

Preliminary Analysis of Global Trends in Forest Plantation Development 1980-2000¹ **by Alberto Del Lungo, Petteri Vuorinen and Jim Carle, FAO, Rome²**

Abstract:

According to the Global Forest Resources Assessment, FRA 2000, forest plantations cover 187 million hectares, of which Asia accounts for 62%. The largest plantation resources are found in China with 24% and India with 17%. The forest plantation area is a significant increase over the 1995 estimate of 124 million hectares. The new annual planting rate is 4.5 million hectares globally, with Asia and South America accounting for 91%. Broadleaf species account for 40% of global forest plantation resources, conifers, 31% and not specified, 29%. Globally, 48% of the forest plantation estate is for industrial end-use; 26% for non-industrial end-use (fuelwood, soil and water, other); and not specified, 26%. Forest plantation ownership is public, 27%; private, 24%; other, 20% and not specified, 29%.

The geographic (national and regional), economic (developed and developing), eco-floristic (tropical and non-tropical) stratification and bases of the global forest resources assessment of forest plantations and reliability of data have varied markedly between FRA 1980, 1990 and 2000. The unspecified species has reduced from 81% in 1980, 58% in 1990 to 34% in 2000. Broadleaf species increased from 12% in 1980 to 36% in 1990 and 40% in 2000. Conifers increased from 4% in 1980, to 6% in 1990 and 31% in 2000. Although in 2000 there remained 26% unspecified purpose, industrial purpose increased from 39% in 1980, 36% in 1990 to 48% in 2000, with the significant increase in the last decade. There has been a corresponding decrease in non-industrial purpose forest plantations.

The total area of forest plantations in developing countries has increased from 17.8 million ha in 1980 to 122.9 million ha in 2000, a seven fold increase over the past two decades.

The potential for forest plantations to partially meet demand from natural forests for wood and fibre for industrial uses is increasing. Although accounting for only 5% of global forest cover, forest plantations were estimated in the year 2000 to supply about 35% of global roundwood, with anticipated increase to 44% by 2020. In some countries forest plantation production already contributes the majority of industrial wood supply.

Introduction:

Background:

Increasingly wood and non-wood forest products, fuelwood, environmental benefits and carbon sequestration will be from forest plantation resources managed on a sustainable basis. The trends in forest plantation development (1980-2000) give indications on the scale, location and direction for future policy, planning, technical and knowledge change required to respond to priority needs for the sector.

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Global Forest Resource Assessments (FRA) have been carried out in 1980, 1990 and 2000 to detail forest cover areas and change, including forest plantations. The results of FRA 2000 have recently become available.

Objectives:

The objectives for including forest plantation data in global forest resource assessments are to:

- (a) Measure trends at regional and global level in forest plantation areas, species, purpose and ownership for planning and policy development;
- (b) Model potential present and future wood and fibre supply;
- (c) Estimate carbon sequestration;
- (d) Estimate the extent to which plantations may reduce pressure on natural forest wood supply;
- (e) Estimate the area of plantations established for the provision of environmental functions and services;
- (f) Estimate the area and species established for the production of fuelwood; and
- (g) Contribute to estimates of new economic benefits.

Concept:

It is not always possible to distinguish forest plantations from natural forests in those countries where long rotation, natural species are grown, often in mixed species plantings in temperate and boreal regions. Between the extremes of afforestation and unaided natural regeneration of natural forests, there is a range of forest conditions where human interventions occur. The distinction between natural forests and forest plantations is more clear-cut if plantings are in single species, uniform planting densities, even age-classes and shorter rotation.

European forests have long traditions of human interventions in harvesting, nursery management, site preparation, tree establishment, silviculture and protection, but are not always defined as forest plantations. Terms like natural forests under management, or assisted natural regeneration, are generally preferred. Reforestation is generally with indigenous species in more heterogenous management mechanisms than the traditional forest plantation concept (single species, uniform planting densities, even age-classes, fixed rotation and clearfell harvesting).

FRA 2000:

Definitions:

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 all the following criteria – minimum area of 0.5 hectare; tree crown cover of at least 10% of the land cover; and total height of adult trees above 5 meters.

In country responses terms such as “man made forest” or “artificial forest” were considered synonyms for forest plantations as defined in FRA 2000.

The definition excludes stands which were established as plantations but which have been without intensive management for a significant period of time. These are considered semi-natural. Due to their increasing significance as a supply of fibre to the wood industries sector, rubber plantations are included as forest plantation resources.

Forest plantations can be classified as afforestation or reforestation according to definitions:

- (a) *Afforestation* is the conversion from other land uses to forest or the increase of the canopy cover to above the 10% threshold;

- (b) *Reforestation* is the re-establishment of forests after a temporary condition with less than 10% canopy cover due to human-induced or natural perturbations.
- (c) *Replanting* where afforestation or reforestation has failed or where the crop is felled and regenerated is not added to the plantation area.

With population pressures on available land for food security, there is an increasing proportion of tree plantings, by human intervention, which also do not fit within the characteristics of traditional forest plantations. Trees supporting livelihoods of rural populations and agriculture (shelterbelts, shade, home gardens), smallholder, social and community forestry, agroforestry (inter-cropping, grazing, multi-purposes, fruit) and urban and peri-urban (schools, parks, reserves) represent a valuable growing stock of planted trees for wood and non-wood forest products in high population density countries. These are defined as “Trees Outside Forests” if canopy closure falls below 10% and as forest plantations if above.

Methodology:

The area of existing forest plantations is ideally derived from statistically designed inventories of forest plantations or statistics for planted areas reported by planting agencies or appearing in national reports. For consistency between countries, 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.

Data Collection:

Country responses were incomplete, however there was sufficient data from questionnaires and other sources to derive the following information:

- (a) Total forest plantation area estimated at the year 2000;
- (b) Annual area of new plantations;
- (c) Species groups according to broadleaf (including rubber), conifer, non-forest (oil palm, coconut palm, bamboo) and where no data was provided, unspecified species;
- (d) Purpose and end-use objective of forest plantations according to industrial (producing wood, or fibre for supply to wood processing industry) and non-industrial (fuelwood, soil and water protection);
- (e) Ownership according to public, private, other (e.g. traditional, customary) and unspecified

Other data requested in the guidelines, that proved difficult for each country to provide by species group included age class distribution; end-use by forest product (industrial plantations); growth (mean annual increment); standing volumes; rotation lengths and harvest yields. Despite the absence of this data, FRA 2000 is the most comprehensive, transparent, neutral and responsive forest plantation resources assessment carried out.

Analysis and Interpretation:

The quantity and quality of forest plantation data provided is dependent upon 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 and capability 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 verify, forest plantation statistics from desk research from available country reports. Additionally regional and national focal persons were appointed to assist in the forest plantation data collection and to ensure that the latest data was available and to maintain co-ordination and communication between

FRA 2000, regional offices and each participating country. On completion of data sets a formal verification process was undertaken with each participating country.

Results:

Regional Forest Plantation Areas, Species and Annual Plantings

According to global forest plantation area distribution, Asia accounts for 62% of the total, Europe, 17%; North and Central America, 9%; South America, 6%; Africa, 4% and Oceania, less than 2%. Based upon annual planting rate, Asia leads with 79%; South America, 12%; North and Central America, 5%; and Africa, 4%. Major new forest plantation development is in Asia and South America.

Table 1: Annual Plantation Rates and Plantation Areas by Regions and Species Groups

Region	Total Area (000 ha)	Annual Rate (000 ha/yr)	Plantation Areas (000 ha) by Species Groups							
			Acacia	Eucalyptus	Hevea	Tectona	Other Broadleaf	Pinus	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
Nth/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

Source FRA 2000

Based upon global forest plantation areas; unspecified species account for 29%; Pinus, 20% Other Broadleaves, 18%; Other Conifers, 11%; Eucalyptus, 10%; Acacia, 4%; Hevea (rubber), 5%; and Tectona (teak), 3%. The species groups vary markedly between geographic regions due to complex eco-floristic and economic conditions. In Europe the species groups were not defined.

In Asia the species distribution is: Other Broadleaf, 27%; Other Conifers, 17%; Pinus, 13%; Unspecified, 13%, Eucalyptus, 9%; Hevea, 8%; Acacia, 7%; and Tectona, 5%.

In North and Central America the species distribution is overwhelmingly dominated by Pinus, 88%; followed by Unspecified 7%; and others, 5%.

In South America the dominant species are Eucalyptus, 46%; and Pinus, 45%; Other Broadleaves, 6%; and others, 3%.

In Africa the species distribution is: Eucalyptus, 22%; Unspecified, 25%; Pinus, 21%; Other Broadleaves, 11%; Other Conifers, 7%; Hevea, 7%; Acacia, 4%; and Tectona, 3%.

In Oceania the species distribution is: Unspecified, 92%; Other Broadleaves, 3%; Pinus, 3%; and others, 2%.

Purpose and Ownership within the Global Forest Plantation Estate

The following table details regional plantation areas by purpose and ownership for the global forest plantation estate. Globally, 48% of the forest plantation estate is for industrial end-use; 26% for non-industrial end-use (fuelwood, soil and water, other); and 26% is not specified.

Within industrial plantations, 34% is publicly owned, 29% is privately owned and 36% is other or unspecified. Within non-industrial plantations, 41% is publicly owned, 37% is privately owned, 22% is other or unspecified.

Table 2: Regional Plantation Areas by Purpose and Ownership

Region	Total Area (000 ha)	Industrial Purpose (000) ha					Non-Industrial Purpose (000) ha					Purpose Unspec'd
		Public	Private	Other	Unspec'd	Sub-Total	Public	Private	Other	Unspec'd	Sub-Total	
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
Nth/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	2	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

Purpose and ownership varies markedly between regions. The purpose and ownership data is not available for European countries.

The industrial forest estate in Asia accounts for 51% of forest plantation area, of which 44% is owned publicly; 10%, privately; and 46%, other or unspecified. The non-industrial estate in Asia accounts for 38% of forest plantation area; of which 39% is owned publicly; 40% privately; and 21% other or unspecified. Forest purpose was unspecified for 12% of forest plantation areas.

The industrial forest estate in North and Central America accounts for 96% of forest plantation area, of which 9% is owned publicly; 90%, privately; and 1%, other or unspecified. The non-industrial estate in North and Central America accounts for 3% of forest plantation area; of which 77% is owned publicly; 12% privately; and 11% other or unspecified. Forest purpose was unspecified for 1% of forest plantation areas.

The industrial forest estate in South America accounts for 90% of forest plantation area, of which 11% is owned publicly; 38%, privately; and 51%, other. The non-industrial estate in South America accounts for 10% of forest plantation area; of which 25% is owned publicly; 53% privately; and 22% other.

The industrial forest estate in Africa accounts for 42% of forest plantation area, of which 52% is owned publicly; 34%, privately; and 14%, other. The non-industrial estate in Africa accounts for 41% of forest plantation area; of which 62% is owned publicly; 9% privately; and 29% other or unspecified. Forest purpose was unspecified for 17% of forest plantation areas.

The industrial forest estate in Oceania accounts for 6% of forest plantation area, of which 80% is owned publicly; 7%, privately; and 13%, other. The non-industrial estate in Oceania accounts for 1% of forest plantation area; of which 8% is owned publicly; 11%, privately; and 82% other. Forest purpose was unspecified for 93% of forest plantation areas.

Leaders in Forest Plantation Development (Top Ten Countries by Area)

The ten largest forest plantation development countries by present reported plantation area are: China, 24%; India, 17%; Russia, 9%; USA, 9%; Japan, 6%; Indonesia, 5%; Brazil, 3%; Thailand, 3%; Ukraine, 2% and Iran, 1%; which account for 79% of the global forest plantation development area. Within the top ten, over 56% of global forest plantations are in the Asia region.

Table 3: Plantation Purpose and Ownership by Reported Area for the Ten Largest Plantation Development Countries

Country	Total Area		Industrial Purpose (000) ha				Non-Industrial Purpose (000) ha					Purpose
	(000 ha)	Public	Private	Other	Unspec'd	Sub-Tot	Public	Private	Other	Unspec'd	Sub-Tot	
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	-
Russia	17,340	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	17,340.0
USA	16,238	1,185	15,053	-	-	16,238	-	-	-	-	-	-
Japan	10,682	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	10,682.0
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	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4,425
Iran	2,284	241	-	-	-	241	1,938	105	-	-	2,043	-
Top 10 Tot	148,403	25,247	20,344	31,796	-	77,387	14,987	15,037	8,545	-	38,569	32,447.0
Top 10 (%)	79%					87%					80%	66%
World Tot.	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

Within the top ten, an estimated 52% of forest plantations are grown for industrial purposes to supply raw material for industry; 26% for non-industrial uses (fuelwood, soil and water protection, biodiversity conservation); and the purpose was not specified in 22%, particularly in Russia, Japan and the Ukraine. The industrial forest estate, where specified in these top ten countries was owned publicly, 33%; privately, 26%; and other or unspecified, 41%. The non-industrial estate, where specified in these top ten countries was owned publicly, 39%; privately, 39%; and other or unspecified, 22%.

The countries with major industrial plantation areas (expressed as a % of national forest plantation area) include: USA, 100%, China, 83%; and India, 37%. These three countries account for 73% of all industrial forest plantations globally.

The countries with major proportions of non-industrial plantation areas include: Thailand, 76%; India, 63%; Indonesia, 42%; and China, 17%. These four countries account for 75% of all non-industrial forest plantations globally.

Global Trends, 1980-2000:

Comparisons

The geographic (national and regional), economic (developed and developing), eco-floristic (tropical and non-tropical) stratification and bases of the global forest resources assessment of forest plantations have varied markedly between FRA 1980, 1990 and 2000 global syntheses. Significant forest plantation data additions to FRA 2000 for the first time include:

- (a) Developed countries (Europe, CIS, North America, Australia, Japan and New Zealand); and

(b) Expanded forest plantation species list, including Hevea (rubber) and "non-forest" plantation species (oil palm, coconut palm, bamboo).

However, the FRA results from each decade allow comparisons of planting rates, species groups, areas and purpose (end-use).

Global Forest Plantation

The global forest plantation estate has increased markedly from 17.8 million hectares in 1980; 43.6 million hectares in 1990 to 187 million hectares in 2000 (table 5).

Table 4: Forest Plantation Species Trends by Regions from 1980-2000

Region	Plantation area by species group (%)							
	Total Plantation	Acacia	Eucalyptus	Tectona	Other Broadleaf	Pinus	Other Conifer	Unspecified
2000:								
Africa	100	4	22	3	11	21	7	32
Asia	100	7	9	5	27	13	17	21
Oceania	100	0	1	0	3	2	0	93
Europe	100	0	0	0	0	0	0	100
North & Central America	100	0	1	0	2	88	1	8
South America	100	0	46	0	6	45	1	2
1990								
Africa	100	10	28	5	0	23	0	34
Asia	100	10	16	6	0	4	0	64
Oceania	100	0	5	3	0	31	0	61
North & Central America	100	0	13	2	0	44	0	41
South America	100	0	50	0	0	5	0	45
1980								
Africa	100	6	28	7	0	14	0	45
Asia	100	0	1	3	0	2	0	94
Oceania	100	0	21	16	0	23	0	40
Europe								
North & Central America	100	0	0	0	0	0	0	100
South America	100	0	0	0	0	0	0	100

Source: FRA 1980; 1990; 2000.

Although in 2000 there remained 26% unspecified purpose, industrial purpose increased from 39% in 1980, 36% in 1990 to 48% in 2000, with the significant increase in the last decade. There has been a corresponding decrease in non-industrial purpose forest plantations.

Table 5: Forest Plantation Purpose Trends by Regions, 1980-2000

Region	Plantation Area by Purpose (000 ha)			
	Total	Industrial	Non-industrial	Unspecified
2000				
Africa	8036	3392	3273	1371
Asia	115847	58803	43662	13381
Oceania	3201	189	24	2987
Europe	32015	569	15	31431
North & Central America	17533	16775	471	287
South America	10455	9446	1004	6
GLOBAL TOTAL	187087	89175	48449	49463
1990				
Africa	2990	1366	1623	
Asia	31775	8991	23119	
Oceania	189	167	22	
Europe				
North & Central America	691	457	234	
South America	7946	4645	3301	
GLOBAL TOTAL	43590	15625	28300	
1980				
Africa	1713	939	780	
Asia	11088	3487	7601	
Oceania	88	41	47	
Europe				
North & Central America	287	272	15	
South America	4604	2261	2348	
GLOBAL TOTAL	17779	7000	10791	

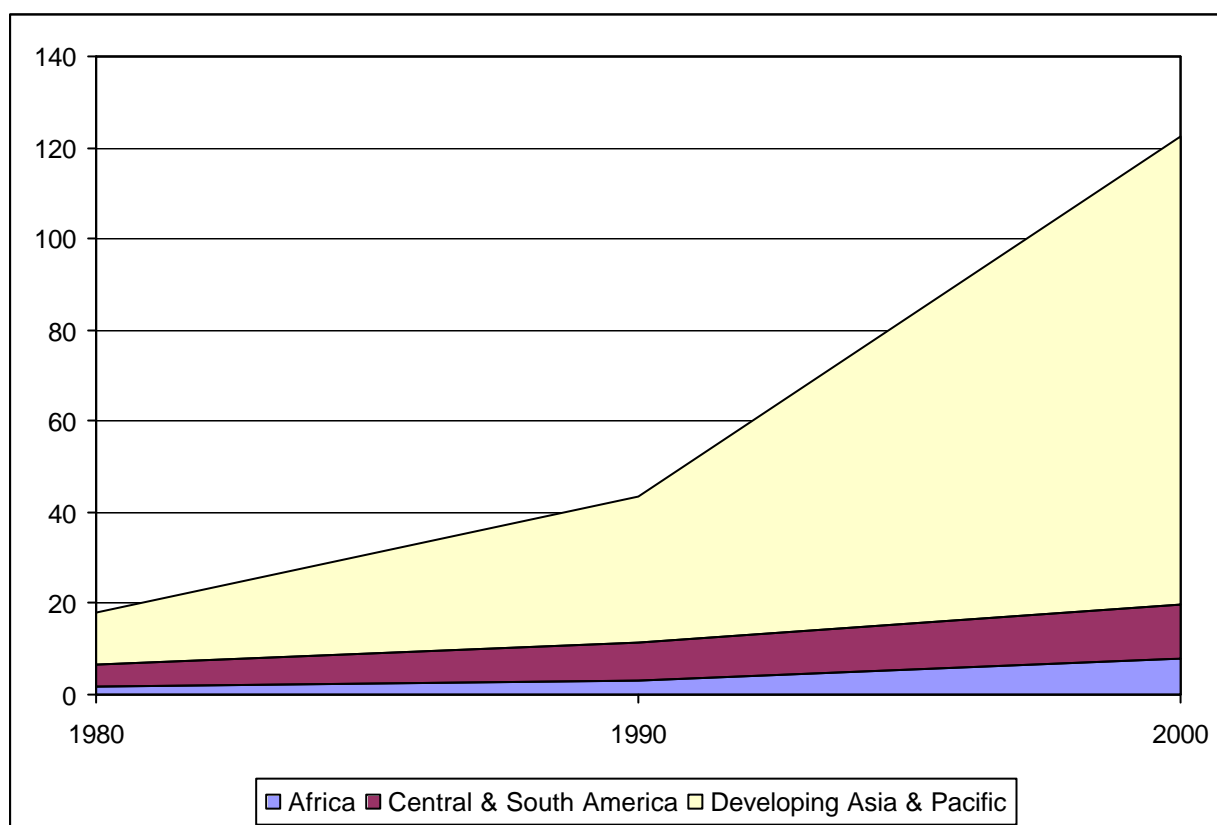
Source: FRA 1980, 1990; 2000

Developing Country Forest Plantation Areas by Major Regions

A comparison of forest plantation areas in developing countries in 1980, 1990 and 2000 is given in Figure 1. The total area of forest plantations has increased from 17.8 million ha in 1980 to 122.9 million ha in 2000. Thus, the current area of forest plantations in developing countries is just seven times greater than in 1980.

Countries regarded as developing by FRA 2000 are located in: Africa; Asia (except Japan, Israel, Russia and other former USSR countries); Oceania (except Australia and New Zealand); South and Central America (including Caribbean and excluding Canada and USA).

Figure 1 *The forest plantation area in developing regions 1980 - 2000*



Source: FRA 1980; 1990; 2000

The figure above also shows the overwhelming predominance of forest plantations in developing countries in the Asia-Pacific region (Asia and Oceania). In 1980, forest plantations in the Asia-Pacific region accounted for about 80 percent of the total forest plantation area in developing countries. By 2000, this share had increased to just under 85 percent. The area of forest plantations in developing countries in Oceania is very small (currently about 3.2 million ha) so the majority of these plantations are found in Asia. In contrast, developing countries in Central and South America currently have about 28 million ha of forest plantations and the figure for Africa is only 8 million ha.

In particular, three Asian countries (China, India and Indonesia) account for over 70 percent of the total area of forest plantations in developing countries. China currently has the largest area of forest plantations in the world, at about 45 million ha. This compares with a figure of only 20 million ha in 1980. The area of forest plantations in India has increased even more dramatically, from only 4.5 million ha in 1980 to 33 million ha in 2000. Indonesia's forest plantation area has increased from 4 million ha in 1980 to 10 million ha in 2000.

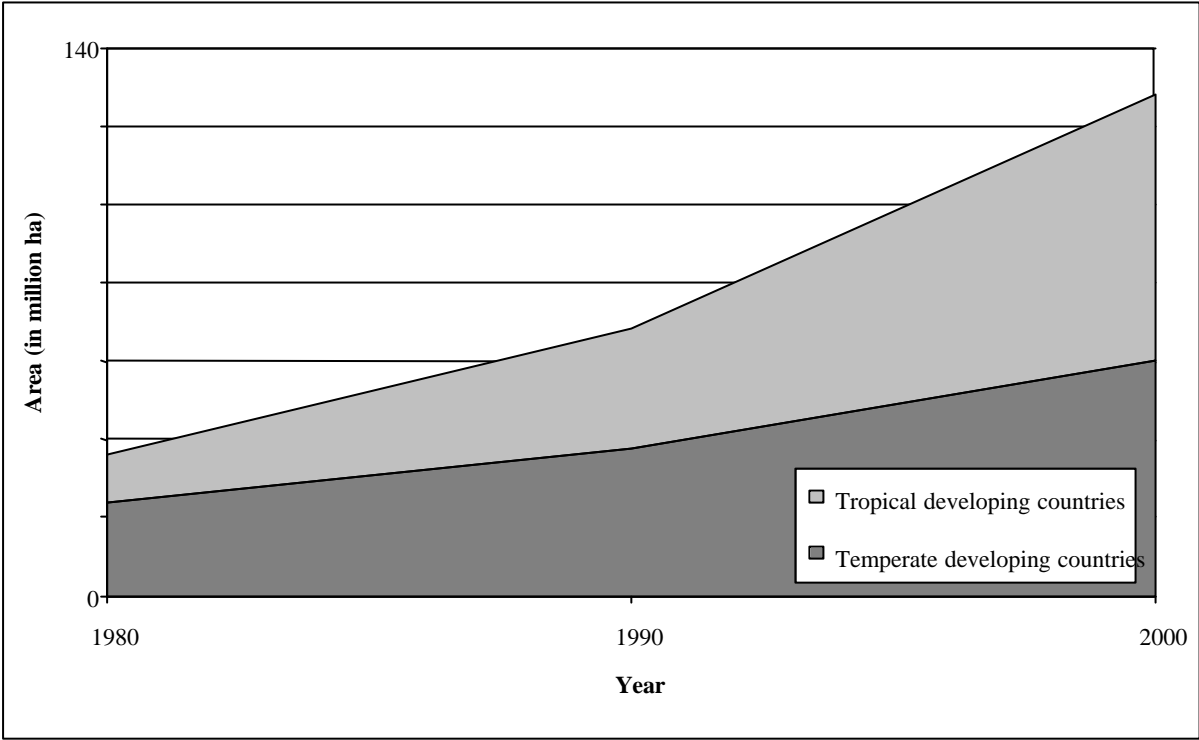
Tropical and Temperate Developing Countries

The temperate and tropical split is that used in SOFO 1997 and 1999 (i.e. temperate includes countries of Northern Asia, Southern South America and Northern and Southern Africa – all other developing countries are tropical).

Figure 2 compares the trends in forest plantation areas between tropical developing countries and temperate developing countries. In 1980, the majority of forest plantations in developing countries could be found in temperate countries (in particular China, which accounted for almost all of the area in temperate countries and 56 percent of the total). However, the area of forest plantations in tropical developing countries has increased much more than in temperate developing countries, particularly in

the last decade. The result of this has been that a little over half of the total forest plantation area in developing countries can now be found in tropical countries. Again, India and Indonesia account for a large share of this growth in tropical countries.

Figure 2 *The forest plantation area in tropical and temperate developing countries 1980 - 2000*

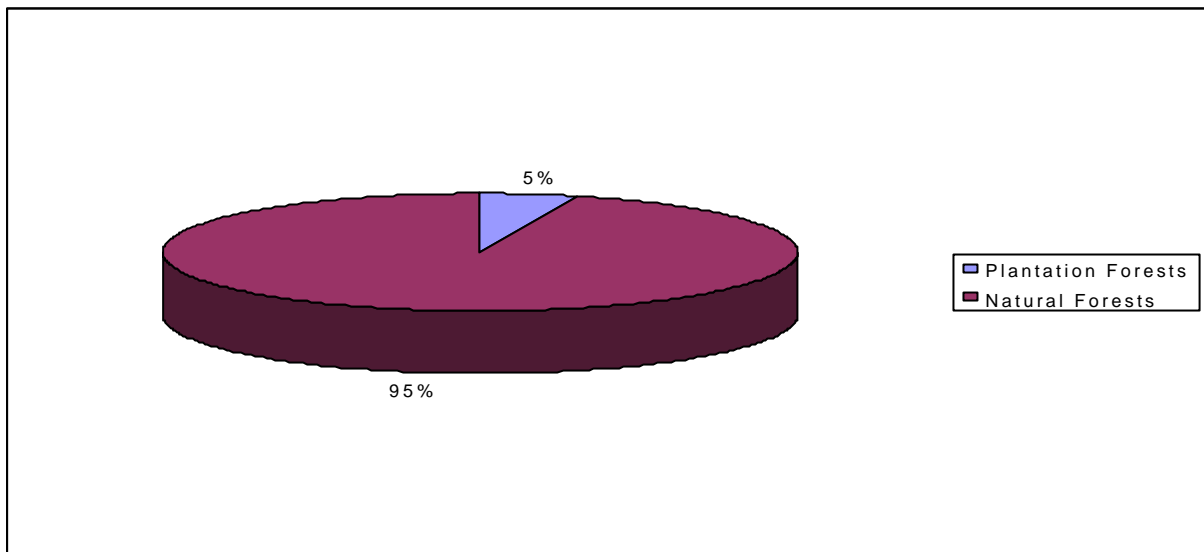


Source: FRA 1980; 1990; 2000

Impact of the Forest Plantation Estate

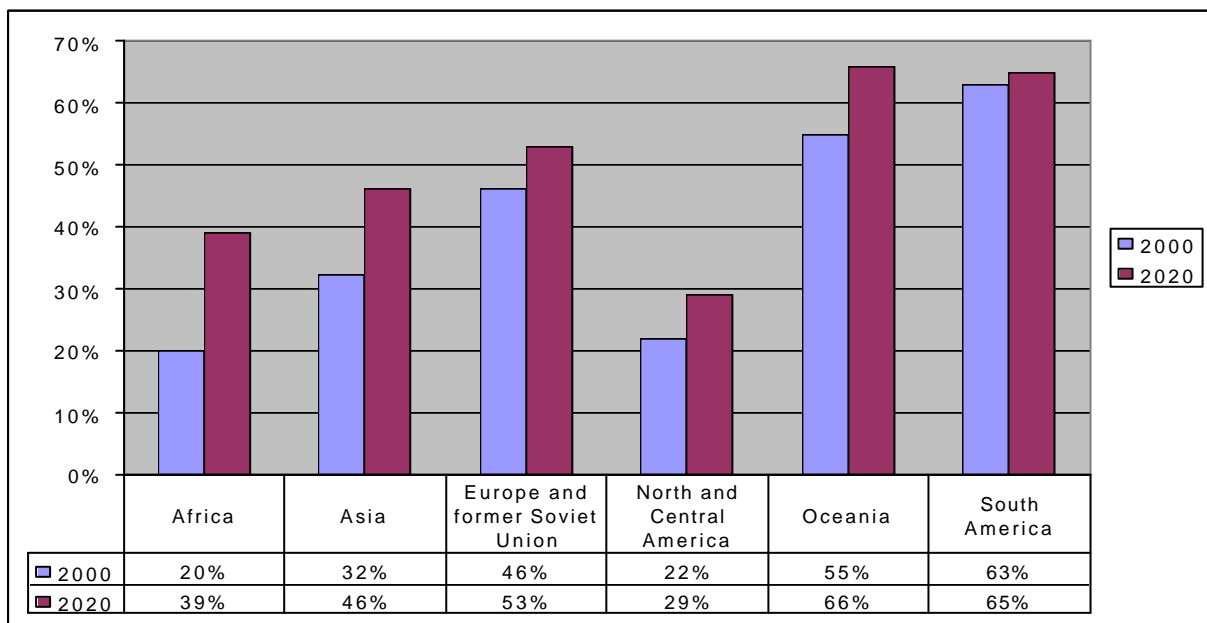
The potential for forest plantations to partially meet demand from natural forests for wood and fibre for industrial uses is increasing. According to FRA 2000, global forest plantation area accounts for only 5% of global forest cover and the industrial forest plantation estate for less than 3%. Forest plantations were estimated in the year 2000 to supply about 35% of global roundwood, with anticipated increase to 44% by 2020 (Jaakko Pöyry, 1999). If targeted at the most appropriate ecological zones and 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 forests resources. Forest plantations in New Zealand met 99% of the needs for industrial roundwood in the country in 1997; the corresponding figure in Chile was 84%, Brazil, 62% and Zambia and Zimbabwe, 50% 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.

Figure 3. Plantations Forest Area Compared to Natural Forest Area



Source: FRA 2000

Figure 4. Predicted Contribution of Plantation Wood to Regional Wood Supply



Source: Jaakko Pöyry 1999

Forest plantations provide additional non-wood forest products, from the tree planted or from other elements of the ecosystem they help to create. They also represent values enhancing environmental, social and economic benefits. Forest plantations are used in combatting desertification, protecting biodiversity, absorbing carbon to offset carbon emissions, protecting soil and water values, rehabilitating lands exhausted from other land-uses, providing rural employment, and if planned effectively, diversifying the rural landscape. They may also provide amenities, and repositories of cultural values.

Select Forest Plantation Technical Issues:

Reliable and consistent data is 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 outturn. In addition to the lack of quantitative data, the poor quality of the available information is a major impediment to policy-making in this field. There is a need to improve the reliability and timeliness of forest plantation data. FAO will continue to support member 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.

Land availability and land tenure is one of the most important social issues related to forest plantation establishment. 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. FAO is assisting developing countries to review the role of forest plantations and facilitating factors for investment in this land-use.

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.

Environmental considerations related to forest plantations include the maintenance of the productive potential of the site. These can be promoted through the development of silvicultural techniques and forest management practices that reduce soil erosion, conserve water, maintain soil fertility (including maintaining fertility in the second and subsequent plantation rotations). Appropriate forest plantation management techniques can also favour the maintenance of biological diversity. The protection of forest plantations from fire, insects and disease is critical. FAO provides policy, planning, management and monitoring support and guidelines to maintain productivity and maximize environmental benefits.

FAO will continue to monitor experiences with mixed species plantations. Such forest plantations may provide a larger range of products and provide “insurance” against unfavourable market conditions, reduce the effects and economic consequences of insect and disease attacks, contain the spread of wildfires, and provide greater variety and aesthetic value in the landscape.

Particularly in SE Asia, wood supply difficulties, has led to the utilisation of woody or fibrous species which are not traditionally considered “forestry” species such as rubberwood, and stems and leaves of oil and coconut palms. This trend is expected to continue and consequences and implications will be monitored by FAO.

The concept of mitigating global climate change through forestry has gained considerable impetus in recent years. Increasing the amount or rate of carbon accumulation by creating or enhancing carbon sinks (carbon sequestration) could offer an option towards the strategic management of forest carbon. Estimates taking into account land availability for afforestation/reforestation indicate that these activities could reasonably absorb about 0.28 billion tonnes carbon per year, and agroforestry could absorb 0.04 billion tonnes carbon per year. Careful selection of project sites is a critical factor.

Conclusions

For reasons already outlined, it is difficult to compare directly between FRA 1990 and FRA 2000. However, it is apparent that:

- (a) New forest plantation areas are increasing globally at the rate of 4.5 million hectares per year;
- (b) Asia and South America account for more new plantation development than other regions;
- (c) The Asian region has the largest areas in forest plantation development;
- (d) Broadleaf species account for 40%; coniferous species, 31% and unspecified species, 29%;
- (e) Unspecified species, purpose and ownership remain too high for accurate analysis;
- (f) Industrial plantations account for 48%, non-industrial, 26% and unspecified, 26% of the global forest plantation estate;
- (g) Industrial plantation resources are dominated by China, India and USA;
- (h) Non-industrial plantation resources are dominated by China, India, Thailand and Indonesia;
- (i) Forest plantation ownership in both industrial and non-industrial plantations is evenly balanced between public and private;
- (j) Developing country forest plantations have increased by 7 fold-factor between 1980-2000;
- (k) Over half the total forest plantation area in developing countries is in tropical countries;
- (l) Forest plantations provide a critical substitute for raw material supply from natural forests;
- (m) Forest plantations provide critical environmental, social and economic benefits

Detailed FRA 2000 reporting on forest resources, including forest plantation descriptions and areas by country, region, species, purpose and ownership together with references are available on www.fao.org/forestry/fo/country/nav_world.jsp and www.fao.org/forestry/fo/fra/index.jsp.

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