

WORLDWIDE PLANTING OF SOUTHERN PINES

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Abstract.--Planting of American southern pines (subsection Australes of the genus Pinus) is reviewed, briefly, in all countries where the species involved are planted in some numbers. This information is summarized by continent/region and in total in tabular form.

Additional keywords: Afforestation, tree nursery, southern pines, loblolly pine, slash pine, Caribbean pine.

INTRODUCTION AND METHODS

The southern pines of North America are among the most widely planted trees. In the following discussion we have described this worldwide planting. When we refer to "southern pines" we really mean, the southern yellow pines. As specified for this symposium, we are referring to the subsection Australes (Loud) of the genus Pinus (Little 1969). This subsection includes eleven species.

Table 1.--Species of the subsection Australes of the genus Pinus

<u>Species</u>	<u>Common Name</u>	<u>Native Range</u>
<u>Pinus caribaea</u> Morelet.	Caribbean pine	Bahama Islands, Cuba, and Central America
<u>Pinus cubensis</u> Griseb.	Cuban pine	Cuba
<u>Pinus echinata</u> Mill.	shortleaf pine	Southeastern United States
<u>Pinus elliotii</u> Engelm.	slash pine	Southeastern United States
<u>Pinus glabra</u> Walt.	spruce pine	Southeastern United States
<u>Pinus occidentalis</u> Sw.	West Indian pine	Hispaniola and Cuba
<u>Pinus palustris</u> Mill.	longleaf pine	Southeastern United States
<u>Pinus pungens</u> Lamb.	Table-Mountain pine	Eastern United States
<u>Pinus rigida</u> Mill.	pitch pine	Eastern United States
<u>Pinus serotina</u> Michx.	pond pine	Southeastern United States
<u>Pinus taeda</u> L.	loblolly pine	Southeastern United States

Incidental information on other species is included where the authors felt it would be of interest.

To estimate the number of trees planted a questionnaire was sent to 24 countries known or surmized to be planting southern pines. Only half of the

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countries responded. To develop added information a number of United Nations Food and Agriculture Organization (FAO), U.S. Agency for International Development (AID), and other publications were reviewed. Much of the resultant data is general or old, but appears to be the best available. A third approach to gathering the needed information was to personally contact individuals knowledgeable about certain areas or countries. Observations by these individuals are cited as "personal communications".

As is usual with data collected from disparate sources, there is a lack of parallel detail, form, or quality. At the same time, some data was simply not available. Where we were aware of this, the best estimates are used. However, we believe a relatively clear general picture of the worldwide planting of southern pines has emerged. There follows a compilation of the information, country by country, within a region/continent. This is followed by a summary.

NORTH AMERICA

United States.--Southern pines are the most commonly planted group of trees in the United States. In 1984, 1.5 billion southern pines were planted in the 13 Southern States in the U.S.A. (Table 2) (South 1984).

Table 2.--Species and number of southern pines planted in the U.S.A.-1984

<u>Species</u>	<u>Number of Seedlings</u>
loblolly (<u>P. taeda</u>)	1,195,387,000
slash (<u>P. elliotti</u>)	252,857,000
longleaf (<u>P. palustris</u>)	25,614,000
shortleaf (<u>P. echinata</u>)	15,713,000
spruce (<u>P. glabra</u>)	32,000
Total	1,489,603,000

Over half of these seedlings were genetically improved to some degree (McDonald 1983). Nearly 3 million of the seedlings (two-tenth's of a percent) were containerized. At a planting rate of 1482 trees per ha (hectare), about 1 million ha were planted to southern pines in 1984.

Mexico.--About 10 000 ha of Caribbean pine plantations have been installed in Oaxaca (Palmer 1985).

CARIBBEAN AND CENTRAL AMERICA

Antigua and Barbuda.--A 1979 trial plantation of Caribbean pine was unsuccessful. Failure to inoculate the seedlings adequately with mycorrhizae was the probable cause of the failure (AID 1983).

Commonwealth of the Bahamas.--Regeneration of Caribbean pine, which is native, is accomplished through seed tree cuts and natural regeneration (AID 1983).

Belize.--There is no large scale reforestation by planting (AID 1982a). Fire protection of pine savannahs, which had previously been stripped of trees, is

allowing their gradual restocking through natural regeneration. The pine species involved is mainly Caribbean pine but, on limited areas of the Mountain Pine Ridge Forest Reserve, Ocote pine (*Pinus oocarpa* Schiede) is also involved. Experimental planting, provenance, and progeny trials have been installed (Whitmore 1985).

Costa Rica.--Twelve nurseries in Costa Rica produced over 2 million trees in 1980 (AID 1982b). Part of this production was Caribbean pine. Scott Paper Company has about 1000 ha of Caribbean pine plantations in and near the Turrialba Valley (Whitmore 1985). Pines in these plantations are growing up to 40m³/ha/year (Evans 1982).

Cuba.--No data. Plantations of southern pines are known to exist, but the extent of them is unknown (Liegel 1985).

Dominica.--Before Hurricane David of 1979 and starting in the early 1960's, about 100 ha of small plantations were established in the high rainfall areas of the country (AID 1983). Caribbean pine was one of the less prominent species in these plantations. These plantations were heavily damaged by the hurricane, but are now (1983) being cleaned and thinned. Future emphasis will be on softwood plantations to reduce softwood imports.

Dominican Republic.--About 1900 ha had been reforested by the government by 1978 (AID 1981a). By mid-1980 the total country-wide area planted was 3200 ha. The main species planted are West Indian and Caribbean pine. West Indian pine is superior above 800 m elevation; Caribbean pine at lower elevations. Caribbean pine seed was imported from Honduras and Belize, but no provenance tests had been made. West Indian pine seed is locally collected.

Guatemala.--The highland pines of Guatemala include no southern pine species. However, in southern parts of the country at lower elevations small areas of Caribbean pine forest exist. There appears to be no reforestation program (AID 1981b).

Honduras.--Ocote pine and Caribbean pine are native species. The former in the mountains and the latter on the Caribbean coastal plain. The Honduran Forestry Development Corporation (COHDEFOR) operates a seed bank and nursery system and plans to eventually plant 10 000 to 15 000 ha annually. In 1977, 2650 ha were scheduled for planting using Ocote and Caribbean pine, and several hardwoods. In the period 1974-1980 COHDEFOR planted more than 3000 ha of pine (AID 1982c).

Jamaica.--Prior to 1980, the Jamaican Forest Service had planted a considerable amount of Caribbean pine (40 000 ha) with good success (Whitmore 1985).

A World Bank forestry project has been underway to create 9250 ha of pine plantations between 1979 and 1984 (AID 1983). By the year 2004 the objective is to have 36 000 ha of pine plantations in existence. The program is hampered by difficulties of purchasing suitable private land for industrial pine plantations. As of 1983 only 4692 ha of private land had been purchased. Liegel (1985a) estimates there are 8100 ha of Caribbean pine plantations existing in Jamaica now.

In Jamaica 187.5 kilograms (kg) of Caribbean pine seed were collected in 1982-83 and 3000 kg and 220 kg were reported imported from Honduras and Grenada,

respectively. The aim is the production of approximately 2 million Caribbean pine seedlings annually. Trials are being carried out in agro-forestry growing coffee plants under Caribbean pines in the Blue Mountains. The aim is to determine optimum density to maximize production of both pine and coffee. One of the major areas of planned forestry research is tree improvement and seed production.

Montserrat.--Some U.S. AID reforestation and fuelwood trial plantations were installed in the early 1980's (AID 1983). Several hardwood species were successful. Caribbean pine has proven difficult to raise in the nursery and establish in plantations. The reasons are not clear, but lack of suitable mycorrhizae might be the problem.

Panama.--In 1967 the Department of Renewable Natural Resources (RENARE) began planting Caribbean pine in humid foothill areas. By 1976 there were about 2500 ha of plantations. Seeds for these come from Belize and Guatemala (IUFRO 1980).

Puerto Rico.--Some 300 to 500 ha of Caribbean pine plantations have been established (Liegel 1985a, Whitmore 1985).

St. Kitts and Nevis.--No pines have been planted in regular plantations (AID 1983), but some small tests with southern pines have been attempted in past years. Results are unknown.

St. Lucia.--Plantation work begun in the 1940's has continued to the present. It reached a peak in the 1960's (AID 1983). Emphasis was on introduction of exotics. Caribbean pine was one of these. The total reforested area of all species is approximately 250 ha.

Trinidad and Tobago.--In 1983 there were 6348 ha of pine plantations (AID 1983). Caribbean pine seeds cannot be collected locally in sufficient quantity because of poor yields of seed from cones and low germination percentages. It is, therefore, purchased abroad from commercial suppliers. Since 1960 most of the seeds have come from Belize. The rate of pine planting has been approximately 200 ha per year, but a considerable amount has been lost to wildfires. Much of the Caribbean pine has been planted on denuded areas to reduce soil erosion and to help prevent floods (Evans 1982).

Turks and Caicos Islands.--Some good natural stands of Caribbean pine exist on Caicos (AID 1983). Only ornamental plantings of trees have taken place. There is no reforestation program.

British Virgin Islands.--In 1983, consultants working for AID found trees were being planted for amenity purposes primarily; there was no mention of southern pine planting (AID 1983). Limited reforestation has taken place on steep slopes in critical catchment areas. It is not likely pines are being planted (Whitmore 1985), although Caribbean pine has been tried, along with several other species.

SOUTH AMERICA

Argentina.--Southern pines constitute about 85 percent of the planting program. The most commonly planted southern pine is slash pine of which 30 000 000 seedlings were produced in 1984 (from questionnaire). In addition 13 000 000 loblolly pines and 720 000 Caribbean pines were produced. Only minor problems

have been encountered in seedling production. Seeds have been imported from the United States, South Africa, and Brazil. Half the loblolly pine and 20 percent of the slash pine seed was selected from origins known to perform well in Argentina. The government and some private companies have imported slash pine seeds from northeast Florida and from southern Georgia and loblolly pine seeds from Livingston Parish, Louisiana. These sources have performed well in provenance trials in Argentina. All Caribbean pine seed used is of Cuban origin, although other provenances have been tested.

The total area planted to southern pines is about 180 000 ha. Over the last 5 years about 14 000 ha of slash pine, 6000 ha of loblolly pine, and 450 ha of Caribbean pine plantations have been established annually.

Bolivia.--Conifers were planted on only about 8 percent of the acreage reforested 1960-75 (264 ha total) (AID 1980a). Eucalyptus is the primary tree planted (probably 90 percent of the stands). The remaining stands consist largely of Monterey (*radiata*) pine (*Pinus radiata* D. Don) and some *Cupressus* and *Acacia*. Other species have recently been planted on a trial basis, but are not planted in significant numbers. There is a need for more pine trials in the inter-Andean Valley (from questionnaire). Species such as Monterey pine, Mexican weeping pine (*Pinus patula* Schiede and Deppe), Merkus pine (*Pinus merkusii* Jungh. and de Vriese), and Khasi pine (*Pinus insularis* Endl.) merit further investigation.

Brazil.--Following 50 years of large scale removal of Parana pine (*Araucaria angustifolia* O. Kuntze) in the southern part of the country for sawtimber and pulp, a concentrated reforestation effort was started in 1966. About 2.9 million ha were reforested from 1968-1976 (FAO 1979).

Thirty-three percent of this planting was *Pinus* spp. which covered 964 808 ha in south, southeast, and central Brazil. These plantations were planted at a density of about 2000 trees per ha, so annual seedling production over the 10 year period averaged about 200 million pine seedlings. As of 1979 the sustained planting rate was about 100 000 ha of pine (and 200 000 ha of eucalyptus) per year.

Most of the pines planted were loblolly and slash pine with lesser amounts of the native Parana pine. Indications are that properly selected sources of the southern pines grow faster than in the U.S.A. (Blackman 1980). Westvaco Corporation evaluated 63 softwood species and, after 5 years, found loblolly and slash pine the most promising (Luke 1978). After added time and evaluation they found loblolly pine was consistently outperforming slash pine on most sites. Consequently, Westvaco is primarily planting loblolly pine in their own plantations. Only modest amounts of slash pine are being planted.

Caribbean pine is being planted in Amazonia in northeast Brazil (FAO 1979). Caribbean pine was first planted on sandy soils at Jari in 1973 (Hornick 1984). By 1980, 32 000 ha of pine had been planted. Seeds for these trees came from a seed orchard in southern Brazil operated jointly by Jari and the Weyerhaeuser Company. About 100 miles down the Amazon River the AMCEL operation had planted 50 000 ha of Caribbean pine as of 1984 (McDonald 1984). This plantation may be the world's largest tropical pine plantation. The plan is to have 88 000 ha of plantations by 1988. About 15 percent of the area is to be Ocote pine, the remainder Caribbean pine.

Brazil is behind only China, the U.S.S.R., and the U.S.A. in terms of total area planted. Their plan in the late 1970's was to stabilize pine plantation areas at 2.6 million ha. Although these objectives have lately been modified by government funding reductions (Alcock 1984), the program is still very large. In 1979, 500 000 ha of pine plantations were being harvested per year; most of this was southern pine (FAO 1979).

Chile.--Southern pines are not planted, but certain species' introduction trials, which include them, have been established (from questionnaire).

The Cooperative Republic of Guyana.--About 7000 ha of Caribbean pine plantations were established in Guyana at two locations in the mid-1970's with the object of producing pulpwood (AID 1983). These plantations have now been abandoned. There is no reforestation work being carried out as of 1983. However, the established plantations of Caribbean pine have been reported to be generally vigorous (AID 1983).

Colombia.--In 1984, 50 000 loblolly pine seedlings were produced and planted on 30 ha. The seeds used were all from the United States. This constituted about 1 percent of the Colombian planting program (from questionnaire).

Ecuador.--About 25 ha of Caribbean pine plantations exist, but southern pine utility is limited because of the highland nature of the country (Liegel 1985b).

Peru.--As of 1976, 106 140 ha had been reforested, 95 percent with eucalyptus. The other species planted were primarily Monterey pine, Podocarpus, and Prosopis. In 1979, limited areas were being reforested with eucalyptus and Caribbean pine (AID 1979). The Forestry Department was reported to have only one nursery. The Peruvian response to our questionnaire indicated no southern pines were being planted in 1984. Twenty percent of the planting program is Monterey (radiata) pine (4.9 million seedlings) grown from seed from Chile. Pine was planted on 4055 ha. Some southern pines (loblolly, longleaf, slash, Caribbean, and spruce) are being investigated for introduction.

Surinam.--Liegel (1985a) has estimated there are 5500 ha of Caribbean pine plantations in Surinam. Nutritional problems were reported (Evans 1982). Nursery production and rate of reforestation are unknown.

Uruguay.--In 1984, 641,000 loblolly and 3,984,500 slash pines were planted (from questionnaire). Most seed came from established plantations; none of it was genetically improved. The planting program is 98 percent southern pines; the rest is maritime pine (Pinus pinaster Ait.).

Venezuela.--A report of the Inter-American Development Bank (1984) indicates over 165 000 ha have been reforested, primarily with Caribbean pine. About 20 000 ha are being reforested annually (Kellison 1985). Most of this reforestation is done by two private corporations. Some other southern pines have been planted in the highlands (Liegel 1985a), but the amount and species are unknown.

AFRICA

(Information is from the Tropical Forest Resources Assessment Project within the Global Environment Monitoring System (FAO 1981), unless otherwise noted.)

Cameroun.--There are about 1000 ha of pine plantations. Five species of pines are included, one of which is Caribbean pine. Most of these plantations were recently established.

Congo.--There are about 3700 ha of pine plantations composed of Caribbean pine and Ocote pine. All were established since 1965.

Ivory Coast.--There are about 300 ha of pine plantations, mainly Caribbean pine, with some Ocote pine. All planted since 1975.

Ghana.--There are about 1200 ha of pine plantations made up of Caribbean pine and Ocote pine. These plantations were started in 1977. Currently about 300 ha are being planted per year.

Guinea.--Only a few test plantations of Caribbean pine exist. Pine plantations total about 700 ha.

Guinea-Bissau.--A few test plantations of Caribbean pine exist.

Kenya.--There are no southern pine plantations, but there are 185 000 ha of softwood plantations.

Liberia.--About 1100 ha of pine plantations exist, primarily Caribbean pine and Ocote pine. All of these were planted since 1975.

Madagascar.--No southern pine plantations exist, but there are 115 000 ha of softwood plantations.

Malawi.--About 69 000 ha of pine plantations exist. Most of these were planted since 1965. They include a small amount of loblolly pine. Most plantations are Mexican weeping pine (P. patula) and are for pulpwood production (Evans 1982).

Mozambique.--Only small test plantations of Caribbean pine exist. There are 12 300 ha of softwood plantations of other species.

Nigeria.--About 2200 ha of softwood plantations exist. Included in these are limited areas of Caribbean pine plantations. These have all been planted since 1975. Some tropical nursery research has been done in Nigeria (Evans 1982).

Rwanda.--About 4600 ha of softwood plantations exist. Primarily cypresses and pines. Some Caribbean pine is included. Most of these plantations have been established since 1975.

Sierra Leone.--Small experimental plantations of Caribbean pine exist.

Republic of South Africa.--Slash pine was introduced into South Africa in the 1920's. A notable success, this species now covers 143 718 ha in South Africa, or 24.1 percent of the area planted to coniferous species, and it is second only to Mexican weeping pine (P. patula) in economic importance (Darrow 1984).

Overall, by 1945 South Africa had over 180 000 ha of plantations of Mexican weeping, slash, loblolly pines and some eucalyptus. In 1978 ten small nurseries

were closed to concentrate production of Mexican weeping and slash pines in one big unit (Evans 1982).

In South Africa's response to the questionnaire, southern pine seedling production in 1983 was: slash pine - 8,400,000, loblolly pine - 6,400,000, Caribbean pine - 500,000, totalling - 15,300,000 trees. All southern pine seeds come from local seed orchards. The 1983 area planted was: slash pine - 5612 ha, loblolly pine - 4258 ha, and Caribbean pine - 356 ha. Southern pines constitute 38 percent of the planting program.

Swaziland.--Slash and loblolly pine are planted in the Usutu Forest. The acreage and number of seedlings is not known.

Tanzania.--About 65 000 ha of softwood plantations existed in 1981 (FAO 1981). Planting from 1955 to 1980 was at a rate of about 11 000 ha per year. The planting rate has declined since 1980. As of 1981, about 2000 ha of Caribbean pine, 1000 ha of slash pine, and 100 ha of loblolly pine were being planted per year (FAO 1981).

All southern pine seed used was imported. The slash pine seed was from Queensland and the Caribbean pine seed was from Belize, the Bahamas, and Fiji. All slash pine was genetically improved. The Caribbean pine was not genetically improved. Overall, 14 percent of the planting program is devoted to southern pines. Foxtailing of Caribbean pine is a problem.

Uganda.--About 2300 ha of Caribbean pine plantations exist. There are 7000 ha of softwood plantations overall.

Table 3 provides information Tanzania supplied in response to our 1984 questionnaire.

Table 3.--Tanzanian seedling production and planting from 1976 through 1984.

<u>Year</u>	<u>Seedling Production (M trees)</u>		<u>Area of Plantations (ha)</u>	
	Slash pine	Caribbean pine	Slash pine	Caribbean pine
1976	15	---	10	---
1977	1,800	---	90	---
1978	1,110	1,500	585	750
1979	2,700	2,050	1350	2025
1980	0	660	0	330
1981	0	750	0	375
1982	0	105	0	53
1983	0	0	0	0
1984	0	375	0	188

Zaire.--There are 1000 ha of softwood plantations, but none of these are pines.

Zambia.--There are 32 000 ha of softwood plantations. About 7000 to 8000 ha are planted per year. None of these softwoods are southern pines.

Zimbabwe.--There were 207 000 slash, 142 000 loblolly, and 7500 Caribbean pine seedlings produced in 1984. The seed was from local seed orchards. In 1983, 151 ha of slash pine, 103 ha of loblolly pine, and 6 ha of Caribbean pine were planted. About 19 percent of the total planting program is southern pine. Loblolly seed viability problems are being experienced (from questionnaire).

ASIA MINOR AND INDIA

(Data from FAO, 1976, unless otherwise indicated)

Bhutan.--No southern pines are planted. There are about 1600 ha of conifer plantations of other pines and cedars (FAO 1981).

India.--Up to 1968-69 the most frequently planted species, in descending order of importance, were: teak, eucalyptus, conifers and other softwoods, cashew nut, bamboos, etc (AID 1980b). No specific mention was made of southern pines. The FAO reported, in 1981, that there were no southern pine plantations except those associated with experiments (FAO 1981). There were about 109 000 ha of plantations of other softwood species.

Nepal.--About 10 300 ha of softwood plantations existed in 1980 (FAO 1981). None of these contained southern pines.

Sri Lanka.--In 1981 there were 8000 ha of softwood plantations, mostly planted since 1970 (FAO 1981). About 90 percent of the plantations were Caribbean pine.

EAST ASIA-PACIFIC

(Information from FAO 1976, unless otherwise indicated)

Australia.--As of 1975, there were 455 200 ha of conifer plantations (total plantation acreage was 480 000 ha). Of these plantations, Monterey pine occupied 312 000 ha, slash pine and loblolly pine 63 000 ha, maritime pine 2100 ha, and Caribbean pine 5800 ha. The trend in plantation totals was definitely upward. In 1950 there were 119 000 ha of plantations; 1960, 207 000 ha; 1971, 466 000 ha; estimated in 1980, 800 000 ha; and estimated for 1990, 1 million ha.

In response to our questionnaire, information was supplied for Queensland only. This is where southern pines are planted in Australia, primarily. Other states in Australia concentrate on Monterey (radiata) pine. Queensland nursery production 1981-82 was: Caribbean pine - 4,808,000 seedlings, slash pine - 1,527,000, loblolly pine - 13,000, slash x Caribbean pine - 5,000, Total - 6,353,000 seedlings.

Brunei.--Experimental plantations incorporating Caribbean pine were started in 1971. Maximum area of these is 200-300 ha (FAO 1981).

People's Republic of China (PRC).--In the PRC forestry sector, particulars concerning forest growing stock volume, increment, etc., for the entire country are not available in any collected form (FAO 1982). Many statistics are percentile increases over previous years or a reference year which had primary source material. Otherwise, the sources of country data are often subjective estimates by different agencies or individual China specialists. Consequently,

the problem of examining the use of southern pines in the PRC becomes one of assembling random data and observations of various authors and travellers into an approximate picture of the situation. At the outset we know the Chinese forestation effort is huge and that the southern pines play a prominent part in it. Before discussing Chinese use of southern pines further, a digression is worthwhile in order to outline the PRC context of plantation forestry.

About 27 percent of the total land area of China (257 million ha) is suitable for forests (FAO 1982). Fully stocked forest covers only about 13 percent of China (Figure 1). At briefings, authorities indicate China plans to increase the area under forest cover to 20 percent by the year 2000. China has afforested nearly 30 million ha since 1949. About 80 percent of these plantations belong to communes and 20 percent to the State (FAO 1982). The rate of afforestation through the 1970's was about 4 to 5 million ha per year (Ross 1980). This is accomplished by having about 700,000 people working on land preparation and planting and about 65,000 people working at nurseries and related operations (FAO 1982). Ross (1980) provided this picture of the tree nursery situation:

"Literally thousands of nurseries throughout China produce bare-root and containerized tree seedlings. In addition to the small nurseries at many communes, the State also maintains nurseries for seedling production. State and commune nurseries tend to be very labor intensive. Irrigation is done by means of trenches between the beds instead of with an overhead sprayer. Although some chemical weed killers are applied, weeding is usually done by hand. All cultivation is also done by hand."

The introduction of American trees into China has a history of nearly 100 years (Sheng 1979). The reason for this was outlined by Pan (1981):

"Climatic, ecological, and floristic analogies exist between the eastern part of our two countries. The climate of eastern and south China is summer-rainfall type and there is an occasional cold spell in the winter, but with occasional low temperatures and heavy precipitation in summer. The best donor region from the U.S. for our eastern country is the eastern United States."

Among the 15 exotic coniferous trees on the official PRC plant introduction list are the following southern pines: slash pine, loblolly pine, Caribbean pine, longleaf pine, and pond pine. This official list is not all-inclusive. For instance, sand pine (*Pinus clausa* (Chapm. ex Engelm.) Vasey ex Sarg.) has been introduced into southern China. The point is that 5 southern pines are on the official "introduced" list.

Nearly all southern pine planting in China takes place in the deciduous broadleaf (zone 3) mixed deciduous and evergreen broadleaf (zone 4), and tropical and subtropical monsoon (zone 5) forest zones in China (Figure 2) (Krugman 1982).

Loblolly and slash pines are the most widely planted non-native species in China (Pan 1981) and are found in 14 provinces (Krugman 1982). Caribbean pine is being planted in the southernmost parts of China (Dickerman 1981) and shows even more promise than slash pine there (Carter 1981, Felton 1983). Other

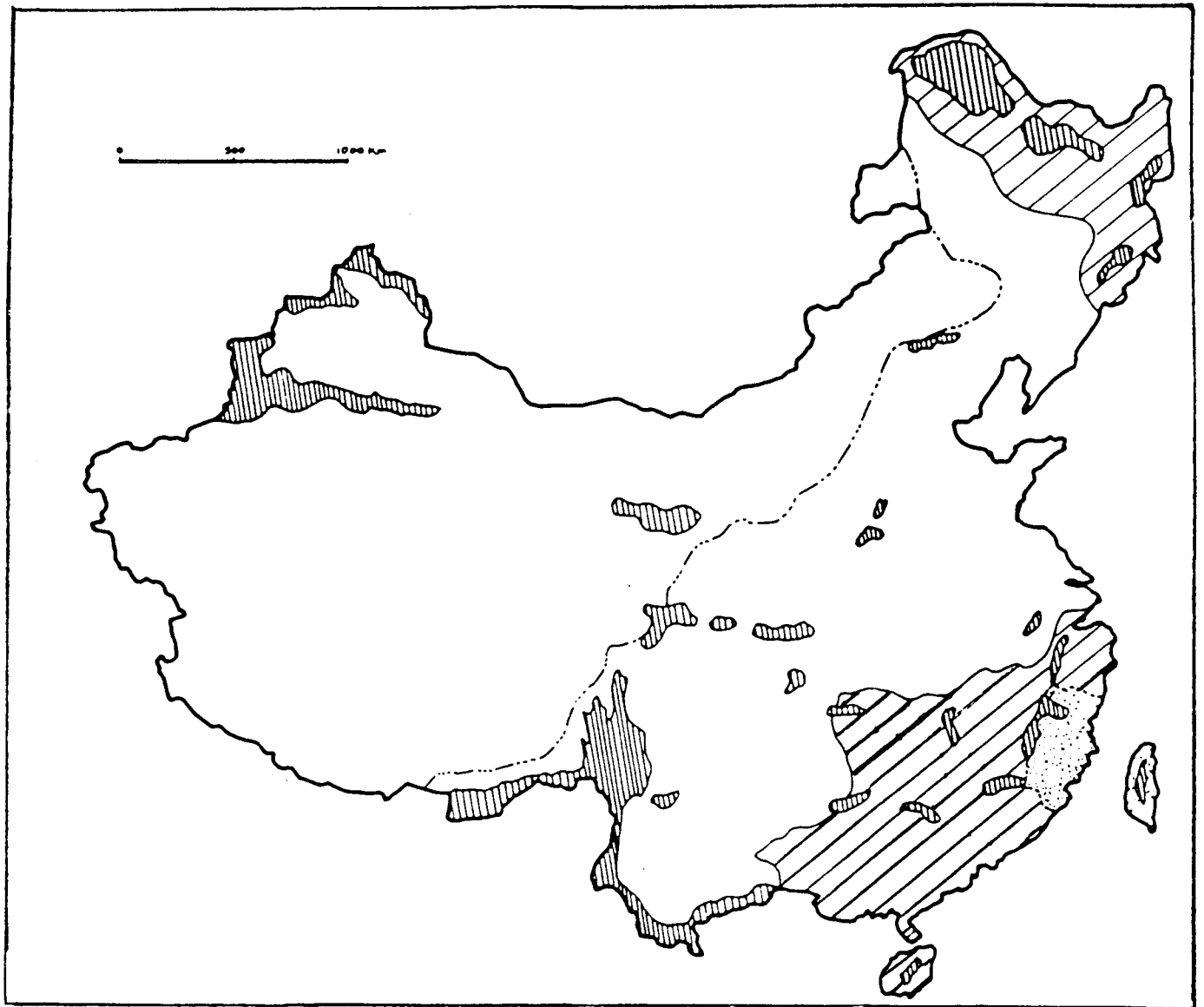


Figure 1.--Natural forest regions of China.

Key



30% to 40% Forest cover



40% to 50% Forest cover



Natural Forest



Figure 2.--Major forest zones of the PRC. Zone 1 - Alpine cold deserts and semidesert shrub communities. Zone 2 - Mixed coniferous and deciduous broad-leaf trees. Zone 3 - Deciduous broadleaf forests. Zone 4 - Mixed deciduous and evergreen broadleaf forests. Zone 5 - Tropical and subtropical monsoon forests.

southern pines are being tested, but generally do not perform as well as slash, loblolly, or Caribbean pines (Felton 1983, Wu 1983), except that shortleaf pine tolerates lower temperatures at higher elevations, as we would expect.

In almost every instance, slash and loblolly pines are reported to outperform (in growth rate and form) the native Masson pine (Pinus massoniana Lamb.) (Carter 1981). Loblolly pine is adapted to a greater range of growth conditions than slash pine and appears to be suitable throughout most of the lower Yangtze River drainage, as long as it is planted at lower elevations (Wu 1983, Johnson 1981).

The amount of southern pine planted is very large. In 1981 the Chinese authorities in southern China, alone, planned to plant up to 400 000 ha per year to pines (Carter 1981). If we assume pine planting in southern and eastern China covers 400 000 - 600 000 ha per year and the planting rate is 1,750 seedlings per ha, 700 million to 1.0 billion pine seedlings would be needed. However, we know southern pine seed supplies are still inadequate to meet the need, even though seed orchards have been installed (Krugman 1982). It is estimated that half the production is still the native Masson pine or other pines and the remainder is southern pine. This means southern pine production in China would range from 350 to 500 million trees per year. It appears that figure will constantly increase as more southern pine seed becomes available and Masson pine planting is reduced.

Fiji.--There were 6840 ha of pine plantations in 1971. These plantations were composed of Caribbean pine (80 percent) and slash pine (20 percent). There are over 40 000 ha of plantations and excess tree seed is being exported (Whitmore 1985). As much as 65 000 ha may exist now, according to Kellison (1985).

Indonesia.--As of the early 1980's there were about 1 million ha of softwood plantations. Approximately two-thirds of these had been planted since 1975. Most of the plantations are Merkus pine. Only a small area has been planted to Caribbean pine (AID 1981c).

Japan.--Japanese pine forests are mostly Japanese red pine (Pinus densiflora Sieb. and Zucc.) and Japanese black pine (Pinus thunbergii Parl.). No southern pines are planted. Slash and loblolly pine have both been tested in southern Japan, with disappointing results.

Kampuchea.--About 300 ha of softwood plantations were established between 1960 and 1970, but none were southern pines.

Republic of Korea.--Pitch pine is widely planted in small stands and breeding orchards in the central and southern parts of Korea, but no acreage figures could be found. There are considerable areas planted to pitch-loblolly hybrid pines.

Borneo-Sabah Malaysia.--About 3800 ha of Caribbean pine plantations exist (AID 1981d). Most of this was planted since 1975. No other pines are used.

Borneo-Sarawak Malaysia.--Limited provenance trials of pine have been planted (AID 1981d).

Peninsular Malaysia.--There are about 7000 ha of softwood plantations (AID 1981d). Approximately 95 percent of this is Caribbean pine, most planted from 1975 to the present.

The figures on plantation area from AID reports for the three portions of Malaysia reported above are considerably different from the country total from a 1976 FAO report. This report indicated that, in 1970, there were 1 090 000 ha of plantations in Malaysia, primarily of Caribbean pine. This figure is probably wrong (Whitmore 1985).

New Zealand.--In 1975, 46 000 ha of softwoods were planted. This area, added to the area of past plantations, generates a total of 650 000 ha. About 80 percent of these plantations are Monterey (radiata) pine. The remainder is made up of Mexican weeping pine, Austrian (Corsican) pine (Pinus nigra Arnold) and slash pine (FAO 1981).

Southern pines were planted in the far north of New Zealand, but have been phased-out over the last 10 years in favor of Monterey (radiata) pine. There were 3861 ha of loblolly, longleaf, and slash pine plantations in 1976.

Papua New Guinea.--About 13 200 ha of softwood plantations existed in 1980. About 2500 ha of this was Caribbean pine, 2400 ha Mexican weeping pine, and the rest araucaria. By 1985 there were about 7400 ha of pine plantations. The species in these were Caribbean pine, Khasi pine (P. insularis) and Mexican weeping pine (P. patula). Relative amounts of the species planted are not known.

Philippines.--In 1968, there were about 146 000 ha of plantations, overall. Forty percent of these were Khasi pine. Some Caribbean and Ocote pines were also planted. The government now requires replanting when clearcutting takes place (AID 1980c). Loggers are generally required to replant with the same tree species taken. The government has a goal of reforestation of 50 000 ha annually. The report also indicated there were 66 000 ha of softwood plantations. Most of this was planted since 1975. It is nearly all Caribbean pine.

Thailand.--In 1985, there were 28 000 ha of pine plantations and 221 ha of broadleaved plantations, primarily teak. The pines planted were mainly Merkus and Khasi pine. No southern pines are planted.

Vietnam.--There are about 67 000 ha of pine plantations. Most of this is Khasi and Merkus pine. There is a small amount of Caribbean pine planted. There have been some experimental plantations with Ocote and slash pines, but results are unknown.

SUMMARY AND OBSERVATIONS

With the mixture of quality and types of data available, generalizations about southern pine planting worldwide are necessarily gross. Nonetheless, we have summarized the information in Table 4. In some cases seedling production figures were available. In other cases, area reforested per year. In some instances both figures or no data were available. Where only one or the other (seedling production or area reforested annually) type of data was available, the other figure was calculated using 1750 seedlings per ha as the multiplier or divisor.

However, with all these reservations about data quality, a number of fairly legitimate observations can be made. First, about two-thirds of all southern pines are planted in the United States. Only small amounts are planted elsewhere in these pines' native ranges (the Caribbean and Central America). About 14 percent of all southern pine planting occurs in South America, primarily in Brazil, Argentina, and Venezuela. This is 40 percent of all of the exotic planting of southern pines. The literature shows southern pines have great potential for creation of fastgrowing plantations in South America. While the proportion of total forested area planted in Latin America is small, its importance in terms of supplying timber for industrial use is increasing. The forest plantations there presently account for only 0.6 percent of the forest area, but they are producing 30 percent of the industrial timber supply (I.A.D.P. 1984). In addition, the southern pines are very valuable in Latin America for other than just fast timber growth. They occupy particular niches on semisterile soils other species do not do well on, are fire or grass competition resistant, or are valuable as tropical timber species (Evans 1982).

Approximately 20 percent of all southern pines planted are planted in the Far East and Pacific Regions; mostly in China. About 60 percent of all southern pines planted outside their native ranges are planted in this Region. The seedling production figures for southern pines in China are estimates based on literature review and judgement, not statistical data. The Chinese would like to plant more southern pines and fewer Masson pines. They are prevented from doing so only by shortages of southern pine seed. We also know the Chinese have a goal of increasing the forested area of their country from about 12 to 20 percent (FAO 1982). This equates to afforesting an added 66 million ha by the end of the century. A large proportion of this planting will undoubtedly be in southern pines. The longer term goal is to have 30 percent of China forested (FAO 1982).

Worldwide, it appears that most exotic planting of southern pines involves loblolly and slash pines, with the other species being valuable in special situations. Of course Caribbean pine is more important in the tropics than slash or loblolly pine, but the overall amount of Caribbean pine planted outside its native range is modest compared to the other two species.

The southern pines are a valuable worldwide resource. They are becoming steadily more important in North and South America and Asia where their growth rates and form often are superior to those of other conifers. This underscores the importance and timeliness of this symposium.

Table 4.--Summary of Major Southern Pine Planting Worldwide

Continent or Region	Annual Seedling Production (thousands)	Hectares planted (per year)	Total seedling output ^{1/} (percent)
<u>North America</u>			
U.S.A.	1,500,000	1 000 000	65
<u>Central America and the Caribbean</u>			
Costa Rica	2,000	1 100	<1
Others	---	small amounts	---
<u>South America</u>			
Argentina	44,000	21 000	2
Brazil	230,000	130 000	10
Colombia	50	30	<1
Uruguay	5,000	3 000	<1
Venezuela	35,000	20 000	2
Others	---	small amounts	---
Totals	315,000	175 000	14
<u>Africa</u>			
Republic of South Africa	15,000	10 000	1
Tangania	375	188	<1
Zimbabwe	350	260	<1
Totals	16,000	10 500	1
<u>Asia Minor-India</u>			
	---	small amounts	---
<u>East Asia-Pacific</u>			
Australia	6,350	3 700	1
P.Rep. China	425,000	250 000	19
Fiji	13,500	7 500	1
Malaysia	3,000	1 500	<1
Philippines	12,500	7 000	1
Others	---	---	---
Total	460,350 ^{1/}	270 000 ^{1/}	20
Grand Totals	2,293,000	1 450 000	100

^{1/} Seedling production and Hectares planted figures for PRC, Fiji, Malaysia, and the Philippines included in this total are estimates. Actual values could range from \pm 25 percent of the figures shown.

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