Forestry Department
Food and Agriculture Organization of the United Nations

FRA 2000

FOREST PLANTATION RESOURCE IN DEVELOPING COUNTRIES

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The Forest Resources Assessment Programme

Forests are crucial for the well-being of humanity. They provide foundations for life on earth through ecological functions, by regulating the climate and water resources, and by serving as habitats for plants and animals. Forests also furnish a wide range of essential goods such as wood, food, fodder and medicines, in addition to opportunities for recreation, spiritual renewal and other services.

Today, forests are under pressure from expanding human populations, which frequently leads to the conversion or degradation of forests into unsustainable forms of land use. When forests are lost or severely degraded, their capacity to function as regulators of the environment is also lost, increasing flood and erosion hazards, reducing soil fertility, and contributing to the loss of plant and animal life. As a result, the sustainable provision of goods and services from forests is jeopardized.

FAO, at the request of the member nations and the world community, regularly monitors the world's forests through the Forest Resources Assessment Programme. The next report, the Global Forest Resources Assessment 2000 (FRA 2000), will review the forest situation by the end of the millennium. FRA 2000 will include country-level information based on existing forest inventory data, regional investigations of land-cover change processes, and a number of global studies focusing on the interaction between people and forests. The FRA 2000 report will be made public and distributed on the World Wide Web in the year 2000.

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Paper drafted by Devendra Pandey and Saori Hirai, and edited by James Space and editorial assistant Patrizia Pugliese

1 Introduction

An assessment of the resource of forest plantations is an integral component of the Global Forest Resources Assessment 2000 Programme of FAO.

At a meeting of specialists held in April 1999 at FAO Headquarters, Rome, on the plantation report for FRA 2000, it was decided that the report should consist of detailed country reports on the 20 countries having the largest area of plantations. These countries comprised more than 93 percent of the plantation area of the developing world in past assessments. These countries, by region, are:

Asia (nine countries):	Bangladesh, China, India, Indonesia, Myanmar, Pakistan, the Philippines, Thailand and Vietnam
Africa (four countries):	Algeria, Morocco, South Africa and Sudan
Latin America (seven countries):	Argentina, Brazil, Chile, Cuba, Peru, Uruguay and Venezuela

Later on, two more countries (Madagascar and Mexico) were added to the list. These countries had a sizeable area of plantations (more than 100 000 ha) reported in 1990 but no report has been received since then. In respect to other countries, which have relatively less area of forest plantations, only the area figures will be updated to the year 2000.

A standard format output table for presenting the plantation data of each country was designed. The main feature of the table is a breakdown of the total plantation area by the main species or species groups with a further break-down by purpose and ownership. To support the data, the output table of each country has references to the source data and a note explaining how the figures quoted in the table were estimated.

The data contained in this report will be entered into the Forest Resources Information System (FORIS). This provide an estimation of the area of plantations at the global, regional and sub-regional levels by major species, purpose and ownership as well as presentation of a synoptic overview.

In addition to the output table a standard format for the detailed report for each of the selected countries was also developed featuring development of the country's plantations since the beginning including policy issues, present trend, growth and productivity.

1.1 Output of the report

This report presents country reports of 15 of the 22 selected countries. Of the remaining seven countries, another consultant is to prepare a report on Algeria, Madagascar and Morocco. Two other countries, Brazil and Sudan, have been postponed until the new data can be obtained. Since there was no new data for Cuba and only partial data was available for Mexico, reports on these 2 countries have also been deferred.
Output tables with explanatory notes have also been prepared for eleven additional countries (nine from Asia plus Angola, South Africa and Colombia), of which country texts are prepared for 4 countries.

Ms Saori Hirai (Associate Professional Officer, Plantation Database), who maintains plantation data for FAO, entered the references into the database. She also estimated the total plantation area and prepared output tables for Madagascar, Morocco, South Africa and Laos and the country texts for Angola, Laos, Malaysia, the Philippines, and Zimbabwe.

1.2 Methodology and limitations

New and existing plantation data was reviewed, particularly the information received in the country reports for FRA 2000.

In previous assessments of plantation resources, plantation data were available up to the reference year for most countries. This made the task easier, since the assessments were prepared after that time. In the present case, the situation is reversed as the reference year is 2000 but data are available only to 1996 or 1997 in most cases and 1998 for a few countries. Thus, plantation areas of all the countries have had to be estimated to the year 2000 from the existing data by extrapolation.
A few countries have data only up to 1990. For these, the rate of planting in preceding years and future planting programmes have been considered. Some countries do not provide information by species, purpose and ownership. In such a situation, these breakdowns were estimated from the broad aggregate data.

Country reports submitted to the FAO Regional Forestry Commissions and previous FAO forest resources assessment reports were reviewed to develop information on plantation development in the past.

1.3 List of countries presented in this report

Region	Country
Countries with explanatory text and output table	
Asia	Bangladesh China India Indonesia Lao People's Democratic Republic Malaysia Myanmar Pakistan The Philippines Thailand Vietnam
Africa	Angola South Africa Zimbabwe
Latin America	Argentina Chile Peru Uruguay Venezuela

Countries with only the output table	
Asia	Bhutan Brunei Darussalam Cambodia Nepal Sri Lanka
Africa	Madagascar Morocco
Latin America	Colombia

2 BANGLADESH

Bangladesh has 2.23 million ha of legally declared forest lands but only about 1.24 million ha, or 8.6 percent of country's area, had natural woody vegetation in 1980 (FAO, 1981). Being one of the most densely populated country in the world (750 persons/km^2), only about 6 percent of the land area (0.8 million ha) had forest cover in 1990 (FAO, 1993). Traditionally, homestead plantations play the most important role in meeting requirements for wood, bamboo and other non-wood forest products.

2.1 Development of forest plantations

Initial attempts to raise plantations in Bangladesh started in 1871 with teak and remained confined to the Chittagong Hill Tracts until 1920. In 1921, plantations were extended to the Cox's Bazar and Sylhet Divisions. Total planted area until 1948 was 4 140 ha with annual planting in the range of 100 to 300 ha. Teak was the main species planted because of its high value (MOEF, 1993a). *Lagerstroemia speciosa, Swietenia macrophylla, Artocarpus integrifolia, A. chaplasha, Cedrela toona,* and *Syzygium grande* were introduced in later years. Planting gradually picked up and the total planted area reached 72 000 ha in 1968.

After Bangladesh became an independent nation, the Forest Department started planting fast-growing species such as *Gmelina arborea, Paraserianthes falcataria* and *Anthocephalus chinensis* in 1974 on a large scale in the Chittagong Hill Tracts and Sylhet Division to produce fuelwood. Coastal afforestation was also accelerated in four divisions. Annual planting continuously increased and reached a peak of 22 800 ha in 1985, of which coastal plantations were about 10 000 ha (MOEF, 1993b). Recent inventories and estimates generally note that 20 to 30 percent of all plantations established during the last 30 years no longer exist. Officially, the reported total plantation area in the country in 1990 was 332 000 ha of which 113 000 ha was in coastal, 21 100 ha in the sal forest zone and the rest, 198 000 ha, in the Hill Forests. Most of the sal (*Shorea robusta*) plantations are non-existent and only 122 000 ha of other long-rotation plantations are traceable (MOEF, 1993a). In addition, there are some recently created pulpwood, veneerwood and fuelwood plantations.

A 1991 inventory of homestead plantations estimated a total of 520 million trees of which more than 60 percent are below 20 cm diameter. The estimated volume of wood is about 54.5 million m^3 (excluding trees below 20 cm diameter)(MOEF, 1993b).

2.2 Species composition

Teak (*Tectona grandis*) has dominated the plantations for industrial wood in the Chittagong Hill Tract, Cox's Bazar and Sylhet. The total area of teak plantations in these three regions to 1998 was about 176 000 ha (Haque, 1999). Haque (1999), however, accounts for only 73 420 ha of this in his age-class distribution. Annual plantation of teak planned for 1999-2000 is about 5 000 ha. Besides teak, other long-rotation species planted for industrial purpose are *Dipterocarpus turbinatus, Artocarpus integrifolia, Switenia macrophylla, Lagerstroemia speciosa, Cedrela toona, Artocarpus chaplasha,* and *Syzygium grande.* Short-rotation species planted for fuelwood and pulp are *Acacia auriculiformis, A. mangium, Eucalyptus camaldulensis, Dalbergia sissoo, Gmelina arborea, Paraserianthes falcataria* and *Anthocephalus chinensis.* Species used in coastal afforestation include *Sonneratia apetala, Aviccenia officinalis, Rhizophora gymnorhija* and *Casuarina equisetifolia* (MOEF, 1996, and Haque, 1999).

2.3 Issues

Use of quality planting material, site preparation and post-establishment maintenance has not been given adequate attention. Due to budgetary and legal constraints adequate protection of plantations from fire, grazing, illegal removal and encroachment has not been provided. There is no clear policy to support homestead plantations (MOEF, 1993a).

2.4 Trend

The Forestry Master Plan (1993) suggested an annual planting target of about 18 000 ha during 1993-2002 and 21 000 ha during 2003-2012 in scenario I and about 17 percent higher in scenario II in order to attain sustainable management of forest resources in Bangladesh (MOEF, 1993a). Potential areas totalling about 700 000 ha exist in the Chittagong Hill Tracts, Cox's Bazaar and Sylhet Districts that are suitable for industrial plantation through private planting agencies.

Forest plantation area of Bangladesh in 2000

Gross estimated area = 624 800 ha		Annual planting = 18 000 ha			
Species	Gross estimated area (%)	Purpose (%)	Owner ship (%)		
			Public	Private	Others
Other Broadleaved spp.	282 500 (45)	Industrial 48	100		
		Non- Industrial 52	100		
Tectona grandis	143 900 (23)	Industrial 100	100		
		Non- Industrial			
Rubber	91 800 (15)	Industrial			
		Non- Industrial 100	n.a.		
Eucalyptus spp.	37 300 (6)	Industrial 48	100		
		Non- Industrial 52	100		
Acacia spp.	32 000 (5)	Industrial 48	100		
		Non- Industrial 52	100		
Gmelina arborea	21 300 (3)	Industrial 48	100		
		Non-Industrial 52	100		
Dalbergia sisoo	10 700 (2)	Industrial 100	100		
		Non-industrial			
Mahoganies	5 300 (1)	Industrial 100	100		
		Non-industrial			

Other Broadleaved spp.; *Shorea robusta, Dipterocarpus spp., Paraserianthus falcataria, Lagerstroemia spciosa, Cedrela toona, Artocarpus chaplasha, Syzygium grande*, Mangroves

Eucalyptus spp.; *E. camaldulensis*

Acacia spp.; *A. auriculiformis, A. mangium*

Mahoganies; *Swietenia macrophylla*

Planted areas of non forest species in 2000

Total reported area = 4 620 000 ha				
Species	Reported area (ha)	Ownership (%)		
		Public	Private	Others
Coconut	31 000	n.a.		

Explanatory note on 2000 estimates

MOEF (1996) gives the total plantation area in 1995 as 443 000 ha. MOEF (1993a) gives the targeted planting rate as18 000 ha per year during 1993-2002 in the Forestry Master Plan, scenario I. Applying this to the total plantation area of the year 1995 as a base, the total plantation area of the year 2000 is estimated.
Apart from the other species, IRSG (1997) gives rubber plantation area in 1979 and in 1989. From them rubber plantation area of the year 2000 is estimated to be 91 800 ha.

Pandey (1997) estimates species composition and industrial plantation area, they are assumed to be valid to the year 2000. Industrial plantation accounts for 54 percent of the plantation except rubber. The percentages of industrial and non-industrial purposes of each species are estimated based on the usual utilisation mentioned by Pandey (1997).

There are some private plantations, but their data is not available. In this estimate, public plantation is estimated. As for rubber, ownership is not mentioned.

APCC (1998) provides coconut plantation area by year from 1993 to 1996. From these, the total area of the year 2000 is estimated to be the average of these year, 31 000 ha. Ownership data is not available.

2.5 References

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FAO. 1981. Forest Resources of Tropical Asia, Tropical Forest Resources Assessment Project, Technical Report 3, UN 32/6.1301-78-04, FAO, Rome 475 pp.

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Zabala, N. Q. and Vivekanandan, K. 1993. An Overview Document, The Existing Situation on Forestation and Future Requirements for Improved Productivity of Man-made Forests in the Member Countries of FORTIP (Forest Tree Improvement Project), UNDP/FAO Regional Project, Field Document No. 10 RAS/91/004, Los Banos, Philippines, 95 pp.

3 BHUTAN

Forest plantation area of Bhutan in 2000

Gross estimated area = 21 400 ha			Annual planting = 800 ha		
Species	Gross estimated area (%)	Purpose (%)	Ownership (%)		
			Public	Private	Others
Other Broadleaved spp.	10 300 (48)	Industrial 84	100		
		Non- Industrial 16	100		
Tectona grandis	3 000 (14)	Industrial 100	100		
		Non- Industrial			
Gmelina arborea	2 600 (12)	Industrial 84	100		
		Non- Industrial 16	100		
Terminalia spp.	1 900 (9)	Industrial 100	100		
		Non- Industrial			
Pinus spp.	2 800 (13)	Industrial 100	100		
		Non- Industrial			
Other Coniferous spp.	800 (4)	Industrial 100	100		
		Non- Industrial			

Other Broadleaved spp.; *Shorea robusta, Albizia* spp., *Chukrasia tabularis, Michelia* spp. etc.

Pinus spp; *P. roxburghii, P. wallichiana*

Other Coniferous spp.; *Cupressus* spp.

Explanatory note on 2000 estimates

MOA (1996) gives information on the establishment of forest plantations in Bhutan from 1947 to 1992 by district. To 1981, the total planted area was 7 320 ha, matching well with the FAO (1981) estimate of 7 000 ha for 1980. The area increased to 10 039 ha by 1987 and to 15 008 ha by 1992. Govil (1999) provided a somewhat lower estimate of total plantation area up to 1997, 14 760 ha. Average annual planting during 1982-1987 was 500 ha and during 1988-1992 was 1 000 ha. The total plantation area to the year 2000 has been estimated by assuming an annual plantation rate of 800 ha, using 1992 as a base.

MOA (1991) provides records of total plantations (11 700 ha) established up to 1989 by division, age class and by main species. Percentages of species have been roughly estimated based on this record.

Based on the standard use of species, 90 percent of the plantations are assumed to be industrial. Almost all plantations are owned by the state.

3.1 References

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4 BRUNEI DARUSSALAM

Forest plantation area of Cambodia in 2000

Gross estimated area = 2 800 ha				Annual planting = 200 ha		
Species	Gross estimated area (%)	Purpose (%)		Ownership (%)		
				Public	Private	Others
Rubber	1 200 (42)	Industrial				
		Non- Industrial	100	100		
Other Broadleaved spp.	870 (31)	Industrial	100	100		
		Non- Industrial				
Acacia app.	400 (15)	Industrial	100	100		
		Non- Industrial				
Tectona grandis	100 (4)	Industrial	100	100		
		Non- Industrial				
Others Coniferous spp.	200 (7)	Industrial	100	100		
		Non- Industrial				
Unspecified	30 (1)	Industrial	100	100		
		Non- Industrial				

Other Broadleaved spp.; *Dipterocarpus spp.*

Acacia spp.; *A. mangium*

Other Coniferous spp.; *Araucaria hunsteinii, Agathis borneensis*

Unspecified; Mixed plantation of *Eucalyptus* spp. and *Pinus* spp.

Explanatory note on 2000 estimates

FD (1999) gives the total area of plantations up to 1998 as 2 360 ha and breakdowns by species and age classes. All plantations are within 1-10 year old and this means establishment of plantations has been done since1988. Annual planting rate is estimated as 200 ha. Applying this to the total of the year 1998 as a base, the total of the year 2000 could be estimated as 2 800 ha. Species composition is assumed to be maintained to the year 2000. Regarding Pinus and Eucalyptus species, each figure is not available. All plantations are established for industrial purposes except rubber. The percentage of industrial plantation is approximately 58 percent. The state owns the whole plantations.

About 504 ha additional plantations are established primarily for environmental and recreational purpose. These are planted inside natural forests, so they should not be included in plantation.

4.1 References

FD. 1999. FRA 2000 Input of Brunei Darussalam, Forestry Department, Brunei Darussalam

5 CAMBODIA

Forest plantation area of Cambodia in 2000

Gross estimated area = 89 900 ha				Annual planting = 2 500 ha		
Species	Gross estimated area (%)	Purpose (%)		Ownership (%)		
				Public	Private	Others
Rubber	72 500 (80.7)	Industrial				
		Non- Industrial	100	n.a.		
Other Broadleaved spp.	9 800 (10.9)	Industrial	n.a.	n.a.		
		Non- Industrial	n.a.	n.a.		
Tectona granids	6 800 (7.5)	Industrial	100	n.a.		
		Non- Industrial				
Eucalyptus spp.	100 (0.1)	Industrial	n.a.	n.a.		
		Non- Industrial	n.a.	n.a.		
Pinus spp.	700 (0.8)	Industrial	100	n.a.		
		Non- Industrial				

Other Broadleaved spp.; *Acacia auriculiformis, Dipterocarpus spp., Peltophorum ferugineum, Hopea odorata* etc.

Eucalyptus spp.; *E. camaludlensis*

Pinus spp.; *P. merkusii*

Explanatory note on 2000 estimates

DFW (1998b) provides forest area by forest type, including plantation. In 1992/1993, the total of plantation was 72 307 ha and in 1996/1997 that was 82 425 ha. While DFW (1998a) mentions that plantation area is estimated between 5 500 ha and 7 000 ha around the year 1998. IRSG (1999) provides rubber plantation area in 1990. From these data, the data presented by DFW (1998b) is supposed to include rubber plantation in its plantation data. On the assumption that the reference year of DFW (1998b) as 1993 and 1997, the annual planting during that period is estimated to be 2 500 ha. Applying this to the total plantation area of the year 1997, the area of the year 2000 is estimated at 89 900 ha.
Assuming this annual planting had not changed since 1990, the total plantation area of the year is estimated to be approximately 64 800 ha. From this, reducing rubber area, the rest is supposed as plantation with other species.
DFW (1998a) gives specie composition, except rubber, in 1972. There is no data available later than 1972. In this estimate, it is assumed that there has been no change in species composition until the year 2000. Regarding purpose, DFW (1998a) suggests that *Tectona grandis* and *Pinus merkusii* are used for industrial purpose. And the rest are used for both industrial and non-industrial purposes, no breakdown is available. Ownership data is not available.

5.1 References

DFW. 1998a. Country Paper on Some Aspects of Forestry in Cambodia submitted to 17th Session of the Asia-Pacific Forestry Commission, at Yogyakarta, Indonesia 23-27 February 1998 by the Department of Forestry and Wildlife, Kingdom of Cambodia Nation Religion King.

DFW. 1998b. Forest Cover Statistic 1998, by DFW Forest Wildlife Research and Education Institute

IRSG. 1999 Rubber Statistical Bulletin, by International Rubber Study Group

6 CHINA

Due to various reasons, China's forests were removed in the past (MOF, 1995a). Forest cover was only 8.6 percent of the land area at the time of the foundation of the People's Republic of China in 1949. To improve the environment and meet demands on forest resources, tree planting has been given great importance. The last completed forest resource inventory revealed that China's forested area has increased to 133.7 million ha covering 13.92 percent of the country's total land area (MOF, 1995a).

6.1 Development of forest plantations

Since 1949, the country has carried out plain afforestation, primarily "Four-side" plantings, windbreak, and farmland shelterbelt plantations. "Four-side" plantings is to establish plantations around rivers, roads, houses and villages. The purpose of these was primarily to control natural disasters such as wind and sandstorms, draughts and floods affecting China's Central plain areas, which constitute 45 percent of the farmland of the country. The major area of the plantations, known as State-owned Forest Farms and Collectively owned Forest Farms are located in this region (MOF, 1995a). Establishment of plantations of fast growing and high yielding species for the development of timber resources started in the mid-1970s. The recorded area of such plantations was 3.2 million ha by 1980 (Kunshan et al, 1997). In December 1981, the Chinese Congress adopted the Resolution on National Compulsory Tree Planting Campaign under which each and every Chinese citizen (excluding young and old) has an obligation to plant three to five trees per year. This gave an impetus to plantation forestry. Such new ecological restoration programmes involving tree plantations as the Coastal Shelterbelt, Taihang Mountain Afforestation and Soil and Water Conservation of the Yangtze River were undertaken and an existing one (Three-north Shelterbelt) was expanded. A national programme to combat desertification has been implemented since 1995.

The area of plantations established between 1980 and 1987 was 28.92 million ha and between 1988 and 1992 was 16.17 million ha (Kunshan et al, 1997). This gives an annual rate of plantation over these years of more than 4 million ha. In 1993, 5.932 million ha were planted (MOF, 1995a). The figures on annual establishment of plantations are quite high compared to the actual increase in area as shown in the inventory reports presented in the following paragraph. In China, the area planted annually is determined on the basis of number of seedlings planted.

The second National Forest Resources Inventory (NFRI) carried out during 1977-1981 found the total area of existing plantations to be 22.28 million ha. The plantation area increased to 31.01 million ha as estimated by the third NFRI carried out during 1984–1988 (MOF, 1995a). The average annual plantation rate during the intervening period of these two inventories (assuming mid years, that is, 1979 and 1986, as reference years for the second and third NFRIs, respectively) was 1.25 million ha. The fourth NFRI carried out during 1989-1993 has estimated the total plantation area as 34.251 million ha, which includes 11.18 million ha area of non-wood forest species, termed economic forest plantations (oil bearing seeds, spices, medicinal plants, rubber, etc.) and 1.05 million ha of bamboo (SFA 1999). The increase in the total plantation area during the 5 years between 1986 and 1991(assuming mid year 1991 of the fourth NFRI as the reference year) was 3.24 million ha.

6.2 Species composition

A large number of tree species are planted to suit various agro-climatic conditions. Conifers dominate the area of industrial plantations, of which *Cunninghamia lanceolata, Pinus massoniana, P. tabulaeformis, P. elliottii* and *Larix* spp. are the main species, constituting about 57 percent of the total area. Among the broadleaved species, *Populus* spp. is the main species and occupies about 4 percent of the industrial plantations. *Eucalyptus* spp. *Paulownia elongeta, P. fortunei*, *Casuarina* spp. and *Acacia auriculiformis* are other popular broadleaved species in plantations (Pandey, 1998). *Tectona grandis* has been planted in a limited area, mainly in Taiwan, Yunnan and Hainan provinces (Jiayu et al, 1999).

6.3 Growth and Yield

Wood production from plantations in 1990 was 27.48 million m^3, constituting about 45 percent of total production. However, in the absence of harvested area figure per-hectare productivity cannot be estimated. Average mean annual increment of all plantations is estimated as 4 m^3/ha/year at an average rotation age 25 years (MOF, 1995b).

Growth rate of some fast growing species

Species	Rotation (years)	Mean annual increment (m^3/ha/year)
Cunninghamia lanceolata	20	10.5
Buxus microphylla	15	15.0
Populus spp.	10	22.5

6.4 Trend

China plans to increase the forest cover of the country to about 17 percent by 2010, a substantial area of which has to be from plantations. China has 63.03 million ha of land suitable for afforestation with 14.09 million ha suitable for timber-production forests. During 1996-2010, China plans to bring a total area of 9.73 million ha into timber plantations, of which new plantations will be 5 million ha, mainly fast-growing high-yielding species. For improvement of the environment, 4.04 million ha in Three-north shelterbelt, 8.1 million ha along the reaches of the Yangtze and Yellow Rivers, 1.07 million ha in the coastal shelterbelt, 1.78 million ha in the Taihang mountain, etc. are to be planted during 2000-2010 (MOF, 1995c). It is planned to increase the percentage of broadleaved trees to 40 percent by the year 2000 and 45 percent by 2010 from the existing 32 percent.

Forest plantation area of China in 2000

Gross estimated area = 48 254 000 ha		Annual planting = 1 785 000 ha			
Species	Gross estimated area (%)	Purpose (%)	Ownership (%)		
			Public	Private	Others
Other Broadleaved spp.	12 735000(26.4)	Industrial 100	29		71
		Non- Industrial			
Eucalyptus spp.	1 494 000 (3.1)	Industrial 70	29		71
		Non- Industrial 30	29		71
Rubber	592 000 (1.2)	Industrial			
		Non- Industrial 100	n.a.		
Acacia spp.	145 000 (0.3)	Industrial			
		Non- Industrial 100	29		71
Other Coniferous spp.	18 333000(38.0)	Industrial 100	29		71
		No-industrial			
Pinus spp.	14 279000(29.6)	Industrial 100	29		71
		Non- Industrial			
Casuarina spp.	676 000 (1.4)	Industrial			
		Non- Industrial 100	29		71

Other Broadleaved spp.; *Populus* spp., *Robinia pseudoacacia*, *Magnolia* spp., *Quercus* spp., *Pawlonia* spp., *Tectona grandis* and etc.

Acacia spp.; *A. auriculiformis*

Other Coniferous spp.; *Cunninghamia laneolata, Larix* spp.

Pinus spp.; *P. elliottii, P. koraiensis, P. tabulaeformis Carr*

Planted areas of non forest species in 2000

Species	Reported area (ha)	Ownership (%)		
		Public	Private	Others
Oil palm	7 000	n.a.		
Bamboo	1 049 000	n.a.		

Explanatory note on 2000 estimates

DFR (1999) gives the area of plantation by their classification, “Forest stands, planted”, “Open forest planted”, ”Immature plantation”, “Nurseries” are considered to be plantation of FRA definition. The total of them is 31 595 000 ha. The reference year is supposed to be 1991, the middle of the period, 1988-1993, when the inventory had been carried out. “Immature plantation” means plantation established last 5 years (North region) or 3 years (South region), the area is 7 138 300 ha. Given that the figure, which is derived by dividing it with 4 (the average of 5 years and 3 years), is the annual planting during the period, 1988-1993 and is assumed to be valid up to the year 2000. Applying this to the total of the year 1991 as a base, the total of the year 2000 is estimated.

Data on species is not available from the latest inventory, Pandey (1998) estimates species composition, which is assumed to be valid up to the year 2000. Jiayu et al (1999) says that *Tectona grandis* is planted, its area is not significant.
Apart from other species, IRSG (1997 and 1999) gives rubber plantation areas in 1989, 1990 and 1995. It is difficult to find out the trend, therefore the average is assumed to be the rubber plantation area of the year 2000.
DFR (1999) gives data by purposes, and MOF (1995b) gives data of ownership, respectively. They are assumed to be valid up to the year 2000.

Regarding non-forest species, ISA (1999) provides the total area of oil palm by year from 1996 to 1999. Ownership data is not available. DFR (1999) gives the total areas of planted and natural bamboo as the result of the fourth National Forest Resources Inventory (NFRI). Considering that the third NFRI says bamboo is all planted, the actual established bamboo area cannot be estimated. Thus the area presented in the fourth NFRI is assumed to be valid up to the year 2000.

6.5 References

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7 INDIA

India, due to its large area, has a variety of forests representing different climatic regions and topography. The main forest formations are tropical dry and moist deciduous, tropical rain, hill and montane. The total forest cover of the country was about 63.3 million ha at the end of 1994, constituting 19.3 percent of the land area. About 37.2 million ha is closed forests and the rest is open forests (FSI, 1997). Most of the natural forests are state-owned.

7.1 Development of forest plantations

The earliest plantation in India is reported to be of a native species, teak, planted in 1840 in Nilambur, Kerala state. Regular planting, mainly of teak, began in 1865 in many of the teak-growing central and southern provinces. In 1910, eucalyptus was introduced in the Nilgiri Hills of the present Tamil Nadu state. Planting of other native species was accelerated after the taungya system was introduced in 1911. These plantations, however, did not cover an extensive area until 1950.

Planned afforestation for soil conservation, industrial wood, fuelwood and fodder started in the late 1950s. The total plantation area to the end of 1972 was about 2.1 million ha (MOA, 1973).

Establishment of plantations remained confined mostly to forest reserves until 1979. The plantation boom occurred when the social forestry projects (similar to community forestry in principal) were launched in many states along with several other afforestation projects carried out with the assistance of external donors. The annual planting rate increased to about 1.0 million ha during 1980-1985. Most of the plantations have since been established outside forest reserves in wastelands owned by the government or on community or private farmers' land. Plantation forestry received further impetus when a National Wasteland Development Board was created in 1985. The annual rate of planting increased to 1.78 million ha during 1985-1990. The area of plantations established during 1980-1990 was estimated by converting seedlings planted/distributed by a notional number, 2 000 seedlings equivalent to 1 ha. Records of plantations established since 1991 are maintained, for planted area and distributed seedlings separately, by the National Afforestation and Eco-development Board (NAEB) created in 1992 at the Union Ministry of Environment and Forests. The annual rate of planting since 1990 has been ranging between 1.4 to 1.6 million ha.

India has sizeable plantation areas of non-forest species. The total area to 1997 was about 2.35 million ha, of which coconut occupied about 1.8 million ha and rubber 0.55 million ha with a small area in oil palm. In addition, bamboo and cashew occupied 408 000 ha and 166 900 ha respectively (FSI, 1999).

7.2 Species composition

Due to varied agro-climatic conditions, a large variety of species are planted. However, detailed information about the composition of species in plantations is lacking. *Acacia* spp., *Eucalyptus* spp. and *Tectona grandis* are the main species, having greater area in the plantations than other species. Among the eucalypts, *Eucalyptus globulus*, *E. grandis* and *E. tereticornis* are most common while among the Acacias, *Acacia auriculiformis, A. catechu, A. mearnsii, A. nilotica* and *A. tortalis* are common. Other commonly planted broadleaves are *Albizia* spp., *Azadirachta indica*, *Casuarina equisetifolia*, *Dalbergia sissoo, Gmelina arborea, Populus* spp. *Prosopis* spp., *Shorea robusta* and

Terminalia spp.. Among conifers, *Cedrus deodara* and *Pinus roxburghii* occupy a major area. *Pinus patula* and *P. caribaea* have been planted to a limited extent.

7.3 Growth and yield

Wood production from forest plantations at the national or sub-national level is not available. It is reported that productivity from plantations in general is quite low. For example, mean annual increment (MAI) for teak at the average rotation age of 58 years varies between 0.6 to 7 m^3/ha/year with a mean of 2.5 m^3 /ha/year in one of the major teak producing states, Kerala (Chundamannil, 1999). Productivity levels of some plantations, mainly of eucalyptus and poplar raised by farmers under private ownership, is better. As per FSI (1999), yield of selected species is as below:

Species	Rotation (years)	Mean annual increment m^3/ha/year
Dalbergia sissoo	30 to 40	4 to 6
Eucalyptus spp.	10 to 20	8 to 12
Gmelina arborea	30 to 40	10 to 15
Acacia nilotica	20 to 25	3 to 4
Populus spp.	8 to 10	20 to 25

7.4 Issues

Only the annual statistics on plantations done under different schemes and the cumulative plantation areas since 1951 are available. Monitoring and inventory of plantations is inadequate and as a result the actual area of existing plantations is uncertain. Part of the annual plantation target (35 to 40 percent), particularly after 1985, is achieved by the distribution of seedlings. Plantations established after 1985 constitute more than 70 percent of the total. Since 1992, NAEB has started survival assessments of first-year plantations in limited areas (about 10 percent), but the results of the assessment are not used to correct the area figures reported.

7.5 Trend

Under the National Forestry Action Programme India has proposed to bring 33 percent more area under forest cover in next 20 years by planting 21.8 million ha of non-forest lands in addition to planting trees on agro-forestry/farm forestry and scrub lands (MOEF, 1999). The present trend of planting is, therefore, likely to accelerate in future. Planting high-yielding clones, particularly of eucalyptus and poplar, and use of root trainer technology is being adopted to enhance productivity (Oberoi et al 1999).

Forest plantation area of India in 2000

Gross estimated area = 32 577 600 ha				Annual planting = 1 508 800 ha		
Species	Gross estimated area (%)	Purpose (%)		Ownership (%)		
				Public	Private	Others
Other Broadleaved spp.	10 245 800 (31.5)	Industrial	30	70	30	
		Non- Industrial	70	70	30	
Eucalyptus spp.	8 004 500 (24.5)	Industrial	30	30	70	
		Non- Industrial	70	30	70	
Acacia spp.	6 403 600 (19.5)	Industrial	7.5	60	40	
		Non- Industrial	92.5	70	30	
Tectona grandis	2 561 400 (8)	Industrial	100	100		
		Non- Industrial				
Dalbergia sissoo	960 500 (3)	Industrial	90	30	70	
		Non- Industrial	10	30	70	
Rubber	559 600 (1.5)	Industrial				
		Non- Industrial	100	n.a.		
Gmelina arborea	320 200 (1)	Industrial	70	30	70	
		Non-industrial	30	30	70	
Terminalia spp.	320 200 (1)	Industrial	100	100		
		Non-industrial				
Casuarina spp.	1 600 900 (5)	Industrial				
		Non-industrial	100	50	50	
Other Coniferous spp.	960 500 (3)	Industrial	100	100		
		Non-industrial				
Pinus spp.	640 400 (2)	Industrial	100	100		
		Non-industrial				

Other Broadleaved spp.; *Shorea robusta, Prosopis spp., Populus spp., Albizia spp., Azadirachta indica, Bombax ceiba, Ziziphus spp., Lagerstroemia spp., Syzygium cuminii* etc.

Eucalyptus spp.; *E. globulus, E. grandis, E. tereticornis* etc.

Acacia spp.; *A. auriculiformis, A. catechu, A. nilotica, A. tortalis* etc.

Casuarina spp.; *C. equisetifolia*

Other Coniferous spp; *Cedrus deodara*

Pinus spp.; *P. roxburghii, P. patula, P. caribaea*

Planted areas of non forest species in 2000

Species	Reported area (ha)	Ownership (%)		
		Public	Private	Others
Coconut	2 147 000	n.a.		
Oil palm	18 000	n.a.		

Explanatory note on 2000 estimates

FSI (1999) gives the total area of forest plantations done to 1997 as 27.463 million ha, of which 9.546 million ha has been achieved by converting distributed seedlings by a notional number. NAEB (1999) provides the amount of plantations since 1985 by year and sub-national unit up to 1999, with a total plantation area to 1999 of 30.518 million ha. An average of about 1.5 million ha of plantations done annually during 1990-1999 has been used to estimate the total reported plantation area of India in 2000. Of the total plantation area, 11.025 million ha has been achieved by the distribution of seedlings and the rest by planting on public land.

Information about the composition of species in the plantations is poor. FSI (1999) provides a breakdown of species only for industrial plantations. The species composition roughly estimated by Pandey (1998) for all plantations has been slightly modified in view of new information given by the FSI (1999) and applied to the 2000 estimate. Apart from the other species, IRSG (1997 and 1999) gives rubber plantation area in 1995 and 1997. Rubber plantation area in 2000 is estimated from them.

FSI (1999) has provided a breakdown of the 27.463 million ha of plantations by purpose about species except rubber; that is, industrial roundwood 34.4 percent, fuelwood 21 percent and other purposes 45.5 percent. The same percentage breakdown has been maintained for the year 2000. Further, as per FSI (1999), about 65 percent of the plantations are state owned and 35 percent privately owned, and the same percentages have been applied to the estimate of plantations in 2000.

APCC (1998) and ISA (1999) provide coconut and oil palm plantation area, respectively.

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8 INDONESIA

Indonesia comprises the largest area of rainforests, next to Brazil. FAO (1993) estimated the total forest cover of the country in 1990 as 109.55 million ha of which 86 percent was tropical rainforest. More than 60 percent of the land area of the country is still covered with forests. Timber from Indonesia's *Dipterocarpus* forests has been an important source of non-oil revenue. All natural forests in the country are state-owned.

8.1 Development of forest plantations

In spite of its rich forest resource, Indonesia started regular forest plantations in 1873, mostly in Java with teak (*Tectona grandis*) and in 1916 with pine (*Pinus merkusii*) in Sumatra. Later on, some fast-growing species were also introduced in trial plantations. The estimated area of plantations to 1950 was 500 000 ha, constituting three-fourths of the total plantation area of the tropical countries (Lanly, 1982). Due to pressure for land in Java, the plantation activity was reduced for a while. In the late 1960s plantation programmes were again stepped up, adding significant area in almost all provinces. Two agencies were made responsible for the reforestation of all state forestlands; Perum Perhutani for plantations in Java and the Directorate of Reforestation and Greening (DITSI) in provinces outside Java. Reforestation within concession areas by concessionaires was initiated in the 1970s. The total area of plantations in 1980 was 2.669 million ha (FAO, 1981), with the major portion in Java.

Perum Perhutani became responsible for managing the existing timber plantations of Java and expanding them. The DITSI programmes were reforestation and rehabilitation in critical watershed basins including planting of fruit and fodder trees in densely populated watersheds, construction of check dams and terraces, etc. About 5.814 million ha was brought under rehabilitation through 1988. Obviously, these areas were not all planted. In the 1990 assessment, Pandey (1995) included the DITSI areas, which inflated the total plantation area of Indonesia. In later reports, these areas were not included (MoF, 1996). In the light of this new information, the revised figure of total plantations in 1990 has been adjusted to 3.750 million ha.
Due to population pressure, the scope for additional plantations in Java is limited. In 1988, the Ministry of Forestry decided to establish 6.2 million ha of additional industrial plantation forests in the long run (about 25 years) with an annual planting rate of 250 000 ha by state and private companies (MoF, 1996). Plantations for industrial production, known as Industrial Timber Plantations or Hutan Tanaman Industri (HTI), are being done in the islands outside Java, mainly in Kalimantan and Sumatra. In addition, farmers establish small woodlots with soft-money loans from the Ministry of Forestry. It is estimated that there are 1.27 million ha of such woodlots of which 1 million ha are in Java (MoF, 1996).

Indonesia has the largest plantation area of non-forest species. In 1997, rubber, coconut and oil palm occupied 3.474 million ha, 3.668 million ha and 2.516 million ha respectively. Most of these plantations are in private holdings. The share of private ownership is rubber (99 percent), coconut (93.5 percent) and oil palm (82 percent). Among private holdings, about 60 percent of the oil palm plantations are in private estates and the rest in small ownerships whereas most of the rubber and coconut plantations are in small ownerships (Anon., 1999).

8.2 Species Composition

Tectona grandis occupies major areas of plantation in Java. Other species planted by Perum Perhutani are *Pinus merkusii*, *Agathis* spp. *Swietenia macrophylla*, *Dalbergia latifolia*, *Paraserianthes falcataria* and *Shorea* spp. HTI plants *Acacia mangium*, *Paraserianthes falcataria, Eucalyptus* spp. and *Gmelina arborea* for pulp and *Swietenia mahogani* and *Dipterocarpus* spp. for timber. Farmers with smallholdings prefer short-rotation fast-growing species. The exact species composition of plantations other than those of Perum Perhutani is not known.

8.3 Growth and yield

Average annual production of roundwood from the plantations of Perum Perhutani was about 1.8 million m^3 during 1994-1997 against the total production of 25 million m^3 in the country. Industrial timber plantations being young, production has only recently started and is around 0.5 million m^3 annually. The data on production from private wood lots is not consistent. During 1994-1995 it was in the order of 125 000 m^3, increasing to 682 006 m^3 in 1996 and to 1 266 455 m^3 in 1997 (MoFE, 1998). The area of the plantations harvested is not available so the yield per unit area cannot be estimated.

The actual mean annual increment obtained from teak plantations of Perum Perhutani at 70 years rotation age is about 3 m^3/ha/year (Ballet al, 1999). In the past, *Pinus merkusii*, *Agathis* spp. and *Paraserianthes falcataria* have yielded 11.6, 13.5 and 25.1 m^3/ha/year MAI, respectively (Anon., 1986).

8.4 Issues

High social pressure, particularly in Java, has resulted in illegal felling, cattle grazing beyond capacity, fire and encroachments into plantations. As a result, actual yield from plantations is quite low. Productivity of teak plantations is further reduced due to the teak termite (Siswamartana, 1999). The timber plantations established in the outer islands by HTI have not been inventoried.

8.5 Trend

To support industrial plantations by HTI to bring the total planted area to 6.2 million ha in the future, some seed centres and 8 modern nurseries have been established with a production capacity of over 80 million seedlings per year. The increasing demand for oil palm nationally and internationally has attracted wealthy investors, especially in Kalimantan and Sumatra, which is detrimental to other land uses including forest plantations (Potter et al, 1998). Smallholders and private estates have increased the area of oil palm plantations by 0.65 million ha, that is, by 50 percent, from 1994 to 1997.

Forest plantation area in Indonesia 2000

Gross estimated area = 9 870 500		Annual planting = 270 700 ha			
Species	Gross estimated area (%)	Purpose (%)	Ownership (%)		
			Public	Private	Others
Rubber	3 476000(35.2)	Industrial			
		Non- Industrial 100	1	99	
Other Broadleaved spp.	2 941000(29.8)	Industrial 81	63	37	
		Non- Industrial 19	51	49	
Tectona grandis	1 470000(14.9)	Industrial 100	100		
		Non- Industrial			
Acacia spp.	641 500(6.5)	Industrial 100	60	40	
		Non- Industrial			
Gmelina arborea	256 400(2.6)	Industrial 70	50	50	
		Non- Industrial 30	50	50	
Mahoganies	187 500(1.9)	Industrial 100	100		
		Non- Industrial			
Eucalyptus spp.	128 300(1.3)	Industrial 100	100		
		Non- Industrial			
Pinus spp.	769 800(7.8)	Industrial 100	100		
		Non- Industrial			

Other Broadleaved spp.; *Shorea* spp., *Dipterocarpus* spp., *Dryocalanops* spp., *Anisoptera* spp., *Agathis* spp. etc.

Acacia spp.; *A. mangium*

Mahoganies; *Swietenia macrophylla*

Pinus spp.*; P. merkusii*

Planted areas of non forest species in 2000

Species	Reported area (ha)	Ownership (%)		
		Public	Private	Others
Coconut	3 668 000	6.5	93.5	
Oil palm	2 516 000	18	82	

Explanatory note on 2000 estimates

MoF (1996) provides plantation areas of Perum Perhutani, HTI and private farmers, in 1995 and annual established areas by HTI. Annual plantation by Perum Perhutani, excluding the area of replanting, is available at PH (1998), as 20 000 ha. MoFE (1998) gives the total plantation area by HTI up to 1996. Applying average annual plantation, except rubber, as 270 000 ha, total plantation area in the year 2000 has been estimated treating 1996 as a base. Only Perum Perhutani provides breakdown of their plantation areas by species. MoF (1996) gives a general indication of the species planted in outer islands. Based on personal communication from officials of the Ministry

of Forestry, Indonesia, Pandey (1998) roughly estimated composition of species. The same composition has been assumed to be valid up to the year 2000. Regarding teak, the record of plantation inventory revealed by Perum Perhutani shows that actual plantation area in 1995 of teak was 603 557 ha and of non-teak was 260 998 ha against corresponding reported areas of 1 106 100 ha and 861 700 ha respectively. Siswamartana (1999) has presented the actual area of teak by age class.
Anon (1999) gives rubber, oil palm and coconut area by year and ownership.
About 76 percent of the total plantations are owned by the government. Most of the plantations are established for industrial, only 10 percent of the total plantations, mainly of fast growing species, have been assumed non-industrial and the rest as industrial.

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9 LAO PEOPLE'S DEMOCRATIC REPUBLIC

In 1940, forests had been estimated to be 17 million ha, covering 70 percent of the whole land. In 1989, forest cover was estimated to cover 47 percent of the whole land. Forest plantation development was initiated in early 1990's. Regarding plantation, plantation development was properly initiated in early 1990s, by both of the government and private (Kingsada, K. 1998).

9.1 Development of forest plantations

In 1960s, some small plantations had been established in Mekong Valley, for protection purpose. Species planted were Teak (*Tectona grandis*), *Dalbergia cochinchinensis*, *Pterocarpus pedatus* and *Hopea* spp. At the beginning of 1960s, *Eucalyptus* spp. and other fast-growing species were introduced. The results of them are not available (FAO, 1981).
Since the foundation in 1975, the government has promoted reforestation and plantation development, associated with land management policy, land allocation programme, and investment programme. The annual planted area has been increased recently. Before the first forestry conference, plantation had been established by the state, after that the area of private establishment has increased (Anon.1996).
According to a survey in 1993, about 1 900 ha of plantation was established prior to 1976. The total plantation area was 9 734 ha. However the survival rate was estimated to be as low as 46 percent (Thongphanmaha, B. 1994).

9.2 Species composition

Tectona grandis is indigenous to Laos, it has been planted since 1930's in Khammoune Province. It is one of the most commonly planted species, consisting 25 percent of whole plantation. These days, instead of the government, private farmers are doing plantation (Cameron DM et al.1995).
Small holders prefer indigenous species, while big companies prefer exotic species such as *Eucalyptus* spp. and *Acacia* spp. (Anon.1996).

9.3 Issues

Lack of knowledge of the management or techniques, appropriate regulations, concrete instructions and procedures, and investments have resulted in poor condition of plantations (Cameron DM et al.1995).

9.4 Trend

The current government policies and objectives relate to the need to reduce and control deforestation. Forest plantation is one of the strategies. It is aimed to control deforestation by 2000 and establish 40 000 ha of plantations, during the period of 1993-2000 (DOF 1995).

Forest plantation area of Lao PDR in 2000

Gross estimated area = 53 900 ha		Annual planting = 6 300 ha			
Species	Gross estimated area (%)	Purpose (%)		Ownership (%)	
				Public	Private	Others
Other Broadleaved spp.	24 200 (45)	Industrial	62	n.a.		
		Non- Industrial	38	n.a.		
Tectona grandis	13 500 (25)	Industrial	100	n.a.		
		Non- Industrial				
Eucalyptus spp.	8 100 (15)	Industrial	62	n.a.		
		Non- Industrial	38	n.a.		
Acacia spp.	5 400 (10)	Industrial	62	n.a.		
		Non- Industrial	38	n.a.		
Gmelina arborea	2 700 (5)	Industrial	62	n.a.		
		Non- Industrial	38	n.a.		

Other Broadleaved spp.; *Azadirachta indica, Alstonia scholaris, Sarcocephalus* spp., *Azilia xylocarpa, Pterocarpus macrocarpus*

Acacia spp.; *A.mangium*

Explanatory note on 2000 estimates

Thongphanmaha (1994) gives the total plantation area in 1993 as 9 734 ha. Anon. (1996) gives the details of annual planting from 1975 up to 1995. In 1995, accumulated plantation area was 21 521 ha and the annual planting during 1993-1995 was 6 300 ha. The total plantation area in the year 2000 has been estimated based on these figures.

Pandey (1998) estimated composition by species and purpose of the plantations. The same estimate has been maintained for the year 2000. There is no data available for ownership.

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10 MALAYSIA

Forest resource is thought to become scarce with the effect by increasing population and the rising demand for timber and forest products. Thus more intensive and prudent practice should be applied to manage forest resources sustainable. Currently, rubber has been planted for latex and at the same time it has been an important source of timber for furniture (FDH. 1997).

10.1 Development of forest plantations

In 1877, the first plantation was established with rubber in Peninsular Malaysia. Small trial plantations of exotic species had been established following years. In 1900, plantation of rubber had become to be established regularly. Rubber plantation had been taken up increasingly by the privates, while plantations with other species did not perform well. But still several trial plantations had been established through the country. During 1920s, it was considered that improvement of the crop from natural forest was better than establishment of plantation. The following decade, no intensive work was made in plantations (FRIM. 1998).
In 1950s, commercial plantation became popular with *Tectona grandis, Acacia mangium, Gmelina arborea* and other fast growing species. *Eucalyptus* spp. and *Pinus* spp. had been introduced (FDH. 1997).
In 1979, the implementation of reforestation and rehabilitation project in Sarawak was initiated to restore deforested land. Its objectives are to ensure sustainable supply of timber, and to emphasise the role of forestry in rural community and etc (FMISS. 1999).
In 1980, the first pulp and paper mill was set in Sabah, *Acacia mangium* was mainly planted to supply material. As the 1980s approached, the industries had grown and it was predicted that only natural forest could not supply enough timber for them. This led the Forestry Department consider to establish plantation to produce timber. And the project, “Compensatory Plantation Project”, was initiated. Under this project, by 1995, 188 200 ha of plantation were established in Peninsular Malaysia, they were planed to produce timber in 15 years rotations (FRIM. 1998).

10.2 Species composition

Rubber is the dominant species, estimated to account for about 85 percent of the whole plantation. This has been taken as an important sources for timbers for several decades. The second largest species is *Acacia* spp., especially *A. mangium* is planted. Fast growing species, such as *Eucalyptus* spp., *Pinus* spp., *Gmelina arborea* and etc., are planted, too (FRIM. 1997).

10.3 Issues

With increasing population, the competition for land between agriculture and plantation is increasing. To rely on a few species may change the ecosystem of their site, the risk of fires is thought to increase in mono-species plantation. There is a lack of supply for good quality planting material, plantation management skills, and human resources (FRIM. 1997).
Shifting cultivation has taken place for many decades, especially in Sarawak and causes an adverse impact on the forest. Due to the nature of slash and barn, it is not easy for the area to regenerate (FDH. 1997).

10.4 Trend

It is expected that the private sector will play a bigger role to develop plantation in the country. The government encourages the private to establish plantation by investment and promote privatisation of governmental plantation. Plantation is thought to be necessary to reduce production from natural forest and to produce timber in sustainable way. A recent survey revealed that there is still more than 1 million ha of idle land suitable for plantation (MTB. 1997).
Commercial ventures in plantation development have not been achieved. Thus it is thought that the government should promote privatisation of existing plantations or to establish new plantations, considering the declining resources (FRIM. 1998).

Forest Plantation area of Malaysia in 2000

Gross estimated area = 1 749 500 ha				Annual planting = 34 900 ha		
Species	Gross estimated area (%)	Purpose (%)		Ownership (%)		
				Public	Private	Others
Rubber	1 478 300 (84.5)	Industrial				
		Non- Industrial	100	12	88	
Acacia spp.	180 200 (10.3)	Industrial	100	100		
		Non- Industrial				
Eucalyptus spp.	19 300 (1.1)	Industrial	100	100		
		Non- Industrial				
Tectona grandis	12 200 (0.7)	Industrial	100	40	60	
		Non- Industrial				
Other Broadleaved spp.	7 000 (0.4)	Industrial	100	80	20	
		Non- Industrial				
Gmelina arborea	5 200 (0.3)	Industrial	100	100		
		Non- Industrial				
Pinus spp.	47 300 (2.7)	Industrial	100	100		
		Non- Industrial				

Acacia spp.; *A. mangium*

Eucalyptus spp.; *E. deglupta*

Other Broadleaved spp.; *Paraserianthes falcataria, Shorea macrophylla, Durio zibethinus* etc.

Pinus spp.; *P. caribaea*

Planted areas of non forest species in 2000

Species	Reported area (ha)	Ownership (%)		
		Public	Private	Others
Coconut	228 000	53	47	
Oil palm	2 767 000	6	94	

Explanatory note on 2000 estimates

The three sub-national units of Malaysia have been reporting on plantations separately. There is a lack of consistency in the total planted area and breakdown by species.

In Peninsular Malaysia, MTB (1997) gives the total plantation area as 69 217 ha in 1996 whereas FD (1999) gives 74 410 ha in 1998 and FRIM (1998) reports 76 750 ha without any reference year. The average annual planting of 2 100 ha based on 1996 and 1998 data has been used to estimate the total planted area in the year 2000, treating the 1998 figure as a base.

Species composition has been provided in all three references. The latest composition mentioned in FD (1999) has been assumed valid for the year 2000. The government owns almost all plantations.

In Sabah, the total plantation area as of 1997 was 123 568 ha, excluding 21 465 ha of rattans as given by FD (1997a). FD (1995) gives an area of 88 822 ha excluding 20 762 ha of rattans in 1995. Average annual planting of about 17 000 ha was achieved during two years (1995-1997) and the same has been used to estimate total plantation area in Sabah in the year 2000.

The breakdown of species in 2000 for Sabah has been estimated from FD (1995). Ownership is divided between public and private as per FD (1997a) but the exact division is not clear. FRIM (1998) has mentioned that private companies and state owned enterprises have planted high-valued timber and rattans.

For Sarawak, FD (1996a) provides the total plantation area as of 1996 as 15 052 ha and FMISS (1999) as 16 960 ha up to 1997, including 2 222 ha of rattans. The average annual planting during 1991-1995 and 1996-1997 was 1 550 ha and 1 900 ha respectively. Since emphasis on plantations is increasing, 1 900 ha per year has been used to estimate the total plantation area in 2000 with species composition as provided by FMISS (1999). All plantations are owned by the state.

DS (1999) gives rubber, oil palm and coconut plantation areas by year. Rubber should be treated as plantation.

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11 MYANMAR

Myanmar is a forest-rich country and is the home of economically important tropical hardwood species such as teak (*Tectona grandis*), pyinkado (*Xylia kerri*), and padauk (*Pterocarpus macrocarpus*). Even with a sizeable loss of forest cover over the years, closed forests still occupy more than 40 percent of the country's area. Since natural forest resources have been plentiful, forest plantations have played a minor role in Myanmar forestry.

11.1 Development of forest plantations

A plantation of teak is reported to have been established around the year 1700 in the Paletwa area of Chin State. Regular planting of teak by the taungya method was initiated in 1856 in Tharyawady in the Bago Division. Planting in those days was sporadic and in the order of 10 ha or so at one time, mainly to compensate for lack of natural regeneration. The total area of teak plantations established up to 1906 was 24 282 ha when planting was stopped (FD, 1999a) due to criticism and in order to favour natural regeneration through improvement felling. Planting was again resumed in 1918 and the taungya method became the standard practice. *Xylia kerri* and *Acacia catechu* were also planted. Bee-hole borer attack in teak again led to controversy. The total plantation area reached 47 167 ha by 1941. Plantations remained a low-key activity with annual planting below 700 ha until the early 1960s, when planting picked up again at a moderate scale, 2 000 to 3 000 ha per year. Total plantation area up to 1979 was 102 050 ha, of which about 56 percent was teak (MF, 1996).

Large scale planting, however, began in 1980 and more than 30 000 ha of forest plantations have been planted annually since 1984. A peak of 38 168 ha was achieved in 1996 (MF 1996). Forest plantations in Myanmar are classified into four types: (a) commercial, (b) village supply, (c) industrial (for supplying raw material to state-owned paper and pulp factories) and (d) watershed. In the early phase, about 80 percent of the plantations were for commercial purposes and rest to meet fuelwood and small timber needs of rural people in forest deficit areas (particularly the central arid zone of Myanmar). Eucalyptus was introduced as a plantation species in 1968 and its annual planting was gradually increased. About 15 600 ha of eucalyptus was planted to 1980, mostly for fuelwood, poles and posts (FD, 1997 and FAO, 1981). Myanmar started establishing watershed plantations in 1979 to restore degraded forests in the upland catchments of important dams. A Pilot Watershed Management Project aided by UNDP/FAO was initiated in 1987 and the full project has been implemented since 1994. Until the end of 1998, a total of 58 446 ha had been planted under watershed protection schemes (FD, 1999b).

11.2 Species composition

The three native species - *Tectona grandis*, *Xylia kerri* and *Pterocarpus macrocarpus* - are mainly planted in the commercial plantations. In the arid areas, besides these three native species, the exotics *Acacia catechu, Cassia siamea* and *Albizia lebbeck* are also planted. Among exotics, *Eucalyptus camaldulensis* is planted in industrial plantations in wet areas and for fuelwood in both in wet and arid areas. *Acacia auriculiformis, A. senegal, A. holocericea, Azadirachta indica* and *Leucaena leucocephala* are planted in arid areas for fuelwood. At high elevations, *Eucalyptus grandis, Pinus caribaea, P. patula* and *P. maximinoi* are planted. Among the main species, teak constitutes 35.5 percent, pyinkado 7.8 percent, eucalypts 8.7 percent and padauk 1.7 percent.

11.3 Issues

Tree and genetic improvement and the use of quality planting material were not given adequate attention in plantation activities in the past. Selection of planting sites and site–species matching was also not satisfactory. Shortages of funds and qualified staff have constrained efficient protection, maintenance and monitoring of plantations (FD, 1997).

11.4 Trend

Until 1991, only the Forest Department was empowered to establish forest plantations. After the adoption of the 1992 Forest Law the situation changed. To increase village wood supplies, the opportunity to establish plantations was opened to the private sector, permitting the establishment of community plantations for local supply as well as commercial purposes. Under the new law national, foreign and joint-venture companies will be permitted to establish their own plantations to meet the needs of their industries (FD, 1997). The Forest Department distributes seedlings free of charge to individuals, local communities and other organisations to encourage tree planting. More than 11 million seedlings have been distributed annually in recent years.

Forest plantation area of Myanmar in 2000

Gross estimated area = 821 000 ha			Annual planting = 36 500 ha			
Species	Gross estimated area (%)		Purpose (%)	Ownership (%)		
				Public	Private	Others
Other Broadleaved spp.	333 300	(40.6)	Industrial 26	50	50	
			Non- Industrial 74	50	50	
Tectona grandis	291 400	(35.5)	Industrial 100	100		
			Non- Industrial			
Rubber	111 000	(13.5)	Industrial			
			Non- Industrial 100	n.a.		
Eucalyptus spp.	71 400	(8.7)	Industrial 70	50	50	
			Non- Industrial 30	50	50	
Pinus spp.	13 900	(1.7)	Industrial 100	100		
			Non- Industrial			

Other Broadleaved spp.; *Xylia kerri, Pterocarpus macrocarpus, Acacia auriculiformis, A.senegal A.holosericea, Albizia lebbek, Leucaena leucephara* etc.

Pinus spp.; *P. caribaea, P. patula, P. maximinoi*

Planted areas of non forest species in 2000

Species	Reported area (ha)	Ownership (%)		
		Public	Private	Others
Coconut	37 000	n.a.		

Explanatory note on 2000 estimates

FD (1999b) provides total plantation area to the reference year 1998 as 644 022 ha. MF (1996) provides total area to the reference year 1995 as 543 288 ha and also mentions an annual plantation target of 32 380 ha. The average planting rate of about 33 000 ha per year achieved during 1995-1998 has been used to estimate the total plantation area in 2000, using 1998 as a base. Apart from the other species, IRSG (1997) gives rubber plantation area in 1990 and in 1994. This should be treated as one of plantation species.
Breakdown of species in area and percentage as well as the purpose of plantations has been mentioned by Tint (1996), FD (1996), MF (1996), FAO et al. (1998) and FD (1999b). FD (1999a) provides area in teak along with age classes up to 1998, and its total area tallies with FD (1999b). The percentage by species from 1998 has been extended to 2000.

Plantations have been categorized into four types: commercial, village supply, industrial and watershed. Commercial and industrial plantations have been treated in the industrial category and the other two in the non- industrial category. The species falling in the industrial/non-industrial categories are broadly indicated in MF (1996). Regarding ownership composition, where not specified, it has been roughly estimated using the distribution of seedlings to people.

Regarding non-forest species, APCC (1998) gives coconut plantation area.

11.5 References

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MF. 1996. Status Paper of Forestry Sector in Myanmar, submitted to the Ministerial meeting on Forestry for Five Continental South East Asian Nations, Hanoi September 1996.

12 NEPAL

Forest plantation area of Nepal in 2000

Gross estimated area = 133 000 ha			Annual planting = 5 300 ha			
Species	Gross estimated area (%)	Purpose (%)	Ownership (%)			
			Public	Private	Others
Dalbergia sissoo	39 900 (30)	Industrial 60	50	50	
		Non-Industrial 40	50	50	
Other Broadleaved spp.	33 300 (25)	Industrial			
		Non- Industrial 100	100		
Eucalyptus spp.	10 600 (8)	Industrial 50	50	50	
		Non- Industrial 50	50	50	
Pinus spp.	33 300 (25)	Industrial 70	100		
		Non- Industrial 30	100		
Other Coniferous spp.	15 900 (12)	Industrial 100	100		
		Non- Industrial			

Other Broadleaved spp.; *Acacia catechu, Bombax cieba, Ficus* spp., *Paraserianthes falcataria, Alnus nepalensis, Tectona grandis* etc.

Eucalyptus spp.; *E. camaldulensis*

Pinus spp.; *P. roxburghii*

Explanatory note on 2000 estimates

Reports on the development of plantations in Nepal are not available beyond 1986. The total plantation area of Nepal in 1986 was 69 200 ha of which 47 300 ha was owned by the government and the rest by communities (FD, 1989). Considering the trend, the total plantation area in 1990 was estimated to be 80 000 ha (Pandey 1995). The Forestry Sector Master Plan proposed an average 7 000 ha annual planting rate during 1990-2000. FD (1997) provides information on annual planting by the government and communities during 1992-1996 as 5 260 ha. The total plantation area of Nepal to the year 2000 has been estimated by assuming this same rate of planting (rounded to 5 300 ha), using 1990 as a base year.

In 1986, *Dalbergia sissoo* occupied 30 percent, *Pinus roxburghii* 25 percent, *Eucalyptus* spp. 8 percent and conifers 12 percent of the plantations. FD (1997) states that *Dalbergia sissoo* is the most common plantation species in the Tarai region and *Pinus roxburghii* in the mountains. The species composition available in 1986 has been assumed to be valid in 2000 as well.

Considering the standard uses of the species planted, about 50 percent of the plantations are assumed to be industrial and the rest non-industrial. Since community plantations are very popular in Nepal, 40 percent of the plantations have been assumed to be under private ownership and rest owned by the state.

12.1 References

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13 PAKISTAN

Pakistan has a low forest cover. The area of natural forest cover in 1990 was 1.855 million ha, constituting only 2.4 percent of the land area of the country, a major portion of which belonged to Hill and Montane forest formations (FAO, 1993). The Forestry Sector Master Plan (FSMP, 1992) quotes the total forest area of the country, including plantations and 1.19 million ha of scrub forests, as 4.22 million ha. Plantations, except about 0.1 million ha, do not legally constitute forests (Siddiqui, 1997).

13.1 Development of forest plantations

Plantations in Pakistan were initially established in 1866 in the plains of Punjab and Sindh provinces for the production of fuelwood for railways. Because of the arid and semi-arid climate of the region, these plantations had to be irrigated through a network of canals and are referred to as "irrigated plantations". The size of the plantations varies between 2 000 ha to 10 000 ha (FAO, 1981, and MFA, 1981). These plantations are now managed to produce industrial wood. During the five year plan from 1977 to 1982, 39 872 ha of regular plantations and 16 200 km of linear (row) plantations were established, mainly in Punjab. During the same period 50 825 ha of watershed areas were also planted, mainly in North West Frontier Province (MFA, 1984). The total annual planting was on the order of 20 000 ha during the period. In Pakistan, a lot of trees have been planted in farmlands and this constitutes a major portion of the wood supply

The areas of different categories of forest plantations were estimated for the preparation of the Forestry Sector Master Plan (FSMP, 1992). The total area of irrigated plantations until 1992 was 103 000 ha, about 50 percent of which were poorly stocked. Farmland trees and linear plantations, when converted to an equivalent area of regular plantations, occupied 466 000 ha and 16 000 ha, respectively. The area in watershed and miscellaneous plantations was 155 000 ha (FSMP, 1992).

13.2 Species composition

Dalbergia sissoo has been the main species in the irrigated plantations. It produces high quality timber as well fuelwood. Other species subsequently introduced were *Morus alba* for sporting goods and *Acacia nilotica* for the mining industry (MFA, 1981). In farm forestry plantations, *Dalbergia sissoo, Acacia nilotica, Eucalyptus* spp., *Populus* spp., *Bombax cieba* and *Melia azedarach* are popular species. *Pinus roxburghii* is planted in subtropical regions.

13.3 Trend

The Forestry Sector Master Plan (FSMP, 1992) proposed to increase the forest area of the country from the existing 4.8 percent to 9.8 percent in 25 years (1993-2017), mainly through plantations. The plan envisages establishing plantations of 3.9 million ha on new areas of which 3.6 million ha will be on private lands - 2.07 million ha on farmlands and 1.53 million ha in watershed areas. The irrigated plantations will be expanded by only 50 000 ha.

Forest plantation area of Pakistan in 2000

Gross estimated area = 980 000 ha			Annual planting = 30 000 ha		
Species	Gross estimated area (%)	Purpose (%)	Ownership (%)		
			Public	Private	Others
Other Broadleaved spp.	294 000 (30)	Industrial 10	10	90	
		Non- Industrial 90	10	90	
Eucalyptus spp.	245 000 (25)	Industrial 25	10	90	
		Non- Industrial 75	10	90	
Acacia spp.	196 000 (20)	Industrial			
		Non-Industrial 100	15	85	
Dalbergia sissoo	196 000 (20)	Industrial 75	50	50	
		Non- Industrial 25	50	50	
Pinus spp.	49 000 (5)	Industrial 50		100	
		Non- Industrial 50		100	

Other Broadleaved spp.; *Populus* spp., *Bombax cieba, Morus alba* etc.

Acacia spp.; *A. nilotica*

Pinus spp.; *P. roxburghii*

Explanatory note on 2000 estimates

FSMP (1992) gives the area of plantations by categories. Assuming 1992 as a reference year, the total planted area in that year has been calculated by FSMP (1992) as 740 000 ha. Keeping in view the plantation rate during the 1980s of 20 000 ha per year and future expansion plans, 30 000 ha has been assumed as the annual rate after 1992 and the plantation area in the year 2000 has been accordingly estimated, treating 1992 area as the base year.

Information on the breakdown by species is also weak. Based on the species composition obtained in the 1992 survey of farmland plantations and indications of species given in other plantations, Pandey (1998) roughly estimated the breakdown of the species in total plantations and the same has been assumed for 2000.

All the farmland and watershed plantations are privately owned and constitute about 82 percent of the total. The same proportion of ownership has been maintained for 2000.

13.4 References

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14 THE PHILIPPINES

The forest is the centrepiece of the Philippines' ecosystems and natural resource base. Forestlands are the main watersheds of rivers, providing water for irrigation, energy generation, industries and households. In 1943, about 17 million ha was covered with forests. Increasing population and shifting cultivation have reduced the forest area (DENR, 1991). In 1990, FAO estimated about 8.7 million ha constituting 26 percent of the land area of the country (FAO, 1993). The country report states only 5.7 million ha in 1994 (FMB, 1997).

14.1 Development of forest plantations

Establishment of forest plantations started in critical watersheds degraded by shifting cultivation in the early 1900s, but these were small and mostly abandoned. Plantations gained importance after the 1960s when the private sector, notably the Paper Industries Corporation of the Philippines (PICOP) and Provident Tree Farms, Inc. (PTFI) started reforestation for industrial purposes (JOFCA, 1996). The government sector also contributed but on a limited scale. FAO estimated the net area of forest plantations at 300 000 ha in 1980, more than 75 percent of which were for watershed protection (FAO, 1981).

The National Forestation Programme (NFP) was launched in 1986 to restore the country's forest cover. An annual plantation target of 100 000 ha per annum was set to achieve 1.4 million ha by the year 2000, pooling the government and private sector efforts. The achievement in the first 4 years was 272 000 ha but the quality was uncertain (DENR, 1991). Until 1992, 50 percent of the plantations established under the NFP were for the production of wood and the rest were for the rehabilitation of critical watersheds. The plantations established by the private sector during that period were mainly in smallholdings (JOFCA, 1996). After the imposition of a logging ban within virgin and ecologically sensitive forest areas in 1991, the government started giving fiscal incentives to private investors to promote industrial plantations. Some of these tax incentives include income tax exemption for the first 3 years after the start of commercial harvest, tax and duty free importation of capital equipment, tax credits on domestic capital, exemption from the contractor tax, etc. (FMB, 1997).

14.2 Species composition

Broadleaves dominate the plantations of the Philippines. The main species are *Acacia mangium, A. auriculiformis, Eucalyptus* spp., *Gmelina arborea*, *Paraserianthes falcataria*, *Swietenia macrphylla, Tectona grandis* and *Leucaena leucocephala* (JOFCA, 1996). Mayhew et al (1997) estimated the area of mahogany to be 25 000 ha in 1992, excluding a sizeable area in private plantations. *Tectona grandis* has been planted since 1910 and was estimated to occupy 21 600 ha up to 1990 (Kaosa-ard, 1995). Among the coniferous species, *Pinus caribaea* is the dominant species.

14.3 Issues

Insecure tenure status for land suitable for plantations, inadequate planning of the program and ineffective laws and regulations have been found to be the main constraints to implementation of large scale and highly productive plantations (DENR, 1991).

14.4 Trend

The Master Plan for Forestry Development has set a 2.5 million ha plantation target for the period 1990–2015 (DNER, 1991). The Socialised Industrial Forest Management Programme (SIFMP) was launched in August 1996 to support industrial forest plantations. It recognises the individual rights of equitable access to natural resource development and utilisation and intends to permit individuals, families, co-operatives or corporations to establish plantations ranging from 1 ha to 500 ha (FMB, 1997).

Forest plantation area of the Philippines in 2000

Gross estimated area = 753 400 ha		Annual planted area = 30 000 ha				
Species	Gross estimated area (%)	Purpose	(%)	Ownership (%)		
				Public	Private	Others
Other Broadleaved spp.	219 000 (29)	Industrial	60	45	55	
		Non-Industrial	40	45	55	
Eucalyptus spp.	188 500 (25)	Industrial	60	45	55	
		Non-Industrial	40	45	55	
Gmelina arborea	105 500 (14)	Industrial	100	45	55	
		Non-Industrial				
Acacia spp.	49 000 (6.5)	Industrial	60	45	55	
		Non-Industrial	40	45	55	
Rubber	97 000 (13)	Industrial				
		Non-Industrial	100	n.a.		
Tectona grandis	37 800 (5)	Industrial	100	45	55	
		Non-Industrial				
Mahoganies	34 000 (4.5)	Industrial	100	45	55	
		Non-Industrial				
Pinus spp.	22 600 (3)	Industrial	100	45	55	
		Non-Industrial				

Other Broadleaved spp.; *Paraserianthes falcataria, Albizia spp., Leucaena leucocephala*

Eucalyptus spp.; *E. camaldulensis*

Acacia spp.; *A. auriculiformis, A. mangium*

Mahoganies; *Swietenia macrophylla*

Pinus spp.; *P. caribaea*

Planted areas of non forest species 2000

Species	Reported area (ha)	Ownership (%)		
		Public	Private	Others
Oil palm	14 000	n.a.		
Coconut	3 809 000	n.a.		

Explanatory note on 2000 estimates

DENR (1991) introduces the result of surveys regarding the successful rate of public and private plantations and gives the plantation area by ownership of the year 1988.
While, FMB (1998) gives established areas since 1976 by public and private. Applying each successful rate to the established area, and taking average of them, the annual planting rate could be estimated by ownership and the total of annual planting, as 28 900 ha. On the assumption that this is the same until the year 2000, the total is estimated to be 656 500 ha. The percentages of ownership are public; 45 percent and private; 55 percent.
Apart from this, IRSG (1997) reports rubber plantation area in 1990 and 1992. From these, annual planting and the total in 2000 are estimated, they should be combined with the other species. Ownership data is not available.

Kaosa-ard (1995) and Mayhew et al. (1997) give teak and mahogany plantation areas, respectively. JOFCA (1996) gives the breakdown by other species. These figures have been used to estimate the percentage by species in 2000. JOFCA (1996) gives industrial plantation area by other species. There is no information about non-industrial species, it is assumed that species of non-industrial plantation is the same with those of industrial plantation.

FMB (1996) gives a breakdown of plantation area by purpose and ownership in 1990 and the same have been assumed for 2000. The percentage of industrial plantations is estimated to be 54 percent.

ISA (1999) and APCC (1998) give plantation areas ofoil palm and coconut, respectively. Their ownership data is not available.

14.5 References

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15 SRI LANKA

Forest plantation area of Sri Lanka in 2000

Gross estimated area = 315 500 ha			Annual planting = 4 300 ha		
Species	Gross estimated area (%)	Purpose (%)	Ownership (%)		
			Public	Private	Others
Rubber	164 000 (52)	Industrial			
		Non- Industrial 100	n.a.		
Acacia spp.	47 000 (14.9)	Industrial			
		Non- Industrial 100	100		
Eucalyptus spp.	43 900 (13.9)	Industrial 20	100		
		Non- Industrial 80	50	50	
Other Broadleaved spp.	25 900 (8.2)	Industrial 10	30	70	
		Non- Industrial 90	25	75	
Mahoganies	7 600 (2.4)	Industrial 100	100		
		Non- Industrial			
Tectona grandis	4 400 (1.4)	Industrial 60	100		
		Non- Industrial 40	100		
Pinus spp.	22 700 (7.2)	Industrial 70	100		
		Non- Industrial 30	100		

Acacia spp.; *A. auriculiformis*

Eucalyptus spp.; *E. grandis, E. camalduensis* etc.

Other Broadleaved spp.; *Azadirachta indica, Artocarpus* spp. etc.

Pinus spp.; *P. patula, P. caribaea*

Planted areas of non forest species 2000

Species	Reported area (ha)	Ownership (%)		
		Public	Private	Others
Coconut	442 000	n.a.		

Explanatory note on 2000 estimates

MALF (1996) gives the total plantation area of Sri Lanka in 1994 as 127 972 ha and annual planting by the Forest Department in 1993 and 1994 as 3 534 ha and 3 964 ha, respectively. Planted areas on private lands by individuals and communities were reported to be 331 ha during 1990-1992 and 3 280 ha in 1994. Govil (1999) mentions a total plantation area as 135 052 ha in 1996 and annual plantings during 1993-1996 by the Forest Department totalling 14 113 ha. The total planted area in the year 2000 has been estimated using an average annual planting rate of 4 000 ha, and a base year of 1996.
Apart from the other species, IRSG (1997 and 1999) give rubber plantation areas in 1994 and

1997. Rubber plantation area should be treated as plantation.

Govil (1999) provides a breakdown of the industrial plantations up to 1992 by species: teak (35 000 ha), eucalyptus (16 202 ha), conifers (16 766 ha) and mahogany (4 055 ha). The same proportion has been assumed to be valid up to 1996. Weerawardane (1999) has quoted the area of teak plantations as 31 713 ha out of which 14 647 ha is not available for management. Eucalyptus is one of the main species planted for fuelwood and also by private individuals. An additional area equal to the area in the industrial plantations has been assumed for such plantations and then the percentage of the main species in the total area of plantations has been calculated. Since *Acacia auriculiformis* is frequently planted for fuelwood, its percentage has been roughly assumed as 5 percent.

In 1992, the total plantation area owned by the Forest Department was about 84 000 ha, of which about 72 000 ha was for industrial wood and 12 000 ha for fuelwood (FSMP, 1995). Adding 14 113 ha of plantations established during 1993-1996, the total planted area owned by the Department comes to about 98 000 ha in 1996, constituting 73 percent of the total plantation area. Remaining plantations are privately owned. The same ownership pattern has been maintained for the year 2000.

Of the total industrial plantations in 1992, only about 40 000 ha are available for wood supply as the rest are being used for protection and other purposes (Govil 1999). The estimated percentage of industrial plantations in 1996 of about 40 percent has also been assumed for the year 2000. This data excludes rubber plantation.

APCC (1998) provides coconut plantation areas, without ownership data.

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16 THAILAND

Thailand's forests have a variety of vegetation types, ranging from tropical evergreen rainforest to dry deciduous (teak) forest. Over the years the forest cover has declined considerably, mainly due to shifting cultivation. Estimated forest cover in 1990 was 12.73 million ha, constituting about 25 percent of the land area of the country (FAO, 1993). All forestlands are state-owned. In 1989, the Royal Thai Government imposed a total ban on logging in natural forests; thus, plantation forestry has been given more emphasis, especially private afforestation.

16.1 Development of forest plantations

The first forest plantations of teak are reported to have been done in 1898. Until 1960, establishing plantations remained a sporadic activity with a total area of 8 500 ha. Regular planting started in 1961. Most of the plantations are located in the Northern and Northeastern region. The Royal Forest Department (RFD) and the Forest Industries Organisation (FIO) originally implemented plantation programmes. Later on, a state owned enterprise (Thai Plywood Company) and other private concessionaires joined in. The three divisions of the RFD – National Forest Land Management, Silviculture and Watershed Management – have been working in three different types of areas. The Silviculture Division concentrates on establishing industrial plantations whereas other two divisions establish plantations on denuded and watershed areas, mainly for non-industrial purposes. Industrial plantations by the Silviculture Division to 1980 were 133 800 ha, 55 percent of which were planted to teak (RFD, 1980). The total planted area up to 1985 was 542 100 ha, of which 110 000 ha were planted in the last three years (RFD, 1985). The pace of planting remained the same and the total area planted up to 1994 rose to 827 677 ha, of which the major area was planted by RFD. In addition, private plantations, woodlots and agro-forestry plantations are reported to have been widely established in Thailand but the extent of these is not known.

Rubber plantations constitute a major supply of roundwood in Thailand. The total area of plantations of rubber in (1999?) was 1 913 865 ha.

16.2 Species composition

Information about the composition of species in plantations is highly inadequate and incomplete. Native *Tectona grandis* has been the most favoured species for industrial plantations. Other broadleaved species such as *Pterocarpus macrocarpus*, *Dipterocarpus* spp., *Swietenia macrophylla* and *Hopea odorata* are planted on a smaller scale for industrial purposes. Among conifers, the native pines (*Pinus merkusii and P. kesiya*) occupy a sizeable area. In addition, *P. caribaea, P. oocarpa*, *Eucalyptus camaldulensis, Acacia auriculiformis, A. mangium, Casuarina* spp*., Melia azedarach* and *Azadirachta indica* are planted both for industrial and non-industrial purposes (Zabala et al., 1993, RFD, 1980 and Kaosa-ard, 1995).

16.3 Growth and yield

In 1990, the production of roundwood from industrial plantations was 0.7 million m^3, from agro-forestry woodlots 1.0 million m^3 and from rubber plantations 2.3 million m^3, which altogether constituted about 50 percent of the total round wood production.

16.4 Issues

On the basis of long-term provenance trials, Thailand has identified suitable provenances of *Tectona grandis* and *Pinus kesiya* and made significant advancements in tree improvement. A national inventory of plantations has not been done. As a result, the actual area of existing plantations at any point in time is not known.

16.5 Trend

A Special Forestry Extension Fund has been established to support tree planting by farmers on land to which they have legal rights over a period of 5 years. It is proposed to plant 800 000 ha in the next five years through this fund. Another 800 000 ha is to be planted in watershed and conservation areas (RDF, 1996a). The manufacture of rubber-wood furniture is expanding rapidly due to its growing demand overseas, mainly in Japan and the USA.

Forest plantation area of Thailand in 2000

Gross estimated area = 4 920 000 ha					Annual planting = 225 000 ha
Species	Gross estimated area (%)	Purpose (%)	Ownership (%)		
			Public	Private	Others
Rubber	2 115 000 (43)	Industrial			
		Non- Industrial 100	>1	<99	
Tectona grandis	836 000 (17)	Industrial 100	73	27	
		Non- Industrial			
Other Broadleaved spp.	541 000 (11)	Industrial 18	73	27	
		Non- Industrial 82	73	27	
Eucalyptus spp.	443 000 (9)	Industrial 18	73	27	
		Non- Industrial 82	73	27	
Acacia spp.	148 000 (3)	Industrial			
		Non- Industrial 100	73	27	
Pinus spp.	689 000 (14)	Industrial 18	73	27	
		Non- Industrial 82	73	27	
Casuarina spp.	148 000 (3)	Industrial 18	73	27	
		Non- Industrial 82	73	27	

Other Broadleaved spp.; *Melia azadirachta, Azadirachta indica, Hopea odorata, Pterocarpus* spp., *Chukrasia* spp. and etc.

Eucalyptus spp.; *E. camaldulensis*

Acacia spp.; *A. auriculiformis*

Pinus spp.; *P. caribaea, P. oocarpa, P. merkusii, P. kesiya*

Planted areas of non forest species 2000

Species	Reported area (ha)	Ownership (%)		
		Public	Private	Others
Coconut	468 000	>1	<99	
Oil Palm	253 800	100		

Explanatory note on 2000 estimates

RFD (1999a) gives public plantation area as 874 122 ha in 1998. RFD (1999b) gives private plantation areas by purposes and public non-industrial plantation area. Based on some references, the average of the reference year is assumed to be 1998.
Zabala et al. (1993) gives target areas of plantation establishment from 1991 to 2020 by every 5 years, according to this, the target area of during the period of 1996 and 2000 is 181 000 ha. This could be used as the annual planting rate. Applying this to the total of the year 1998, the total area of the year 2000 is estimated at 2 822 000 ha.
Apart from the other species, RFD (1999b), IRSG (1999) and Kashio (1999) give the areas of rubber plantation. On the assumption that the reference years of RFD's and Kashio's are the same as 1996, the total of the year 2000 can be estimated to be 2 098 000 ha.
Regarding species composition and purposes, except rubber, is not enough. Pandey (1998) estimated them based on data of Zabala et al (1993), RFD (1980), and Kaosa-ard (1995). The same species composition and purpose have been assumed to be maintained to the year 2000. About 27 percent of the plantations are estimated as industrial plantation.

Regarding non-forest species, coconut and oil palm are planted. CAI (1996) and RFD (1999b) give their areas by year. From these, annual planting rate and the total areas of the year 2000 can be estimated.

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17 VIETNAM

Vietnam has a variety of forests due to its complex topography. Almost three-fourths of its lands are in mountains, hills and high plateaux dissected by a dense network of watercourses. The total forest cover of the country in 1990 was about 8.3 million ha constituting 25.5 percent of the land area of which 4.95 million ha was closed broadleaved forests, mainly concentrated in the highland, central and south-eastern parts (FAO, 1993, and MARD, 1996).

17.1 Development of forest plantations

Teak was the first species planted in 1908, introduced from Laos. Planting gained momentum with people's participation under a popular plantation and afforestation campaign in the early 1960s. Establishment of plantations, however, remained on a small scale and the total planted area up to 1975 was 219 290 ha. Establishment of plantations by the Forest Department, mainly for industrial purposes, increased greatly since 1976. During 1976-1985 the total area planted was 1 054 281 ha. However, the emphasis placed on planting was on achieving the target plantation area with little concern as to crop composition and survival. The average rate of survival was 40 percent (Lung, 1994). Plantations of scattered trees by people around villages, in homesteads, along farm boundaries and shelterbelts have been very popular in Vietnam and about 200 million trees are reported to be planted every year, of which about one-fourth are timber species.

With the initiation of the Doi moi (open-door to outside world) policy in 1986, plantation forestry again got a boast. The new policy allocates agriculture and forestlands to the private sector and grants loans to farmers at a very low rate of interest to establish forest plantations. During the eight-year period of from 1986 to 1993 a total area of 1 015 149 ha was planted.

Consistent and consolidated data about the total area of plantations with a breakdown by species and purpose are lacking.

17.2 Species composition

A large number of tree species are planted to suit various agro-climatic conditions. The main native species are *Pinus kesiya, P. merkusii, P. massoniana, Styrax tonkinensis, Manglietia glauca, Hopea odorata, Dipterocarpus alatus* and *Cassia siamea*. Plantations of *Tectona grandis* have been extended in the recent past but the total area is limited. Among exotics, *Eucalyptus camaldulensis* occupies the major area. Other exotic species are *Eucalyptus teriticornis* and *E. europhylla, Acacia mangium, A. auriculiformis* and *Casuarina* spp. Native species of mangroves; *Rhizophora* spp. and *Bruguiera* spp. are planted along the coasts. Farmers favour fast growing species like *Eucalyptus camaldulensis*, *Acacia mangium* and *A. auriculiformis* (Lung, 1996).

17.3 Issues

Capital investment in forestry plantations is low. As a result, the protection and management of plantations is inadequate and plantation yields are quite low compared to their potential (Lung, 1994).

17.4 Trend

Legalization of land use rights of organisations and private stakeholders involved in reforestation following promulgation of the Land Law of 1993 and subsequent policies has stimulated tree planting activity (MARD, 1998). Extraction of timber from natural forests is gradually being reduced with the intention of replacing wood from natural forests with plantation timber. Plans are to reforest 5 million ha of bare land and denuded hills during 1998–2010.

Forest plantation area of Vietnam in 2000

Gross estimated area = 1 710 800 ha			Annual planting = 80 300 ha			
Species	Gross estimated area (%)		Purpose (%)	Ownership (%)		
				Public	Private	Others
Other Broadleaved spp.	503 700	(29.5)	Industrial 40	70	30	
			Non- Industrial 60	97	3	
Eucalyptus spp.	451 500	(26.4)	Industrial 40	70	30	
			Non- Industrial 60	97	3	
Rubber	299 900	(17.5)	Industrial			
			Non- Industrial 100	n.a.		
Acacia spp.	127 000	(7.4)	Industrial 40	70	30	
			Non- Industrial 60	97	3	
Tectona grandis	70 600	(4.1)	Industrial 100	70	30	
			Non- Industrial			
Pinus spp.	253 900	(14.8)	Industrial 40	70	30	
			Non- Industrial 60	97	3	
Casuarina spp.	4 200	(0.3)	Industrial			
			Non- Industrial 100	97	3	

Other Broadleaved spp.; *Manglietia glauca, Styrax tonkinensis,* Mangroves etc.

Eucalyptus spp.; *E. camaldulensis, E. tereticornis, E. europhylla*

Acacia spp.; *A. mangium, A. auriculiformis*

Pinus spp.; *P. kesiya, P. merkusii, P. massoniana*

Planted areas of non forest species 2000

Species	Reported area (ha)	Ownership (%)		
		Public	Private	Others
Coconut	215 000	n.a.		

Explanatory note on 2000 estimates

MARD (1996) gives the total plantation area in 1995 as 1.05 million ha. While FIPI (1999) gives that in 1997 as 1 194 900 ha. From these, annual planting rate can be estimated as 72 000 ha. Using the total area of 1997 as a base, the total area of the year 2000 is estimated as 1 410 900 ha. Species data is not available later than estimation by Pandey (1998) except for Teak. Naghia (1999) gives area of Teak. Species composition has been assumed to be valid up to the year 2000. Utilisation of Teak and *Casuarina* spp. is presented by Nghia (1999) and Ha et al. (1996), respectively. Apart from the other species, IRSG (1997 and 1999) gives rubber plantation areas in 1994 and 1997. This should be treated with plantations of other species.
FIPI (1999) estimates compositions of ownership and purposes, these could be assumed to be valid up to the year 2000. Industrial plantation covers about 38 percent of the whole plantation, excluding rubber.

Regarding non-forest species, APCC (1998) gives coconut plantation area, without ownership.

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18 ARGENTINA

About 75 percent of the total land area of Argentina is in arid and semi-arid regions. In the early 1950s the estimated total forested area, consisting of all types of tree stands and brushwood, was about 60 million ha; that is, 22 percent of the area of the country. Of the total, over half of the forests were privately owned and the rest by the state and provinces (MOA, 1952). The forested area is now reduced to 35 million ha (13 percent) located mainly in border areas away from economic centres, of which only 18 to 20 million ha are considered accessible for exploitation (Anon., 1994).

18.1 Development of forest plantations

Establishment of forest plantations began in 1940 as a consequence of pressure of the market for cellulose and paper pulp. The original plantations were done using the native species *Araucaria angustifolia*. Two North American species; *Pinus taeda* and *P. elliottii,* and other fast-growing species of the genera *Eucalyptus*, *Populus* and *Salix* were later introduced. The national forest administration encouraged private owners to raise plantations by providing credits, technical assistance and selling seedlings at promotional prices. The annual scale of planting during 1953-1957 was about 4 000 to –5 000 ha (MOA, 1952). Estimated plantation area in the country in 1956 was 185 891 ha, a substantial portion of which was on account of the policy of giving liberal credit to private owners (MOA, 1960). The total area of plantations reached 261 060 ha in 1964 (MOA, 1964).

A fiscal incentive scheme launched in 1974, giving a 70 percent subsidy on forest plantations, further accelerated the rate of planting. Estimated planting was 650 000 ha in 1979 (MOA, 1982). The system of subsidy was modified in 1992/1993 by the Secretariat of Agriculture, Livestock, Fishery and Food (SAGyP) and a new Forest Plantation Promotion System has been established. Plantation plans are broadly divided into two categories; large and medium projects of more than five hectares with an obligation to use genetically superior planting material and small producers plantations of less than five hectares. The subsidy is paid once the plantation is completed
About 57 percent of the total plantations are located in the region of Mesopotamia, which consists of Misiones, Corrients and Entre Rios provinces. About 18 percent of the plantations are in the region of Buenos Aires. Annual planting up to 1994 has been on the order of 20 000 ha and has increased in subsequent periods.

18.2 Species Composition

Pinus species and Eucalyptus species are main species they cover 50 percent and 30 percent of the total plantation, respectively. Regarding pines, *Pinus taeda, P. elliottii, P. ponderosa* and *P. patula* are planted for industrial purposes. Regarding Eucalyptus, *Eucalyptus globulus, E. dunnii, E. viminalis* and *E. tereticornis* are planted for both industrial purpose (cellulose and paper pulp) and non-industrial purpose (charcoal and firewood), mainly in Buenos Aires. *Salix* spp. and *Populus* spp. cover about 16 percent planted area and used for industrial purposes. Species covering the rest of the plantation are *Araucaria angustifolia, Melia azedarach, Grevillea robusta, Pawlonia* spp. and so on (Maradei 1999, SAGP 1994 and SAGPA 1999).

18.3 Growth and Yield

The production of roundwood from plantations in 1996 was about 7.15 million m^3 (5.35 million tonnes) constituting more than 85 percent of the total production (Anon., 1998). The area of mature plantations being harvested is, however, not known so it is not possible to estimate the actual productivity from plantations per unit area. The following growth rates have been reported for the main species (Anon., 1994).

Species	Plants per ha	Rotation (years)	Mean annual increment m^3/ha/year
Pines	1111	20-25	20-25
Eucalyptus	1666	10	25-50
Poplar	833 to 1111	10-13	30-38

18.4 Issues

Plantations are established mostly by private agencies and yields are reported to be high but no inventory of the plantations has been carried out so far. A national inventory of forest plantations was, however, started in 1998 with the assistance of the World Bank.

18.5 Trend

The decree on foreign investment in 1993 by Argentina has made the foreign and domestic investors almost equal in all matters. Capital and profit settlement and repatriation have become free (SAGP, 1994). This has attracted many foreign companies such as Italy, German, USA etc (Maradei. 1999). For example, the Chilean company Tissue SA and the Italian textile company Benetton have already started establishing forestry plantations and forest industries in Argentina (SAGP, 1998). More than 20 million ha of highly productive land is available which can potentially be planted at low cost without competing with food production (SAGP, 1994). There are plans to double the existing plantation area in the next 10 years.

Forest plantation area of Argentina in 2000

Gross estimated area = 926 000 ha			Annual planting = 126 000 ha		
Species	Gross estimated area (%)	Purpose (%)	Ownership (%)		
			Public	Private	Others
Eucalyptus spp.	277 800 (30)	Industrial 80		100	
		Non- Industrial 20		100	
Other Broadleaved spp.	185 200 (20)	Industrial 100		100	
		Non- Industrial			
Pinus spp.	463 000 (50)	Industrial 100		100	
		Non- Industrial			

Other Broadleaved spp.; *Salix* spp., *Populus* spp.*, Melia azedarach*, *Grevillea robusta, Pawlonia* spp. etc.

Eucalyptus spp.; *E. globulus, E. dunnii, E. viminales, E. tereticornis*

Pinus spp.; *P. taeda, P. ellliottii, P. ponderosa, P. patula*

Explanatory note on 2000 estimates

SAGPA (1999) gives the total plantation area up to 1998 as 800 000 ha. According to Maradei (1999), about 126 000 ha of plantation was estimated to be established in 1999. Adding this to the total of 1999, the total area of the year 2000 is estimated to be 926 000 ha.
SAGPA (1999) also gives breakdown by species. Maradei (1999) describes *Pinus* spp. in detail.
Maradei (1999) says that all plantations are private-owned.
Industrial plantation is calculated from data of production volume (Anon.1998), as about 92 percent.

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19 CHILE

A long and narrow country, Chile has a varied climate; desertic in the north, Mediterranean in the centre and cold and wet in the extreme south (Garcia, 1994). Although potential forestland in the country is about 47 million ha, forests occupied only 7.018 million ha, constituting 9.4 percent of the land area as of 1990 (FAO 1995). The area of other wooded land was about 8.5 million ha. Native forests are mainly located in southern Chile (Regions IX through XII).

19.1 Development of forest plantations

Plantation forestry in Chile is about 100 years old. *Pinus radiata* and *Eucalyptus globulus* were introduced in the last century but plantations on a modest scale only started in the 1930s when the first law promoting afforestation was passed. Under the law, lands on which forest plantations were established were exempted from taxation for 30 years (Lora et al, 1993). The planting rate gradually increased from 6 000 ha in 1940 to about 15 000 ha during 1945-1959 but declined subsequently.

Since 1965, the government became actively involved in the creation of nurseries and afforestation of public lands, which has boasted annual planting to 30 000 ha and above. In 1972, the Corporación Nacional Forestal (CONAF), the main governmental agency in the forestry sector, was created to establish and manage plantations. Decree Law 701, passed in 1974 and amended in 1979, promoted an increased rate of planting on private lands, as it a provided 75 percent subsidy for the establishment of new plantations and silvicultural treatments (Jelvej et al, 1990). The law, however, also made replanting mandatory after final harvest in all existing and new plantations at the owner's cost. Average annual planting reached about 80 000 ha during 1975-1986 and a record high of 130 429 ha in 1992.

In 1986, CONAF stopped direct planting and started selling established plantations to private companies and individuals. By 1990 all plantations in Chile were privately owned, about 60 percent by large- and medium-sized companies each owning at least 10 000 ha and remainder by small owners with 50 to 150 ha each (Pandey 1995). Most of the plantations are located in Regions VII through X.

Plantation area in Chile is growing because of continued support by the government to the private sector. Some of the supportive measures in additional to the subsidy previously mentioned include authorization to export forest products to any country, support to international marketing efforts, funding of research and technical training, clear and secure land and tree tenure rights, etc. (Lora et al, 1993, and LATEN, 1994).

19.2 Species composition

Pinus radiata has been the predominant species and constituted more than 75 percent of the planted area in 1997 (INFOR, 1998). *Eucalyptus* spp., mainly *E. globulus,* is the second most common genus, whose proportion is gradually increasing and made up 17 percent of the area as of 1997. The balance is comprised of *Artiplex nummuleria* (2.6 percent), *Prosopis tamarugo* (1 percent), *Populus* spp. and other native species, many of which are of non-industrial interest.

19.3 Growth and yield

The fast growth rate of the forest plantations has been main driving force in the growth of plantation forestry in Chile. The total production of industrial wood has increased from 4.996 million m^3 in 1976 to 23.606 m^3 in 1997. The contribution of plantations to the industrial wood supply was 87 percent in 1997, most of which was radiata pine (INFOR, 1998).

The growth rate of *Pinus radiata* varies from site to site and under different climatic conditions. In general, it grows from 16 to 40 m^3/ha/year mean annual increment with an average of 22 m^3/ha/year (Demastro, 1992).

19.4 Trend

The annual plantation rate declined considerably after 1995 when the subsidy law of 1974 expired in 1994 and because of draught in 1996/1997, perhaps also due to a poor economic situation. The new version of the subsidy law was passed early in 1998. However, it provides subsidies only to small producers or those planting on degraded soil, so its effect in subsequent periods is yet to be determined (SH, 1999). The percentage of eucalyptus in plantations has gradually increased from 12 percent in to 17 percent in 1997.

Forest plantation area of Chile in 2000

Gross estimated area = 2 017 000 ha			Annual planting = 85 000 ha			
Species	Gross estimated area (%)		Purpose (%)	Ownership (%)		
				Public	Private	Others
Eucalyptus spp.	342 900	(17)	Industrial 100		100	
			Non- Industrial			
Other Broadleaved spp.	149 300	(7.4)	Industrial 30		100	
			Non- Industrial 70	100		
Pinus spp.	1 524 800	(75.6)	Industrial 100		100	
			Non- Industrial			

Eucalyptus spp.; *E. globulus*

Other Broadleaved spp.; *Artiplex nummuleria, Prosopis tamarugo, Populus* spp. etc

Pinus spp.; *P. radiata*

Explanatory note on 2000 estimates

INFOR (1998) provides the total planted area in Chile as 1881 925 ha by the end of 1997. Annual planting during 1996 and 1997 was 78 600 ha and 79 500 ha, of which new plantations were 42 500 ha and 44 300 ha respectively. Though planting is expected to pick up in the coming years as the new subsidy law becomes effective, a moderate rate of new planting of 45 000 ha per year of has been assumed for the next 3 years (1998 through 2000) in estimating the total plantation area in 2000.

INFOR (1998) provides a breakdown of the species in plantations and the same has been maintained for the year 2000. Almost all plantations are industrial except for about 5 percent belonging to the "other broadleaves" category and they have been assumed to be owned by the public. All industrial plantations are privately owned.

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20 COLOMBIA

Forest plantation area of Colombia in 2000

Gross estimated area = 141 000 ha		Annual planting = 6 500 ha			
Species	Gross estimated area (%)	Purpose (%)	Ownership (%)		
			Public	Private	Others
Eucalyptus spp.	26 800 (19)	Industrial 50	100		
		Non- Industrial 50	100		
Other Broadleaved spp.	16 000 (11.4)	Industrial 50	100		
		Non- Industrial 50	100		
Gmelina arborea	5 400 (3.8)	Industrial 50	100		
		Non- Industrial 50	100		
Tectona grandis	4 000 (2.8)	Industrial 100	100		
		Non- Industrial			
Pinus spp.	77 500 (55)	Industrial 100	100		
		Non-industrial			
Other Coniferous spp.	11 300 (8)	Industrial 100	100		
		Non- Industrial			

Other Coniferous spp.; *Cupressus* spp.

Planted areas of non forest species in 2000

Species	Reported area (ha)	Ownership (%)		
		Public	Private	Others
Oil palm	29 000	n.a.		

Explanatory note on 2000 estimates

Anon. (1999) provides the total area of plantations in Colombia since the beginning (1949) up to 1998 as 128 207.5 ha. Plantation figures are quoted on a five-year interval along with the area of each planted species. The report, however, is not consistent with previous reports. The National Forestry Action Plan (DNP, 1988) estimated 175 652 ha of plantations to 1987 and Pandey (1998) estimated the net area as 171 000 ha in 1995. The total area in 2000 has been estimated by treating the recent report as the most reliable and using the average annual planting rate achieved during 1994-1998.

The composition by species has been assumed to be constant. There is no report on use and ownership. Based on the standard uses of species about 17 percent of the plantations are assumed to be industrial. All plantations are assumed to be owned by the public.
Regarding non-forest species, ISA (1999) gives the area of oil palm since 1996 to 1999. Ownership data is not available.

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21 PERU

Peru has a large area of the tropical rain forest type. In 1990, forest cover in the country was 67.9 million ha, constituting 53.1 percent of the land area, of which rain forests were 59 percent (FAO 1993).

21.1 Development of forest plantations

Establishment of forest plantations in Peru was initiated in the last century (1870) with the introduction of *Eucalyptus globulus* to produce fuelwood (MDA, 1993). Until 1963, the total area of plantations was 44 970 ha, when the World Bank financed and USAID supported the first plantations started in rural areas of the mountainous region. The average annual planting rate during 1963-1976 was 4 400 ha and 106 000 ha were planted by 1976. The plantations were, however, not very successful (MDA, 1991). During the period 1976-1979, an additional 24 000 ha were planted, mainly by farming communities in the mountainous region (MDAA, 1980).

Planting has increased since 1980. The average annual rate was 12 000 ha and the total officially reported area reached 262 997 ha in 1990. Of the total, however, only about 50 percent were successful and 70 000 ha was suitable for commercial purposes (MDA, 1991). After formulation of the National Forestry Action Plan in 1991 a number of measures were taken for its implementation. At the end of 1992, a national institution, Instituto Nacional de Recursos Naturales (INRENA) was created by Decree Law 25902 to promote and oversee sustainable development of natural resources (MDA, 1997a). A Reforestation Committee was created to manage the tax fund for tree planting realised from timber harvesting. A National Programme of Watershed Management and Soil Conservation (Programa Nacional de Manejo de Cuencas Hidrográficas y Conservación de Suelos – PRONAMACHOS) in co-ordination with Regional Directors of the Agriculture Ministry started supporting development of plantations in the public sector. These activities boosted the rate of planting significantly, increasing to more than 25 000 ha per year since 1993 (MDA, 1996). More than 80 percent of the plantations are located in the mountainous region or sierra.

21.2 Species composition

Eucalyptus globulus has dominated planting since the beginning and occupied a major area of the plantations up to 1995 (MDA, 1996). In new plantations native species, particularly broadleaves, are being encouraged. Some of these are *Swietenia macrophylla, Cedrela odorata, Aspidosperma cylindrocarpon* and *Spondias mombium,* etc. Among conifers, *Pinus radiata*, *P. caribaea* and *Cupressus* spp. are common (MDA, 1997b).

The mean annual volume increment of *Eucalyptus globulus* varies between 10 to 15 m^3/ha/year depending on the site and rotation period, which ranges between 10 and 30 years (MDA, 1982).

21.3 Issues

An inventory to ascertain the actual area of successfully established plantations, their management status and productivity is needed.

21.4 Trend

Under the National Forestry Action Plan about 10.5 million ha of land has been identified as suitable for forestry plantations and annual planting is continuously increasing. In 1996, 57 448 ha were planted. Instead of concentrating mainly on *Eucalyptus* spp., several native species are now being planted (MDA, 1997b).

Forest plantation area of Peru in 2000

Gross estimated area = 640 000 ha		Annual planting = 50 000 ha				
Species	Gross estimated area (%)	Purpose	(%)	Owner ship (%)		
				Public	Private	Others
Eucalyptus spp.	480 000 (75)	Industrial	50	30	70	
		Non- Industrial	50	30	70	
Other Broadleaved spp.	128 000 (20)	Industrial	50	30	70	
		Non- Industrial	50	30	70	
Other Coniferous spp.	32 000 (5)	Industrial	50	30	70	
		Non- Industrial	50	30	70	

Eucalyptus spp.; *E. globulus*

Other Broadleaved spp.; *Swietenia macrophylla, Cedrela odorata, Aspidosperma cylindrocarpon* etc.

Other Coniferous spp.; *Pinus radiata, P. caribaea* and *Cupressus* spp.

Planted areas of non forest species in 2000

Species	Reported area (ha)	Ownership (%)		
		Public	Private	Others
Oil palm	9 250	n.a.		

Explanatory note on 2000 estimates

MDA (1997b) gives the total plantation area to 1996 as 428 315 ha. Per PRONAMACHOS (1998), 62 136 ha was planted in 1997 making the total 490 451 ha. Keeping in view the plantation trend and the plantation target mentioned by Arabaiza (1996), 50 000 ha has been assumed as the annual planting rate for 1998-2000. The total plantation area in the year 2000 has been estimated using this rate.
Reliable data on a detailed breakdown by species is not available. Pandey (1998) estimated 90 percent eucalyptus until 1995. Since emphasis has been given to native species since 1993, the percentage of eucalyptus has been assumed to be less by the year 2000.
Reliable reports on ownership and purpose are not available. Most of the plantations prior to 1992 were privately owned. Since part of the new plantations are in the public sector, 30 percent has been assumed to be public and the rest in the private sector. About 50 percent of the existing plantations were for industrial purpose until 1990 and this have been maintained for 2000.
Regarding non-forest species, ISA (1999) gives oil palm plantation areas by year from 1996 to 1999.

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22 URUGUAY

Uruguay is one of the privileged countries having a high percentage (> 85 percent) of its territorial land productive for raising livestock and growing crops. The forest cover in the country has been quite low and commercially less valuable. As per the agriculture census of 1937, the area of the native forest was 530 000 ha, constituting about 3 percent of the land area of the country (Anon., 1949). FAO estimated forest cover in 1990 as 657 000 ha (FAO, 1995). The increase in the forest cover occurred mainly because of a difference in definitions. The Oriental Republic of Uruguay classifies land as a forest when it has fifty percent or more crown cover, whereas FAO considers as forest land anything with crown cover greater than ten percent (Altrell, 1999).

22.1 Development of forest plantations

The small amount of forest in the country has long necessitated the establishment of plantations. In 1937, forest plantations covered 72 000 ha, of which eucalyptus, pine and poplar occupied 46 500 ha, 7 000 ha and 6 500 ha respectively. The plantation area increased to 143 115 ha in 1961 (Anon., 1964).

The annual planting rate during 1975-1985 was about 2 000 ha and the estimated total plantation area in 1985 was about 180 000 ha. More than 80 percent of the plantations were owned by about 50 000 private individuals having an average landholding of 3.4 ha. The fiscal incentive given to establish private plantations was withdrawn in 1978. Most of the plantations were for fuelwood and protective purpose, except about 30 000 ha (reported by Anon., 1990 in: Pandey, 1995).

To support plantations, new regulations were established in 1989 under Forest Law Nr. 15.939 of 1988. Private planters are provided by the government a subsidy up to 50 percent of the standard estimated cost for plantations, during the year following planting, as well as a tax exemption for the planted areas. There are also provisions to provide soft loans for 12 years and duty-free import of equipment and other material (MGAP, 1994). The foreign investment system has been made open and non-discriminatory, with no restrictions on movement of capital, profit and dividends. This has increased the annual planting rate from 6 505 ha in 1989 to 25 875 ha in 1992. More than 40 000 ha has been planted annually since 1993. Until 1995 about 45 percent of the plantations were located in the coastal region, 38 percent in the Northeast and the rest in the southwest (MGAP, 1996a).

22.2 Species composition

Eucalyptus is the principal genus and covers about 80 percent of the plantations. The main species are; *Eucalyptus grandis* and *E. globulus. Eucalyptus tereticornis, E. saligna* and other eucalyptus species occupy smaller areas. *Pinus* is the second most common genus, occupying about 16 percent of the area. The main species are *Pinus elliottii* and *P. taeda.* Other species include *Pinus pinaster* and *P. radiata. Populus* spp. and *Salix* spp. occupy the balance of the plantations.

22.3 Growth and Yield

Expansion of plantations in Uruguay is relatively recent. Established plantations of eucalyptus, pines and willow have given high productivity and have been attracting private investors. The following average growth rates have been reported for the main species (MGAP, 1994);

Species	Plants per ha	Rotation (year)	Mean annual increment m^3/ha/year
Eucalyptus grandis	1,100 to 2,500	8 to 10	23 to 25
Pinus elliottii	1100 to 2500	18 to 20	15.5 to 26
Salix spp.	300 to 600	10	15 to 25

22.4 Trend

To promote forestry development, the Forestry Department has identified more than 3.6 million ha of "forestry priority areas" located in the sandy prairies of the central and northern regions, on the Uruguay River coast and in some hill areas. These areas have been found suitable for raising highly productive industrial plantations when planted with recommended species. Private planters would derive fiscal incentives when planting in such lands (MGAP, 1994).

Forest plantation area of Uruguay in 2000

Gross estimated area = 622 000 ha				Annual planting = 40 000 ha		
Species	Gross estimated area (%)	Purpose (%)		Ownership (%)		
				Public	Private	Others
Eucalyptus spp.	497 600 (80)	Industrial	60		100	
		Non- Industrial	40		100	
Other Broadleaved spp.	24 900 (4)	Industrial	60		100	
		Non- Industrial	40		100	
Pinus spp.	99 500 (16)	Industrial	60		100	
		Non- Industrial	40		100	

Eucalyptus spp.; *E. grandis, E. globulus, E. tereticornis, E. saligna* etc.

Other Broadleaved spp.; *Populus* spp., *Salix* spp.

Pinus spp.; *P. elliottii, P. taeda, P. pinaster, P. radiata*

Explanatory note on 2000 estimates

MGAP(1999) provides the area of plantations established between 1975 and 1997 as 345 175 ha and annual planting from 1981 through 1997. Estimated plantation area prior to 1975 was about 155 000 ha (total planted area up to 1985 (180 000 ha) minus the area planted during 1975-1985 (24 683 ha)). Thus, the cumulative estimated total plantation area as of 1997 was about 500 000 ha. MGAP (1998) reported the total plantation area in 1997 as 472 000 ha. Possibly, old plantations might have been harvested. The total plantation area in the year 2000 has been estimated by relying on the MGAP (1998) figure and using 40 000 ha as the annual rate of planting for the next three years.

MGAP (1999) gives a detailed breakdown of species planted during 1975-1997 and the breakdown of species prior to 1975 has also been used in estimating the species composition for the year 2000.

Of the total plantations established during from 1975 to 1995, 165 096 ha or about 72 percent was for industrial purposes. Since a major area (85 percent) of the plantations prior to 1975 was for non-industrial purpose, an overall 60 percent has been assumed for industrial purposes in all plantations up to 2000. All plantations are privately owned.

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23 VENEZUELA

Venezuela possesses a rich natural forest resource. Of the total land area of 88.2 million ha, 45.6 million ha, constituting about 52 percent of the land area, was covered with forests in 1990. A major portion of the forests belong to the tropical rain forest formation, located mainly in the Guyana-Amazonas region (FAO, 1993).

23.1 Development of forest plantations

Prior to 1963 only experimental plantations of different species of eucalypts and pines were tried. These plantations covered about 1 000 ha by 1963 (MARNR, 1964). Planting remained a low-key activity until 1970 when state-owned companies, Corporación Venezolana de Guayana (CVG) and Compañia Nacional de Reforestación (CONARE) started establishing industrial plantations of *Pinus caribaea* and eucalyptus in Monagas and Anzoategui states, respectively. Since 1976, private companies have also been encouraged to establish plantations. Corporación Forestal Guayamure (CFG) is the main private company. The total area of plantations by the end of 1980 was 124 000 ha (FAO, 1981).

Annual planting rates gradually picked up from around 12 000 ha in the early 1980s to 30 000 ha in 1987. The total area of plantations reached 362 000 ha by the end of 1990 (MARNR, 1991). A new society, PROFORCA was formed by the government in collaboration with CONARE and CVG to undertake the extraction of timber and inventory of plantations. The principal purpose of plantations is the production of pulp for paper. The annual planting rate has increased further in the recent years. Most of the plantations are concentrated in Monagas and Anzoategui states.

23.2 Species composition

Pinus caribaea has dominated the plantations of Venezuela and covers about 78 percent of the total area. Other tropical pines are also planted but on a very small scale. Eucalyptus is the second major genus in the plantations, occupying about 12 percent (estimated) of the area. The other species occupying significant area in the plantations are *Gmelina arborea*, *Leucaena leucocephala*, *Fraxinus american*, *Tabebuia rosea*, *Cedrela odorata*, *Swietenia macrophylla* and *Tectona grandis* (MARNR, 1996). The breakdown of the area in these species is not known.

23.3 Growth and yield

In 1996, the total production of round wood was 966 648 m^3 of which 42.7 percent came from plantations of *Pinus caribaea* (MARNR, 1998a).

23.4 Issues

Plantations in Venezuela are reported to be expanding at a rapid rate but there is no inventory so their actual status is unknown.

Forest plantation area of Venezuela in 2000

Gross estimated area = 863 000 ha		Annual planting = 50 000 ha			
Species	Gross estimated area (%)	Purpose (%)	Ownership (%)		
			Public	Private	Others
Eucalyptus spp.	103 600 (12)	Industrial 95	75	25	
		Non- Industrial 5	100		
Other Broadleaved spp.	43 100 (5)	Industrial 50	100		
		Non- Industrial 50	100		
Gmelina arborea	25 900 (3)	Industrial 100	70	30	
		Non- Industrial			
Pinus spp.	690 400 (80)	Industrial 100	87	13	
		Non- Industrial			

Other Broadleaved spp.; *Leucaena leucocephala, Fraxinus american, Tabebuia rosea, Cedrela odorata, Swietenia macrophylla, Tectona grandis* etc.

Pinus spp.; *P. caribaea*

Explanatory note on 2000 estimates

MARNR (1998a) provides total plantation area up to 1996 as 662 989 ha of which 85 percent was planted by state companies (CVG - PROFORCA, CONARE etc). Since the plantation area up to 1990 was 362 000 ha, the average annual increase in plantations works out to be about 50 000 ha. The total plantation area in the year 2000 has been estimated using an annual planting rate of 50 000 ha with 1996 as the base.

Except for *Pinus caribaea*, breakdown of the other species planted has not been clearly spelt out in any of the reports. Based on the breakdown given in MARNR (1996), Pandey (1998) roughly estimated the composition of the main species and this has been maintained for 2000.

Most of the plantations have been established by state companies and only 15 percent are privately owned (MARNR, 1998a). Though most of the plantations are for industrial purposes, some plantations are also established for protection purposes. In 1990, the area in protection plantations was about three percent (MARNR, 1991) and the same percentage has been assumed for 2000.

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24 ANGOLA

The forestry sector's contribution to the economy is not as large as other sectors such as mining and oil production. However, forests play an important role. People living in rural areas are highly dependent on forests for their livelihood (Zola, 1998).

24.1 Development of forest plantations

Plantations in the country were first established during the colonial period. Most of the plantations were established by the railway company and paper companies to produce fuelwood for locomotives and raw material for paper production. Apart from these uses, public woodlots were established for several purposes such as production of fuelwood and watershed protection.
Since independence most plantations have been abandoned (Zola, 1998).
A 1975 inventory showed 148 000 ha of plantations. In 1989, there was a plan to plant 250 000 ha trees to provide shade and to protect soil from erosion. However, this plan was never implemented (IUCN, 1992). Continuation of planned plantation establishment was impossible because of the civil war. However, the demand for fuelwood and timber has continuously increased (MADR, 1994).

24.2 Species composition

The main species is *Eucalyptus,* accounting for 80 percent of the plantations. *Pinus* spp. and *Cupressus lusitanica* follow in popularity (Zola, 1998). The country is the only one in Africa with such a large area of *Eucalyptus* spp. (MADR, 1994).

24.3 Issues

There is no forest management plan for the country, and the country suffers from a lack of skilled people and adequate financial resources. Lack of a forest inventory and other data makes estimates of forest resources unreliable (Zola, 1998). Due to lack of silvicultural treatments, most plantations are thought to be degraded (IUCN, 1992 and MADR, 1994).

Forest Plantation area of Angola in 2000

Gross estimated area = 141 000 ha		Annual planting = 100 ha					
Species	Gross estimated area (%)	Purpose (%)		Ownership (%)			
				Public	Private	Others	
Eucalyptus spp.	112 800 (80)	Industrial	40	100			
		Non- Industrial	60	100			
Acacia spp.	1 400 (1)	Industrial	40	100			
		Non- Industrial	60	100			
Other Broadleaved spp.	1 400 (1)	Industrial	40	100			
		Non- Industrial	60	100			
Pinus spp.	21 200 (15)	Industrial	40	100			
		Non- Industrial	60	100			

Casuarina spp.	2 800 (2)	Industrial	40	100		
		Non- Industrial	60	100		
Other Coniferous spp.	1 400 (1)	Industrial	40	100		
		Non- Industrial	60	100		

Acacia spp.; *A. rubra*

Other Broadleaved spp.; *Prosopis juliflora, Azadirachta indica, Trichilia* spp., *Leucaenea leucocephala, Terminalia catata*

Pinus spp.; *P. patula*

Casuarina spp.; *C. equisetifolia*

Other Coniferous spp.; *Cupressus lusitanica*

Planted areas of non-forest species in 2000

Species	Reported area (ha)	Ownership (%)		
		Public	Private	Others
Coconut	21 000	100		

Explanatory note on 2000 estimates

Zola (1998) gives the total area in 1990 as 140 000 ha and established area in 1990 as 100 ha. During the period of 1993-1998, the total of established plantation area is 422 ha, thus the annual planting can be assumed at 100 ha until the year 2000. Applying this to the total of the year 1990, the total of the year 2000 is estimated at 141 000 ha.
Zola (1998) says that all the land is owned by the government and gives established area during 1993-1998 by species.
Regarding purposes, Pandey (1998) estimates industrial plantation at approximately 40 %, this is assumed to be valid up to the year 2000.

Regarding non-forest species, ISA (1999) gives the total plantation area of oil palm by year from 1996 to 1999. Zola (1998) says that all the land is owned by the government.

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25 MADAGASCAR

Forest plantation area of Madagascar in 2000

Gross estimated area = 180 300 ha		Annual planting = 5 600 ha			
Species	Gross estimated area (%)	Purpose (%)	Ownership (%)		
			Public	Private	Others
Eucalyptus spp.	83 800 (46.5)	Industrial 44	95	5	
		Non- Industrial 56	49	51	
Other Broadleaved spp.	31 600 (17.5)	Industrial 51	n.a.		
		Non- Industrial 49	n.a.		
Acacia spp.	5 400 (3)	Industrial 51	n.a.		
		Non- Industrial 49	n.a.		
Pinus spp.	55 900 (31)	Industrial 51	n.a.		
		Non- Industrial 49	n.a.		
Casuarina spp.	3 600 (2)	Industrial 51	n.a.		
		Non- Industrial 49	n.a.		

Eucalyptus spp.; *E. camaldulensis, E. citriodora, E. grandis, E. robusta*

Other Broadleaved spp.; *Callitris* spp.

Acacia spp.; *A. dealbata*

Pinus spp.; *P. elliottii, P. kesiya, P. patula*

Casuarina spp.; *C. cunninghamiana*

Planted areas of non-forest species in 2000

Species	Reported area (ha)	Ownership (%)		
		Public	Private	Others
Coconut	33 000	n.a.		

Explanatory note on 2000 estimates

Randrianjafy (1999) says that Eucalyptus plantation was about 146 700 ha in 1994, and accounts for 46.5 percent of the whole plantation. Thus the total of that year is estimated to be approximately 315 900 ha. Levasseur (1996) gives plantation area established during 1987-1990 at 22 587 ha. Given that the average is annual planting, 5 600 ha, and that this is valid up to the year 2000, by applying this to the estimated total of the year 1994 as a base, the total of the year 2000 is estimated at 180 300 ha.
Regarding species composition, Randrianjafy (1999) reports that *Eucalyptus* spp. is used as the main species, and it accounts for 46.5 percent of the whole plantation. Data is not available for the other species. However, Ramamonjisoa (1999) presents species names. Devendra (1997)

estimates species composition, except Eucalyptus spp., this is supposed to be valid up to the year 2000.
Ownership and purposes are not mentioned in detail, except *Eucalyptus* spp. Randrianjafy (1999) gives data about them for Eucalyptus. Purpose is estimated using the data of production. An estimate about purpose by Devendra (1998) is supposed to be valid up to the year 2000. Industrial plantation accounts for 47.8 percent of the whole plantation.

Regarding non-forest species, APCC (1997) reports coconut plantation areas by year between 1993 and 1997. During the period, the total has been the same. On the assumption that the total area is the same up to the year 2000, the area is supposed to be 33 000 ha.

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26 MOROCCO

Forest plantation area of Morocco in 2000

Gross estimated area = 533 700 ha			Annual planting = 9 600 ha		
Species	Gross estimated area (%)	Purpose (%)	Ownership (%)		
			Public	Private	Others
Eucalyptus spp.	213 500 (40)	Industrial n.a.	74	8	18
		Non- Industrial n.a.	74	8	18
Other Broadleaved spp.	42 700 (8)	Industrial			
		Non- Industrial 100	74	8	18
Acacia spp.	26 700 (5)	Industrial			
		Non- Industrial 100	74	8	18
Other Coniferous spp.	234 800 (44)	Industrial 100	74	8	18
		Non- Industrial			
Pinus spp.	16 000 (3)	Industrial 100	74	8	18
		Non- Industrial			

Eucalyptus spp.; *E. camaldulensis, E. gomphocephalla*

Other Broadleaved spp.; *Quercus suber, Populus* spp.

Acacia spp.; *A. mearnsii* etc.

Other Coniferous spp.; *Cupressus* spp., *Cedrus* spp. etc.

Pinus spp.; *P. halepensis, P. pinaster Var. magrebiana, P. pinaster Var. atlantica* etc.

Explanatory note on 2000 estimates

AEFCS (1997) gives plantation areas by species and ownership. The reference year is presented as 1995-1996. The total area of the year 1994-1995 is also available. Assuming these as 1995 and 1996, respectively, the annual planting is estimated to be 9 600 ha. On the assumption that the annual planting is the same up to the year 2000, applying this annual planting to the total of the year 1996 as a base, the total plantation area of the year 2000 is estimated to be approximately 533 700 ha.
Species and ownership are assumed to be the same up to the year 2000.
DEFCS (1992) mentions that coniferous species are planted for industrial purpose, Eucalyptus species are used for both purposes, and broadleaved species are used for non-industrial purposes such as production of tannin and poles. Regarding Eucalyptus species, breakdown by purposes is not available.

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27 SOUTH AFRICA

South Africa has only a small area of natural forests. The natural forests are mostly in small scattered patches with a total area of 327 600 ha, constituting only about 0.2 percent of the land area of the country. In addition, open savannah woodlands occupy about 28 million ha (DWAF, 1996a). FAO has estimated the area of the natural forest cover in 1990 as 7.243 million ha or 5.9 percent of the land area of the country (FAO 1995). The difference in area appears to be mainly due to differing definitions of forests.

27.1 Development of forest plantations

Establishment of forest plantations in South Africa was initiated in 1896 to meet for the need for fuel, props for mines and timber. Exotics from Australia, America and Europe were tried, as the growth rate of native species was too slow. The areas planted increased rapidly from 1920 onwards. The first large plantings were of wattle, grown for its tannin-rich bark. Several species of eucalyptus were then planted, mainly for mine props. The need for construction timber led to the establishment of large-scale plantations of pine in Cape Peninsula. Trees were planted on high-lying grassland areas, particularly in wetter regions (Anon., 1995). The private sector soon joined in. The afforested area, however, expanded faster after the Second World War with increased involvement of the private sector. Emergence of a domestic pulp and paper industry became the major driving force, along with the availability of suitable land, a favourable climate and government support (DWAF, 1997). The total area planted reached to 923 900 ha by 1965. Annual planting during 1960-1965 was about 45 000 ha (FAO, 1967).

Prior to 1972, afforestation proceeded more or less unchecked. In that year a permit system was introduced to control and disperse afforestation among catchments, as the plantations and naturalization of the planted species was adversely affecting water supplies for urban and industrial purposes (DWAF, 1996a). The annual rate of planting during 1981-1990 was about 18 000 ha and the total planted area to the end of 1990 was about 1.333 million ha (DWAF, 1991).

Of the total plantation area of 1.487 million ha in 1995, four large private companies together owned 47 percent and smaller private companies and individuals, including out-growers, owned 23 percent. The rest was owned by the state, of which 270 400 ha was with the state-owned company, SAFCOL, and the balance on land of former apartheid "homelands". Most industrial plantations are located where climatic conditions are suitable for afforestation: Mpumalanga (41 percent), Kwazulu-Natal (37 percent), the Eastern Cape (11 percent), the Western Cape (6 percent) and the Northern Province (5 percent) (DWAF, 1997).

27.2 Species composition

Eucalyptus and *Pinus* are the main genera dominating the plantations of South Africa. *Eucalyptus grandis* is the main eucalyptus species. Other eucalyptus species are *E. saligna* and *E. camaldulensis*. The main pine species are *Pinus patula, P. elliottii* and some to extent *P. taeda* and *P. radiata*. *Acacia mearnsii* has been planted for bark production for the tanning industry. Plantations yield 19 million m^3 of round wood, which gives an average productivity of 11 m^3/ha/year. Experts, however, claim that about 15 to 18 m^3 /ha/year could be achieved (DWAF, 1997). Growth rates of some of the species are;

Genera	Rotation in years	Average mean annual increment (m^3/ha/year)
Pines	25 to 35	17 to 20
Eucalyptus	8 to 12	18 to 20
Acacia	8 to 12	11.5

(Source: Pandey 1995)

27.3 Issues

There is a major concern about the effects of plantation forestry and naturalized plantation species on water resources and biological diversity and investigations are ongoing about how to manage and mitigate these effects. There is also concern about the possible spread of new pests and diseases, the risks inherent to monoculture forests and future effects on atmospheric pollution or from unpredictable drought (DWAF, 1997).

27.4 Trend

Because of various regulations introduced by the government on the use of water and land, the forestry sector has been put under tighter control and the cost of planting has increased (SH, 1999). Afforestation permits are not issued for many of the catchments in the country and areas suitable for afforestation are diminishing (DWAF, 1997). The strategy is to enhance the annual production of roundwood from the existing plantation areas by applying genetic improvement and better silviculture to all plantation areas. The present policy of the government emphasises promoting community forestry and timber outgrowers schemes.

Forest plantation area of South Africa in 2000

Gross estimated area = 1 554 000 ha				Annual planting = 12 000 ha		
Species	Gross estimated area (%)	Purpose (%)		Ownership (%)		
				Public	Private	Others
Eucalyptus spp.	606 100 (39)	Industrial	90	12.9	87.1	
		Non- Industrial	10	12.9	87.1	
Acacia spp.	108 800 (7)	Industrial	90	7.2	92.8	
		Non- Industrial	10	7.2	92.8	
Other Broadleaved spp.	15 500 (1)	Industrial	90	54.4	45.6	
		Non- Industrial	10	54.4	45.6	
Pinus spp.	823 600 (53)	Industrial	100	45.7	54.3	
		Non- Industrial				

Eucalyptus spp.; *E. grandis, E. saligna, E. camaldulensis*

Acacia spp.; *A. mearnsii*

Pinus spp.; *P. caribaea, P. oocarpa, P. radiata, P. patula, P. elliottii, P. kesiya*

Explanatory note on 2000 estimates

FOA (1998) provides the total plantation area as 1 518 138 ha to the reference year 1996/1997 and the areas of new afforestations over the last 7 years, from 1990/91 to 1996/97. After 1995 the average annual planted area is approximately 12 000 ha, which has been used to estimate the total plantation area in the year 2000, using 1996/1997 data as the base.
Regarding species and ownership, FOA (1998) gives the figures. They are assumed to be valid up to the year 2000.
DWAF (1996b) gives the percentage of non-industrial plantations as four percent whereas Pandey (1998) has estimated as six percent. An average of five percent has been assumed for non- industrial plantations for 2000

28.2 References

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28 ZIMBABWE

Plantation is concentrated in the high altitude, high rainfall Eastern Highlands of Zimbabwe. Over 90 percent of the whole plantation are found there. Mainly exotic species are planted (Gwaze et al., 1998). 42 percent of the whole plantation belong to the government and are managed by Forestry Commission. Private companies manage 54 percent of the whole plantation. It can be said that most plantations are managed by large scale (FC, 1996). Forestry contributes about 3 percent of GDP and is largely based on the wood processing industry, which is mainly based on plantations of exotic species. Plantation has other minor non-wood products, such as resin, honey and recreation. Because of lack of formal trade, it is very difficult to give production and consumption figures (Gwaze et al., 1998).

28.1 Development of forest plantations

In the 1890s, exotic species plantations were introduced, and planted as wind breaks, woodfuel for tobacco curing, packaging and poles for mines. In 1897, plantation was said to be necessary to protect indigenous forest and reduce import of timber, and this made the opening of the first nursery in 1904. By 1936 exotic plantation area reached 2 354 ha, which belonged to the state and the private sector came into play in the late 1930s (Gwaze et al., 2000).
Until 1934, *Pinus radiata* was the most important commercial species, but due to its susceptibility to disease, its planting was abandoned. *P. patula* has been the most important commercial species since then (Wanyancha, 1991).
In 1965, commercial and industrial plantation area was 100 208 ha, of which 68 percent were softwoods. From softwood plantations, construction materials and wood pulp were produced. In 1985, the additional area of non-commercial and non-industrial plantations was 11 783 ha, consisting of 7 percent softwoods and 93 percent hardwoods (FAO, 1990).
Currently there are 2 types of plantations, commercial and non-commercial plantations. The former is for industrial purpose, such as timber, pulpwood, matchwood etc. And the other is mainly for households use for fuelwood and poles (Gwaze et al., 2000).

28.2 Species composition

Exotic species are planted mainly. *Pinus* species covers about 70 percent of whole plantation. *Pinus patula, P. taeda, P. elliottii, P. kesiya* are common and used for industrial purpose (FC, 1996). The rest is mainly constituted of *Acacia mearnsii* and eucalyptus species, mainly for non-industrial purposes. *Acacia mearnsii* is used to produce tannin, and *Eucalyptus* species are used as pulp, paper and poles. Since 1988, there has been a generally decrease in plantation area under eucalyptus species and *Acacia mearnsii*, opposed to that of pinus species (FC, Anon.).

28.3 Issues

The age class of *Pinus* species is not balanced with most trees in the over mature class, 25 years of more. This unbalance was caused by limited markets, low milling capacity and remoteness of some growing stocks. And the quality of the over-matured stocks are poor with small diameters and heavy branching caused by poor planting material and no silvicultural management.
The information of trees outside of forests is not sufficient. The method to collect it should be developed (Gwaze et al., 1998).
There are several environmental issues; plantation results in loss of biodiversty, land degradation including soil compaction is cause by highly mechanical plantation operation, reduction of soil

fertility by harvesting and burning of the rest and reduction of water yield and water quality (Gwaze et al., 2000).
Fire is the major cause to damage plantation, and droughts follow (FC, Anon.).

28.4 Trend

Currently Zimbabwe is self-sufficient in sawn timber, and about 20 percent of the total output is exported to neighbouring countries of European countries. Future demands for forest products have been estimated. It is projected that the demand for construction materials, packaging materials as paper will increase.
In 1997, Timber Producer's Federation developed and encouraged its members to implement the Environmental Conservation Guidelines, which prescribes conservation procedures at management of plantation and so on, so as to manage plantations in sustainable way (Gwaze et al., 1998).

Forest plantation area of Zimbabwe in 2000

Gross estimated area = 140 800 ha		Annual planting = 2 200 ha			
Species	Gross estimated area (%)	Purpose (%)	Ownership (%)		
			Public	Private	Others
Acacia spp.	21 100 (15)	Industrial			
		Non- Industrial 100	42	58	
Eucalyptus spp.	12 700 (9)	Industrial 32	42	58	
		Non- Industrial 68	42	58	
Other Broadleaved spp.	5 600 (4)	Industrial			
		Non- Industrial 100	42	58	
Pinus spp.	94 400 (67)	Industrial 99	42	58	
		Non- Industrial 1	42	58	
Other Coniferous spp.	7 000 (5)	Industrial			
		Non- Industrial 100	42	58	

Acacia spp.; *A. mearnsii*

Eucalyptus spp.; *E. grandis, E. cloeziana*

Other Broadleaved spp.; *Populus* spp.

Pinus spp.; *P. patula, P. elliottii, P. kesiya, P. taeda*

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2. *FRA 2000 Guidelines for assessments in tropical and sub-tropical countries (43 pp. - E/F/S/P)*
3. *The status of the forest resources assessment in the South-Asian sub-region and the country capacity building needs. Proceedings of the GCP/RAS/162/JPN regional workshop held in Dehradun, India, 8-12 June 1998. (186 pp. - E)*
4. *Volume/Biomass Special Study: georeferenced forest volume data for Latin America (93 pp. - E)*
5. *Volume/Biomass Special Study: georeferenced forest volume data for Asia and Tropical Oceania (102 pp. - E)*
6. *Country Maps for the Forestry Department website (21 pp. - E)*
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