

Status and Trends in Global Forest Plantation Development

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1. Introduction

This paper is based upon the FAO Forest Resources Assessment 2000 (FRA 2000) Main Report. New forest plantation areas were reported as being established globally at the rate of 4.5 million hectares per year, with Asia and South America accounting for more new plantations than the other regions. Of plantations established, about 3

million hectares per year were estimated as being successful. Of the estimated 187 million hectares of plantations worldwide in 2000, Asia had by far the largest area. In terms of species composition, *Pinus* spp. (20 percent) and *Eucalyptus* spp. (10 percent) remain dominant worldwide, although the overall diversity of species planted was shown to be increasing. Industrial plantations account for 48 percent, non-industrial plantations for 26 percent and

plantations for unspecified use for 26 percent of the global forest plantation estate.

The results of the plantation assessment were the first global estimates with a uniform definition of forest plantations and can therefore not be directly compared to previous estimates. FRA 2000 country statistics on plantations may also differ from those reported in prior FAO publications (FAO 1981; FAO 1995), partly because of changes in definitions. Countries participated directly in the assessment, providing technical documentation and supporting analysis and validating the results generated by FAO. Several experts around the world were enlisted to provide detailed information on various aspects of the plantation situation in the form of special studies.

2. Concepts and definitions

Between the extremes of afforestation and unaided natural regeneration of natural forests, there is a range of forest conditions in which human interventions occur. European forests have long traditions of human intervention in site preparation, tree establishment, silviculture and protection; yet these are not always defined as forest plantations. The traditional forest plantation concept tends to be applied to single species, uniform planting densities and even age classes. Terms such as "natural forest under management" or "assisted natural regeneration" are applied to stands of indigenous species in more heterogeneous management mechanisms in Europe and other industrialized temperate and boreal countries.

In FRA 2000 "forest plantations" are defined as those forest stands established by planting or/and seeding in the process of afforestation or reforestation. They are either of introduced or indigenous species which meet a minimum area requirement of 0.5 ha; tree crown cover of at least 10 per cent of the land cover; and total height of adult trees above 5 m.

In country responses, terms such as "human made forest" or "artificial forest" were considered synonyms for forest plantations as defined in FRA 2000. Because of their increasing significance as a supply of fibre to the wood industries sector, rubber (*Hevea brasiliensis*) plantations were included as forest plantation resources.

3. Methods

The area of existing forest plantations would ideally all have been derived from statistically designed inventories of forest plantations or statistics for planted areas reported by planting agencies or appearing in national reports. However, information also comes from many other sources including nursery production, seedling distribution and estimates derived from the goals of planting programmes. The vast range of agencies, industries and non-governmental organizations within countries engaged in planting programmes made the comprehensive collection of all relevant source documents a major logistical exercise. For FRA 2000, over 800 source documents were analysed to derive the forest plantation estimates. In most developing countries a national clearinghouse for collecting information on plantations is either lacking or ineffective owing to the enormity of the task and limited resources.

3.1 Data collection

To retrieve the source documents for the plantation study, FAO made formal requests to all developing coun-

tries, some of which contributed the necessary materials. Most of the reports were collected directly by FAO staff during FRA 2000 workshops and visits to national ministries. For consistency FRA 2000 prepared guidelines and questionnaires for the collection of forest plantation statistics in which the objectives, scope, definitions, sources of data and templates for specific data collection were supplied to each country. Parameters requested included:

- total estimated forest plantation area, 2000;
- annual area of new plantations;
- species groups: broadleaf (including *Hevea* spp.), conifer, non-forest like, African oil palm (*Elaeis guineensis*), coconut palm (*Cocos nucifera*) bamboo or unspecified;
- purpose and end-use objective of forest plantations: industrial (producing wood or fibre for supply to wood processing industry) or non-industrial (fuelwood, soil and water protection);
- ownership: public, private, other (e.g. traditional, customary) or unspecified.

Other data requested in the guidelines, which proved difficult for countries to provide by species group, included age class distribution; end-use by forest product (industrial plantations); growth and yield (mean annual increment); standing volumes; and rotation lengths. Despite the absence of these data, FRA 2000 is the most comprehensive forest plantation resources assessment that has been carried out.

In previous assessments of forest plantation resources, plantation data were available up to the reference year for most countries, since the reporting followed the reference year. In FRA 2000, the reference year was 2000, so if data were not available to that date, then existing area and annual planting data were used to extrapolate the necessary information. For the few countries that have no data sets since 1990, the rate of planting in preceding years and future planting programmes were considered in projections to the year 2000.

FAO also enlisted the assistance of several experts around the world to make specific technical contributions on the forest plantation situation in the 1990s. These studies constituted an important part of the global results as well, and complemented the country information.

3.2 Analysis and interpretation

The quantity and quality of forest plantation data provided is dependent upon the capacity of the national forest inventory systems to collect and analyse data and to adjust the information to conform with global and regional reporting parameters. In many developing countries there is a lack of institutional capacity to carry out periodic national forest inventories, so data can be incomplete, inconsistent, outdated and of variable reliability. Because of this, it was necessary to derive and in some instances to verify forest plantation statistics through desk research using available country reports. All sources of country data were referenced and made available in a transparent manner. In addition, regional and national focal persons were appointed to assist in the forest plantation data collection, to ensure that the latest data were available and to maintain coordination and communication between FRA 2000, FAO regional offices and each participating country. On completion of the data sets, a formal verification process was undertaken with each participating country.

4. Results

4.1 Regional forest plantation areas, species and annual plantings

The annual plantation rates and plantation areas by regions and species groups are summarized in Table 1.

According to global forest plantation area distribution, as depicted in Figure 1., Asia accounts for 62 percent of the total; Europe, 17 percent; North and Central America, 9 percent; South America, 6 percent; Africa, 4 percent; and Oceania, less than 2 percent.

Globally, broadleaves make up 40 percent of forest plantation area with *Eucalyptus* the principal genus. Coniferous species make up 31 percent of which *Pinus* is the principal genus (Figure 2).

In FRA 2000 the global rate of new planting was estimated at 4.5 million hectares per year. Asia accounted for 79 percent and South America for 11 percent (Figure 3).

non-industrial plantations are aimed for example at supplying fuelwood, providing soil and water conservation, wind protection, biological diversity conservation and other non-commercial purposes.

Globally, 48 percent of the forest plantation estate is for industrial end-use; 26 percent for non-industrial (fuelwood, soil and water, other); and 26 percent is not specified (Figure 4).

Globally, industrial plantations are 34 percent publicly owned, 29 percent privately owned and 37 percent other or unspecified (Figure 5). Within non-industrial plantations, 41 percent are publicly owned, 37 percent are privately owned and 22 percent are other or unspecified (Figure 6).

4.3 Leaders in forest plantation development (top ten countries by area)

As detailed in Table 3, the ten countries with the largest forest plantation development account for 79 percent of the global forest plantation development area. Six of these

Table 1. Annual plantation rates and plantation areas by region and species group

Region	Total area 000 ha	Annual rate 000 ha/yr	Plantation areas by species groups (000 ha)							
			<i>Acacia</i>	<i>Eucalyptus</i>	<i>Hevea</i>	<i>Tectona</i>	Other broadleaf	<i>Pinus</i>	Other conifer	Unspecified
Africa	8 036	194	345	1 799	573	207	902	1 648	578	1 985
Asia	115 847	3 500	7 964	10 994	9 058	5 409	31 556	15 532	19 968	15 365
Europe	32 015	5	-	-	-	-	15	-	-	32 000
North and Central America	17 533	234	-	198	52	76	383	15 440	88	1 297
Oceania	3 201	50	8	33	20	7	101	73	10	2 948
South America	10 455	509	-	4 836	183	18	599	4 699	98	23
WORLD TOTAL	187 086	4 493	8 317	17 860	9 885	5 716	33 556	37 391	20 743	53 618

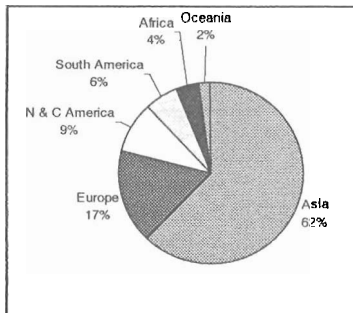


Figure 1. Distribution of forest plantation area by region

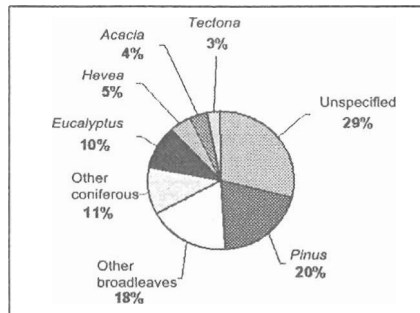


Figure 2. Distribution of plantation areas by genus

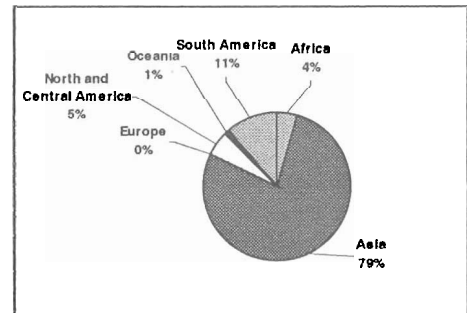


Figure 3. Distribution of annual planting area

In many countries, particularly in the developing world, the end purpose of the plantations is not clearly defined at the outset. In some of these cases, valuable tree resources are established which coincidentally match future needs. However, in other cases the lack of planning may result in plantations that have little commercial value and a low potential for local use.

4.2 Purpose and ownership within the global forest plantation estate

Purpose and ownership of forest plantations vary markedly among regions (Table 2). Industrial plantations provide the raw material for wood processing for commercial purposes, including timber for construction, panel products and furniture, and pulpwood for paper. In contrast,

countries, accounting for 56 percent of global forest plantations, are in Asia.

The top ten countries according to area are China, 24 percent; India, 17 percent; the Russian Federation, 9 percent; the United States, 9 percent; Japan, 6 percent; Indonesia, 5 percent; Brazil, 3 percent; Thailand, 3 percent; Ukraine, 2 percent and the Islamic Republic of Iran, 1 percent (Figure 7).

Within the top ten, an estimated 52 percent of forest plantations are grown for industrial purposes to supply raw material for industry; 26 percent for non-industrial uses (fuelwood, soil and water protection, biodiversity conservation); and the purpose was not specified in 22 percent (Figure 8). The industrial forest estate in these top ten countries was owned publicly, 33 percent; privately, 26 percent; and other or unspecified, 41 percent (Figure 9).

Table 2. Regional plantation areas by purpose and ownership

Region	Total area	Industrial purpose (000 ha)					Non-industrial purpose (000 ha)					Purpose unspec.
		Public	Private	Other	Unspec.	Sub-total	Public	Private	Other	Unspec.	Subtotal	
Africa	8 036	1 770	1 161	51	410	3 392	2 035	297	611	330	3 273	1 371
Asia	115 847	25 798	5 973	27 032	-	58 803	17 177	17 268	9 145	72	43 662	13 381
Europe	32 015	-	-	-	569	569	9	6	-	-	15	31 431
North and Central America	17 533	1 446	15 172	118	39	16 775	362	58	16	35	471	287
Oceania	3 201	151	14	-	24	189	21	3	-	19	24	2 987
South America	10 455	1 061	3 557	-	4 827	9 445	251	528	-	225	1 004	6
WORLD TOTAL	187 086	30 226	25 876	27 202	5 871	89 175	19 836	18 161	9 772	680	48 449	49 463

Source: FRA 2000

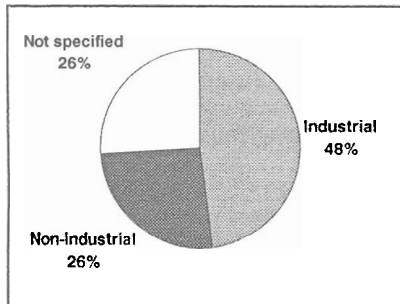


Figure 4. Distribution of forest plantations end-use, worldwide

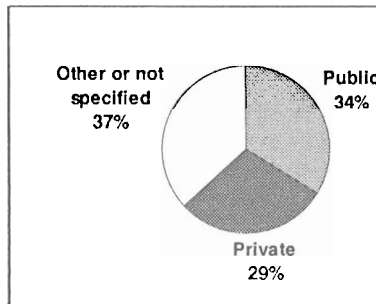


Figure 5. Ownership of industrial forest plantations, worldwide

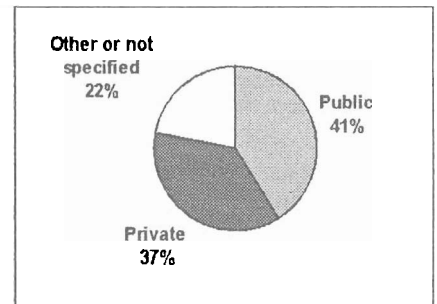


Figure 6. Ownership of non-industrial forest plantations, worldwide

Table 3. Plantation purpose and ownership by reported area for the ten largest plantation development countries

Country	Total area 000 ha	Industrial purpose (000 ha)					Non-industrial purpose (000 ha)					Unspecified purpose
		Public	Private	Other	Unspecified	Subtotal	Public	Private	Other	Unspecified	Subtotal	
China	45 083	10 182	-	26 994	-	37 176	102	-	7 805	-	7 907	-
India	32 578	8 258	3 749	-	-	12 007	11 370	8 641	560	-	20 571	-
Russian Federation	17 340	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	17 340
United States	16 238	1 185	15 053	-	-	16 238	-	-	-	-	-	-
Japan	10 682	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	10 682
Indonesia	9 871	4 531	1 228	-	-	5 759	358	3 754	-	-	4 112	-
Brazil	4 982	-	-	4 802	-	4 802	-	-	180	-	180	-
Thailand	4 920	850	314	-	-	1 164	1 219	2 537	-	-	3 756	-
Ukraine	4 425	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	4 425
Islamic Republic of Iran	2 284	241	-	-	-	241	1 938	105	-	-	2 043	-
Top 10 Total	148 403	25 247	20 344	31 796	-	77 387	14 987	15 037	8 545	-	38 569	32 447
Top 10 %	79%					87%					80%	66%
WORLD TOTAL	187 086	30 226	25 876	27 202	5 871	89 175	19 836	18 161	9 772	680	48 449	49 463

Source: FRA 2000

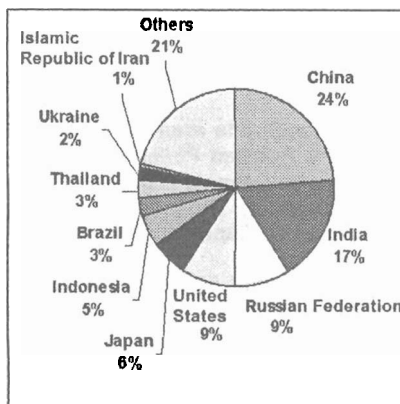


Figure 7. Leaders in forest plantation development – percentage of area

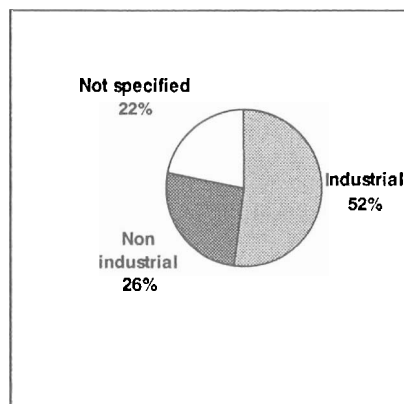


Figure 8. End-use of forest plantations, top ten countries

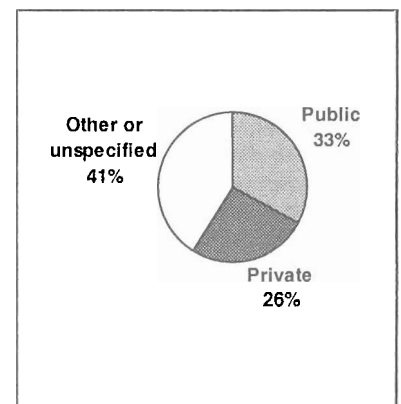


Figure 9. Ownership, industrial plantations, top ten countries

5. Selected global trends, 1980-2000

5.1 Comparisons

FRA 2000 country statistics on plantations may differ from those reported in prior FAO publications (FAO 1981; FAO 1991), partly because of changes in definitions. For example, rubber (*Hevea* spp.) plantations were not previously considered as forest plantations but are included in FRA 2000 plantation data. Previous assessments also used regional reduction factors to indicate the successful proportion of plantations remaining after establishment. The FRA 2000 assessment applied reduction factors according to the best available data from each country independently. There have also been changes in the information base from which the estimates were derived. The statistics now include data from many industrialized countries, none of which were included in the prior global assessment reports. Despite these differences, comparison of FRA results from each decade allows analysis of some trends including planting rates, genera, areas and purpose (end-use).

5.2 Global forest plantation estate

The global forest plantation estate has increased from 17.8 million hectares in 1980 and 43.6 million hectares in 1990 to 187 million hectares in 2000 (Table 4).

Table 4. Forest plantation purpose trends by region, 1980-2000

Region	Plantation area by purpose (000 ha)			
	Total	Industrial	Non-industrial	Unspecified
2000				
Africa	8 036	3 392	3 273	1 371
Asia	115 847	58 803	43 662	13 381
Oceania	3 201	189	24	2 987
Europe	32 015	569	15	31 431
North and Central America	17 533	16 775	471	287
South America	10 455	9 446	1 004	6
GLOBAL TOTAL	187 087	89 175	48 449	49 463
1990				
Africa	2 990	1 366	1 623	
Asia	31 775	8 991	23 119	
Oceania	189	167	22	
Europe				
North and Central America	691	457	234	
South America	7 946	4 645	3 301	
GLOBAL TOTAL	43 590	15 625	28 300	
1980				
Africa	1 713	939	780	
Asia	11 088	3 487	7 601	
Oceania	88	41	47	
Europe				
North and Central America	287	272	15	
South America	4 604	2 261	2 348	
GLOBAL TOTAL	17 779	7 000	10 791	

Source: FAO 1981, 1995, 2000

Although in 2000, 26 percent of plantations continued to be for unspecified purpose, there was a significant increase in plantations for industrial purposes in the past decade: from 39 percent in 1980 and 36 percent in 1990 to 48 percent in 2000. There has been a corresponding decrease in forest plantations for non-industrial purposes.

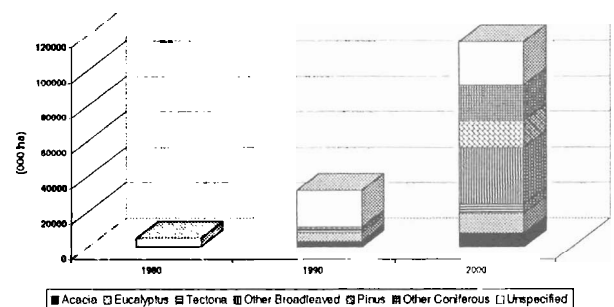
5.3 Species trends by region – a graphic illustration

The direct comparison of trends for the period 1980 - 1990 - 2000 can only be done for the developing coun-

tries as developed country inputs were not reported prior to FRA 2000. Species trends from FRA 1980, FRA 1990 and FRA 2000 are graphically illustrated by region in Figure 10 to Figure 14 (FAO 1981; FAO 1995). The graphics are not to scale but illustrate relative growth within the region over the period and show trends in species used.

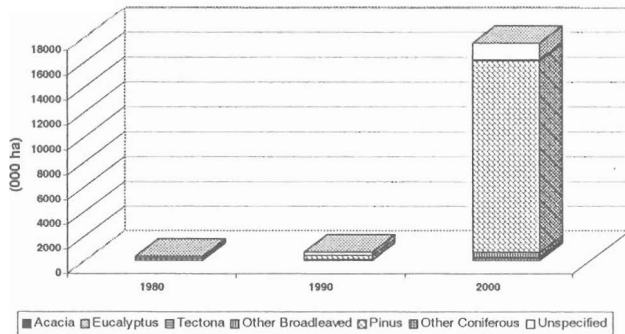
6. Impacts of the forest plantation estate

The potential for forest plantations to partially meet demand for wood and fibre for industrial uses is increasing. According to FRA 2000, the global forest plantation area accounts for only 5 percent of global forest cover and the industrial forest plantation estate for less than 3 percent. However, as an indication only, forest plantations were estimated in the year 2000 to supply about 35 percent of global roundwood and an increase to 44 percent anticipated by 2020 (ABARE and Jaakko Pöyry 1999) (Figure 15). If plantation development is targeted at the most appropriate ecological zones and if sustainable forest management principles are applied, forest plantations can provide a critical substitute for natural forest raw material supply. In several countries industrial wood production from forest plantations has significantly substituted for wood supply from natural forest resources.



Countries not included in years 1980 and 1990: Japan

Figure 10. Plantation areas by genus, Asia



Countries not included in years 1980 and 1990: Canada and USA

Figure 11. Plantation areas by genus, North and Central America

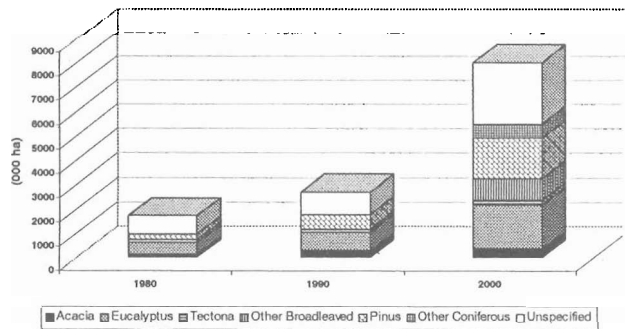
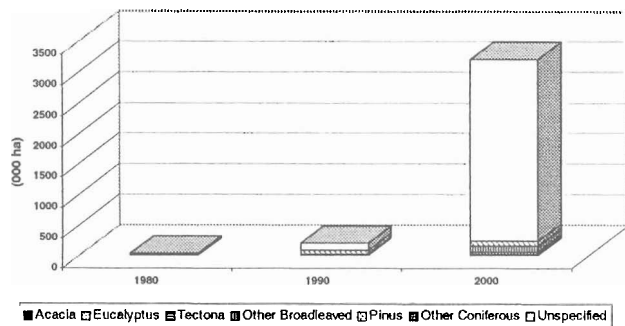


Figure 12. Plantation areas by genus, Africa



Countries not included in years 1980 and 1990: Australia and New Zealand

Figure 13. Plantation areas by genus, Oceania

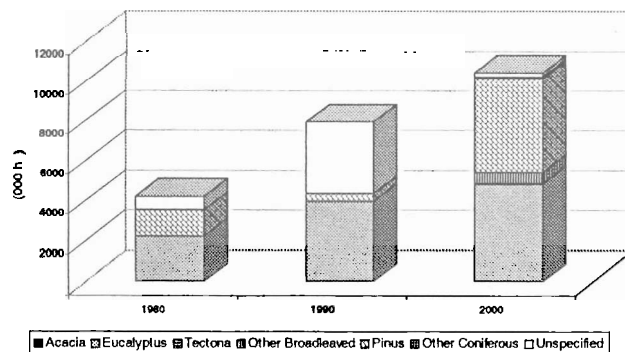
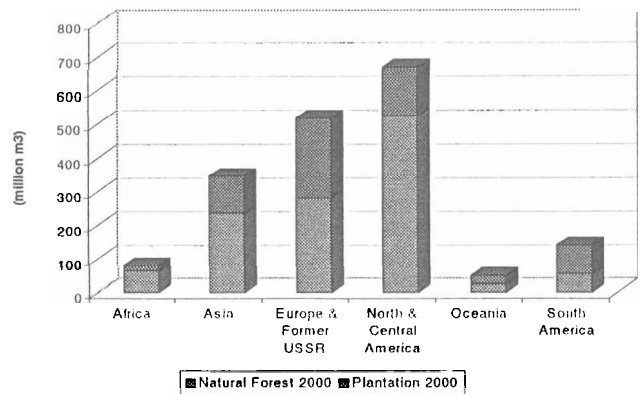
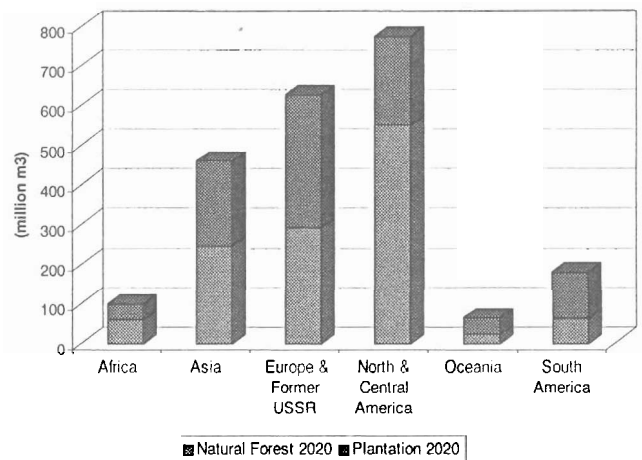


Figure 14. Plantation areas by genus, South America



Source: ABARE and Jaakko Pöyry 1999

Figure 15a. Predicted ratio of regional roundwood supply from natural forests and plantations at year 2000



Source: ABARE and Jaakko Pöyry 1999

Figure 15b. Predicted ratio of regional roundwood supply from natural forests and plantations at year 2020

Forest plantations in New Zealand met 99 percent of the country's needs for industrial roundwood in 1997; the corresponding figure in Chile was 84 percent, Brazil 62 percent and Zambia and Zimbabwe 50 percent each. This substitution by forest plantations may help reduce logging pressure on natural forests in areas in which unsustainable harvesting of wood is a major cause of forest degradation and where logging roads facilitate access that may lead to deforestation.

Forest plantations also provide additional non-wood forest products, from the trees planted or from other elements of the ecosystem that they help to create. They contribute environmental, social and economic benefits. Forest plantations are used in combating desertification, absorbing carbon to offset carbon emissions, protecting soil and water, rehabilitating lands exhausted from other land uses, providing rural employment and, if planned effectively, diversifying the rural landscape and maintaining biodiversity.

Not all forest plantation development has positive economic, environmental, social or cultural impacts. Without adequate planning and without appropriate management, forest plantations may be grown in the wrong sites, with the wrong species/provenances, by the wrong growers, for the wrong reasons. Examples exist where natural for-

ests have been cleared to establish forest plantation development or where customary owners of traditional lands may have been alienated from their sources of food, medicine and livelihoods. In some instances poor site/species matching and inadequate silviculture have resulted in poor growth, hygiene, volume yields and economic returns. In other instances, changes in soil and water status have caused problems for local communities. Land use conflicts can occur between forest plantation development and other sectors, particularly the agricultural sector.

The negative impacts of forest plantations can draw the focus away from the fact that forest plantation resources are totally renewable and can be economically, socially, culturally and environmentally sustainable with prudent planning, management, utilization and marketing.

7. Selected forest plantation topics technical issues

7.1 Data

Reliable and consistent data are not available on the forest plantation resource - on areas of natural forest cleared for forest plantation establishment; areas established with mixtures of tree species; total areas of forest plantations by species, purpose, ownership, age class distribution, growth, rotation, harvest yield and forest products output. In addition to the lack of quantitative data, the poor quality of the available information is a major impediment to policy-making and monitoring. There is a need to improve the reliability and timeliness of forest plantation data.

FAO will continue to support developing countries in institutional strengthening and capacity building to provide increasingly accurate data on forest plantations at regional and global levels, to be used in national policy making, in regional and global outlook studies and in a range of other studies.

7.2 Land

Land availability, land tenure and crop ownership are important issues which determine confidence for forest plantation investment. In developed countries and in some countries with economies in transition, surplus, or marginal agricultural land is becoming increasingly available for forest plantation development; however, such land may not be suitable for the establishment of all kinds of forest plantations, nor may the owner be willing to commit land for the long term investment to maturity. Land-use conflicts can occur where forest plantations are developed on land perceived as "waste-land" but actually used for grazing and provision of non-wood goods and services by landless people. In developing countries land ownership, land-use and crop ownership rights may not be clear or secure.

FAO is assisting developing countries to review the role of forest plantations in reducing poverty, contributing to economic development and ensuring that facilitating factors are put in place for secure investment in this land-use.

7.3 Substitution of forest products from natural forest

While it is clear that plantations will have an increasingly significant role in substituting wood and non-wood forest products from natural forests, the impact will be felt on a case-by-case basis as governments and investors

determine where and how plantations can be technically, economically and socially feasible as well as environmentally friendly. Globally the current pace of industrial plantation development will barely keep pace with losses from deforestation and transfer of natural forests to protected status. While it would be theoretically possible, actual plantation development is, at present, not sufficient to offset both growing consumption and declining harvest from natural forests (FAO 2001a).

FAO is assisting through FRA 2000 outlook studies, support to development of national forest plans and provision of policy and technical support to primarily developing countries

7.4 Sustainable plantation management

It is possible not only to sustain but also to increase productivity in successive rotations. This requires clear definition of the end-use objective for forest plantation development and a holistic view in their management. There is a need to integrate strategies for tree improvement programmes, nursery practices, site and species/provenance matching, appropriate silviculture (site preparation, establishment, weeding, fertilizing, pruning, thinning), forest protection and harvesting practices with prudent management. New Zealand and the southern United States have shown that substantial gains can be made by adopting this holistic approach. In developing countries where resources may be constrained, highly technical solutions may not be essential but it is critical to get the fundamentals correct: careful species and provenance choice, good nursery stock, site preparation, planting techniques, weed control and, less frequently, fertilizer inputs. Once healthy and uniform plantations have been established, later silvicultural tending may become increasingly important, depending on the end-use objective (FAO 2001e).

Burning and excessive cultivation in site preparation, soil compaction from mechanical operations, inappropriate harvesting techniques and poor forest protection can contribute to loss of nutrients and soil erosion, with a resultant loss in productivity of forest plantation sites. This can be addressed by the adoption of the whole range of tree improvement, silviculture, protection and harvesting techniques in an integrated forest management strategy. Additionally forest plantations can help to conserve biological diversity if managed prudently.

FAO is assisting developing countries to establish and manage forest plantations according to sustainable forest management principles and practices and maximise environmental benefits.

7.5 Carbon sequestration and climate change

In the past ten years, the development of forest plantations as carbon offsets has evolved towards a market mechanism, although an organized market with carbon prices defined according to supply and demand forces. The adoption of the Kyoto Protocol in 1997 triggered a strong increase in investment in plantations as carbon sinks, although the legal and policy instruments and guidelines for management are still debated. A number of countries have already prepared themselves for the additional funding for the establishment of human-made forests. The 1997 Costa Rica national programme was the first to establish tradeable securities of carbon sinks that could be used to offset emissions and the first to utilize independent certification insurance.

To date, greenhouse gas mitigation funding covers about 4 million hectares of forest plantations worldwide (FAO 2001d). The recognition of afforestation and reforestation as the only eligible land use, land use change and forestry activities under the Clean Development Mechanism of the Kyoto Protocol, as agreed in Bonn during the second part of the Sixth Conference of the Parties to UNFCCC in July 2001, will lead to a steep increase in forest plantation establishment in developing countries. The sink decision of the Bonn Agreement is expected to funnel additional funds into forest activities in developing countries and thus to strengthen the international efforts in this field. However, it will also require a monitoring and verification system to ensure that these plantations will not be established at the expense of the local population or efforts to conserve biological diversity. Thus the decisions taken in Bonn to make the Kyoto Protocol ratifiable will also bear new challenges for forest plantation development.

FAO has established an Inter-departmental Working Group on Climate in relation to Agriculture and Food Security that is active in international dialogue and in assisting in the developments of standards.

7.6 New sources of fibre

Particularly in SE Asia, wood supply difficulties and advances in wood utilisation technology have led to the utilisation of woody or fibrous species which were not traditionally considered "forestry" species such as rubberwood (9.7 million ha) and stems and leaves of African oil palm (6 million ha) and coconut palm (12 million ha). All grow in the humid tropics. This trend is expected to continue and consequences and implications will be monitored by FAO.

7.7 Trees outside forest

Increasingly trees are being planted to support agricultural production systems, community livelihoods, alleviate poverty and to provide food security. Communities and smallholder investors, including individual farmers, grow trees as shelterbelts, home gardens, woodlots and a diverse range of agroforestry systems to provide wood, non-wood forest products, fuelwood, fodder and shelter. Outgrower schemes under various forms of contract with wood processing industries can also provide valuable sources of wood supply. Smallholder investors are producing an increasing proportion of decorative veneer species, especially teak, using such schemes.

FAO is presently carrying out a review and an analysis of experiences with outgrower and contract schemes, to develop extension guidelines.

8. Conclusions

New forest plantation areas are reported to be increasing globally at the rate of 4.5 million hectares per year, but net areas may be much less. Asia and South America account for more new plantation development than other regions. The Asian region has the largest areas in forest plantations. Broadleaf species account for 40 percent of forest plantations, coniferous species 31 percent and unspecified species 29 percent.

Industrial plantations account for 48 percent and non-industrial 26 percent of global forest plantations. Industrial plantation resources are dominated by China, India and the United States, while non-industrial plantation resources are dominated by China, India, Thailand and Indonesia.

Forest plantation ownership in both industrial and non-industrial plantations is evenly balanced between public and private.

Because data on forest plantations remain too weak for more detailed analysis, countries need to be encouraged and supported to establish national mechanisms to strengthen their national inventory programmes, data bases, management information systems, adoption of standard terms/definitions and reporting protocols to collaborate more closely with international agencies analysing and incorporating this information into global reports.

Forest plantations can provide critical environmental, social and economic benefits. Sound forest plantation management, tree improvement and silviculture can sustain and/or enhance productivity of forest plantations. To do so, however, it is important that forest plantations be managed in accordance with a defined end-use objective and compliance with sustainable forest management principles and practices.

Forest plantations provide a critical substitute for raw material supply from natural forests, including industrial roundwood and fuelwood. In addition, non-forest species such as rubber (*Hevea brasiliensis*), coconut (*Cocos nucifera*) and oil palm (*Elaeis guineensis*) are becoming important sources of wood and fibre. Finally, there is increasing potential for forest plantation investment to offset carbon emissions and contribute significantly to the Clean Development Mechanism.

Detailed FRA 2000 reporting of forest resources, including forest plantations by country are available on: www.fao.org/forestry/fo/country/nav_world.jsp; Main Report on: www.fao.org/forestry/fo/fra/main/index.jsp and State of the World's Forests (SOFO) 2001 on: www.fao.org/forestry/FO/SOFO/sofo-e.stm

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