination.

The Taiwan Forestry Research Institute, with its headquarters in Taipei, was established in 1908. Besides the main station and its research laboratories in Taipei, the Institute operates six experimental forests, ranging in size from 334 ha. to 10,158 ha. with a total area of 14,014 ha. The research work is divided into six main projects, namely: 1) Forest Biology, 2) Silviculture, 3) Forest Management, 4) Forest Utilization, 5) Forest Chemistry, 6) Pulp and Paper. The projects cover the following main items:

- a) Tree identifications, herbarium collection, ecology;
- b) Culture of Laquer, quinine, camphor and rubber trees, natural regeneration of Pine and *Chamaecyparis*;
- c) Management of *Chamaecyparis*, *Cunninghamia* and *Acacia*, growth studies, yield table studies;
- d) Wood technology, strength tests, wood preservations;
- e) Wood distillation, tanning extracts, glue, resin, plastics;
- f) Chemical analysis, cellulose studies, pulping studies, and paper making.

In addition to serving as field laboratories for the Taipei Institute, research on the experimental forests is concentrated mainly on the following items: Cultivation and management of exotic trees for oil, rubber, medical purposes and miscellaneous uses; regeneration of hardwoods, and conversion of hardwoods to coniferous species.

The Taiwan University, School of Forestry, conducts laboratory research in the same subjects as the Forestry Research Institute, but on a considerably smaller scale. The university operates an experimental forest of 34,000 ha. This tract, with headquarters at Chusan, was formerly set aside as a demonstration forest by the Tokyo University. The University experiment station staff is now in the process of making a new management plan for the area. It appears, that after a few initial investments, particularly in reforestation, this station will soon be on a self-sustaining basis and at the same time contribute considerably on a demonstration basis as well as scientifically to silviculture and forest management in Taiwan.

RECOMMENDATIONS

It is suggested that practical aspects of forestry be given more attention in research work. Emphasis should specifically be placed on extension work and on cooperation among the research agencies and the Forest Administration in the solution of mutual problems. In need of solution are several problems in forest management. These include methods and severity of thinning in young stands, selective cuttings, natural regeneration, growth studies, yield tables, and revision of forest statistics. Intensified research is also needed in reforestation, plantation care, propagation of exotic species, nursery practices and windbreak establishment. It is suggested that the experiment station undertake seed germination testing

for the Forest Administration on a service basis and, that seed storage facilities be constructed for the purpose of preserving seed vitality for better nursery results. To accomplish this expanded program it will be necessary to increase somewhat the present number of personnel, as well as to shift the present emphasis in regard to priorities.

It is strongly recommended that a Research Advisory Committee be established for the purpose of maintaining close coordination between research and research needs. The committee should be composed of representatives from public agencies interested in conservation, management and utilization of forest resources. The function of the committee would be to scrutinize the nature, results and value of conducted research in relation to local problems, and to advise the research organizations of research needs.

9. PROPOSED FORESTRY PROGRAM

Further denudation, unwise land use and lack of repairs will result in conditions which will eventually be impossible to correct. These conditions include land slides, erosion, floods, decreasing water supply and a rapidly diminishing forest capital. In order to minimize the resulting agricultural losses and power shortages and to increase wood production so as to prevent future unbearable expenditures for import, it is essential that certain measures be taken now. Of foremost importance is the necessity to impress the government with the essence of forestry and that forestry may not under the circumstances be expected to yield net revenue. Harvest of timber may, however, be expected to pay the costs of repair. The recommended steps therefore are to:

- a. revise the present forest policy and regulations to fit the conditions in Taiwan;
- b. enforce this policy through proper support of enforcement officers and forestry personnel;
- c. reorganize the Forest Administration for more efficient functioning in line with the forest policy;
- d. provide "in-service" training for forestry field personnel in line with the forest policy and the objectives of forestry in Taiwan.
- e. initiate a concentrated education and information program for the purpose of gaining public support and re-establishment of forest protective associations;
- f. increase drastically the reforestation program during the next ten years so to secure a balance between growth and drain within at least 15 years and eventually to produce export materials;
- g. re-establish the seacoast windbreaks for the purpose of increasing agricultural production;
- h. enforce better utilization of forest products on the present logging areas through coordination of wood using agencies; and
- i. supplement present wood production through moderate import of scarce products.

FOREST POLICY

In any revision of the present forest policy and regulation it is urged that the following points be specified:

- a. Objectives: The objectives of forestry in Taiwan are:
 1. to keep the mountains green, stable and productive, thereby minimizing land slides, erosion and floods;
 2. to conserve forest resources, water resources, soil and scenic values;
 3. through forest management to maintain adequate wood supply, production and employment, consistent with normal population increases.
- b. Administration of National Forest Land: The above points being of national interest, the general policy of the government should be:
 1. All wild land, including bare mountains and waste land, when better suited for forestry than other purposes, should be designated as forest land.
 2. National forest land is public property and should therefore be managed by the government, including the harvest of timber, unless otherwise designated.
 3. Present and future national forest land timber resources should be under the exclusive control of the Provincial Forest Administration, regardless of the present conditions and uses of such lands.
 4. National forest land should not be sold, but may be leased when such lease is in the interest of public welfare.
 5. Uses of such land for private forestry purposes may be granted only by the Forest Administration following approval of a management plan submitted by the user.
 6. Uses of national forest land for other than forestry purposes may be granted only through the local forest officer following proper examination on the ground.
 7. Permission for temporary use must stipulate reforestation or afforestation by the user at the termination of contract and specify species for reforestation.
 8. The user must obtain documentary proof of permission.
 9. Management of privately owned forest land should conform with the government policy and be subject to government supervision.
- c. Management of national forest: The national forest management policy should be to manage all forest lands for their best uses and to maintain sustained yield of forest products, therefore:
 1. to hold the present timber area without losing further ground, all national forest areas now carrying species of commercial value must remain as productive forests;
 2. to improve the present forest land and forest capital through the best applicable silvicultural management and timber stand improvements, and;
 3. to extend the present productive areas through artificial reforestation of non-productive or sparsely stocked areas.
- d. Protection: The principal purpose of forest cover is for soil and water resource protection.

1. Forest areas or waste land on which forest cover is deemed essential for protection of soil, water resources, rivers, construction, agricultural production and human welfare should be designated as protection forests, regardless of present ownership.
 2. Areas designated as protection forests should serve to their best capacity the purposes for which intended.
 3. Areas so designated may be managed as other productive forest land under accepted silvicultural practices which will increase their value for the purposes intended.
 4. No cutting should be allowed in such areas prior to personal examination and recommendations by a recognized silviculturist and the Forest Administration director.
 5. The local forest officer should be responsible for protection and use of national forest land.
 6. Forest officers must receive full support by the government in the performance of their duties.
- e. Sale of government forest products: Forest products grown on government land are public property, therefore:
1. Sales of standing national forest timber, exceeding specified volumes, should be made through closed bids.
 2. Sale of logs or timber products produced by the government should be made at public auctions or closed bids.
 3. Advertisements of government timber or forest products for sale should be made 30 days prior to opening of bids.
 4. Sales of government timber, not exceeding specified volumes, or free use permits for fuel or other local purposes may be made directly by the forest officer in charge upon application.
 5. In sales of government standing timber the utilization limit and other sales conditions, as well as penalty clauses for violation, should be specified.
- f. Reforestation: In conformity with the national forest management policy reforestation of cut-over forest land should be made mandatory.
1. Clear-cut areas, irrespective of ownership, should be reforested within one year following felling.
 2. Lack of reforestation following clear-cutting of private land should result in land confiscation by the government. If the owner reclaims the land he should repay to the government all management expenses.
 3. For purpose of quick reforestation of denuded or unjustifiably cultivated national forest land, areas close to dense populations may be rented for reforestation.

REFORESTATION

The purpose of a coordinated and sharply increased reforestation program is to balance the growth and drain of forest products as early as possible. It is believed that the total 10-year goal of the Forest Administration is too high and beyond its annual ability (Table 11). Somewhat

less area over a 15-year period, as shown in table 13 below, is however feasible. Table 15 shows that this program will balance growth and drain in 15 years.

Table 13. REFORESTATION GOAL *

Year	Annual hectares	Accumulative hectares	Annual growth per ha. m ³	Accumulated volume m ³	Annual cost NT\$ **
1951	15,000	15,000	—	—	20,400,000
1952	15,000	30,000	0.5	15,000	20,400,000
1953	15,000	45,000	1.5	82,500	20,400,000
1954	15,000	60,000	2.0	202,500	20,400,000
1955	15,000	75,000	2.5	390,000	20,400,000
1956	15,000	90,000	3.0	660,000	20,400,000
1957	15,000	105,000	3.5	1,027,500	20,400,000
1958	15,000	120,000	4.0	1,507,500	20,400,000
1959	15,000	135,000	4.5	2,115,000	20,400,000
1960	15,000	150,000	5.0	2,865,000	20,400,000
1961	10,000	160,000	6.0	3,825,000	13,600,000
1962	10,000	170,000	6.0	4,845,000	13,600,000
1963	10,000	180,000	6.0	5,942,000	13,600,000
1964	10,000	190,000	6.0	7,065,000	13,600,000
1965	10,000	200,000	6.0	8,265,000	13,600,000
Total,	200,000				272,000,000

* Total, all ownership, in same proportion as shown in Table 11.

** Total, government costs, including subsidy of NT\$100 per ha. for private and other public lands.

WINDBREAK FOREST

It is recommended that the requirements for re-establishment of windbreaks be completed in a 5-year period. The annual requirements are shown below :

Table 14. WINDBREAK PLANTING GOALS

Year	Annual hectare	Annual cost NT\$*	Total reforestation and windbreak NT\$
1951	1,755	2,316,600	22,716,600
1952	1,755	2,316,600	22,716,600
1953	1,755	2,316,600	22,716,600
1954	1,755	2,316,600	22,716,600
1955	1,755	2,316,600	22,716,600
Total planting	8,775	11,583,000	112,583,000

* Based upon a subsidy of 55% of the total cost shown in Table 12.

Table 15. ESTIMATED WOOD PRODUCTION, REQUIREMENTS AND GOALS ^①

Year	Annual Requirements ^② m ³			Capital without Reforestation m ³	Growth ^③ m ³	Import m ³	Deficit m ³	Effect of Reforestation		
	Timber Product	Fuel	Total					Accumulated volume m ³	Revised capital ^④ m ³	Allowable ^⑤ Cut Timber Products m ³
1951	800,000	400,000	1,200,000	70,400,000	704,000	250,000	246,000	—	70,156,000	550,000
1952	812,000	406,000	1,218,000	70,156,000	701,560	250,000	266,440	15,000	70,171,000	562,000
1953	824,180	412,090	1,236,270	69,881,560	698,900	250,000	287,370	82,500	69,964,060	574,180
1954	836,560	418,280	1,254,840	69,602,190	696,020	250,000	308,820	202,500	69,804,690	586,560
1955	849,010	424,800	1,273,810	69,293,370	692,980	250,000	330,380	390,000	69,683,370	599,010
1956	861,750	430,870	1,292,620	68,962,490	689,620	200,000	403,000	660,000	69,622,490	661,750
1957	874,670	437,330	1,312,000	68,566,490	685,660	200,000	426,340	1,027,500	69,593,990	674,670
1958	887,790	443,890	1,331,680	68,140,150	681,400	200,000	450,280	1,507,500	69,647,650	687,790
1959	901,110	450,500	1,351,610	67,689,870	676,900	200,000	474,710	2,115,000	69,804,870	701,110
1960	914,630	457,320	1,371,950	67,215,160	672,150	200,000	499,800	2,865,000	70,080,160	714,630
1961	928,340	462,170	1,390,510	66,715,360	1,000,730	150,000	289,780	3,825,000	70,540,360	722,340
1962	942,270	471,130	1,413,400	66,475,580	997,130	150,000	266,270	4,845,000	71,320,580	792,270
1963	956,400	478,200	1,434,600	66,209,310	993,140	150,000	291,460	5,942,000	72,151,310	806,400
1964	970,750	485,370	1,456,120	65,917,850	988,770	150,000	317,350	7,065,000	72,982,350	820,750
1965	984,630	492,320	1,476,950	65,600,500	984,010	150,000	342,940	8,265,000	73,865,500	834,630

① All volumes are in terms of total standing tree volume.

② Annual requirements based on 1.5% annual population increase.

③ Growth is based upon 1% for the first 10 years and 1.5% thereafter.

④ Add accumulated growth from reforestation (Table 13) to "capital without reforestation".

⑤ Based on rates of import. In addition, the full fuel requirements may be cut. After 15 years the estimated growth will be 2% per year due to removal of over-mature stands. The capital will thus be on a sustained yield basis, and import will be limited to products which can not be grown locally.

10. PROPOSED JCRR PARTICIPATION IN FORESTRY PROGRAM

1. REFORESTATION: While government forestry in Taiwan, contrary to many other places in the world, is and can continue to be a profitable business, such profits have in the past been made to the detriment of future production. To bring about a balance between growth and drain under increased future production will cost more than the present national economy can bear.
2. WINDBREAKS: Although the farmers and other organizations now are anxious to re-establish windbreaks and windbreak forests, the magnitude of the problem is beyond the farmers' own financial ability, and the government is unable, financially, to speed up the program to its desired proportions.
3. EROSION CONTROL: Repair of damage caused by indiscriminate cutting, burning and unwise land use comes under the same category.
4. FOREST SURVEY: Re-survey of forest resources, necessary to revise the forest management plans, needs to be financially encouraged. Under the present economic conditions it will otherwise be "put off".
5. TRAINING: To effectuate an intensified management and protection program on a permanent basis, a training program for existing personnel is necessary. Financial aid in this will considerably stimulate and strengthen this project.
6. EXTENSION: Extension work is now completely lacking due to the financial situation. Funds invested in this project will have far reaching effects upon land use practices in the mountains and reduce future costs of repair.
7. RESEARCH: Practical research must be encouraged. The present appropriations are entirely inadequate for solution of pressing forest management problems.
8. PUBLICATIONS: A considerable amount of past research results are already in manuscript form. Appropriations for publication are not available.

Investments in forestry are of a long range nature and tangible results may not be expected immediately. Nevertheless, in Taiwan where 64% of the land area are steep mountains, classed as forest land, forestry not only is an indispensable part of an agricultural program, but it affects the entire national economy. It is urged therefore that JCRR takes an active part in the recommended forestry program. It should be made clear, however, that financial aid by JCRR is a stimulant designed to encourage maximum efforts by the government.

In addition to financial aid, it is recommended that JCRR provides increasing technical assistance and advice in the above phases of forestry and in others as deemed necessary.

Table 16 below shows the recommended financial participation by JCRR during Fiscal Year 1952.

Table 16. RECOMMENDED ANNUAL FINANCIAL AID

Item	Subsidy NT\$	Approximate subsidy %
Reforestation	3,060,000	15
Windbreak	2,316,600	55
Erosion Control	750,000	50
Forest Survey	300,000	50
Training	225,000	70
Extension	225,000	80
Research	600,000	—
Publications	150,000	100
Miscellaneous	248,400	50
Total	7,875,000	

11. CONCLUSIONS

Wood is one of the most essential and at the same time the only replaceable natural resource in the world. With the dwindling of other resources wood becomes increasingly important, and the per capita consumption is steadily rising. Maintenance of sufficient forest capital is of the highest importance to a nation's future economy. While the forest capital in most surrounding countries has been decreased to the point where the growth no longer meets demand, Taiwan still has considerable forest capital and large areas of denuded land, better suited for forest production than for any other purpose. The greater part of the forest capital, however, is inaccessible and must not be counted upon too strongly. For this reason, Taiwan never has been, and will not for some time be self-sufficient in wood production. Future imports of wood products must be largely discounted because of the dwindling supply of this resource in the outside world. The future of forestry and wood production in Taiwan, for indigenous use and for future export, lies in the accessible and presently denuded areas on which timber can be grown and harvested comparatively cheaply. The opportunity for export must not be overlooked. Furthermore, the forested mountains control the water resources and are of such a composition that unless they are protected by forest cover they erode and their water holding capacities will be depleted. This already is resulting in losses to agricultural and other production.

The revenue derived from present timber harvest is insignificant when compared with the losses resulting from further land destruction. Such revenues are however sufficient for repair

and investment in continued and increased future production. Taiwan now faces a crucial decision. Continuation of present policies and practices will inevitably lead to early liquidation, loss of production, heavy drain on the local economy for imports and poverty. Adoption of recommended policies and practices gives promise of increased production and future prosperity with only a comparatively small investment.

Unlike many surrounding countries, repair is not too late in Taiwan and the cost is comparatively cheap, but increases sharply with every year of neglect. Policy must be made clear and those who are assigned to carry out the task of execution must be given full support.

12. SUMMARY

1. Taiwan, according to available statistics, possesses a great wealth of forest land and forest capital, 0.27 ha. and 24.6 m³ per capita, respectively. The forest area covers 64% of the total land area. Of the total forest area 89.7% are government owned; 9.5% are in private ownership and the remaining 0.8% is owned by other public agencies. For the forest capital the figures are 93.5%, 5.8% and 0.7% correspondingly.
2. The total forest capital is shown as more than 206 million cubic meters. Of this, however, 66% are low value broadleaved species. Of the total capital, 22.3% are contained within protection forests in which no cutting is allowed. Of the remaining capital, 44%, or a little over 70 million cubic meters are classed as accessible. Based upon the present wood requirement and an annual population increase of 1.5%, the present accessible forest capital will be liquidated in 45 years.
3. Present forest statistics for Taiwan are based upon old surveys of questionable quality. They are believed to be over-optimistic and unreliable. Actual growth data is not available. Due to a high degree of over maturity in natural stands, it is believed that annual drain exceeds growth.
4. Notwithstanding its high forest capital, Taiwan never has been self-sufficient in wood production, but has depended upon import of about half of the needs. The reason for this is the locations of the natural stands and the difficulties involved in logging and transportation. Wood shortages result in thefts and premature cutting of young artificial stands in accessible locations.
5. Despite certain wood shortages in Taiwan, logging operations are wasteful and strictly on a profit basis and there is a lack of coordination among wood using agencies. Taiwan will be self-sufficient in wood products only when more timber is grown in artificial stands in accessible locations and utilization is improved.
6. The Taiwan Forest Administration which is responsible for the management and protection of government forest lands, functions as a revenue producing government business agency. It operates six logging stations which in 1950 produced 38% of the timber production, exclusive of fuel, which constitutes about a third of the total annual wood drain. The profits from government logging operations and timber sales are claimed by the government.

While these profits would cover total forestry needs, the appropriations for forestry are insufficient for management and maintenance of future production.

7. Present private logging operations on government lands are confined chiefly to hardwoods. Operations are on an annual stumpage allocation basis, the maximum of which is 5,000 m³. Government supervision of these operations is inadequate. This results in high-grading which leaves the areas in poor condition for future growth. The price of stumpage received by the government will not cover reforestation of hardwood areas.
8. Following the restoration of Taiwan, all supervisory forestry personnel were filled with foresters from the mainland and by local personnel formerly occupying subordinate positions. There is, furthermore, an abundance of half trained personnel who lacks the overall grasp and understanding of the problems, and a serious lack of skilled technicians. The resulting inefficiency is still evident.
9. Protection of forest land is inadequate because of shortage of field personnel and means of transportation. The office forces, on the other hand, are considerably in excess of actual needs. Protection personnel lack backing by the government in the performance of their duties.
10. The overall forest policies in Taiwan are vague and non-specific and are not taken seriously. They are urgently in need of revision, recognition and enforcement.
11. Unwise land-uses in the mountains have increased sharply since the restoration due to the more democratic and lenient attitude of the new government. This is now causing accelerated erosion and water shortages to the detriment of agricultural production. Because of the steepness of topography much of the erosion already is beyond control. Immediate financial gains from cultivation of unsuitable mountain sides are more than offset by losses below.
12. The area of bare land is 21.6% of the total forest land. Of this the government owns 93%. The total area of denuded land has increased rapidly during the past decade as result of illegal land-clearing, fires, thefts and lack of reforestation. Although the government during the past five years has reforested about 10% of the total denuded government land, reforestation has not kept pace with denudation. Furthermore, most of the recently established plantations have died due to lack of weeding. Planting stock production, reforestation and plantation maintenance lack planning and coordination.
13. The past and present insufficient reforestation is unwise considering that denuded areas are now largely accessible as result of past construction for exploitation. The next logging of these areas would involve less expenditures and result in cheaper timber production costs. This is necessary to offset logging costs in natural stands as these costs will increase in proportion to distance and inaccessibility.
14. A total of about 14,000 hectares of windbreaks was formerly established along the coasts for protection against high wind and flying sand. About 80% of these were cut, partly as a military measure during the past war, but primarily for fuel and lack of control during the following years. About 25% of the destroyed windbreaks have been re-established since 1946, but nearly 9,000 ha. are still in need of replanting. Cutting of the windbreaks is causing

high agricultural losses, particularly on the west coast where sand dunes once more are invading agricultural lands.

15. Forestry research in Taiwan is carried out by the Forestry Research Institute and by the Taiwan University. While there is a definite lack of information on practical problems, most research is of an academic nature. There appears to be a lack of coordination among administration and research.
16. Provided that immediate corrective measures are taken in form of legislation, enforcement, forest management, improved utilization and reforestation, Taiwan can be self-sufficient in wood products in a few years and will eventually be in a position to export.

13. SUMMARY OF RECOMMENDATIONS

1. Revision of the present fictitious statistics on forest capital and growth must be speeded up, through examination of aerial photos, if possible, otherwise, by field survey. A new cutting plan must be based upon actual growth and accessibility.
2. In government logging operations, profits must not take priority over utilization. Full utilization is necessary for maintenance of future supply and reduction of import. Inferior products should be harvested at cost or above.
3. Closer cooperation and better coordination of wood using and wood producing government agencies must be established.
4. Increased logging of hardwoods by private operators on government land should be encouraged in order to meet the wood shortages.
5. In sales of government stumpage to private operators, contracts must specify degree of utilization, silvicultural practices and penalties for violations. Stricter government supervision of such operations is necessary.
6. Sales of standing timber, as well as wood products produced by the government logging stations, should be made by auction or closed bids. The additional price thus obtained should be used to aid reforestation and future production.
7. It is urged that the present forest policies and regulations be revised to include all aspects of forestry in Taiwan and that the new policy be taken seriously.
8. It is recommended that the Forest Administration be given full jurisdiction over forest lands and authority to make improvements necessary for future sustained yield and maximum production.
9. It is recommended that the Forest Administration be reorganized to the effect that logging and forestry be separated, with greater future emphasis on the latter.
10. It is proposed to increase the forest field force for protection, management and field supervision. For the most part, this can be accomplished through reduction of excessive office forces and transfer of suitable personnel to the field.
11. It is recommended that a field personnel training school be established, particularly for personnel of the ranger, field assistant and guard type. The course should center principally

around practical field training, but should include the basic principles of forestry.

12. It is strongly recommended that several technical foresters be given practical training in the U. S. A. For best results, the trainees should be selected among experienced technical personnel.
13. Sharply increased reforestation activities are most strongly urged. Reforestation of denuded accessible areas is one of the soundest investments in Taiwan, both for production and continued employment.
14. For the purpose of increased reforestation activities it is urged that forest nurseries be expanded immediately and that nursery production be coordinated and standardized.
15. In order to reduce unwise land use it is recommended that extension work be carried out cooperatively by agricultural and forestry specialists. It is also urged that forestry personnel be given stronger support by the government in attempts to reduce illegal clearing and burning.
16. Inasmuch as there now seems to be considerable local interest in re-establishment of windbreaks, it is proposed that attempts be made to establish windbreak associations whose responsibility would be to coordinate windbreak work and protection. The local institutions should be under the direction of a central windbreak commission.
17. It is urged that closer cooperation be established between research and administration, and that more efforts be made toward solutions of practical problems, particularly in forest management.
18. It is also recommended that a Research Advisory Committee be established for the purpose of scrutinizing the nature, results and value of conducted research as related to local problems, and to advise the research organizations of research needs.

APPENDIX I

A List of the Names of Important Plants Mentioned in This Report

SCIENTIFIC NAME	CHINESE NAME	ENGLISH NAME
<i>Abies Kawakamii</i> Ito	臺灣冷杉、白松柏(台)	Taiwan Fir
<i>Acacia confusa</i> Merr.	相思樹	Taiwan Acacia
<i>Agave</i> spp.	龍舌蘭類	Century plant
<i>Casuarina</i> spp.	木麻黃類	Beefwood, or Swamp Oak
<i>Castanopsis uraina</i> Kanehira	烏來櫨	Urai Chinkapin
<i>Chamaecyparis formosensis</i> Matsum.	紅檜、薄皮(台)	Taiwan Red Cypress
<i>Chamaecyparis taiwanensis</i> Masam. et Suzuk.	臺灣扁柏、厚殼(台)	Taiwan Cypress
<i>Cinchona</i> spp.	奎寧樹	Cinchona Tree
<i>Cinnamomum camphora</i> Sieber	樟	Camphor Tree
<i>Cryptomeria japonica</i> D. Don.	柳杉	Japanese Cryptomeria, Peacock Pine.
<i>Cunninghamia lanceolata</i> Hook.	杉木	China Fir
<i>Dalbergia sissoo</i> Roxb.	印度檀、茶檀	Sissoo Tree
<i>Engelhardtia formosana</i> Hay.	臺灣黃杞、黃杞	Taiwan Engelhardtia
<i>Eucalyptus robusta</i> Smith	大葉桉	Swamp Mahogany
<i>Juglans formosana</i> Hay.	臺灣核桃	Taiwan Walnut
<i>Juniperus formosana</i> Hay.	臺灣檜、刺柏樹	Formosan Juniper
<i>Juniperus squamata</i> Lamp.	山柏	Mountain Juniper
<i>Keteleeria Davidiana</i> Beissn.	油杉	David Keteleeria
<i>Leucaena glauca</i> Benth.	銀合歡	White Popinac
<i>Libocedrus formosana</i> Florin	肖楠	Taiwan Incense-cedar
<i>Machilus Kusanoi</i> Hay.	大葉楠	Kusano Machilus
<i>Miscanthus</i> spp.	荳草	Miscanthus Grass
<i>Michelia Compressa</i> Max. Var. <i>Formosana</i> Kanehira	烏心石	Formosan Michelia
<i>Pandanus odoratissimus</i> var. <i>sinensis</i> Kanehira	林投	Textile Screw Pine
<i>Picea morrisonicola</i> Hay.	玉山雲杉	Taiwan Spruce
<i>Pinus Armandi</i> Franch.	華山松	Armand Pine
<i>Pinus luchuensis</i> Mayr	琉球松	Luchu Pine
<i>Pinus massoniana</i> Lamb.	馬尾松	Chinese Red Pine
<i>Podocarpus Nakaii</i> Hay.	百日青	Nakai Podocarpus
<i>Pseudotsuga Wilsoniana</i> Hay.	威氏帝杉、松柏(台)	Wilson's Pseudotsuga
<i>Quercus gilva</i> Blume	石櫟、赤皮	Red Bark Oak
<i>Quercus glauca</i> Thunb.	青岡櫟、校橫	Ring Cupped Oak
<i>Schima superba</i> Gard et Champ.	木荷、櫟仔	Schima
<i>Castanopsis longicaudata</i> Kanehi et Hatus.	白校橫、長尾尖錐栗	Caudata-leaved Chinkapin
<i>Swietenia Mahagoni</i> Jacq.	桃花心木	Mahogany
<i>Taiwania cryptomerioides</i> Hay.	亞杉、臺灣杉	Taiwania
<i>Tectona grandis</i> Linn.	柚木	Teak
<i>Tsuga chinensis</i> Pritzell	鐵杉	Chinese Hemlock
<i>Vitex Negundo</i> Linn.	埔姜、牡荊	Chinese Chaste-tree
<i>Zelkova formosana</i> Hay.	臺灣櫟、雞油	Taiwan Zelkova

APPENDIX II

TRANSLATION

STATEMENT ON INTRODUCED ECONOMIC PLANTS IN THE
TAIWAN FORESTRY RESEARCH INSTITUTE AND ITS SUBSIDIARY STATIONS

Prepared by the Forestry Research Institute

March, 1951

The following introduced economic plants in the Taiwan Forestry Research Institute and its subsidiary stations have been tested and found to be desirable for purpose of increasing production:

A. PLANTS FOR TIMBER

1. *Ochroma* — This belongs to the family *Bombacaceae* and is commonly known as light wood or balsa. It originates from Central and South America and is a sun-loving evergreen tree, thriving on dry, cool, and deep soil. In its native country, it grows to a giant tree of 60 cm. diameter at breast height, in 5 or 6 years. Its specific gravity is only 0.12 to 0.20, which is lighter than cork. In the olden time, it was used by the Spaniards as floats in the canoe and fish nets. Now it is extensively used for military purposes as insulating material, in the making of surface mines, and for insulation of sound, and is generally considered a high priced timber of great potentiality.

The balsa was introduced into Taiwan in 1930. It was first planted at Chu-tou-cho and Liu-kuei of Pingtung and later transplanted to the Stations at Hengchun and Chungpu and Shan-tse-ting of Chiayi. Growth was good and the plants have formed small colonies of 30 meters in height and 40 cm. in diameter. The plant seems to have a promising future. Promotion of its plantation should be encouraged for local timber production as well as for purpose of national defence.

Three species of balsa have been introduced into Taiwan: (1) *Ochroma bicolor* Rowlee, (2) *Ochroma Lagopus* Swartz, and (3) *Ochroma limonensis* Rowlee. The growth of the latter two is better than that of the first. Experimental planting in the various stations of the Forestry Research Institute has been satisfactory and growth of the trees planted in the compounds of the sugar factories and in villages south of Chiayi has been universally good, demonstrating that the balsa is suitable for planting in the tropical regions in the southern Taiwan. The Institute planted some balsa from seeds in the Botanical Garden of Taipei in the winter of 1949. The two years' growth has resulted in plants of about 1 meter in height, demonstrating that the balsa does not do well in the climate of northern Taiwan.

2. *Tectonia grandis* Linn. — is of the *verbena* family and is commercially known as teak or Indian-oak. It is indigenous of central and southern India and Thailand. It is a sun-loving, deciduous tree, thriving on high, dry, fertile soil. In its native country, it grows to the large

size of 2 meters D. B. H. It is the most fast growing, and highest priced of broadleaved trees. It makes good timber of small contractibility, good durability, beautiful sheen, and agreeable fragrance, and is in large demand for manufacture of high class furniture and ship-building.

It was first introduced in 1902 and planted in the Stations at Hengchun, Liu-kuei, Chiayi, and Chungpu. Twenty years after they were planted, the trees attained a height of 21.8 meters and a diameter of 22.7cm. This growth is comparable to that in the native place of the tree. The future of this tree is very promising. Like the balsa, it is now widely planted in the tropical regions in southern Taiwan. For extension on a larger scale, however, expansion in selection and nursery work will be necessary.

B. SPICE PLANTS

1. *Cananga odorata* Hook. f. — belongs to the family *Anonaceae* and is commonly called Ylang-Ylang or Ilang-Ilang. It is indigenous of the Philippines, Java, Malaya, and many islands in the Pacific. It was introduced in 1902 and planted in the Stations of Hengchun and Chungpu. The introduction has been successful and the plant is now widely scattered in southern Taiwan. It is also planted in the Botanical Garden of Taipei, where its growth is not so good and flowers are not many. It is a shade tolerant evergreen tree that thrives on moist, fertile soil, especially suitable for planting in village courtyards and sunny slopes which are slightly shaded. Growth is rapid, reaching 5 to 11 meters in height in 14-15 years. The flowers are greenish yellow with pungent fragrant odor. The flowering periods in Taiwan are April-May and September-October. The distilled essence is the most highly priced material for making perfume. It is cultured in France, where the annual production is 17-24 tons. It can be planted either by seeds or seedlings. Because of its high economical value, the promotion and extension of this plant seem to be very feasible.

2. *Malaleuca leucadron* Linn. — is a member of the family *Myrtaceae* and is commonly called cajuput. It is indigenous of northern Australia, Malaya, western Vietnam, Dutch Indies, etc. It was early introduced into Taiwan and extensively planted both in the north and the south. On the western coast of the Island, it is planted with Australian pine, Eucalyptus, and silk-oak (*Grevillea robusta* A. Cunn.) as windbreaks and is quite satisfactory. Because of its peculiar budding characteristic, it is often planted as a hedge-row, the top branches being trimmed off for distilling of oil. The oil is used in the manufacture of several kinds of medicinal oils and balms. It is also used as perfuming material in eye medicine, liniment, toilet-soap, and tooth paste. The annual production of the oil in Annam and Australia is 95 to 100 tons and is of considerable economic importance. As timber, it is strong and fine. There is an outer cork layer which is consisted of many very thin layers of fibrous material. This can be used for cigarette tips and for packing of citrus fruits. Its complete utilization and its adaptability for planting both in the north and south of the Island make the cajuput a very valuable tree.

C. MEDICINAL PLANTS

1. *Santalum album* Linn. — belongs to the family *Santalaceae* and is commonly called sandal-wood. It is indigenous of southwestern India and Malaya. It is parasitic and not shade tolerant. Its culture therefore requires a certain set of environmental conditions not easily met with. Both the wood and the leaves are fragrant. Distillation of its heartwood yields santalol, which is well known perfume essence and the standard medicine for treatment of gonorrhoea. Its wood is fine grained and of elegant appearance, with a pleasing aroma. When polished, a fine sheen is developed. It is therefore ideal for sculptural purpose and is used to a great deal in India for carving the Buddha. The upper branches are used for incense. The plant therefore has high economic value.

The sandal wood was introduced both in 1913 and 1916 and planted in the Hengchun Station of the Institute. Unfortunately, the trees were damaged by typhoon in 1919 after they had reached the fruiting stage. In 1921, the tree was replanted, and four suitable hosts, *Clausena lunulata* Hayata, *Hibiscus tiliaceus* Linn., *Lantana camara* Linn., and *Vitex negundo* Linn., were selected. The result was quite satisfactory, the trees flourished, and good sandal-wood has been obtained. The future holds good for the planting of this tree, especially in the tropical regions of southern Taiwan such as Chungpu and Liukuei.

2. *Cinamomum zeylanicum* Breyn. — is a member of the *Lauraceae* family. It is indigenous of Ceylon and is commonly called the Cinnamon tree or Ceylon cinnamon. It is shade tolerant and is suitable for growth on muck soil. Its bark contains the aromatic cinnamon oil well known as spice and drug.

Introduction into Taiwan was made in 1871. The first planting in Taiwan gave mediocre result, but subsequent transplantation to Shan-tze-ting of Chiayi resulted in better growth. This plant has high economic value and can be planted either from the seeds or the seedlings. Its extension seems to be feasible.

D. OIL PRODUCING PLANTS

There is a scarcity of oil producing plants in Taiwan. The tung tree and the *Sapium sebiferum* Roxb. are not suitable for planting on the Island. According to past observation and experience, the *Camellia oleifera* Rehd. et Wils. seems to be more suitable.

The camellia is a member of the *Theaceae* family. It is indigenous of South China, and is extensively planted in the Kiangsi and Hunan Provinces. It is an evergreen shrub that thrives on red alluvial soil of considerable depth. Under good growth condition, it may become tree shaped with a round crown. Life of the tree is long. Renovation is not required until the tree reaches 60 years in age. Fruits appear 9 years after the planting. The camellia planted by the Institute at Shan-tze-ting (Chiayi) have a fair growth and have already reached the fruiting stage. The planting of this shrub should be extended on deep soil on sunny slopes.

E. TANNIN PLANTS

1. *Haematoxylon campechianum* Linn. — belongs to the family *Caesalpinaceae*. It is a small evergreen tree commonly of 7-10 meters in height and 15-18 cm. in diameter. Its wood is hard. The sapwood is yellow in color and of no value. The heartwood is purplish brown, and from it the staining cells in microscopy, for dyeing high class woolen fabrics (especially for purple green and black velvet), and as an astringent in medicine. It has therefore high economic value. It is indigenous of Mexico and thrives on hot moist level land, but can also be planted on moist hillsides. It can be cut after its tenth year.

The plant was introduced into Taiwan in 1911 and planted at the Hengchun Station of the Institute. Fruiting occurs in 3-5 years. Germination of the seeds is 75-90%. There were small forests of this plant in Taiwan before World War II, but they were cut down by the Japanese during the War. Extension of this plant is feasible.

2. *Acacia Mellissima* Willd. — is a member of the *Mimosa* family and is commonly known as green wattle. It is a small deciduous tree indigenous to Australia. Its bark contains 30-38% tannin, which is used in leather tanning.

The green wattle was introduced into Taiwan in 1911 and planted in the Hengchun Station. The 5 year tree reached 10 meters in height. In its 8th year, the bark could be stripped. The seeds are small, but of good germination power. It can be planted in all localities where the water table is high. To ensure success, however, it should be planted in southern Taiwan, because it is not tolerant to low temperature and strong wind.

3. *Terminalia chebula* Retz — is a member of the *Combretaceae* family and is commonly known as myrobalan. It is an evergreen tree indigenous to northern India. The fruits are egg-shaped or round, of 3.5cm. in length. The fibrous skin is yellow in color and contains as much as 48-52% of tannin when the fruit is ripe. It is an important source of tannin for leather tanning and for preservation of fish nets. It was early introduced into Taiwan and found to be growing well and giving good yield. It should be widely extended in order to increase the local production of tannin.

REMARKS :

Among the catechu plants known for their tannin content are the plants of the *Acacia sp.* and *Rhizophora sp.* The latter thrive in the brackish water regions and tidal flats and are useful in protecting the dykes. Their mode of reproduction is peculiar. The fruits drift with the current and tide to all places suitable for their growth. In this manner, they spread to tropical Asia, Australia, and many Pacific islands. These plants have high tannin content. The bakau of commerce are *Braquiara conjugata* (L) Merr. (*Rhizophora conjugata* L.), and *Rhizophora mucronata* Lam.; the tengah are *Ceriops tagal* (Perr.) C. B. Reb. (*Rhizophora tagal* Per.), and *Geriopa Roxburghiana* Arn. The *B. conjugata* R. *mucronata*, and *Ceriops tagal* are commonly found along the Kaohsiung Harbor. Another species, the *Kandelia Candel*

Merr. (*R. Candel L.*), is found along the harbors of Keelung, Tanshui, and Hsinchu. The local fishermen know of the value of these plants and use them extensively for dying fish nets. Due to ruthless collecting, the stocks at Keelung and Hsinchu are fast being depleted.

As stated, these plants are valuable for the protection of the dykes and furnish the tannin for preserving the fish nets. If unrestricted collection is allowed to go on, it is afraid that they would become extinct. For protecting the sea dykes and preserving the supply of tannin, restrictive measures should be promulgated and enforced and encouragement for the planting of them should be provided.

APPENDIX III

RECOMMENDATIONS FOR THE IMPROVEMENT OF
FORESTRY IN TAIWAN

To promote greater opportunity and incentive in the development of maximum effectiveness and administrative efficiency in forest management, reforestation and silviculture and in logging engineering; to utilize more completely the special qualifications of available technical foresters and logging engineers; to facilitate the formulation, execution and supervision of improved policies, programs and procedures relating to forestry and logging engineering, and to promote and strengthen the conservation, development, more orderly harvesting and replacement of forest resources, the following recommendations are presented:

1. There should be clear and complete separation of responsibilities, budget, personnel, policies, program and operations between forestry and logging.

Comment: All responsibilities, activities, functions and operations relating to logging now exercised or performed by any office or unit of the Forest Administration should definitely and completely be removed and logging established as a separate distinct agency of PDAF, leaving the Forest Administration solely and completely responsible (both administratively and technically) for all forestry, forest management, silviculture and reforestation activities. Except for the Commissioner of PDAF, no subordinate person should concurrently have responsibility or perform any operation or function relating to both forestry and logging. Following separation, Forestry should be accorded Bureau status in PDAF.

2. There should be positive, straight-line responsibility and matching authority for all forestry matters extending directly from the Provincial Governor through the Commissioner of PDAF to the Director of the Forestry Bureau and through him, directly to the responsible persons in charge of each Forest District Office.

Comment: The Forestry Bureau should be recognized as an autonomous, separate and dependent agency of PDAF, fully responsible to the Commissioner for all forestry, forest management, silviculture and reforestation matters and with complete jurisdiction over the personnel, program and operations of all Forest District Offices.

3. All aspects of the Forestry Bureau's work should be carried out on the basis of an approved program and annual budget entirely financed through regular annual governmental appropriations.

Comment: The Forestry Bureau, including its administrative, operational and supervisory activities should function solely on the basis of a regular, annual program of work which should be reflected in an approved annual budget financed through regular annual governmental appropriations with expenditures authorized only on the basis of approved individual projects.

4. All areas and locations of cutting for all government-owned land; the annual volume and kind of timber to be cut; the silvicultural methods of cutting, and the degree of utilization on all logging jobs should be planned and supervised by the Forestry Bureau.

Comment: The Forestry Bureau should be the recognized authority having undivided control over all government-owned forest lands in regard to determination of areas and locations of cutting; annual volume and kinds of timber to be cut; silviculture; method of cutting; and the management of all government forest land. After logging, complete jurisdiction over the land and remaining timber should revert automatically and immediately to the Forestry Bureau.

COMMENT ON LOGGING

It is to be noted that no recommendations relating to logging engineering (other than that logging should be definitely and completely separated from the Forest Administration and made a separate agency of PDAF) have been made. It is felt that logging should be established as an integral part of the PDAF and subject to full administrative control by the Commissioner of PDAF. However, the details of such establishment, operation, lines of authority, etc. are for the judgment of the Commissioner of PDAF with such consultation as may be desired from the Sr. Logging Engineer of J. G. White Engineering Corporation. Further, it is believed that it would be in the best interests of the Chinese Government to arrange to have the entire proceeds derived from all logging operations channeled directly to the government treasury, and all logging operations conducted on the basis of funds provided through regular governmental appropriations.

APPENDIX IV

PROPOSED PLAN FOR REORGANIZATION OF FOREST ADMINISTRATION

(Proposed changes in organic law covering forestry and forest land)

A. FORESTRY

The name "Forest Administration" shall be changed to "Forestry Bureau" to be established within PDAF (see chart). The Chief of the Forestry Bureau shall have full authority all over technical forestry matters and shall be directly responsible to the Commissioner of the PDAF for such authority. Functions of the Bureau shall be:

1. To manage government forests, forest lands, and timber for the purpose of maximum sustained yield.
2. To supervise cutting of all government timber.
3. To enforce regulations governing government forest lands and timber.
4. To reforest all government forest lands immediately following cutting.
5. To reclaim idle government forest lands for increased production through reforestation.
6. To protect government forest lands and timber against fire, insects, diseases, illegal cutting and land clearing.
7. To remedy erosion and protect soil and water resources.
8. To supervise and coordinate functions of Forest Districts and their subordinate sub-districts.
9. Through cooperation and assistance to promote sound forestry practices on public and private forest lands.

B. LOGGING

1. GOVERNMENT LOGGING: A separate agency to be known as "Central Logging Office" shall be established under PDAF. (see chart). The Chief of the "Central Logging Office" shall be responsible to the Commissioner of the PDAF. Logging districts (areas now controlled by Logging Stations) shall be classed as Forest Sub-districts and shall be under the direct administrative and supervisory control of the Forestry Bureau. Functions of the Central Logging Office shall be:

- a. To produce logs, lumber and other forest products on designated government forest land.
- b. To operate and maintain government owned sawmills, logging railroads and other equipment.
- c. To supervise and coordinate functions of subordinate local offices.
- d. To advertise and assist in sales of government produced logs and lumber according to regulations.
- e. Through subordinate local offices to cooperate with the Forestry Bureau in carrying

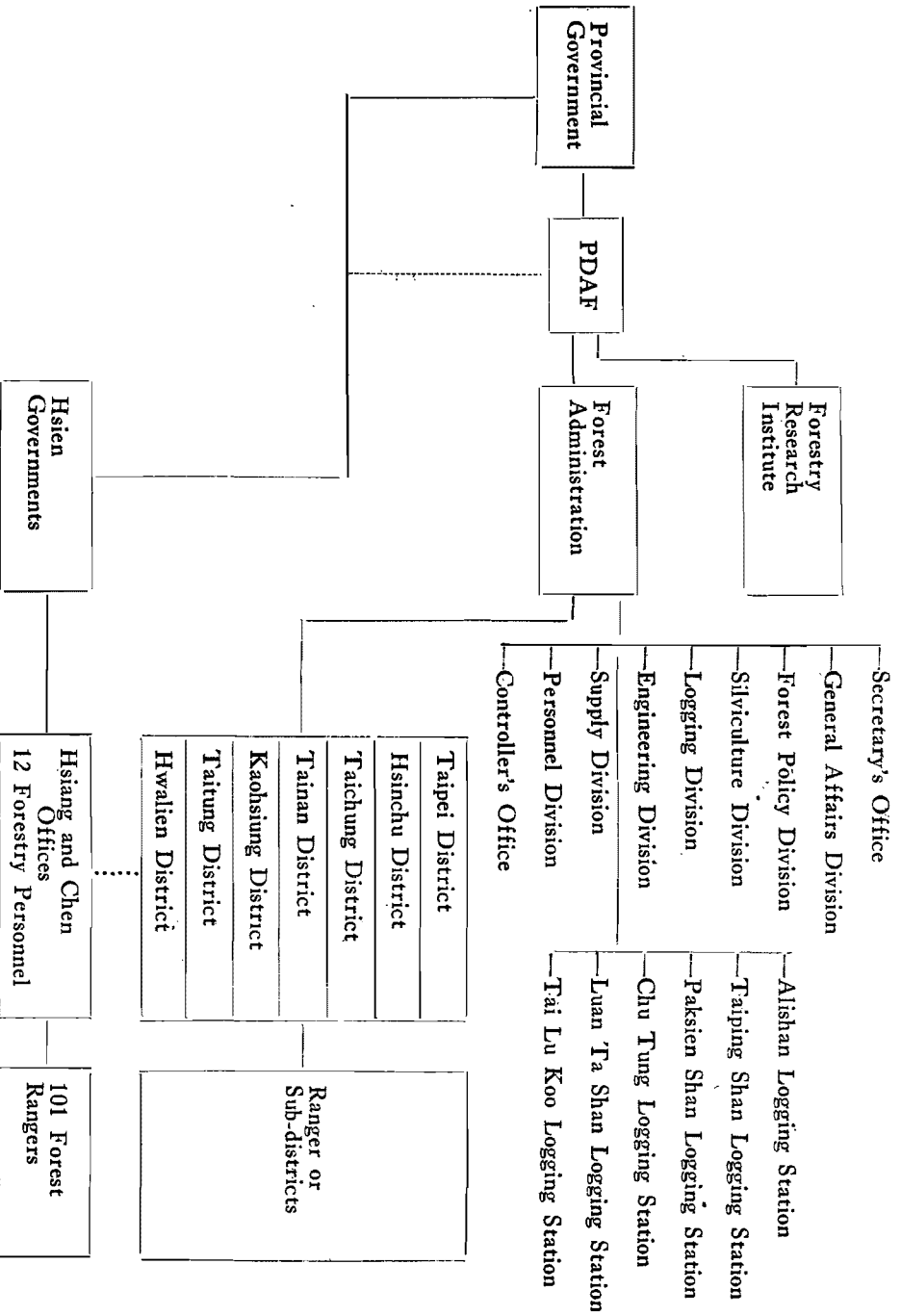
out forest regulations, management practices, protection and reforestation of operational areas.

2. PRIVATE LOGGING: Private logging operations on government forest lands and sales of standing timber shall be under direct jurisdiction of the Forestry Bureau.

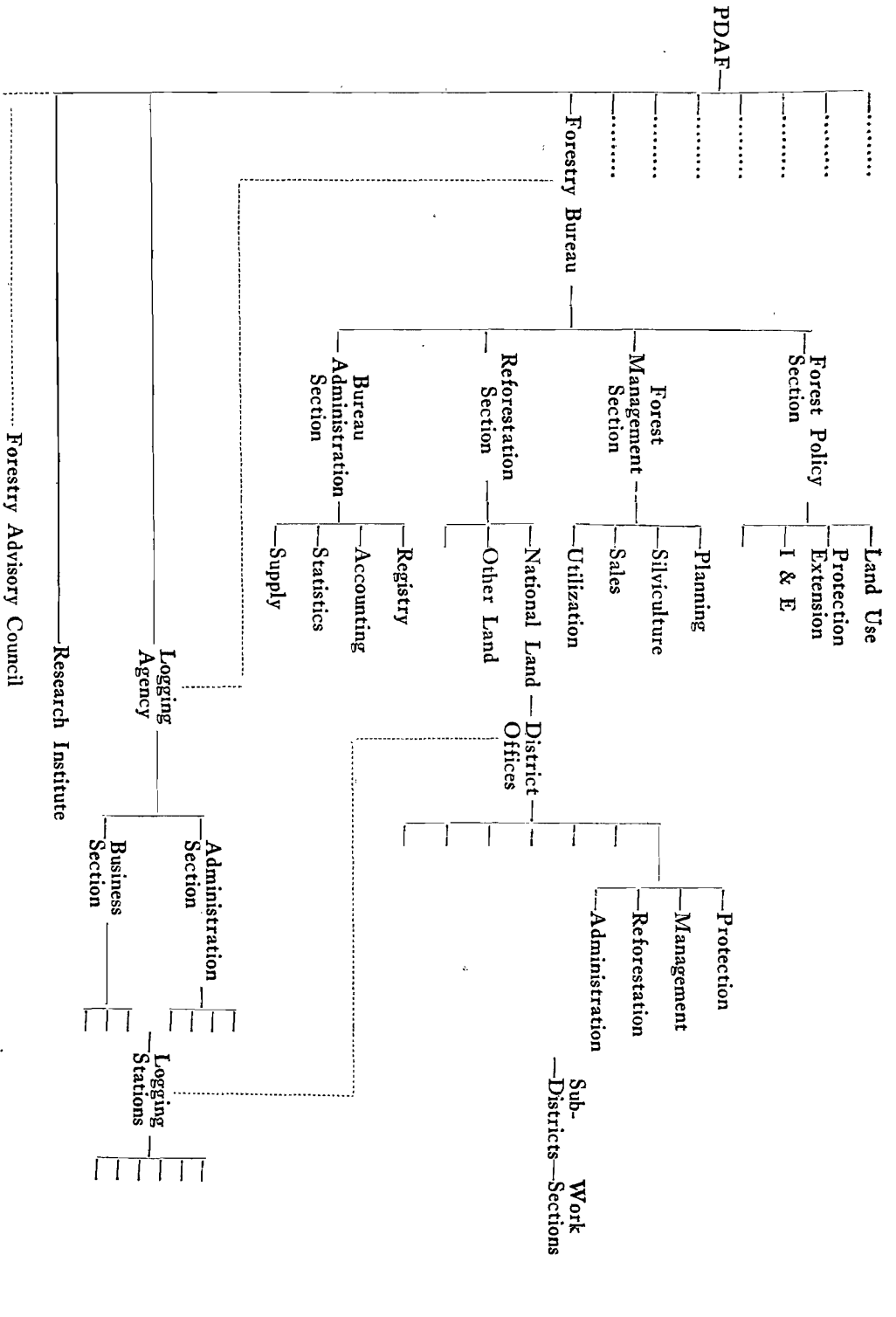
C. COORDINATION

1. For the purpose of overall coordination of all forestry activities there shall be established a committee which shall be known as the "Forestry Advisory Council". The functions of this committee shall be:
 - a. To advise generally in forestry matters.
 - b. To make recommendations in disputes regarding land use, and timber allocations.
 - c. To review annual plans for reforestation, afforestation and other functions of the Forestry Bureau.
 - d. To review annual plans for cutting and sales of timber.
 - e. To scrutinize the overall forest policy and recommend action against violations of the policy and regulations.
2. The committee shall consist of at least nine members selected to represent the following organizations:
 - a. Provincial Government
 - b. Provincial Department of Agriculture and Forestry
 - c. Provincial Land Bureau
 - d. Provincial Forestry Bureau
 - e. Provincial Water Conservancy Bureau
 - f. Provincial Forestry Research Institute
 - g. Taiwan University
 - h. Taiwan Power Company
 - i. Chinese Forestry Society
 - j. Other Organizations Concerned with land use and conservation of forest resources.

PRESENT ORGANIZATION
TAIWAN FOREST ADMINISTRATION



PROPOSED ORGANIZATION



APPENDIX V

PROPOSED REGULATIONS GOVERNING GOVERNMENT FOREST LANDS AND TIMBER

1. Management of all government forest lands and timber shall be under the jurisdiction of the Forestry Bureau of PDAF.
 - a. Renting out or disposal of government forest lands for forestry or other purposes shall be decided jointly by a Forestry Committee, the Forestry Bureau and the Land Bureau.
 - b. Forest sub-districts (formerly logging districts under logging stations) shall be manned with forestry personnel for forest management supervision, protection and reforestation.
2. Management of timber on government lands shall follow established or revised management plan.
3. For the purpose of financial and technical coordination, annual volumes of timber, and areas to be cut, reforested and afforested shall be determined in advance by (1) the Provincial Governor, (2) the Commissioner of PDAF, (3) the chief of Forestry Bureau and, (4) the Forestry Committee.
 - a. Plans for all activities shall be completed prior to October 1st each year.
 - b. Annual timber volumes and areas planned for cutting, reforestation and afforestation shall be shown on accompanying maps.
 - c. Timber and areas to be cut shall be marked or designated by representatives of the Forestry Bureau.
 - d. Silvicultural methods of cutting and degree of utilization on cutting area shall be specified by the Forestry Bureau separately for each cutting area.
 - e. Timber cutting, logging, utilization and scaling of all government timber shall be under supervision of the Forestry Bureau.

APPENDIX VI

PROPOSED REGULATIONS GOVERNING SALES OF GOVERNMENT TIMBER

A. STANDING TIMBER

1. SALES UNDER SEALED BIDS

- a. Volumes in excess of 500 m³ shall be advertised 20 days prior to sale.
- b. All bids will be opened publicly on a specified date and hour in the presence of (1) the bidders, (2) the Forestry Bureau Chief and, (3) the Forestry Committee. Bids below the specified appraised value may be rejected.
- c. Sales contract with successful bidder will be signed by the Forestry Committee Chairman and the Forestry Bureau Chief.
- d. The Forestry Committee on recommendation by the Forestry Bureau may award special contracts to established logging firms with stationary investments within the logging area. The unit price in such sales shall be not less than those offered in bids under similar logging conditions.
- e. Scaling of timber shall be done by the Forestry Bureau representatives at a predetermined yarding point. No timber shall be transported from this point without containing government scale stamp and log number corresponding to log number in scale book.
- f. Sales may be closed as result of specific contract violations.

2. SALES WITHOUT BID

- a. Forestry Bureau may make direct sales without bid, of volumes not to exceed 500 m³ to be signed by Chairman of the Forestry Committee and the Forestry Bureau Chief.
 - b. Forest District Offices may make direct sales without bid, of volumes not to exceed 100 m³ in each sale, for local uses only. Permits over 50 m³ to be signed by Forestry Bureau Chief.
 - c. Forest Sub-District Offices may make direct sales without bid of volumes not to exceed 50 m³ in each sale for local use only. All permits to be signed by District Office.
 - d. No direct sales shall be made at prices less than those received under bids in same locality and under similar conditions.
 - e. Not more than one direct sale without bid may be made annually to any one person or group.
 - f. Volumes cut in direct sales shall be check-scaled by a representative of the Forestry Bureau or the local Forest District Office. Logs shall contain scale stamp and number corresponding to log numbers in scale book.
 - g. Resale of standing timber obtained without bids, or uses other than specified are not permitted.
3. No timber shall be sold unless previously determined and specified.
 4. No sale, direct or under bids, may be extended beyond the time limit or volume specified.

- a. When time limit is exhausted, remaining timber shall be readvertised.
- b. All timber cut in excess of the specified volume of sale shall become government property and sold at auction.

B. TIMBER CUT BY GOVERNMENT AGENCY

1. SALES BY AUCTION OR SEALED BIDS

- a. Logs or lumber in lots exceeding 200 m³ shall be advertised 10 days prior to sale, either by public auction or sealed bids as conditions may warrant.
- b. Volumes shall be check-scaled by a representative of the Forestry Bureau.
- c. Auctions shall be supervised by the Chief of Central Logging Office and by a representative of the Forestry Committee.
- d. Following advertisement sealed bids shall be received by the Central Logging Office. Bids will be opened publicly on a specified date and hour in the presence of (1) bidders, (2) Chief of Central Logging Office and (3) Forestry Committee. Bids below the appraised price may be rejected.

2. SALES WITHOUT BID

- a. Direct sales of logs or lumber to local business may be made jointly by the Forestry Committee and the Central Logging Office. No such sale shall exceed 100 m³.
- b. Direct sales of logs and lumber for specific local uses may be made by the Central Logging Office. No such sale shall exceed 25m³. The sales shall be signed by a Forestry Committee representative.
- c. Direct sales of logs or lumber for specific local uses may be made by the local Logging Office. No such sale shall exceed 5m³. The sales shall be signed by the Central Logging Office.
- d. No direct sales shall be made at prices less than those received under auction or bids in same locality and under same conditions.
- e. Not more than one direct sale without bid may be made annually to any one person or concern.
- f. Volumes involved in direct sales shall be check-scaled by a representative of the Forestry Bureau or local Forest District Office.
- g. Resale of logs or lumber obtained without bid, or uses other than specified are not permitted.

3. No timber shall be sold unless previously determined and specified.

C. FINANCE. No cash transactions shall be permitted.

1. Payment for government timber, either standing or cut and regardless of volume, shall be made directly to the Provincial Treasury in the form of certified checks or bank-draft.
2. Forestry Bureau and Central Logging Office each shall operate on the basis of separate regular annual government appropriations.

行政院農委會圖書室



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