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Brazil: A Country Profile of the Forests and Forest Industries

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TABLE OF CONTENTS

LIST OF MAPS

LIST OF TABLES

CHAPTER V.

CHAPTER VII.

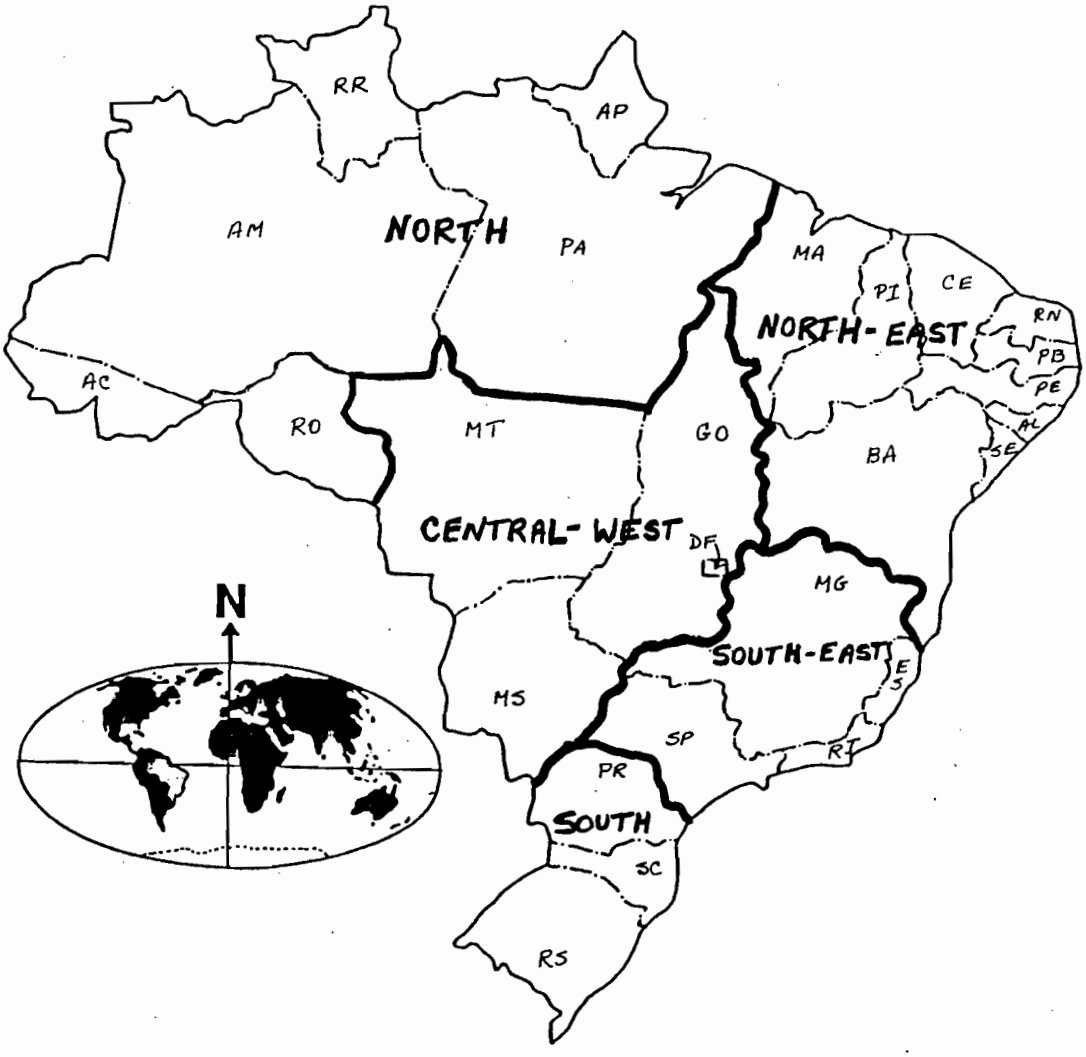
LIST OF APPENDICES

MAPS

Map 1. Brazil - Political Boundaries

SOURCE: U.S. Dept. Commerce (1985).

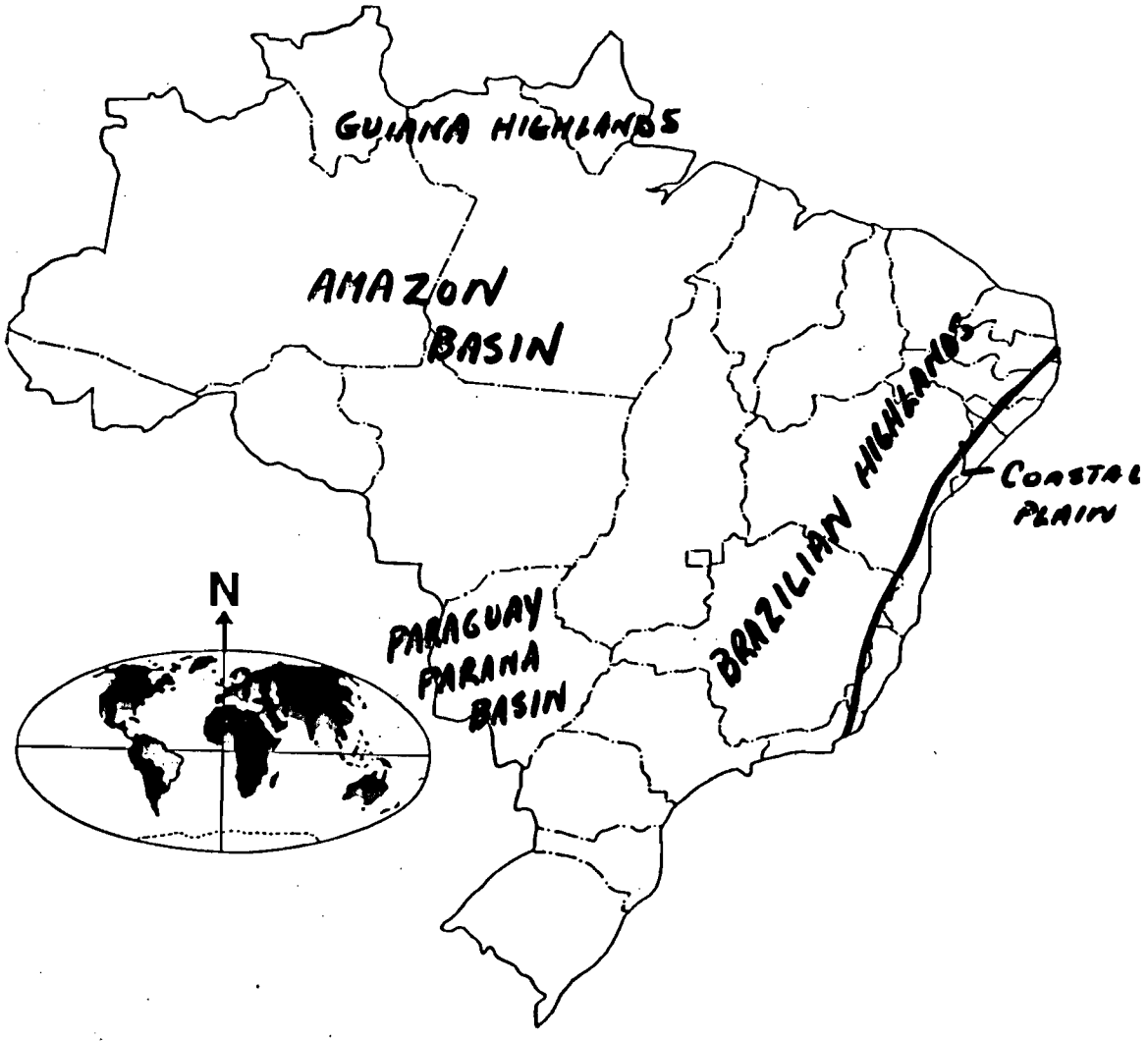
Map 2. Brazil - Geographical Regions



SOURCE: Momsen, R.P. (1968).

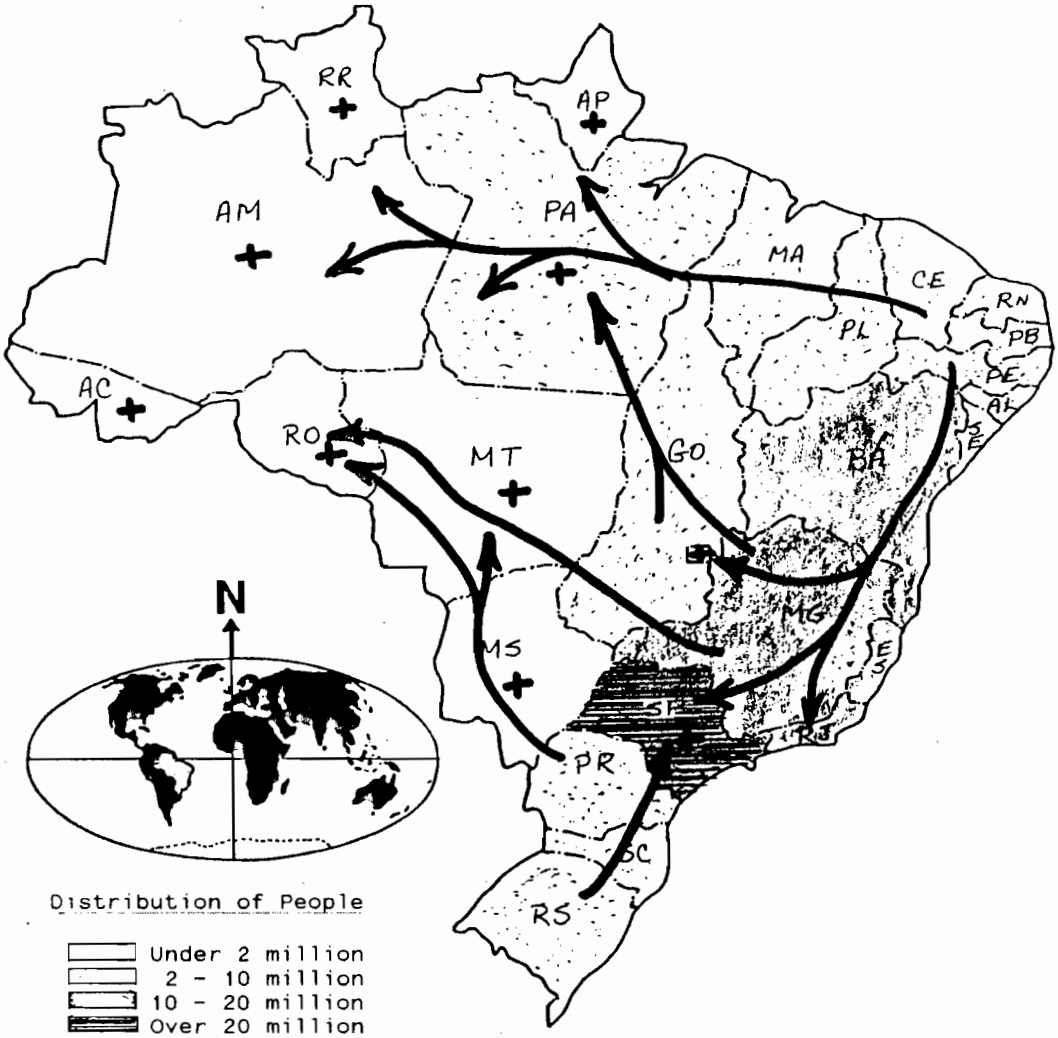
(Initials stand for state names; see Map 1.)

Map 3. Brazil - Topographical Regions



SOURCE: Momsen, R.P. (1968).

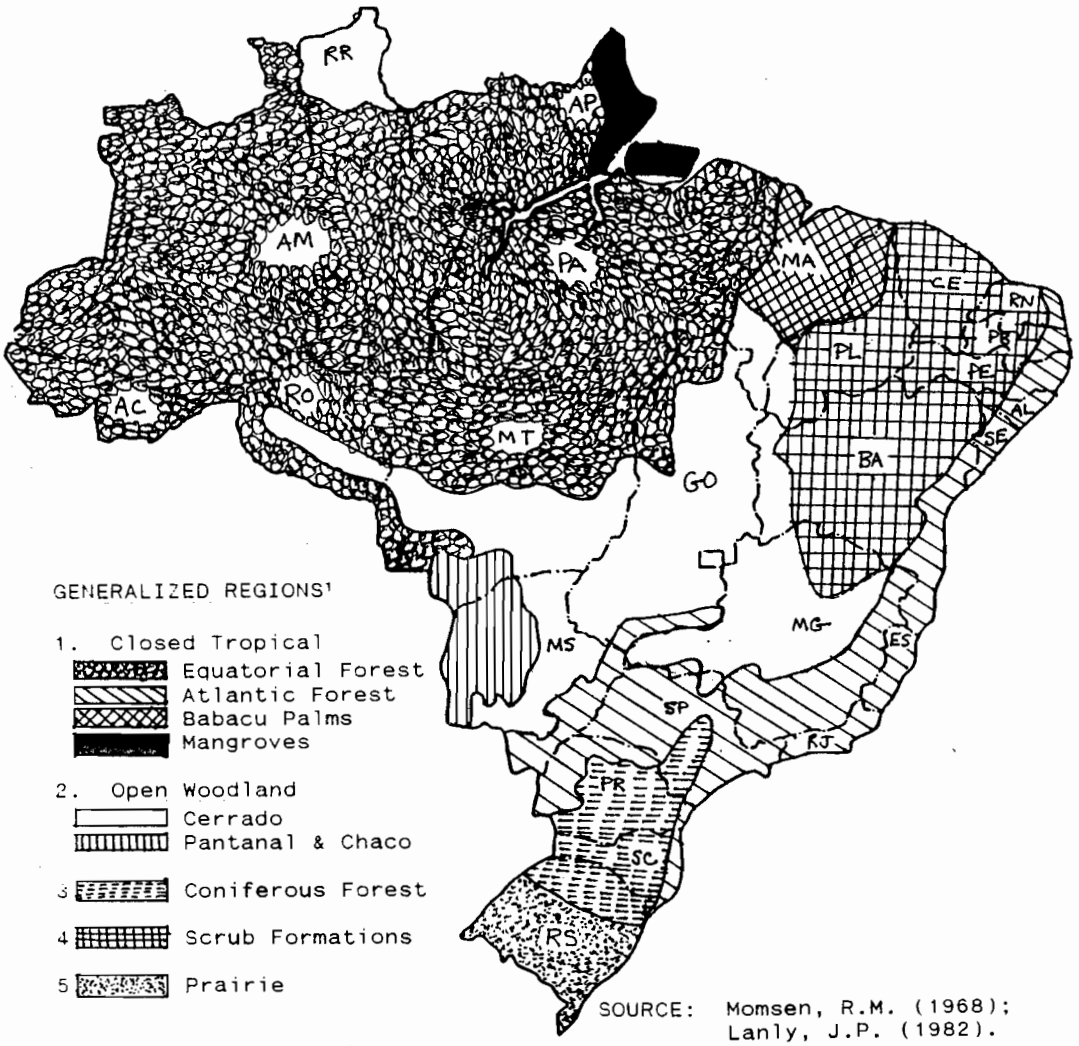
Map 4. Brazil - Population Distribution and Movements



SOURCE: Vesilind, P.J. (1987).

(Initials stand for state names; see Map 1.)

Map 5. Brazil - Vegetative Types



SOURCE: Momsen, R.M. (1968); Lanly, J.P. (1982).

(Initials stand for state names see Map 1.).

500 MILES
500 KILOMETERS

¹ These generalized regions are compiled from a map showing vegetation types (Momsen, 1968) and from the written description of forest land types (Lanly, 1982). Portions of the regions have been cleared, mainly for agricultural development, but the actual locations of the clearings are difficult to determine.

CHAPTER I. INTRODUCTION

Brazil has one of the larger natural forest areas of the world yet, historically, the level of development of the forest industry has been relatively low. More recently, however, there has been significant growth in the pulp and paper sector. This has been largely as a result of the government's positive support and emphasis on the development of this industry. Fiscal incentives have encouraged the establishment of large areas of plantation strategically located near industrial centers. Such programs have enabled Brazil, formerly a large importer of pulp and paper, to become close to self sufficient in these products and moreover a major world exporter of pulp. Brazil is certainly in an interesting and increasingly significant position *vis-a-vis* the global forest industry situation.

The objective of the present paper is to provide an in-depth review of the literature and data pertaining to the forest resource and forest industry of Brazil. The first chapter gives a general orientation to the country, then follows a detailed description of the forest resource and the three important sectors of the forest industry: the solid wood sector, the pulp and paper sector, and the energy wood sector.

The numerous sources of both literature and data examined included: international symposia, current periodicals, trade journals, newspapers featuring business and economics, Brazilian papers and government documents, and United Nations' publications. Wherever possible, Brazilian sources were used to report the various statistics for production and trade of forest products. The "Relatorio Estatistico" publication of Associacao Nacional dos Fabricantes de Papel e Celulose (The National Association of Pulp and Paper Industries) provided most of the data for the pulp and paper sector. For the solid wood sector, values represent combined statistics from the Brazilian Institute for Forestry Development (IBDF) and Foreign Trade Department (CACEX), the U.S. Dept.of Agriculture, Foreign Agriculture Service Wood Market Reports and Forest Products Annuals (attache reports from the American embassy in Brazil), and the FAO Yearbook of Forest Products provided the majority of the data. The Brazilian Association of Charcoal's "Anuario Estatistico" supplied much of the statistics for the energy wood sector. Conflicts within and between the various data sources are pointed out within the text wherever deemed relevant.

To aid the reader, a list of Brazilian institutions, and their respective acronyms is provided (Appendix III-9).

CHAPTER II. GENERAL COUNTRY DATA[1]

1. PHYSICAL DESCRIPTION

1.1 Location and Total Area

Brazil is an immense country covering the east-central two-thirds of South America between parallels 50° 16′ 19" latitude North and 330° 45′32" West. Its total area is 851 million ha (8.5 million km^2) making it the fifth largest country in the world. Brazil is a Federal Republic comprised of 24 States, 2 Federal Territories and the Federal District where Brasilia, the capital, is located (see Map 1). These 27 political divisions are grouped into five geographical regions by common physical, human and economic characteristics (see Map 2).

1.2 Topography, Climate and Resources[2]

The land surface of Brazil is generally flat with the higher elevations primarily located near the borders giving the country a bowl-like overall shape. There are five major topographic regions which correspond roughly to the above-mentioned political regional divisions (see Map 3). The most important of these in terms of physical size is the Amazon basin which covers one third (2.8 million km^2) of the total land area.[3] This lowland region is the least populated, the least exploited and is primarily covered in lush, tropical rain forests. The Guiana Highlands, located north of the Amazon, form Brazil's northern border with peaks to above 2,500 meters. The Brazilian Highlands (East-Central) also contain some of the higher peaks interspersed with rolling hills. Here a mixture of dry scrub, tropical deciduous and araucaria pine vegetation are found. These highlands separate Amazon and the Coastal Plain. This eastern strip along the Atlantic Ocean is the highest populated area and thus has the largest portion of converted forest. The Parana/Paraguay Basin (Panatal Matogrossense), in the South-West is a low-lying area which is periodically flooded. A sixth, smaller topographical area is located in the northeast tip of Brazil. This semi-arid region, with its characteristic drought-resistant vegetation, is the most economically depressed region in Brazil.

Approximately 90% of the country lies within the hot and humid equatorial zone. The climate is accordingly tropical with moderate to heavy rainfall; up to 3,000 mm or more per year fall in some northern Amazonian regions. The mountainous regions and southern portion of the country receive more moderate rainfall and are characterized by a temperate climate; freezing temperatures occur in the southern-most states.

Brazil is rich in mineral reserves possessing large quantities of iron ore, gold, manganese, copper and bauxite. Though poor in energy sources such as coal and oil, Brazil holds abundant alternative energy sources in the form of water and wood energy. Indeed, the hydroelectric potential of Brazil exceeds the energy equivalent of all the oil reserves in the Middle East (Foster, 1986).

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1 This section is based upon the following references:
1) The Economist Intelligence Unit Publicatons:
- Country Report -- Brazil, no.s 1,2 3, 1988
- Country Profile - Brazil, 1988/89, 1987/88, 1986/87
2) United States Department of State, Bureau of Public Affairs. Background Notes -- Brazil, Dec.1987.
3) U.S. Dept. of Commerce, International Marketing Information Series. Foreign Economic Trends and Their Implications for the United States. -- Brazil, July 1987 and Jan. 1989.
4) Inter-American Development Bank. 1988. Brazil - Economic Indicators. Economic and Social Progress in Latin America. U.S. Govt. Publ., Washington.
Further sources are referenced directly within the text.

2 The forest resources of Brazil are not discussed here as they will be described in detail in Chapter III.

3 Whereas the topographical area division (corresponding to the Brazilian portion of the Amazonian basin) covers the states of Para, Amazonas, Acre, Rondonia, Amapa and the federal territory of Roraima, the "Legal Amazon" also includes the state of Mato Grosso and parts of Goias and Maranhao (Vesilind, 1987).

2. HISTORICAL DESCRIPTION

2.1 Political Development

Before the Portugese "discovered" Brazil in 1500, the country was sparsely inhabitated by native Indians. After independence from Portugal was granted in 1822, Brazilian politics swung between popular government (in the form of a federal republic) and military dictatorship. This is illustrated in Table II-1.

Table II-1. Political Rule in Brazil: 1889 to present.

Time Period	Type of Political Rule
1989-1930	Loosely federated republic
1930-1945	Military dictator
1945-1961	Federal republic (more liberal)
1961-1964	Goulart rule characterized by high inflation rates, economic stagnation
March 31, 1964	Military coup
1964-1968	Military rule characterized by economic stabilization policies
1979-1985	Figueirdo rule characterized by "abertura" or political liberalization
1985	Elections for "New Republic" - Neves died before taking office, therefore
1985-present	Jose Sarney as president

SOURCE: U.S. Dept. of State (1987)

2.2 Economic Development

Early economic development in Brazil is characterized by single product cycles (Bethel et al., 1982). In the 16th and 17th centuries sugar was the dominant product; during the 18th century gold was number one. The twentieth century saw the beginning of industrialization especially after the 1930 military takeover. Despite the moves towards an industrial economy and urbanized society, Brazil still remained essentially an agricultural economy until intensified industrialization began in the 1950s.

3. ECONOMIC HISTORY (RECENT)

3.1 1950 to 1973

During the 1950s the GDP grew at approximately 6% per year. As stated in Table II-1., the Goulart popular rule was characterized by high inflation rates. After the coup in 1964, the military government concentrated on reducing inflation and increasing economic stability. By 1968, the economic situation was stable enough to warrant attention to expansion. For the years 1968-1973 GDP growth rate averaged 11% per year; it was this impressive growth expansion that earned Brazil the title of the "Economic Miracle" and put the country into the rank of a "Newly Industrialized Country" (Truitt, 1985). Unfortunately, the military government paid little attention to distribution of income and many people remained in poverty in spite of the huge economic growth.

3.2 1973 to 1985

After the first oil crisis in 1973, the government continued to sustain a moderated annual growth rate (averaging 6% per year from 1974-1980) through permissive international financing. It was during this period that the federal government initiated huge development projects such as hydroelectric energy generation. These contributed to the federal deficit and when the second oil crisis struck in 1979, Brazil had already accumulated a foreign debt of nearly $70 billion.

Being oil-poor, Brazil was thus forced to import high-priced oil; this happening at a time when prices of their own agriculture product exports were dropping, leading to a balance of payments deficit. Credit terms, relatively generous during the first oil crisis, tightened with the sharp increase in international interest rates. As a result, Brazil's overall debt and interest payments increased. Lowered revenues from exports together with increased debt resulted in upward spiraling debt service ratios. Annual inflation rates also skyrocketed from 40% in 1978 to a record 235% in 1985.

3.3 February to November 1986

The Cruzado Plan or "Economic Stabilization Plan" was decreed in February 1986 as the newly-elected president Sarney's solution for controlling inflation. Prices, wages, rents and mortages were frozen, and the currency was revised by dividing through by 1000 and changing the name from cruzeiro to cruzado. Unfortunately the plan collapsed in November; the aftermath saw unprecedented inflation rates (~350%).

4. GENERAL ECONOMIC CHARACTERISTICS

4.1 Economic Overview

Brazil has the eighth largest economy in the world, up from 48th twenty years ago (Foster, 1986). The nominal gross domestic product (GDP) was $US 385 billion in 1988, $60 billion more than in 1987. Nominal per capita GDP grew from $2,224 in 1987 to $2,666 in 1988. Real GDP growth, averaging 1.3% per year between 1980 and 1983, increased to an average of 6.8% from 1984 to 1986. However, it dropped drastically to 2.9% in 1987 and down to less than 1% in 1988. This drop is reflective of the high inflation rates in the Brazilian currency.

Consumer price index rose from 65% in 1986 to 365.9% in 1987 and up to an unprecedented rate of 934% for 1988. For the average Brazilian, such an inflation rate means worthless bank accounts and drastically reduced spending power. The cruzado (Cz), created in 1986 (see previous discussion in section 3), exchange rate grew from 36.7 Cz per American dollar in 1987, to 264.3 Cz/$ in 1988.

4.2 Debt

Brazil accumulated a large foreign debt over the seventies and early eighties when the government relied on external financing to sustain economic growth. As a result, today Brazil has the largest foreign debt of all developing countries: between $110 and $120 billion. The servicing of such a huge debt requires interest payments amounting to a major portion of Brazil's balance of trade. Debt rescheduling in September 1988 provided some relief to this situation.

4.3 Production

Brazil now has the seventh largest industrial production in the world (WSJ, 1989) and therefore a labor base consisting of numerous highly skilled people. Brazil's high rank among the industrialized world demonstrates the shift from agricultural to industrial production. Industrial development, up until recently, has been concentrated in the southeastern states of Rio de Janeiro, Sao Paulo, Parana, and Rio Grande do Sul but is now expanding north- and west-ward.

Industrial production ranges from basic industries such as steel, chemicals and petro-chemicals to finished consumer goods and high technical equipment. Brazilian products have a reputation of being of high quality and thus are traded throughout the world. For example, Embraer, a Brazilian aircraft company, competes sucessfully in world markets with its turbo-propelled aircraft (Truitt, 1985). Brazil is the third leading producer of hydroelectric energy and sixth largest steel producer in the world (Foster, 1986).

Brazil is still very strong in agricultural production, second only to the United States. The country is self-sufficient in every agricultural product except wheat. It ranks number one in the world for coffee production and number two for soya beans and cocoa. Other major agricultural products include: sisal, sugar, meat, cotton and orange juice concentrate. Another important agriculture product is sugar cane much of which is used to produce ethyl alcohol to help fuel Brazil's vehicles.

The production structure of the economy is divided into three categories as illustrated in Table II-2. The agricultural sector has decreased both in terms of percent share of GDP and percent total growth; the ser-

vices sector, on the other hand, has increased claim of GDP (6% increase) while substantially decreasing its percent annual growth.

Table II-2. Production Structure of Brazil's Economy.

YEAR	1965	1985	1965-80	1980-85
Agricultural GDP				
as % of GDP	19	13		
% annual growth			4.7	3.0
Industrial GDP				
as % of GDP	33	33		
% annual growth			10.0	0.3
Services GDP				
as % of GDP	48	48		
% annual growth			9.4	1.8

SOURCE: Economist Intelligence Unit (1988/89).

4.4 Trade

4.41 Trade Balance. The years since 1982 have witnessed a growing trade surplus in Brazil (see Table II-3.). In 1988, the paramount surplus reached $19 billion, well over the most optimistic earlier offical projection (WSJ, 1989). The projected figure for 1989 is $US 11 billion. The large trade surpluses, especially from 1984 to the present were achieved through increased exports of manufactured goods, lower oil prices plus some containment of imports.

Table II-3. Trade Balance in Brazil: 1977 to 1988 (in million $US).

YEAR	1977..1982	1983	1984	1985	1986	1987	1988
Imports	13257 21069	16801	15210	14332	14045	15061	14692
Exports	12120 20213	21899	27005	25639	22376	26225	33781
BALANCE	-1137 -856	+5098	+11795	+11307	+8331	+11164	+19089

(Imports are CIF and exports are FOB).

SOURCE: UN Stats (1989b) and WSJ (1989).

4.42 Exports and Imports Exports boomed in 1988 reaching a record total of $33.8 billion as the internal market continued depressed. There are two major categories of exports from Brazil: commodities consisting of items such as coffee, soya products and iron ore; and industrial products such as manufactured steel and iron, transportation equipment, processed coffee, concentrated orange juice and footwear.

Brazilian exports exhibit an increasing selection and breadth of goods with increased industrial exports. Industrial products made up 71.3% of the exports in 1988 versus 63.1% in 1987 (WSJ, 1989). Not only do these industrial exports help to boost the trade surplus, they also assist in protecting the country from the international price fluctuations associated with commodities and other primary goods. Also apparent is the increased exports of value-added products as demonstrated in the two largest exports, steel and transportation equipment (see TableII-4).

In addition to this increasing breadth of export goods, Brazil's markets are also broadening. In 1988, exports to the European Community (EC) exceeded those to the U.S. (WSJ, 1989). The EC accounted for 27.7% of all exports in 1988 versus the 25.8% sent to the United States. The $9.3 billion worth of exports to the EC in 1988 represents an increase of 35% over the value in 1987 whereas the $8.7 billion worth of exports to the U.S. represents an increase of only 19% over 1987 figures. Other destinations of exported goods include Asia, Latin America and the Middle East.

Brazil is less dependent on imports than most nations in the world (U.S.Trade Rep., 1986). Fuel materials rank among the top imported items as indicated in Table II-4. The country's imports may be categorized by capital goods (for example, electrical machinery), intermediate products (fuel and lubricants) and consumer goods. The main sources of imports were, for 1987: U.S.(21.2%), OPEC nations (15.3%), Europe (13.7%), Japan (5.6%) and Argentina (3.9%).

Table II-4. Brazil's Major Exports and Imports: 1988 & 1987.

Category	1988	1987
EXPORTS ($billion)		
1. **Industrial**		
Steel	4.00	–
Transportation	3.18	2.76
2. **Commodities**		
Soy Products	3.05	2.34
Coffee	2.23	2.19
Orange Juice	1.14	.83
IMPORTS ($million FOB) (not avail. for 1988)		
1. **Fuel**		
Crude oil & derivatives	–	4,123
Coal	–	850
2. **Capital Goods**	–	3,958
3. **Chemical Products**	–	1,830
4. **Wheat**	–	250

* This item had higher tonnage exports in 1987 but world prices were lower than in 1988.

SOURCE: Exports - WSJ (1989)
Imports - U.S.Dept.Comm. (1989).

4.43 Trading Policy Brazilian trading policy is guided by the "Law of Similars" and the "Market Reserve Policy" (U.S.Trade Rep., 1986). The former policy means that Brazil can withhold import licenses for any product that is produced in Brazil. The latter policy results in import exclusion from certain market sectors. A number of trade barriers are employed to help protect the economy: lack of intellectual protection, high tariffs, quantitative restrictions and import licensing[1] are among the most important.

4.44 U.S. - Brazil Trade Disputes Several trade desputes between the United States and Brazil have errupted over Brazil's restrictive trade policy and lack of intellectual protection. Recent disagreements related to the informatics and the pharmaceutical industries. Inadequate intellectual property legislation and the two subsequent Section 301 investigations have resulted in the U.S. black-listing Brazil, along with Japan and Mexico, in the Super 301 trade bill of May, 1989, which imposed trade sanctions on these countries ((WSJ, 1989).

4.5 Investment

4.51 Overview Net foreign investment, after declining for several years, is rising again spurred in part by the government's successful debt conversion plan. Although as yet unconfirmed, total investments are expected to be $3 billion in 1988 (WSJ, 1989). The rise in new foreign investment began in 1987 when investors responded to the renewed 6.8% real increases in GDP from 1984 to 1986. They were not deterred by low GDP increases in the next two years, believing rather in the enormous potential of Brazil.

1 An import license is required for virtually all imports to Brazil (U.S. Trade Rep., 1986).

Business transactions are often frustrated by the profusion of bureaucratic agencies with their myriad of rules and regulations and hampered by the enormous inflation rates and resultant variety of government policies put forward to fight this inflation. However, the large economy, abundant hydoelectric capacity, efficient telecommunications network and ever-growing variety of high quality, locally produced capital goods contribute positively to business operations (WSJ, 1989).

4.52 Foreign Investment Policies While foreign capital input was strongly encourged during the military regime (1964 to 1985), the current democratic government follows a "market reserve" policy similar to that followed for imports (USDC, 1985b). Particular market sectors have been identified as "sensitive," that is, are considered to be essential to national development. These areas are thus reserved for Brazilians and include: coastal merchandise shipping and commercial air transportation; communication enterprises; computers, microelectronics and other forms of informatics; and financial institutions (WSJ, 1989). Recognizing the need to encourage inflow of foreign capital while, at the same time, realizing the importance to strengthen local private firms, the government looks for investments which will increase local value-added, create exports and result in an effective exchange of technology (Jackson and Novak, 1985).

4.53 Debt-for-Equity and Debt-for-Nature Swaps Brazil eliminated over $6 billion of its foreign debt (appproximately 5% of the total) through debt conversion in the broad sense of the term (WSJ, 1989). Debts worth $3.6 billion were converted to equity at a discounted rate giving a net investment of $3 billion Debt conversion is an operation whereby the banks holding Brazil's public and private debts offer portions of this debt at a discounted rate to foreign investors. The central bank of Brazil then redeems the debt paying or issuing bonds in local currency. The debt is either recovered at face value of the original debt or a discounted rate determined through an auction. This money is then available for use in investment projects.

In recent years conservation groups have been buying debt in a similar manner and turning over the purchased bonds to local Brazilian environmental groups to finance conservation projects (Work and Smith, 1989). The debt-for-nature swap idea initially drew great support from world-wide groups. However, there is, understandably, a great reluctance on the part of the Brazilian government to allow a scheme which would jeopardize its ability to manage its own natural resources and "internationalize" the Amazon basin. In addition, the debt swaps tend, in general, to exacerbate inflation and merely postpone debt repayment.

5. POPULATION AND SOCIETY

5.1 Demographics

The results of a 1980 population census indicated a total of 121 million people; estimates for 1988 increase this figure to 144 million (UN Stats, 1989a). As such, Brazil's population makes up half that of South America (Foster, 1986). Current growth rates of 2.1% (average per year between 1970 and 1987) suggest that the country's populaton will be close to 200 million by the turn of the century. The population profile is weighted towards the younger age group; 47% of the population is under the age of twenty (Intl.Labor Off., 1987). Forty-two percent of the people are economically active.

The population is becoming increasingly urbanized; while 46% were urban dwellers in 1960, 59% in 1970, 75.8% were in 1986. In 1985, 21% of the population was concentrated in Brazil's nine top metropolitan areas with 10% of the population living in the top two: Sao Paulo (pop.= 10.1 million); and Rio de Janeiro (pop.= 5.6 million).

5.2 Brazilian Society

Four major groups make up the Brazilian population: the indigenous Indians; the Portugese who originally colonized the country; Africans brought to Brazil as slaves; and various European and oriental immigrant groups that have settled in Brazil since the mid-19th century. Immigrant groups include peoples from Italy, Germany, Spain, Japan, Poland and the Middle East. The largest group of Japanese people outside Japan reside in Brazil. The indigenous Indians, whose population constitutes less than 1% of Brazil's total, live primarily within reserves situated mainly along the western and northern borders and in the Amazon basin.

A history of strong national unity and pride has been encouraged by Brazil's common religion of Catholicism and the national language of Portugese (unique to South America). As a result, Brazil is characterized by overall cultural and national homogeneity along with political unity.

5.3 Income Distribution and Social Welfare

The constrast between wealth and poverty is very striking in Brazil. The country, with one of the world's most uneven distribution of income, is fighting a social deficit in terms of widespread poverty. When considering numbers for malnutrition, infant mortality or life expectancy, Brazil ranks among some of the poorest nations in the world (Foster, 1986).

Average life expectancy in Brazil is 62.8 years, infant mortality (average 1980 to 1985) is 70.7 per 1000 and the adult literacy rate is 68.7% (UN Stats, 1989a). Twenty-nine percent or 15.3 million of the country's active work force earn less than the official minimum wage of $58 per month (1986 figures). As a result, 64.7% of the Brazilian work force live in misery or poverty; misery is defined as below $58 monthly (Foster, 1986).

Disparity is particularly prevalent in the northeast region of the country where the per captia income is half that of the national average (Vesilind, 1987). Here infant mortality is very high with two in ten children dying before the age of one. Nearly half the people are illiterate and most are malnourished.

5.4 Population Movements

Recent population movements, as well as population distributions, are illustrated in Map 4. Beginning in the mid-1970's, the government, in an attempt to dispel the concentrations of the wretchedly poor living in slums on the fringe of major cities, built roads and created favorable conditions for the resettlement of people into the legal Amazon region. The Amazon, Brazil's "wild-west" frontier with vast, untapped resources and large land areas, has served as "an escape hatch for [the] densely populated southern areas" (Truitt, 1985) in these population resettlement programs.

One such program, Polonoroeste, involved the paving of the BR-364 highway which cuts deep into the state of Rondonia and the tropical forest (Ellis, 1987). After the completion of the paving in 1984, thousands of people followed the road to the promise of 100 ha of virgin forest granted to the new settlers. Unfortunately, the areas of fertile agriculture soil are limited. The soil in the remaining plots is of limited agricultural value; what few nutrients that did exist in the newly-cleared soil humus layer are generally exhausted after several years of farming.

As a result, the settlers tend to sell out to ranchers and other big land owners within five years after which they move on clearing new land which they claim as squatters. Violence erupts when the squatters are evicted by the landlords' representatives. In 1986, for example, at least 130 people died in this type of quarrel (Vesilind, 1986). Critics of the settlement programs cite the high failure rate, human misery and environmental cost as reasons for discontinuing them.

6. CURRENT AND FUTURE SITUATION

6.1 New Constitution and Up-coming Elections

The new constitution, promulgated on 5 October 1988, is one more step for Brazil in the process of strengthing its democracy. While there were previous constitutions which contained statements on individual liberties and separation of powers, these were rendered insignificant with virtually unbridled power assigned to the executive branch (WSJ, 1989). This constitution goes much further towards, among other aspects, the guarantee of individual rights. An election, to be held in November 1989, adds another step towards the solidification of Brazil's democracy.

6.2 New Economic Plan

A new economic plan, the so-called "Summer Plan," was decreed on 15 January 1989 (WSJ, 1989). Yet another in the series of economic plans to curb inflation, this plan has been hailed as the most complete to date. A new currency called the "cruzados novos" was created by, once again, removing three zeros from the end of the previous cruzado. Other moves included a 17% currency devaluation, price freezes, elimination of automatic monthly cost-of living increases and official indexing, and a temporary suspension of the debt conversion scheme. Also, in an attempt to reduce the public deficit, a number of federal employees were dismissed and many programs were cut. To prevent the surge of consumer demand that destroyed pre-

vious anti-inflation plans, the government agreed to pursue a tight monetary policy with high interest rates and restrictions on consumer credit.

6.3 Future

Brazil faces a number of challenges for the future. These include economic problems such as the very large foreign debt, very high inflation and interest rates. Although rich in natural resources, the country must continue rather high rates of economic growth just to stay even with debt servicing payments. Inflation must be controlled without slowing economic growth or reducing employment. Socio-economic problems, such as income disparities, lack of wide-spread quality public education and reduced employment for its growing labor force, also require attention. However, there is much optimism both from within Brazil and from without as reflected in positive flows of foreign investments into the country. Politically, the country is working to strengthen its new democracy as demonstrated by the new constitution.

7. ROLE OF FORESTRY IN THE ECONOMY

7.1 Contribution to GDP and Employment

The contribution of the total forestry output[1] to the national economy of Brazil was considered to be approximately 4% of GDP in 1987. Direct employment per year is approximately 60,000 jobs and indirect employment accounts for another 300,000 jobs (Rezende and Neves, 1988).

7.2 Contribution to Trade Balance

While forests cover a large proportion of the land area of Brazil, exported products from these forests have been less important directly to the economy of Brazil as forest products have constituted a rather small proportion of the total trade. In the period from 1974 to 1978, there was an overall deficit in the forest product trade sector (Bethel, et al., 1982). From 1978 on, however, there has been an increasing surplus and exports have made a positive contribution to Brazilian total trade. The percent contribution of forest products exports to total exports ranged from a low of 3.9% in 1985 to a high of 5.0% in 1986 (see Table II-5.).

Table II-5. Percent Contribution of Forest Products to Total Exports in Brazil: 1981-1986 (in million $US).

Year	Total Exports	Forest Products Exports	Percent Contribution
1981	23,293	1,073	4.6
1982	20,175	847	4.1
1983	21,899	978	4.4
1984	27,005	1,223	4.5
1985	25,639	991	3.9
1986	22,393	1,119	5.0

SOURCE: CACEX and IBDF (pers. comm. de Barros, 1989; original obtained in incomplete form).

What is perhaps of more importance is the contribution forest products have made in terms of indirect benefits to the trade balance. A serious obstacle to industrial expansion in Brazil has been the lack of a domestic supply of coal or oil energy source (Bethel et al., 1982). Consequently, the forest biomass is exploited as an energy substitute and extensive forest cutting for energy wood has taken place. The wood is either used directly as fuelwood or it is converted to charcoal, methanol or ethanol. The steel industry,

1 This includes a range of products from "basic" (brazil nuts, charcoal) to "manufactured" (palm-heart conserves, paper) products. See Chapt. IV for complete information.

shown previously to be Brazil's most important trade product, is a large user of charcoal. Forest products thus most importantly benefit the trade balance by their energy contribution to steel production.

7.3 Other Benefits to the Economy

Information on the total contribution of forests and forest products to Brazil's economy is not complete, as a number of forest products do not pass through the market system and their intangible contribution is difficult to valuate. These types of products include, among other things, construction material produced and used privately, food and shelter to many native people, the provision of energy through the use of privately-gathered firewood.

CHAPTER III. THE FOREST RESOURCE

1. GENERAL OVERVIEW

1.1 Total Forest Land Areas and Global Position.

The total forest land area of the world[1] is approximately 4,400 million ha (see Table III-1). According to a worldwide FAO survey of tropical forest resources coordinated by Jean-Paul Lanly (1982) and carried out between 1978 and 1981, the total global area of tropical closed forests is roughly 1,200 million ha or 27% of the overall world forest land area.

Table III-1. Forest Land Areas: World and Brazil.

Forest Land Area	World	Brazil	
		Total	Amazon
All Types			
million ha	4,400	681	–
% of world	–	15%	–
Tropical Closed			
million ha	1,200	356	332
% of world	–	30%	28%

SOURCE: Lanly (1982).

Based on Lanly's survey, Brazil holds approximately 681 million ha of forest land[2] or 15% of the total global forest land area. More significantly, however, over 50% of this land area is tropical closed forest. As depicted in Table III-1, Brazil has a total of 356 million ha of tropical closed forest which is primarily located in the Amazon basin. Thus the country possesses the largest continuous block of tropical closed forest of any country in the world; 28% of the total global tropical closed forest area (332 million ha) is located in the Brazilian Amazon.

Lanly's estimates of forest land area for Brazil are as of the end of 1980. More current estimates of forest land area for the end of 1985 (also from Lanly) are presented in section 5.4. These are projected figures based upon an estimated rate of deforestation.

1.2 Total and Productive Areas by Forest Land Type

Lanly categorizes Brazil's total forest land area by six distinct forest land types - five native forest types including: closed tropical forest, open woodlands, coniferous forests, scrub formations and forest fallows; and one man-made type: plantations. The first four types listed are described in sections two and three; plantations are discussed in section four. Forest fallow refers to areas of "secondary forests mixed with agriculture" (Lanly, 1982), or forest land which, having been previously cleared for agriculture, is now at varying stages of natural reforestation. Although much of this land area may never fully or even partially recover to the previous forested condition, the land is still classified as "forest land".

While the total area of "forest fallow" land area is thus classified as unproductive forest land, other forest land types contain portions of their total area which are also classified as unproductive. These areas are considered to be unproductive for physical (poor stocking, inaccessible terrain, etc.) or legal (protected

1 Evans (1982) makes reference to a 1974 publication of a world forest survey conducted by Persson in which the global forest land area is estimated at approximately 4,400 million ha.; the original Persson reference was not available.

2 See the discussion in section 1.3 concerning the validity of this figure.

status) reasons. Table III-2. presents the total and the productive areas for the six forest land types. The overall productive forest land area is approximately 66% of the total area; productivity ranges from 84% of the total area for tropical closed forests to 25% for the scrub formations. Specific forest land type definitions of productivity are described for each native forest type in section three and for the plantations within section four.

Table III-2. Total and Productive Forest Land Areas: 1980.[1]

Forest Land Type	Total Area	Productive Area	
	(million ha)	(million ha)	(% of total)
Closed Tropical	356	301	84%
Open Woodland	211	117	55%
Coniferous	1.2	0.3	38%
Scrub	61	23	25%
Forest Fallow	46	–	0%
Plantation	6	6	100%
TOTAL	681.2	447.3	66%

SOURCE: Lanly (1982).

Plantations are especially important in terms of their high productivity in relation to their total area. While plantations occupy less than one percent of the total forest land area, and only 1.3% of the productive forest land area, they provide a large proportion of the total wood used for industrial purposes.

The large size of the country, diversity of vegetation types and lack of accessibility to portions of the forested area especially that within the Amazon basin complicate the forest inventory process in Brazil. The Lanly (FAO) paper, upon which the majority of this chapter is based, used two main sources of information for estimating forest areas:

- the RADAMBRASIL project, which, carried out in the 1970's, provided radar survey material and detailed vegetative interpretation for a large portion of the Legal Amazon; and
- small-scale vegetation maps produced for the rest of the country from Landsat satellite images taken between 1972 and 1976 by the French Institute "Carte Internationale du Tapis Vegetal (C.I.T.V.) under the auspices of UNESCO.

1.3 Discrepancies in the Reported Data of Forest Area.

While a number of other studies describe forest types and forest land areas in Brazil, Lanly's study appears to be the most complete. There are various discrepancies between the references as to the total forest land area and the area of each forest land type in Brazil. Much of this is the result of differing definitions of "forest land" especially in relation to the so-called "secondary forest" or areas of natural reforestation resulting from previous clearing for agriculture, and problems in determining actual deforestation rates. For example, Lanly classifies the "scrub" vegetation formation as forest land type whereas many other authors do not consider this to be forest land. Actually, later in the same paper, Lanly himself does not include this "scrub" forest land type in the determination of total forest productivity nor does he include unproductive open woodlands.[2]

Appendix 1 compares the forest land areas from a number of references. Few literature sources attempt to estimate the entire forest area of Brazil. The data from the US Dept.Commerce (1985a) agree most closely with Lanly's figure and indicate 680 million ha of land (or 80% of the total land area) are "forested to some

1 Note that some of the numbers presented here do not agree with those presented in Table III-7 of section 5.4. The reasons for these discrepancies are discussed both in section 1.3 and 5.4.

2 See also section 5.4.

degree." Kengen (1987) submits that the total forest area is 516 million ha, while Persson (1972) and Fishwick (1975) both estimate the total forest area to be roughly 320 million ha. The latter two do not include scrub or plantation forest land types; their figures for open woodlands are a good deal lower than Lanly's estimates presumably because they do not include unproductive woodlands in their numbers. Most of these authors included in Appendix 1 estimate the area of tropical forest in the Amazon to be between 260 and 300 million ha. It appears that they do not include unproductive Amazonian forests in their estimates.

2. DESCRIPTION OF NATIVE FOREST TYPES

Growing conditions are favorable to forest growth throughout almost all of Brazil. Generally, ecological factors, in particular, climate, determine the extent of each particular vegetation type. Near the equator, the high rainfall and low elevation provide suitable conditions to support a vast area of tropical hardwood forest. Within the southern warm temperate woodland and cooler upland coniferous zone, scattered local tropical forest patches occur where favorable ecological conditions exist. In other areas, lack of rainfall or alkaline soils determine the distribution of drought- and fire-adapted vegetation. The generalized vegetation type regions are depicted in Map 5. These include:

1. Closed Tropical Forest
2. Open Woodland
3. Coniferous Forest
4. Scrub Formations
5. Prairie

The actual land area for each type, shown in Table III-2., is subject to much discrepancy as discussed in section 1.3 and later in section 5.4.

2.1 Closed Tropical Forests

Also called "closed broad-leaved forests" by Lanly, this type is the most extensive in Brazil covering approximately 356 million ha. Generally lush in appearance, these forests are known for their diversity of plant and animal life. As illustrated in Map 5, there are four generalized vegetation regions within the closed forest type including: equatorial forest, atlantic forest, babacu palm and mangrove. Division into these forest sub-types is dependent both on geography and tree species.

The type is characterized by either evergreen or deciduous forest cover, the distribution of which is related to rainfall and elevation. The evergreen forest receives abundant, year-round rainfall, is usually low to mid elevation and is typically very dense with three stories of vegetation. The deciduous forest, with a pronounced dry season in which the trees shed their leaves, is often intermingled with the wetter evergreen forest away from the river flats on low to somewhat higher and dryer elevations (Guest et al., 1976).

It should be noted that less than 10% of tropical forests grow in rich soils; the vast majority grow in lateritic soils which are high in silica and nitrogen but low in calcium, potassium and phosphorous (Truitt,1985). As a result, the nutrient and energy reserves of the major portion of the tropical forests are not found in the soil, but rather in the living or rotting litter on the forest floor.

2.11 Equatorial Forest The equatorial forest, commonly known as the "tropical rain forest" or "jungle", covers 332 million ha or most of the Legal Amazon region, and corresponds with humid to very humid climates (100 to 400+ cm rainfall per year) and low to mid elevations (Guest et al., 1976). This forest, with its dense, typically evergreen vegetative cover which is often three-layered, is the home of a vast number of plants and animals. It also contains a number of internationally well-known tree species such as mahogany, rubber and Brazil-nut.[1]

There are three basic categories of these Amazon forests: varzea, igapo and terra firme (Shoumatoff, 1986; Correa de Lima and Mercado, 1985). The varzea, or periodically flooded forests, and igapo, permanently

1 See Table III-3. in section 3.6 for list of important commercial tree species by forest type.

flooded forests, occur along the rivers. The terra firme or upland forests occur on better drained soils away from the rivers. Varzea forests, which only cover approximately 2.5% of the Amazon basin are the most extensively exploited forests producing important commercial species such as virola. The less exploited terra firme forests account for nearly 90% of the total area whereas the varzea and igapo forests cover another 2.5% each (Correa de Lima and Mercado, 1985; Peck, 1983). The remaining 5% cover are scattered, isolated patches of less dense cerrado- or scrub-like vegetation.

2.12 Other Closed Tropical Forests A narrow strip of humid evergreen forests stretches from the eastern-most point of Brazil south along the Atlantic coast to the state of Santa Catarina. This forest has two distinct areas: the evergreen forest located on the seaward side and a deciduous forest located on the upper slopes of the leeward side. The Atlantic forest region was originally known for high quality wood production of, for example, rosewood (Guest *et al.*, 1976). As this region was the first to be settled in Brazil and thus now has the highest human population density, it has been heavily exploited for timber and the forest largely cleared for agriculture. Most of the remaining area (less than three million ha) is now protected (Lanly, 1982).

Between 1.3 and 3.6 million ha (areas differ between surveys) of mangroves (primarily *Rhizophora mangle* and *Avicennia nitida*) are scattered all along the Atlantic coast forest but most concentrated around the mouth of the Amazon. Whereas small patches of palm forests occur in the varzea areas along the rivers in the Amazon basin, the largest continuous area of babacu palms (*Orbignya speciosa*) is located east of Belem in the state of Maranhao.

2.2 Open Woodland

These"wooded savannas", as indicated in Table III-2, are second in size after the closed tropical (211 million ha), range in a continuum from the densely-treed multi-storied vegetation types to "scrub savnnas" with scattered shrubs. This type, which Lanly also calls "open broadleaved tropical forest", is distinguished from the closed tropical forest type by a gramineous grass layer which makes them sensitive to degradation by fire: they are often compared to the African savannas.

Within the open woodlands there are two sub-types: the Cerrado, and the Pantanal and Chaco.[1] The cerrado region, extending from the states of Rondonia in the west and southern Maranhao in the east, south to Sao Paulo and Matto Grosso do Sul, covers over 170 million ha. Other types of woodlands exist in various parts of the country. For example, the periodically inundated areas of the "Pantanal Matogrossense" (Parana/Paraguay basin) shown on Map 5, cover more than 12 million ha. Also in this area along the border of Paraguay, the "chaco" stands, characterized by distinct tree species, cover nearly 2 million ha. Throughout the Amazon basin, in areas of localized drought conditions or distinct soil types, small patches of cerrado are found.

2.3 Coniferous Forests

These badly degraded forests are characterized by the dominant coniferous species *Araucaria angustifolia* or parana pine which is similar to yellow (loblolly) pine. They originally covered 16-17 million ha including most of the state of Parana, and about 25% of the states of Santa Catarina, Rio Grande do Sul, Sao Paulo and Minas Gerais. Occupying plateaus above 500 meters these forests often have three distinct vegetation layers; the aforementioned primary storey dominated by parana pine, a secondary storey of *Podocarpus spp.*, and a thick undergrowth of shrubby trees (Guest *et al.*, 1976). Exploitation for timber and fuelwood, and clearing for agriculture have reduced this forest area[2] to less than 1.2 million ha, and, as such is the smallest forest type area.

1 The open woodland forest type is also known by the first of these two sub-types. That is, open woodland and "cerrado" are often used interchangeably.

2 See section 5.22 for a discussion of the deforestation and resulting productivity in this forest type.

2.4 Scrub Formation

A semi-arid "caatinga" area covers approximately 61 millionha principally in the northeast states of Piaui, Ceara, Rio Grande do Norte, Paraiba, Pernambuco, Alagoas, Sergipe and Bahia. This type is comprised of a complex mixture of woody vegetation with patches of the original dry "sclerophyllous" forests. The vegetation of most of this region is at varying stages of degradation due to fuelwood collection, clearing for agriculture and grazing, and fires (Lanly,1982).

3. STOCKING AND PRODUCTION OF NATIVE FORESTS

The following section is based upon the 1982 Lanly study which used, among various sources, the RADAMBRASIL project figures for the Amazon forests. Several of these studies carried out small-scale forest inventories to obtain estimates for volume per ha (vol/ha). Values for vol/ha are based upon the volume above bark (VOB) of the boles of all trees more than 10 cm diameter breast height (DBH) and used to calculate total growing stock. Commercial growing stock calculation uses the vol/ha estimated to be "actually commercialized"[1] (ie. that vol/ha of merchantable logs which are extracted per ha). The method Lanly used to estimate total and commercial growing stock as of the end of 1980 are described in the sections below. Appendix 2 gives further details of the calculation of these estimates.

3.1 Productivity Classes

As mentioned in section 1.2 and illustrated in Table III-2., the various forest types contain portions which are classified as "productive" and "unproductive". The "productive" portion is further broken down into "productive-unlogged" and "productive-logged". Thus vol/ha numbers are given for the three different productivity classes within the various forest types. Volume actually commercialized (ie. commercial volume) is only given for the productive-unlogged class.

For the open woodlands, a vol/ha figure is only listed for productive-unlogged areas as the with other productivity classes have been largely disturbed by agriculture and thus have a very low forest productivity. Similarily, the scrub forest land type is considered to have a very low overall forest productivity and is not included here.

3.2 Stocking per ha

3.21 Closed Tropical An average vol/ha of 155 m^3/ha for unlogged and 145 m^3/ha for logged areas is given for productive Amazonian closed tropical. Closed tropical forests outside the Amazon (non-Amazon) have higher average vol/ha of 195 m^3/ha for unlogged and 175 m^3/ha for logged areas. Unproductive vol/ha is 80 m^3/ha for Amazon and 95 m^3/ha for non-Amazon. The volume actually commercialized is estimated at 5 m^3/ha for Amazon forests and 10 m^3/ha for non-Amazon forests.

3.22 Open Woodland and Coniferous The productive open woodlands are estimated at 50 m^3/ha for total volume. The volume actually commercialized is approximately 5 m^3/ha. The coniferous forests are the most productive type with 350 m^3/ha. Productive logged and unproductive coniferous areas are grouped together and contain vol/ha of 100 m^3/ha. The commercial volume in the coniferous forests is 50 m^3/ha.

3.3 Total and Commercial Growing Stock

Total growing stock is calculated by multiplying each individual vol/ha number times the estimated areas per productivity class (within each forest type). An overall total growing stock of 57.6 billion m^3 is estimated for the entire forest of Brazil. This consists of 51.6 billion m^3 closed tropical, 5.8 billion m^3 open woodland and 0.19 billion m^3 coniferous.

Total commercial growing stock for Brazil is given as approximately 2.1 billion m^3 or roughly 4% of the total volume. This is comprised of 1.5 billion m^3 (3% of total volume) for closed tropical forests, 0.59 billion m^3 (10% of total volume) for open woodlands, and only 14 million m^3 (7% of total volume) for coniferous forests.

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1 Lanly uses the term "volume actually commercialized" (VAC). The definition of this term is given in section 3.4.

The low percent of commercial versus total growing stock (3% of total volume) for the closed tropical type reflects the immense diversity and complexity of the Amazon forest. Of the estimated 2,500 tree species occuring in this region, approximately 150 species have been identified as having some commercial value, only 25 are used locally and a mere 10 - 15 are exported (Marques and Rezende, 1988; USDC, 1985a). Whereas approximately 370 trees occur per ha, only 15 - 20 trees per ha are used (Beer and Rizvi, 1986).

3.4 Other Estimations of Growing Stock

As with the forest land areas of Brazil, there are various discrepancies between the figure appearing in the Lanly study and those of other authors. This is not surprising as the same problems which complicate the estimation of forest areas, confound the calculations of growing stock. In addition, with regard to commercial growing stock, many different definitions are used. For example, Lanly defines commercial volume as the m^3/ha which "are supposed to be extracted per ha in the form of merchantable logs". Other authors use such terms as "currently usable" or "currently marketable" usually without a complete definition (Bodig and Sa'Ribero, 1983; Correa de Lima and Mercado, 1985). Erfurth and Rusche (1978), in an FAO paper on the marketing of tropical wood, define a commercial species to be one that is produced in quantities above 1,000 m^3/year.

Appendix 3 presents a comparison of several different references and the values given therein for total and (where possible) commercial growing stock. Correa de Lima and Mercado (1985) cite a 1978 paper by Pandolfo which suggests that the vol/ha for varzea and upland Amazon forest sub-types is 90 m^3/ha and 170 m^3/ha respectively. The total Amazonian growing stock is estimated at 43.7 billion m^3 of which 15.4 billion m^3 (35% of the total) is considered currently utilizable. A more recent publication by Rezende and Neves (1988) estimates the total tropical growing stock at 50 billion m^3 of which 30% is said to be commercial (no definition of "commercial" is presented). Bianchetti (1987) suggests that the cerrado "wood production potential" is roughly 6 billion m^3.

3.5 Value of the Forest Growing Stock

As suggested in section 3.3, interpretation of total growing stock value is difficult as much of it is tropical and thus of a highly complex nature. The RADAMBRASIL survey suggested that the value of the currently-usable Amazonian hardwood stocks are worth over $1 trillion at 1980 prices (Hammond, as cited by Denevan, 1981). Indeed, as world supplies of tropical forests decrease and demand for their products increase, the currently marketable volumes (and thus values) of the Amazon forests should accordingly increase as lesser-known species are increasingly utilized.

3.6 Commercially Important Species

The following table lists the most important native commercial species by forest type. A more detailed able listing Latin names, trade and other common commercial names, and uses is found in Appendix 4.

4. PLANTATIONS

4.1 Historical Perspective

As shown in the preceeding sections, the native forest in Brazil is distributed rather unevenly throughout the country both in terms of area and volume (Bianchetti, 1987). The sparcely populated northern region possesses roughly 70% of the productive forest area and commercial growing stock and approximately 90% of the total growing stock. The population and therefore industry are concentrated in the southern regions where the native forests have been badly depleted. As a result, this is the region where plantation activities commenced.

Table III-3. Important Commercial Native Species.

Forest Type	Commercial/Common Name
Amazon	
Varzea	virola (ucuuba)
	sumauna (Ceiba sp.)
Terra Firme	mahogany
	andiroba
	Spanish cedar
	satin wood
	cupiuba
	jatoba
	ipe
Atlantic	rosewood
	jacaranda (Pau ferro)
Araucaria	parana pine
	podocarps
	laurel
	louro

SOURCE: Various (see Appendix 4.)

Initial large scale *Eucalyptus* plantations were established in 1910 by a railway company for the purpose of supplying fuelwood, sleepers and posts. Later, in the 1940s and 1950s, large scale plantations of *Eucalyptus* began to supply charcoal for the steel industry in Minas Gerais. Softwood planting started somewhat later (in Parana) beginning with *Araucaria angustifolia* and *Cryptomeria lanceolata*, then subsequently *Pinus elliotti*. By the end of 1965, there were approximately 500,000 ha of plantations with the major species being *Eucalyptus* (80% of total) (Lanly, 1982).

4.2 Fiscal Incentive Scheme

In 1962, a study prepared by a Working Group from the Ministry of Agriculture indicated that the annual rate of planting was 20,000 ha which covered only 0.6% of the total area harvested per year. The group noted that some action on the part of the government was required (as, for example, a special financial scheme) to slow the destruction of the Southern forests (Kengen, 1987).

The arguments for the government incentives program were that:

1) The forest resource had been historically over-exploited.

2) Because the availability of forest resource close to major consumption areas was declining rapidly, based industries were facing increasing costs due to long wood transport distances.

3) A reliable source of raw material (other than natural forests) for wood-based industries was important in view of increasing domestic and world demand for wood products.

4) Increasing world demand and subsequent shortages of supplies in wood-based products would lead to increasing prices; securing a reliable source of wood would allow Brazil to expand its share in the international market thus benefiting their trade balance (Kengen, 1987)

In 1966, a law regulating a fiscal incentives granted to forestry was passed thereby initiating a unique tax incentive program with a major aim of establishing large industrial forest plantations. At the same time, the "Instituto Brasileiro de Desenvolvimento Florestal -- IBDF" (Brazilian Institute for Forestry Development) was created out of a number of fragmented government forestry agencies. Thus any reforestation project to be granted incentives had to be approved by the IBDF (Kengen, 1987).

Initially the incentives consisted primarily of tax concessions of up to 50% of income tax due. This was later revised downwards and by 1978 the tax deduction for reforestation projects was 25% (Kengen, 1987). As a result of these fiscal incentives, Brazil has one of the world's larger plantation establishment programs (Ayling, 1981) with approximately 6 million ha plantations consisting of primarily eucalypts and pine.

4.3 Total Area Approved under the Fiscal Incentive Scheme

Data for plantations appears to be grouped by into two categories: total area of plantation that was approved per year, and total area of plantation that was established per year. In some cases, references did not make clear whether their numbers for "plantations" refered to areas approved or areas actually established. This section (total area approved) uses Brazilian data (primarily sourced from Kengen, 1987). Section 4.4 (total area planted) uses Lanly's FAO paper (Lanly, 1982) with data for "areas established". A comparison of other sources is also presented in section 4.42. Note that all data presented refers to areas of plantations using the fiscal incentive plan unless otherwise stated.

4.31 Totals by Species The total area approved for "afforestation"[1] from the years 1967-1986 amounted to 6,252,483 ha. Of this, 52% (3.23 million ha) were *Eucalyptus*, 30% (1.86 million ha) were *Pinus* sp., while the other approximately 20% was comprised of *Araucaria*, other natives, fruit trees, palmito and others. Appendix 5 contains a detailed breakdown of areas approved by year and species.

Many *Eucalyptus* species are planted; the most important being: *E. saligna* (32%), *E. alba* (18%), *E. citriodora* (14%), and *E. terectiocornis* (12%). Pine species comprisesubtropical pines: *P. elliottii* (var. *elliottii, densa*), *P. taeda* and *P. patula*; and tropical pines: *P. caribaea* (var. *hondurensis, caribaea, bahamensis*) and *P. oocarpa*. Natives include the following species: *Nectandra mollis* ("black cinnamon"), *Copaifera langsdorfii* (copahyba) and *Ocotea pretiosa* (canela sassafras). "Others" include mainly other temperate/subtropical conifers such as *Cryptomeria japonica, Cunninghamia lanceolata* and *Cupressus lusitanica* plus exotic hardwoods such as *Gmelina arborea* (Lanly, 1982).

4.32 Totals by State and Species Table III-4 presents the top ten states for areas approved for plantations (1967 to 1986). A more detailed table is located in Appendix 6. Minas Gerais, a very important steel-producing area of Brazil, claims a substantial majority (1,828,919 ha or 30%) of area approved due to the high demands on the wood resource in terms of charcoal production used for energy in the steel mills (see Chapter 8. for further information). Other states of importance are, in order of decreasing importance: Parana (13.5%), Sao Paulo (11%), Bahia (8.5%), and Mato Grosso do Sul (8.5%).

Table III-4. Areas Approved for Afforestation by State and Major Species (1967 - 1986).

State	Total Area Approved	Major Species
Minas Gerais	1,828,919	Eucalypts
Parana	841,215	Pines
Sao Paulo	700,795	Eucalypts
Bahia	534,930	Pines and Eucalyp.
Mato Grosso do Sul	530,507	Eucalypts
Santa Catarina	365,795	Pines
Rio Grande do Sul	301,680	Pines
Espirito Santo	151,767	Eucalypts
Piaui	149,055	Fruit trees
Goias	148,442	Eucalypts
TOTAL	6,252,483	Eucalypts

SOURCE: IBDF (original not seen; cited Kengen, 1987).

1 There appears to be an interchange of the two terms "reforestation" and "afforestation" through the literature. Thus, planting taking place on new forest land is not distinguished from that taking place to replant logged areas.

Minas Gerais, a very important steel-producing area of Brazil, claims a substantial majority (1,828,919 ha or 30%) of area approved due to the high demands on the wood resource in terms of charcoal production used for energy in the steel mills (see Chapter 8. for further information). Other states of importance are, in order of decreasing importance: Parana (13.5%), Sao Paulo (11%), Bahia (8.5%), and Mato Grosso do Sul (8.5%).

The major species reflects the types of industrial activities in the various states. For example, the importance of eucalypts in Minas Gerais reflect the predominance of charcoal production in that state as this species is important for energy wood production. More discussion of plantation end use is found in section 4.6. Almost 70% of fiscal-assisted plantations occur in the South or Southeast regions of the country reflecting the higher degree of industrialization in these areas. Only 2.6% of the plantations are found in the North (Kengen, 1987).

4.4 Total Area Planted

4.41 Fao/Lanly Data The FAO publication by Lanly (1982) reports the area of plantations established by the end of 1980 and 1985 as follows in Table III-5. It should be noted that this table gives the *total* area of plantations established over time (dating back to 1941 and earlier) both within the fiscal incentive program and outside the program. However, as noted earlier, the total amount ofplantation forests prior to the incentives scheme was approximately 500,000 ha. Also, very few plantations have been established outside the program. The plantations of Jari Florestal, 50,834 ha of *Gmelina arborea* and 31,106 ha of *Pinus caribaea* at the end of 1980[1], are notable exceptions (Truitt, 1985).

Table III-5. Total Area of Plantations Established by the end of 1980 and 1985; Breakdown by Species and Plantation End Use.

END USE	SPECIES	AREA (1000 ha)	
		1980	1985*
Industrial (pulp and fiberboard)	*Eucalyptus sp.*	600	1,000
	Gmelina arborea	75	120
	Natives	66	81
	Total Hardwoods	741	1,201
	Pinus sp.	1,132	1,725
	Other conifers	100	120
	Total Softwoods	1,232	1,845
	OVERALL INDUSTRIAL	1,973	3,046
Others (charcoal and food)	*Eucalyptus sp.*	1,505	2,505
	Fruit trees	114	184
	Palms	263	363
	OVERALL OTHER	1,882	3,052
	Total Eucalypts	2,105	3,505
	Total Pine	1,132	1,725
	Total Plantations	3,855	6,098

SOURCE: Lanly (1982).

The total established plantation area is estimated at 3.9 million ha by the end of 1980 and 6.1 million ha by the end of 1985. In comparison, the 1980 figure for total areas approved to date is 4.2 million ha. Surprizingly, the total area approved to the end of 1985 is lower (5.8 million ha) than the established plantation area. It also appears that more *Eucalyptus* plantations were actually established than approved by the end of 1985 (3.5 million ha versus 3.1 million ha).

1 This is over 100,000 ha by now (Peck, 1983).

4.42 Other Data Sources The Sociedade Brasileira de Silvicultura (SBS) estimated that there are presently approximately 5 million ha *Eucalyptus* and *Pinus* species in forest plantations in Brazil by the end of 1987 (deBarros, 1989b). The USDA Foreign Agricultural Service American embassy attache in Brazil reports a total plantation area of 5.3 million ha by the end of 1986 (USDA/FAS, 1987/88). The Brazilian Charcoal Association (ABRACAVE, 1988) reports a total of 5.5 million ha reforested through fiscal incentives by the end of 1986/87. They do not provide a break-down by species. On the optimistic side, Rezende and Neves (1988) suggest that some 6.6 million ha were planted by 1987.

These differences could be attributed to a number of problems more importantly the differing reliability of data sources, plantation definition differences, and differing reported survival rates of the various species and plantations.

4.5 Production

4.51 Volume per ha and Rotation Age Volume and rotation age vary with location and species. *Eucalyptus spp.* yield from 5 - 35 m^3/ha/yr and have rotations of anywhere from 8 to 21 years. Pines produce 8 - 24 m^3/ha/yr with generally longer rotations of 20 - 35 years. *Gmelina arborea*, reported to be one of the faster growing species existing, yields 38 m^3/ha/yr and has a 10 year rotation (Lanly, 1982; Nahuz, 1988; Ayling, 1981; Evans, 1982).

The vol/ha/year is considerably improved, and rotation ages are shortened through the use of genetically superior stock. Production increases are occuring yearly with increased introduction of breeding programs and seed orchards. A number of companies (both forestry and other industry) have their own genetic improvement programs for the seed production of *Eucalyptus* (Magalhaes, 1988). Kellison (1988) reports improvements from 33 m^3/ha/yr to 70 m^3/ha/yr over the past ten years for *E.grandis* and *E.urophylla.* Up to 100 m^3/ha/yr have been estimated for hybrid eucalypts growing under research conditions (USDA/FAS, 1987).

4.52 Annual Total Production The Sociedade Brasileira de Silvicultura (SBS) goes on from their 5 million ha eucalypt and pine plantations estimate (see section 4.42) to suggest that a total of 64 million m^3/yr of wood are thus produced (deBarros, 1989b). Their growth rate (12.8 m^3/ha/yr) is perhaps somewhat conservative. A simple calculation, based on the above listed range (and average of this range) for eucalypt and pine growth rates and Lanly's 1985 established plantation areas, is illlustrated in Table III-6.

Table III-6. Calculation of Total Production for Eucalypt and Pine Plantations.

SPECIES	Growth rate (m^3/ha/yr)	Plantation Area (1000 ha)	Total Production (million m^3)
Eucalypt	5 - 35	3,505	17,525 - 122,675
range	20	3,505	70,100
average			
Pine	8 - 24	1,725	13,800 - 41,400
range	15	1,725	25,875
average			
TOTALS	–	–	31,325 - 164,075
range	–	–	95,975
average			

SOURCE: Various (see details in text).

4.6 End Uses of Plantation Wood

In general, eucalypts are used for charcoal production and other fuelwood, pulpwood and reconstituted panels whereas pines are mainly used for pulp, particleboard and sawnwood. The use of eucalypts for sawnwood is just starting and very little pine is used for energy wood, probably due to the added cost with the longer rotation (see Chapter 8. for further information).

"Industrial" wood is defined as that used for the pulp and paper industry and in other processed wood uses while energy wood ("other") is fuelwood used directly as firewood or that wood which is used to produce charcoal, methanol or other distilled fuels. There appears to be some overlap in these two wood categories as occationally in the literature that wood used for forest industrial energy uses is refered to as "industrial" rather than "energy".

As a result, there is some discrepancy between literature sources as to the area of plantations destined for energy end uses and the area destined for forest industry end uses. On average though, approximately one third of the total plantations are energy plantations, another one third are pulp and paper plantations, roughly 20% are for other forest industries and the remaining 14% are used for other purposes such as food production (Lanly, 1982; USDA/FAS, 1987/88; and ABRACAVE, 1988).

4.7 Advantages of Plantations

The push behind the fiscally-assisted large planting program in Brazil occurred as a result of the government's objectives to assure that a low cost "...supply [of] raw material [would be available to those] industries whose expansion would strongly contribute to the economic growth of the country..." (Reis, 1983 cited by Kengen, 1987). These included industries which relied upon wood as an energy source (such as steel and pig-iron), and those which used wood directly (pulp and paper, sawmilling etc.) In addition, the goal was to improve Brazil's energy balance which had relied heavily on costly foreign imports (Rezende and Neves, 1988) and forest products trade balance (USDC, 1985a).

Plantations provide a simple, attractive alternative to native forests in that they are more easily managed, provide more volume per ha, and are generally located close to industrial sites thereby reducing transportation costs. There is an abundance of cheap, flat, accessible land available for plantations.[1] This combination of advantages helps to ensure a delivered cost of plantation wood that is sufficiently low so as to ensure world competibility in the forest industry (Laarman *et al.*, 1987) and provide inexpensive energy sources to other industries. Additionally, the plantations may be viewed as "compensatory plantings" as they increasingly relieve the cutting pressure on the remaining native forests.

4.8 Future Perspective - Fiscal Scheme Completed

As a result of the economic crisis in Brazil through 1986 and 1987, the "Plan of Macroeconomic Control" was announced in July, 1987. This plan called for a frontal attack on Brazil's growing fiscal deficit. Accordingly, financial sources for the fiscal incentive-based reforestation were discontinued (deBarros, 1989c).

This cessation of government incentives for reforestation has resulted in a great deal of uncertainty regarding raw material supply in the medium and long term. In the period of fiscal incentives (1967-1987), reforestation still lagged behind exploitation (deBarros, 1989c). Now, without these incentives there will no doubt be increased pressures on the rapidly deteriorating supplies of native forest, especially that of the cerrado in the South. This situation could well prove ecologically dangerous for Brazil.

5. LAND-USE CONFLICTS AND DEFORESTATION

5.1 Land-Use Conflicts

As the population increases, demands on the land base for agricultural, industrial and residential uses also increase. These demands thus result in land-use conflicts between forestry and the other sectors. Usually, those land uses which are, or are preceived to be, more economically valuable take precedence over those less economically valuable land uses. In addition, those uses which better suit the needs of the increasing, potentially restive population may effect greater consideration. Such land-use conflicts between forestry and other sectors have been significant in the southern and southeastern densely populated areas of Brazil especially since the end of World War II. More recently, these conflicts have become increasingly evident in northern areas of the country as well.

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1 According to Kengen (1987), this was not the case in the latter years of the fiscal incentives program, in fact, the program caused an increase the cost of land.

5.11 Southern Land-Use Conflicts Since Brazil was settled, native forest land uses have come into competition with agricultural, industrial and residential land uses in southern Brazil. More recently plantation forestry has competed with other agricultural plantations. For example, generally in Brazil, corn and soybean have taken precedence over forestry, but in Minas Gerais, where charcoal is relied upon in the steel-making process, the forestry plantations take precedence (Rezende and Neves, 1988).

5.12 Northern Land Use Conflicts Population shifts (described in Chpt II, section 5.4) and increased industrial and agricultural development activity in the Amazon region have resulted in a number of land use conflicts. Invvolved, often competing "parties/interests" include:

- hydroelectricity and mining
- cattle ranchers
- resettlement/colonization
- gold seekers
- forest industry
- native Indians
- rubber tappers
- tourism
- domestic environmentalists

In addition to the above, foreign interests, especially those concerning environmental issues have become very vocal in recent years. Also included in foreign interests are scientists and foreign investors.

The conflicts between interested parties are usually rather complex. For example, resettled colonizing peoples and cattle ranchers can serve each others' needs as the former parties open up "new" land which they subsequently sell to ranchers. However, when these colonizers become squatters on cattle rancher's land, conflicts occur. While the forest industry can gain greater access to forested areas via highways built for the colonization programs, and can receive increased short term log supplies as land is cleared, the fires used to clear land for agriculture often destroy more forest than originally intended thereby decreasing the viability of the forest industry in the long term. Other examples of conflicts include that of the colonizing people, industrialists and gold-seekers versus native Indians and rubber tappers (Groeneveld, 1987).

*5.13 Short Term Versus Long Term View*Unfortunately, what may be viewed as more economically valuable in the short term is not always so in the long term. Indeed, in the various land use conflicts, best use for sustained (and often even short term) development is not always given consideration. For example, the demand for agricultural land often results in the inappropriate use of forested lands for agriculture. Land which is not best suited for agricultural production is often cleared in spite of its marginal value in this regard.

This is certainly the case for Rondonia. The land survey published through the National Secretary for Agricultural Planning in 1980 indicated that only 3.7% of the state was suitable for sustainable cultivation of annual crops (Groeneveld, 1987). And yet population increase considerations in other parts of the country put pressure on land clearing for agriculture in the resettlement programs (described in Chpt II, section 5.4). This massive immigration has led to many conflicts in land- use between native Indians, rubber tappers, and, in some cases, forestry. The conflicts have been of such serious nature that there is a definite threat to the very survival of the Indians and their reservations. The ecological preservation of the forestry habitat for a number of plants and animals is also of concern.

The following quotation from the U.S. Dept. of Commerce paper on forestry in Brazil (USDC, 1985a) summarizes the problem: "The Brazilian Government appears to be in somewhat of a quandary...between conserving and managing its valuable biological resource, while at the same time encouraging settlement of the area by thousands of unemployed, underemployed, potentially restive citizens from the densely populated, impoverished regions in the northeast and southern coastal belt".

As colonizers increasingly penetrate forest land which has been designated as "production forest", the future tropical timber reserves of Brazil are threatened. Although land use by forestry is presently less valuable than alternate land uses, this trend may well reverse in the future.

5.2 Causes of Deforestation

The result of the forest versus other land-use conflict is generally deforestation. Truitt (1985), defined deforestation as "a direct manifestation of the pressure placed on the forest resource by both successful and unsuccessful economic and social systems". A number of studies have examined the causes of

deforestation; these have produced various explanations for the phenomenon and do not always agree as to the main causes.

The principle causes for world deforestation summarized by the Tropical Action Plan[1] (Brandao, 1988) and for Brazilian deforestation (Keipi, 1986) are presented in a synthesized form below:

1. The low commercial value of the native forests leads to the conversion of these lands to more valuable land uses.

2. Population and unemployment pressures, subsequent increasing lack of agricultural soils for cultivation and deficient land planning lead to the deforestation of marginal agricultural lands and sloping uplands. These lands provide low agricultural productivity thus resulting in unsuitable land uses.

3. Fuelwood gathering, especially in northeast Brazil have resulted in deforestation.

4. Hydroelectric projects, mining activities and timber harvesting are of minor direct importance.

Other authors have presented the following additional causes:

1. Fuelwood harvesting for charcoal production (Lanly, 1982; Evans, 1982; and Truitt, 1985).

2. Institutional problems such as:
   - weak and underfunded govt. institutions (Brandao, 1988; and Laarman *et al.*, 1987)
   - poorly conceived and impractical forestry laws and regulations (Laarman *et al.*, 1987)
   - inapropriate land ownership distribution (Brandao, 1988).
   - inadequate definition of forest land ownership and tenure (Laarman, *et al.*, 1987)
   - inadequate development projects which do not take forestry into account (Brandao, 1988)
   - lack of forestry tradition and know-how (Laarman, *et al.*, 1987)

Appendix 7 contains a more detailed comparison of different literature sources concerning causes of deforestation.

5.21 Amazon Deforestation Most of the forest clearing in this region appears to be done by highway builders and ranchers (Truitt, 1985). Lanly (1982) suggests that in the southern Amazon forest (north part of Mato Grosso and south part of Para) large scale cattle ranching is particularily serious. As stated in the UN World Commission on Environment and Development publication "Our Common Future" and cited in Tropical Timber (1987), "governments have encouraged large-scale conversion of tropical forests to livestock ranches...many of [which] have proved ecologically and economically unsound, yet the conversions have been underwritten with land grants, tax credits, subsidized loans and other inducements". The ambitious highway-building program between 1966 and 1977 is said to have accounted for 25% of Amazonian deforestation (Beer and Rizvi, 1986).

The colonization programs related to the network of trans-Amazonian highways provided financial incentives to encourage people to settle in these northern, more sparcely-occupied areas of Brazil. Whereas only 20% of Amazonian deforestation is a direct result of colonizers clearing small patches (Truitt, 1985), a much larger percentage[2] is caused by "escape" fires, thus indirectly attributable to agricultural clearing (both peasant and cattle ranching) (USDC, 1985a).

5.211 Deforestation Cycle The typical scenario in the Amazon forest is the initial selective logging of a forest site. As access is thus increased, peasant farmers often move in and further remove the vegetative cover. They then cultivate the land for several years until it can no longer support crop growth. At this point larger ranchers buy the small cleared patches and integrate them with other patches. These larger areas are then seeded and fertilized to encourage grass cover. They then provide cattle forage for several more years until noxious weeds invade. In the best scenario, the land is then left to reforest naturally. In the worst scenario it remains as waste land (Lanly, 1982).

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1 The Tropical Forestry Action Plan was devised by FAO as a response to the world deforestation situation.

2 No actual percentage figure was found in the literature.

5.22 Southern Deforestation In general, in the southern areas deforestation is the combined result of clearing for agriculture and cutting for charcoal production (Lanly, 1982), and land use for urban and industrial expansion (Evans, 1982). In the coniferous (parana pine) forest type, deforestation is the result of overcutting for charcoal and the sawmilling industry, and clearing for agriculture (Lanly, 1982). Deforestation in the open woodlands (cerrado) is the result of the use of forests for charcoal, the gathering of fuelwood for private and industrial uses, the clearing of land for agriculture and the mining or developing of land for other industrial purposes. Clearing for cattle ranching is especially serious in the northern cerrado (Lanly, 1982).

5.221 Deforestation Cycle The deforestation cycle in southern regions is somewhat different from that in the north. Here forested areas are generally overcut for energy wood (charcoal) or sawlogs (sawmilling). These areas are then used for crop cultivation or cattle ranching. If the agricultural use is too intensive for the land productivity, wasteland will develop. Otherwise the land tends to remain in agricultural production.

5.3 Rates of Deforestation

Although many comments and judgements on deforestation can be found in a number of sources, very few papers appear to provide complete quantitative data which could be used to make a sound estimate as to the extent of the problem. One difficulty in evaluating the various reported rates of deforestation is that the definition of "deforestation" varies between studies. For example, one must ask whether the study includes in the deforestation figure, cleared land which is expected to return to forest. If so, is the "temporary" land use of a low enough intensity so as to ensure the return to productive forest? Or, alternatively, is it of a higher intensity so that the long term forest will be of a degraded nature? Often degradation of forests is overlooked in the deforestation figures (Denevan, 1981). In fact, the degradation of forests may even be a worse problem than the problem of deforestation (Beer and Rizvi, 1986).

5.31 Deforestation Rate per Year A large-scale study of deforestation published by the Institute de Pesquisas Espaciais (INPE) used Lansat satellite imagery of differing dates to evaluate trends over the 1970's. Lanly's FAO paper relied on much of this data to report an estimated annual deforestation rate of 2.53 million ha. (total) for all closed, coniferous and productive woodlands of Brazil (1976 to 1981). This figure is comprised of:

- 1,360,000 ha/yr for closed broadleaved forests
- 120,000 ha/yr for coniferous forests; and
- 1,050,000 ha/yr for open woodlands (productive only).

If productive scrub forest land type deforestation (660,000 ha/yr) is added to this, a total of 3.19 million ha/yr are said to be deforested. The productive cerrado deforestation consists of 900,000 ha/yr clearing for agriculture and 150,000 ha/yr cutting for charcoal (Beattie, as cited by Lanly, 1982). Denevan (1981) cites two other Brazilian sources for deforestation rates in the Amazon:

- 1.04 million ha/yr (from the Brazilian Institute for Forestry Development - IBDF); and
- 1.28 million ha/yr (from the Brazilian Amazon Development Agency - SUDAM).

More recently (1987/88), the Society of Brazilian Silviculturalists (SBS) estimated that approximately 6 million ha of forest, primarily cerrado and Amazon types are cut each year (from deBarros, 1989b). Vesilind (1987), in a National Geographic article discussing Amazonian colonization, states that some ecologists estimate deforestation in this region to be approximately 13,000 km^2 (1.3 million ha/yr).

5.32 Total Estimated Deforestation Norman Myers, in his National Research Council, (USA, NRC) report on "Conversion of Tropical Moist Forests" suggested that by 1979 as much as one-third of the Brazilian Amazon forest was already cleared (cited by Denevan, 1981). In contrast, the National Research Institute for the Amazon (INPA) estimated that 10% and at most 25% were deforested by 1979 (also cited by Denevan, 1981). Peck (1983) suggested that less than 5% of the Amazon forest was deforested.

More recent figures suggest increased or similar amounts as these earlier estimates. Dr. Setzer, head of an Amazon meteorological study started in July 1987 by the Brazilian Institute for Space Studies, suggested that "there is an accepted number [for the amount of rainforest destroyed in Brazil] of about 700,000 km^2

deforested in the past ten years" (interview by Maduro in August, 1988: Maduro, 1989). He stressed, however, that there was no official figure and that any numbers were based on estimates or calculations. The U.S. Dept. of Agriculture, Foreign Agricultural Service's attache in Brazil reported that 10 to 20% of the Amazonian "natural vegetation" was lost in the past ten years (USDA/FAS, 1988).

Later studies tend to show that the trend has continued. Of the original area of Atlantic tropical forest, only 2% remains today (Nahuz, 1988; and Mittermeier, 1987). According to Knight (1988), the area of *Araucaria* forests (ie. coniferous) existing today covers less than 5% of the original area; this is down from 20% only 20 years ago. Indeed, Lanly (1982) suggested that by the end of 1985, all the productive coniferous forest would be destroyed and only some 720,000ha unproductive coniferous forests would remain.

Appendix 7 presents further figures for deforestation rates and amounts. It also includes, as mentioned earlier, suggested causes for the deforestation. Almost all the published reports stress that the rate of deforestation (in the Amazon forest) is increasing and thus more forested area is being cleared each year. In addition, there is increased likelihood that once a forested area is cleared, it will either revert back to badly degraded forest or not revert back to forest at all.

5.4 The Effects of Deforestation

5.41 Forest Area and Growing Stock Decreases Direct, interrelated results of deforestation include a decreased total and productive forest land area, and decreased total and commercial growing stock. The following table summarizes Lanly's figures for forest area and production in 1980 and 1985. Estimates for 1985 are projections based on afore-mentioned rates of deforestation. Appendix 8 details growing stock calculations by the decreased areas within each forest type and productivity class.

Table III-7. Total and Productive Forest Area, and Total and Commercial Growing Stock: 1980 and 1985. (area = million ha and vol = billion m^3)

Forest Type		Closed Tropical			Cerrado*	Coniferous
		Amaz.	Non-Amz.	Total		
FOREST AREA						
Total	1980	332	24.6	356.6	117	1.2
	1985	332	16.8	348.8	112	0.72
Product.	1980	286	14.6	300.6	117	0.28
	1985	283	12.1	295.1	112	nil
GROWING STOCK						
Total	1980	47.9	3.7	51.6	5.8	0.19
	1985	47.7	2.7	50.4	5.6	0.07
Commerc.	1980	1.41	0.08	1.49	0.59	0.014
	1985	1.39	0.05	1.44	0.56	nil

* Only productive cerrados are used in this estimate and thus total and productive forest areas are the same.

SOURCE: Lanly (1982).

Over the five years between 1980 and 1985, the total forest area decreased from 474.8 million ha to 461.5 million ha, representing a total drop of 13.3 million ha or approximately 2.7 million ha per year. Closed tropical forest area fell by 7.8 million ha, productive cerrado dropped by 5 million ha and conferous decreased by 0.48 million ha. The total productive forest area decreased from 417.9 million ha to 407.1 million ha, representing a total drop of 10.8 million ha or roughly 2.2 million ha per year. This was composed of a 5.5 million ha decrease for closed tropical forests, a 5 million ha drop in productive cerrado forests and a 0.28 million ha fall in coniferous forests.

Interpretation of these data are difficult because figures for the total forest area and productive forest area (for 1980) in the above table do not agree with those found in section 1.2, Table III-2. The present figures do not include scrub forest land, unproductive cerrado, forest fallow or plantation areas. Actually, the above

number for total forest area is somewhat misleading as, while it does include total areas of closed tropical and coniferous forests, it only includes that portion of the cerrado forests which are productive. As a result, the above figure for productive forest area is a better estimate.

An overall total growing stock of 56.1 billion m^3 was calculated for 1985 (by Lanly). This represents a decrease of 1.5 billion m^3 over the 1980 figure (57.6 billion m^3). The total growing stock fell by 1.2 billion m^3 in closed tropical forests, by 0.2 billion m3 in productive cerrado forests and by 0.12 billion m^3 in coniferous forests. The total commercial growing stock in 1985 was 2 billion m^3, a 0.1 billion m^3 over the 1980 figure. This was comprised of a 0.05 billion m^3 drop for closed tropical, a 0.03 billion m^3 for cerrado and a 0.014 billion m^3 drop for coniferous forests.

Considering the heavier concentration of wood-based industries in the southern region of Brazil, the much smaller total area of this region's forest, and the much longer period of deforestation in this region, southern deforestation, and the resulting decrease in commercial growing stock, appears to have a more immediate serious consequences for the Brazilian economy than does that of Amazonian deforestation (Lanly, 1982). However, the long term effects of Amazonian deforestation could well prove more serious. Certainly decreased commercial growing stock will affect the future potential of wood-based industries in this area.

As world supplies of tropical timber decrease through both an increase in the demand for these products and a decrease in the supply (often a result of depletion due to mismanagement), the demand on Brazil's forest resource will increase. If the resources are managed carefully they would become increasingly valuable (USDC, 1985a). If mismanaged and subsequently depleted, the loss of potential for the Brazilian wood product industry would be increasingly profound.

5.42 Other Effects of Deforestation The effects of deforestation are numerous and of varying intensities. Listed below are some examples of other effects of deforestation:

1. Decreased ecological condition and viability of the land.
2. Removal of native habitat for people, animals and plants such that many species are endangered or become extinct.
3. Depletion of genetic reservoir such that the potential for new discoveries in (for example) medicinal pharmaceuticals is diminished.
4. Particulate air pollution from the widespread burning associated with deforestation.
5. Contribution to the "green-house" effect thus inducing global warming and drying (Beer and Rizvi, 1986).[1]

5.5 Future Outlook

The general impression from the literature is that the outlook for continued health and productivity of Brazilian native forests is compromised. A number of pessimistic, though often unsubstantiated, remarks in the vast array of literature dealing with this topic suggest that deforestation will result in the demise of the Amazon by year 2000. As expressed by Dr. Setzer (Maduro, 1989), the great concern is that the rate of deforestation is increasing yearly. He suggests that the increase per year in this rate, would result in a doubling of the deforested area every three years and thus predicts "10 or a maximum of 15 years for the forest".

Certainly the forest areas in other parts of Brazil have decreased substantially over their original amounts. For example, the Araucaria (coniferous) forests have decreased such that only 4% of the original forest area remains; once Brazil's most productive forest, Lanly (1982) claims that no productive area exists today. Similarly, the area of Atlantic tropical closed forest at present is a mere 2% of the original area (Mittermeier, 1987).

The above pessimistic outlooks have been criticized for their dramatic and often subjective point-of-view. In many cases, predictions do not appear to be based upon sound, quantitative data. As Lanly (1982) points

1 This issue of world climatic regulation is a very controversial topic; it is difficult to assess the immediate and long term effects of deforestation on the global climate (Beer and Rizvi, 1986).

out, few writers have carried out the investigations necessary to make an objective assessment of the problem. Differing definitions of the term "deforestation" imply subjective comments. Indeed Dr. Setzer in his above-stated prediction for the Amazon forest, appears to disregard that portion of deforested area which will regenerate.

The Brazilian government, aware of the problem for many years, have taken steps to combat deforestation. For example, one of the objectives of the fiscal incentive program for establishing plantation forestry, (as discussed in section 4.0) was to relieve the pressure on native forests of southern Brazil. More recently, a plan entitled "Our Nature" is aimed at legislation to protect the Amazon and, at the same time, reemphasize Brazil's sovereignty in the area (WSJ, 1989). Some of the main objectives of this program are to strengthen environmental protection, increase public awareness of environmental issues, establish rational rules for occupation of the Amazon, regenerate damaged tropical ecosystems, and protect Indian communities. Proposals include a revision of the fiscal incentive policies regarding agriculture in the Amazon, creation of new forest reserves and a restructuring of the government's role in environmental protection activities.

6. FOREST OWNERSHIP, MANAGEMENT, RESEARCH AND EDUCATION

6.1 Forest Ownership and Legal Status

6.11 Forest Ownership The majority of forest land is state-owned (average for Brazil = 87%). This is due to the large government holdings in the northern Amazon region(93%). However, much of this northern forest is not in use (for forestry). The major portion of those forest lands which are in use, are privately-owned (USDC, 1985a). These occur in the southern, more populated regions where privately-owned forests account for about 71% of the total (Lanly, 1982). Whereas more than one half of the private land is held in large (over 1,000 ha) holdings, there are numerous small forest ownerships averaging less than four to five ha (Bethel *et al.*, 1982). The trend is towards increased private ownership of the forest.

6.12 Legal Status The legal status and total area of a variety of "protected forest areas"[1] is outlined in Table III-8. Approximately 12 million ha in Brazil are considered under "protected forest area" status. There are 16 National Forests and Biological Reserves under the Brazilian Forestry Administration (formerly IBDF - see section 6.2) covering over 2 million ha. According to Lanly (1982), these National Forests "are permanent forest reserves intended for the production of raw material for wood processing industries". Two larger National Forests occur in the Amazon state of Para: Caxinana and Tapajos. There are also a number of smaller ones in the southern and southeastern regions where plantations exist (Lanly, 1982).

Table III-8. Protected Forest Areas: 1987

Type of Reserve	Number	Total Area (ha)
National Parks	32	8,796,870
States Parks	44	1,007,067
National Forests and Biological National Forests and Biological Reserves (IBANR reserves)	16	2,033,672
Biological Reserves (State reserves)	32	56,619
Ecological Stations	30	n.a.
TOTAL	124	+11,894,228
% of Brazil's Total Land Area	–	1.39%

SOURCE: Anuario Estatistico do Brasil 1987/1988 (original not available; deBarros, pers.comm.).

There are roughly 10 million ha of National and State Parks, and State Biological Reserves in Brazil (as shown in Table III-8). According to Brazilian law (No.4771/65, as cited by Lanly, 1982) these parks and

1 The exact definition of this term is not given.

reserves have the objective of "safeguarding exceptional attribute [sic] of nature while conciling integral protection of the flora, fauna and natural beauties with the utilization for educational, recreational and scientific objectives". Several of the larger National Parks are located entirely within the Amazon region including: Parque Nacional Pico da Neblina, Parque Nacional de Amazonia and Parque Nacional de Pacaas Novos. More southerly parks include: Itataia and Serra dos Orgaos in the state of Rio de Janeiro, and Itaipa in Parana state (Lanly, 1982).

6.2 Government Agencies Involved in Forestry

6.21 IBDF The IBDF or Instituto Brasileiro de Desenvolvimento Florestal (Brazilian Institute for Forestry Development) is the main administrative and financing agency for forestry in Brazil (O.T.A., 1983) under the Ministry of Agriculture. Its roles include:

- responsibility for the formation and execution of Brazilian forest policies which concern both flora and fauna of the forest;
- maintaining the National Parks and Biological reserves
- enforcing measures which are aimed at the protection and conservation of nature.

The various Departments assist in achieving this agenda; several are listed, along with their responsibilites, below:

- Forest Economics Dept.: native managment techniques and remote sensing;
- Commercialization Dept.: orientation and monitoring of domestic and export forest product trade;
- Reforestation Dept.: coordination of fiscal incentive program and other tree planting programs;
- Research Dept.: manages all research related to flora and fauna (see section 6.6)
- National Park Dept.: maintains the National Parks and Equivalent Reserves.

Just recently, in 1989, the IBDF was replaced with a new organization called the IBANR or Instituto Brasileiro do Meio Ambiente e Recursor Naturois Renovaveis (IBANR) (pers.comm. deBarros).

6.22 Other Agencies There are a number of other government agencies, institutions, organizations and departments that are at least partially involved in forestry matters. For example, several of the institutions involved in development planning are concerned with forestry matters. The SUDAM (Superintendency for the Development of the Amazon) and the SUDENE (Superintendency for the Development of the North East), both under the Ministry of the Interior, and the IPEA (Institute for Social and Economic Planning) include forestry plans in their development projects. The CDE (Economic Development Council) and the CDI (Industrial Development Council), along with the BNDES (National Bank of Economic Development) are involved in the financing of forest industry development projects. There are also a large variety of agencies dealing with forestry research. This aspect is discussed in section 6.6.

In addition to the various government agencies, there exist numerous forest industry associations. For example, the ABIMCE (Brazilian Association of Plywood Industries), the ANFPC (National Association of Pulp and Paper Industries) and ABRACAVE (Brazilian Association of Charcoal) all represent their respective forest-related industrial sectors. Appendix 9 contains a more complete list of the names and acronyms for Brazilian organizations (both government and industrial) involved in forestry.

6.3 Forest Management

6.31 Difficulties in Forest Management Forest management, carried out primarily through the various government agencies mentioned in the above, has improved markedly over the past two decades (USDC, 1985a). However, partially as a result of the immense size and inaccessibility of the forest area, and partially as a result of the many alternative land-use pressures on this land, the regulatory controls on timber harvest and conservation are not as effective as would be desired. Although regulations exist, enforcement of them, through under-funded government agencies, is difficult.

For example, in the government resettlement programs, each new colonizer is alloted 100 ha, 50 ha (50%) of which is, by law, to be kept forested. However, this "50%" law is disobeyed by the majority of settlers because it is not adequately enforced (Groeneveld, 1987). In such situations, the IBDF is largely confined to the unpopular role of policeman and taxman, work which is often ineffectively carried out due to lack of staff (Palmer, 1977).

6.32 Forest Management in Southern Brazil Perhaps the better examples of forest management are in the southern regions of Brazil where sophisticated forest management of plantations is carried out by numerous private companies. Here the fiscal incentives have encouraged participation in sustained forest management. Plantations have reduced the pressures on native, hard to regenerate species such as parana pine.

6.33 Forest Management in the Amazon Very little forest management of tropical forests is carried out in Brazil (Peck, 1983) though there have been some attempts in the national forests (Lanly, 1982). There is a 600,000 ha pilot project coordinated between the IBDF and FAO dealing with integrated forestry and forest management systems at Santerem on the Tapajos river. The philosophy behind this project is that the "controlled and managed concept of tropical forest utilization" through sustained yield management will provide employment and contribute positively to Brazil's economy (Peck, 1983; Correa de Lima and Mercado, 1985). Selective logging is followed by reforestation where additional indigenous seedlings are planted to "enrich" natural regeneration. Some attention is also being given to the possibility of incorporating agro-forestry systems to replace shifting cultivation. Such systems are new to the Amazon and may be valuable in the terra firme areas (Eden, 1982).

6.34 Exotic Species Plantations The application of such experimentation in these forest management systems has been very limited (Eden, 1982). The more common form of tropical forest "management" is the entire removal of the existing forest cover and its subsequent replacement with exotic species. Companhia do Jari, or the "Jari project", as it was more commonly known before a consortium of Brazilian companies and the government took it over in 1982, is the most prominent example. Over 100,000 ha of exotic species such as *Gmelina arborea* and *Eucalyptus* sp. have been planted on land cleared of its original tropical forest to furnish its floating pulp mill. Other examples of Amazonian plantations include the 1970's line planting of rosewood and virola at the Curva-Una experimental station.

The fiscal incentive scheme tends not to favor tropical plantation operations. However, several private companies, as for example the above-mentioned Jari project, have established plantations despite lack of fiscal support. While exotic species plantations will undoubtably continue in the Amazon region, the IBDF research centers at Santarem, Manaus and Belem have increased research into the regeneration and utilization of a number of native species (USDC, 1985a).

6.4 Forest Protection

6.41 Pest Problems in Plantations There are surprisingly few insect and disease problems in the large plantations (Hodges and McFadden, 1986). The most serious losses occur as a result of leaf-cutting ants which cause serious defoliation; three defoliations in the first two years can kill even vigorous seedlings (Palmer, 1986). However, attacks by defoliating insects have been heavy only locally.

The best form of control appears to be biological controls, the exception to this are the use of baits and fumigation to control the leaf-cutting ants. Control for disease is based primarily on the selection and propagation of resistant seedlings.

6.42 Forest Fires The scrub and cerrado forest land types are particularly sensitive to degradation through fire (Lanly, 1982). Although many fires are "wild", clearing for agriculture or the burning of trees in primative charcoal-making have resulted in large areas of the cerrado being burnt. In the Amazon, the slash and burn techniques used in shifting cultivation and the burning of land prior to cattle-grazing often result in wild fires which destroy many more hectares than was the original intention to clear (USDC, 1985a).

6.5 Timber Harvesting and Log Supply

Timber harvesting in the Amazon region is generally in the form of selective logging and usually confined to seasonally flooded areas (Bethel *et al.* 1982). Very little mechanized equipment is used with the majority

of logging done by hand and the logs floated out down Amazon tributaries in the rainy season. As a result, the most heavily utilized forest in the Amazon is a narrow, 100-300 meter strip of varzea forests along the easily accessible rivers (Peck, 1983). Access to the upland forests is restricted to a few small areas accessible by roads (Correa de Lima and Mercado, 1985). More recently a main source of logs is from the newly-cleared agricultural settlements (USDA/FAS, 1988).

As commercially utilized timber becomes increasingly scarce along accessible rivers and water transport distances are accordingly increasingly long, log shortages are forcing the industry to consider mill-controlled logging operations which would help to guarantee supplies versus the more common practice of relying on third-party loggers (Palmer, 1977). Log shortages are also forcing the industry to use more species per hectare and better utilize the roundwood they secure.

6.6 Research and Education

Forest research in Brazil is carried out through government agencies (at both the state and federal level), universities and private companies (Bianchetti, 1987). Research undertaken by private companies is often done in cooperation with universities.

6.61 Government Agencies As part of the Ministry of Agriculture, the IBDF and EMBRAPA (Empresa Brasileira de Pesquisas Agropecuarias - Brazilian Company of Agricultural Research) are under political obligations to carry out forest research in the country (Bianchetti, 1987). Other government agencies which are involved include the SUDAM, SUDENE, (see section 6.22) and the INPA (Instituto Nacional de Pesquisas da Amazonia - National Institute for Research of the Amazon Region).

The research department of the IBDF has a number of research stations through Brazil as well as a Forest Products Lab in Brasilia where studies in wood processing, forest energy biomass, residue utilization, technological characterization of new species and other subjects are carried out (O.T.A., 1983).

6.611 National Program of Forestry Research (PNPF) This program, created in 1977 through an agreement between the IBDF and EMBRAPA, is coordinated by EMBRAPA through its National Center of Forest Research (CNPF) and serves to rationalize the utilization of funds for forestry research. It operates within a cooperative system of EMBRAPA units, other research institutions, universities and private companies (Bianchetti, 1987). Several of its objectives are:

- to increase the productivity and quality of wood products from plantations;
- to develop better utilization systems for native forests; and
- to improve silvicultural techniques to provide more effective land use.

6.612 National Institute of Research in the Amazon (INPA) This institute is associated with the National Counsel of Technology and Scientific Development (CNPq) and was created to carry out research in the Amazon (Bianchetti, 1987). As such, it deals exclusively with tropical forest resources and their sustainable management (O.T.A., 1983). The Tropical Forest Products Research Center (CPPF), under INPA, has, for example, carried out experiments regarding stress grading of a number of tropical timbers (Kauman, 1988).

6.62 Research Institutions for Pulp and Paper There are no research institutes in Brazil which deal specifically with pulp and paper. Those centers researching pulp and paper are usually part of larger, broader-based research organizations. Among those, the Instituto de Pesquisas Tecnologicas do Estado de Sao Paulo, Centro Tecnico de Celulose e Papel (IPT - CTCP) is by far the best equipped for pulp and paper (Colodette, 1988). This organization performs research encompassing many areas of pulp and paper, and often forms research cooperations with the industry. Two other institutions involved in pulp and paper research are the INPA, which researches tropical wood species for pulping, and the Instituto Agronomico de Campinas, which investigates the use of non-wood fibers in pulping (Colodette, 1988). (See next two sections for other organizations involved in pulp and paper research).

6.63 University Research Institutes Five universities in Brazil carry out forestry research in conjunction with higher level education (Bianchetti, 1987). They are:

- Universidade Federal de Vicosa (UFV)
- Escola Superior de Agricultura "Luiz de Queiroz" (ESALQ)
- Escola Politecnica da Universidade de Sao Paulo(EPUSP)
- Universidade de Sao Paulo (USP)
- Universidade do Parana (UFPR)

With the exception of USP, the four above universities have facilities for research in pulp and paper.

In 1969, the Centre of Forest Research was founded (Malinovski, 1987). This institution is linked to both the forestry faculty of UFPR and the forest companies. Forest research conducted at the Federal University of Parana and funded through the Centre of Forest Research has consisted, for example, of forest inventories for both the south and Amazon regions of Brazil.

The Foundation of Forest Research of Parana was set up in 1972 with the ojective of financing forest research and creating the opportunities for associations between the UFPR and private companies (Malinovski, 1987). Studies in forest management, harvesting, fauna management and silviculture have been sponsored by the Foundation for Forest Research of Parana (Malinovski, 1987).

6.64 Industrial Research Institutes The vast majority of forest industry research carried out in Brazil is by the pulp and paper companies. Nearly all the larger companies support research groups. According to Brandao of Aracruz Celulose, most of the research is conducted in close cooperation with universities, Brazilian government institutions and international research institutions (Brandao, 1988). The majority of the research is devoted to kraft processing of hardwoods (Colodette, 1988), not surprising considering the importance of this pulp type.

6.65 International Research Organizations in Brazil There are many different international organizations which conduct research in Brazil; some are involved in research dealing with fast-growing exotic species whereas others concentrate on a vast variety of forestry topics in the Amazon. IUFRO (International Union of Forest Research Organization), in seeking to strengthen its role in solving forestry problems of the developing world, has created a "Special Program for Developing Countries" with the following three goals:

- to improve communication of research findings by assisting in bringing researchers to meetings;
- to improve the supply and quality of trees for many uses through a number of workshops in various countries; and
- to improve utilization of timber resources.

Under this program, a group project on tropical woods was developed (Kellison, 1988). This has been concentrating on improved utilization of timber resource in Brazil (and the rest of Latin America) and funding of various projects which would improve technology transfer.

6.7 Forestry Education

There are 13 forestry schools in Brazil which offer undergraduate programs in forestry. Universities are generally owned by the state or federal government with this being their major funding source. Graduate study opportunities specializing in pulp and paper are available at UFV, ESALQ and EPUSP (Colodette, 1988).

Technical training in forestry is available a number of schools throughout the country. Specific technical training for the pulp and paper industry is provided in two technician schools.

CHAPTER IV. GENERAL OVERVIEW OF THE FOREST INDUSTRY

1. HISTORICAL PERSPECTIVE

Soon after the Portugese discovery of the land, exports of "Pau Brasil" (*Caesalpinia echinata*) began moving to Europe. This wood, originating from the Atlantic Coastal forests north of Rio de Janeiro, was bright red in color and appropriately named "brasa", after the Portugese term signifying "red-hot embers". By 1540 the country took its name from the wood and thereafter was known as Brazil. For many years this wood was the primary export; its supplies were exhausted around 1875 (Fishwick, 1975).

Throughout the following four centuries from the 1500s to the 1900s, forestry activity continued in a similar exploitative manner concentrating in the Atlantic Coastal forests and the Araucaria forests with clearing of land for agriculture and the export of tropical hardwoods from the former forests and parana pine from the latter. Early in the the 20th century logging concessions were granted to foreign enterprises and thus began the establishment of mills such as the then large and modern sawmill in Tres Barra (Santa Catarina). In addition, a number of small sawmilling enterprises were set up. After the second World War, given the low value of exported lumber compared with the high value of processed pulp imports, the government began to encourage the establishment and modernization of pulp and paper mills (Fishwick, 1975). This southern industry began to experience wood shortages in the fifties leading thus to the fiscal incentive scheme for establishing *Pinus* sp. and *Eucalyptus* sp. plantations discussed in Chapter III, section four.

2. COMPONENTS OF THE TOTAL FOREST OUTPUT

The term "total forest output" refers to the many wood and non-wood products which have their origin in forests.[1] These products are categorized (by Brazil) as basic, semi-manufactured and manufactured depending on their degree of refinement. Table IV-1. indicates the breakdown of forest output into these refinement categories.

Table IV-1. Total Forest Output by Refinement Category.

Refinement Category	Products
Basic	
Non-wood	nuts, tea, live plants, others
Wood	charcoal, logs & sleepers**
Semi-manufactured	
Non-wood	raw veg.oils, tannins, others
Wood	sawnwood, pulp
Manufactured	
Non-wood	palmheart conserves, aromatic & veg. oils, others
Wood	treated wood, plywood, veneer, compositeboards., paper

** Brazil actually includes sleepers under "semi-manufactured" but, to provide better agreement with FAO categories, sleepers are added together with logs.

SOURCE: IBDF/CACEX (pers.com. deBarros, 1989).

1 "Origin in forest" is a rather loose generalization. It is taken to mean plantation and native forests. Tea, for example, is classified under this category.

2.1 Sectors of the Forest Industry

The forest industry of Brazil has three sectors which produce wood-based products. These are listed in Table IV-2 along with their respective products. These three sectors are described in Chapter V (Solid Wood), Chapter VI (Pulp and Paper) and Chapter VII (Energy Wood).

Table IV-2. Forest Industry Sectors and Products.

Sector	Products
Solid Wood	logs & sleepers, sawnwood & treated wood, plywood, veneer, particleboard, hardboard, fibreboard
Pulp and Paper	pulp, various papers
Energy Wood	charcoal, fuelwood (industrial & domestic)

3. VALUE OF PRODUCTION AND CONTRIBUTION TO ECONOMY

The contribution of total forest output to the national economy of Brazil, as discussed in Chapter II, section 7.1, was roughly 4% of GDP in 1987 (Rezende and Neves, 1988). Calculation of this total output is complicated by the difficulty in valuating products which do not pass through the market. However, a portion of the total contribution, the output of the solid wood, and pulp and paper sectors, can be valuated. A rough calculation for the total value of production indicates an estimate of 8.14 billion $US for 1986. Using the U.S. Department of State's published figure of $270 billion (US Dept.State, 1987) as an approximation for Brazil's 1986 GDP, the share of total GDP for these two forest sectors equals three percent.

The solid wood sector contributes 5.53 billion $US (68%) whereas the pulp and paper sector contributes 2.61 billion $US (32%) to this total value of production (see Table IV-3.). Thus the total contribution to the national economy (based on this value of production) is roughly 2% for the solid wood sector and 1% for the pulp and paper sector. See Appendix 10 for details of this calculation.

4. CONTRIBUTION OF FORESTRY TO THE ENERGY BALANCE

As a result of the second energy crisis in 1978/79, the forest sector was called upon to help improve Brazil's energy balance which then relied some 80% on imported oil. As discussed in Chapter II, the energy wood sector now makes a large contribution to the economy of Brazil through its indirect contribution to the trade balance. Wood-based fuel provides an energy source to industries which are essential to the economy of Brazil. For example, the steel industry relies heavily on charcoal originating from short-rotation energy plantations. Other industries utilize firewood directly as an energy source. In 1986, firewood and charcoal contributed 15.7% to the total energy consumed by the industrial sector.

5. TRADE

5.1 Exports

The total forestry exports in 1986 (this includes both wood and non-wood products as shown in Appendix 11) were valued at 1,118.8 million $US. Approximately 90% of this resulted from exported products of the solid wood, and pulp and paper sectors; 10% came from non-wood products the most significant being, in decreasing order of importance, brazil nuts, extractives and tannins, vegetable wax, and tea. As shown in Table IV-3, the solid wood sector export value is about half that for the pulp and paper sector (in contrast to the total value of production for these two sectors.).

The important (in terms of value in $US) exported products were treated wood[1], sawnwood and plywood for the solid wood sector. Chemical pulp, printing and writing papers, and wrapping and packaging papers were the more important exported products for the pulp and paper sector.

1 This product is not well defined in the data sources. It probably refers to treated or planed lumber.

Table IV-3. Comparison between the Solid Wood and the Pulp & Paper Sectors: 1986.

Value	Solid Wood million US$	Pulp&Paper million US$	Total million US$
Total Production*	5,530	2,610	8,140
Exports	311	674	985
Imports	32	149	181
Balance	+279	+525	+804

* See Appendix 10 for production value calculation.

SOURCE: ANFPC (1987) for pulp and paper production.
CACEX and IBDF (pers.comm. deBarros, 1989).[1]

5.2 Imports

Total forest imports were valued at 252.4 million $US in 1986.

Seventy two percent of imports were in the solid wood or pulp and paper sectors. Of the 28% of total imports in non-wood products, raw rubber is by far the most important. The solid wood sector accounted for 13% of total imports (32 million $US), and the pulp and paper sector accounted for 59% (149 million $US). Newsprint, pulp, sawnwood, logs and veneer are the important imports.

5.3 Trade Balance and Changes Over Time

The forest products trade balance has improved steadily since 1978 as shown in Table IV-4. The balance (includes all non-wood and wood products) increased from +238 million $US in 1978 to +866 million $US in 1986. As discussed in Chapter II, section 7.2, the percent of export contribution to total trade is rather low - 5.0% for 1986.

Table IV-4. Trade Balance for all Forest Products: 1978 to 1986 (values in 1000$US FOB for both imports and exports[2]).

Year	Export Value	Import Value	Balance
1978	441,366	203,039	238,327
1979	696,232	257,215	439,017
1980	1,063,449	272,473	790,976
1981	1,073,143	294,187	778,956
1982	846,736	225,442	621,294
1983	977,832	199,790	778,042
1984	1,222,861	213,290	1,009,571
1985	991,127	182,989	808,238
1986	1,118,774	252,407	866,367

SOURCE: IBDF/CACEX (pers.comm. deBarros, 1989).

1 The CACEX data is used trade data in this table for the purposes of constistency. Pulp and paper trade data in Chapter VI relies on ANFPC data. Thus the numbers for trade in this table do not quite agree with those for trade from Chapter VI.

2 The Brazilian data (from the IBDF and CACEX) gives import data in FOB terms which makes comparison with FAO data for imports (given in CIF values) difficult.

More specifically, within the solid wood, and pulp and paper sectors, exports have increased dramatically in the past 10 to 15 years. Solid wood products exports rose from 118 million $US in 1971 to over 311 million $US in 1986 (USDA/FS, 1985; and CACEX/IBDF). More remarkable is the increase in exports of pulp and paper. Pulp export value rose from less than 5.0 million $US in 1971 to 327 million $US in 1986; paper export value grew from less than 1.0 million $US in 1971 to 347 million $US (USDA/FS, 1985; CACEX/IBDF). This is partially a result of fiscal encouragements (through the fiscal incentive program for plantation forestry) which assisted the pulp and paper sector to increase exports. It is also the result of rather stiff tariffs on imported forest products.

6. GLOBAL POSITION

6.1 Forest Product Production

Brazil ranks second behind the USSR in the world for total area of forested lands (U.S.Dept.Comm., 1985a; Foster, 1986). In total and industrial roundwood global production however it holds fifth place. Over the past ten years (1976 to 1986), both total and industrial roundwood have increased their percent share of global production from 6.4% to 7.3% and from 2.5% to 4.2% respectively. The larger increase in global share for industrial roundwood production reflects the increased efforts in plantations. Other upper ranking products include: fuelwood, charcoal, sawnwood, hardboard, and pulpwood (Table IV-5).

Table IV-5. Global Percent Share of Production and World Ranking for Selected Forest Products in Brazil: 1976 and 1986.

	% of world share		World Rank
Product	1986	1976	1986
Fuelwood & charcoal	10	10	3
Charcoal	27	28	1
Sawnwood (NC)	8	5	4
Hardboard	6	4	4
Pulpwood (NC)	12	5	2

SOURCE: FAO (1988a)

6.2 Exports

Although Brazil ranks among the top ten globally for most forest products in terms of production, and despite considerably improved global percent shares of exports for 1986 over 1976, their world rankings and global percent share in forest products exports are much lower in comparison with those of production. Total forest products[1] exports were a mere 0.5% of world shares in 1976 improving to 1.6% in 1986. This however still ranked them at a modest 16th place globally (versus 27th place in 1976). There are only five products where Brazil ranks within the top ten for export value ($US) for 1986 as listed in Table IV-6. Percent share of global exports has increased for each of these products over the ten year period from 1976 to 1986.

7. ROUNDWOOD PRODUCTION AND DEMAND BY FOREST SECTORS

7.1 Present Production Situation

According to the Foreign Agricultural Service American embassy attache in Brazil (USDA/FAS, 1988), it is almost impossible to obtain accurate data on total roundwood production in Brazil due to:

1 Here "total forest products" refers to just those products which FAO lists in their yearbook (ie. only wood-based products).

Table IV-6. Global Percent Share of Exports and World Ranking for Selected Forest Products in Brazil: 1976 and 1986 (export value basis).

Product	% of world share 1986	1976	World Rank 1986
Hardboard	12	9	3
Veneer sheets	4	6	7
Sawnwood (NC)	4	2	8
Plywood	2	<1	10
Chemical pulp	4	<1	7
Bleached sulphate pulp	5	(na)	5

SOURCE: FAO (1988a).

1. diversity and area of tropical forests
2. lack of government control
3. widespread burning
4. illegal clearing of land
5. contraband (to avoid taxation)

The FAO estimate total roundwood production (1986) at 237.8 million m^3 (FAO, 1988a). Of this, roughly 72% (171.6 million m^3) are said to be used for energy wood (fuelwood and charcoal) with the remaining 28% (66.1 million m^3) being classified as industrial roundwood. Almost all (90%) the energy wood is non-coniferous, but only 59% of the industrial roundwood is non-coniferous (FAO, 1988a). As mentioned above, Brazil ranks fifth in the world for total and industrial roundwood production.

The USDA Foreign Agricultural Service attache (USDA/FAS, 1988) reports an estimate of 80 million m^3 for "current industrial roundwood" (1986). It is probable that this figure includes some wood that is used by the industry (thus classified "industrial") for energy wood.

7.2 Production Change Over Time

FAO data indicate that the total roundwood production increased by approximately 6% per yr. between 1975 and 1980, and roughly 2% per yr. between 1980 and 1975 (FAO, 1988a). Industrial roundwood increased 20% per yr. between 1975 and 1980 and slowed to just over 1% per yr. for the period between 1980 and 1985. The percentage industrial roundwood of total roundwood production increased from 19% in 1975 to 29% by 1980 but remained approximately the same in 1985.

That percent of total production used for energy wood decreased between 1975 and 1980 (81% to 71%), but remained the same in 1985. Percent of wood used for charcoal appears to have remained the same over this ten year period.[1] This data for charcoal contradicts the U.S. Dept. of Commerce report (USDC, 1985a) which maintains that roundwood production increases yearly mainly due to the higher demand for charcoal.

7.3 Native Forest Production

The Amazonian contribution to total Brazilian roundwood production is very small in comparison to the total forest area or growing stock. In fact, the Amazonian forests contribute less to total roundwood production than do the southern industrial plantations (USDC, 1985a). Amazonian roundwood output has increased in the past several years as due to extensive clearing for agriculture. The contribution of the coniferous (*Araucaria* sp.) forests to roundwood production has declined considerably as a result of deforestation. The cerrado forest is very important in terms of its roundwood contribution to energy wood.

1 This does not agree with the statements made (using a different data source) in section 1. of the Energy Wood chapter (Chpt. VII).

Native species are used primarily for sawnwood, veneer and energy wood production whereas plantation wood is generally used in fiber production for pulp and paper, and for composite board production, as well as for fuelwood and charcoal production.

7.4 Production Outlook

Lanly (1982) suggests that the percent industrial roundwood of total roundwood will increase as a result of the recent efforts in plantations and the capacity expansions planned for the pulp and paper sector (see chapter VI). Although native forest production may increase in the short term due to the increased clearing in the Amazon[1], Lanly surmises that roundwood production in Amazon, and other native forests, will decrease. According to growing stock production data for 1985 (chapter III, section 5.41), no productive coniferous forests exist. While it might be expected that production of coniferous will thus be decreased in the future, the USDA Foreign Agricultural Service attache wood market report predicts an increase in softwood logs due to the entry into the market of products from pine plantations.

Table IV-7. Roundwood Demands in the Forest Industry: 1987 (in million m^3).

	BRAZIL (demand)*		FAO (product.)*	
Product	total	%	total	%
Total Roundwood	267	–	241.5	–
Fuelwood	134.6	51	141.8	59
Charcoal	92.8	35	33.4	14
Pulp/Paper	17	6	–	–
Pulp/Paper + particles	19	7	20.9	9
Sawnwood,Veneer,Plywd.	20.4	8	40	16
Other indust.	–	–	5.4	2

* Note that the Brazil data refers to "demand" whereas the FAO data refers to "production".

SOURCE: FAO (1988a) and Celulose e Papel (1987; original not seen, cited by ABRACAVE, 1988).

7.5 Roundwood Demand

Contrasting data (from Brazil and FAO) for the 1987 wood demands in the the forest industry are presented in Table IV-7. The major portion (between 73% and 86%) of the total roundwood production is used in the energy wood sector. Roughly 50% of the total is used for fuelwood; this includes domestic and industrial firewood, and fuelwood which is used to produce distilled fuels such as methanol and ethanol.

Whereas the Brazilian data emphasize charcoal demands on roundwood, the FAO stress the solid wood sector. Although the data do not agree, the lesser importance of the solid wood, and pulp and paper sectors in terms of wood demand are clear.

1 It is probable that if the data for Amazon wood production does/will show increases, the numbers will be low due to the afore-mentioned problem of contraband.

CHAPTER V. THE SOLID WOOD PRODUCT SECTOR

1. GENERAL OVERVIEW

1.1 Recent Growth Rates of the Sector

The solid wood product sector, comprised of the sawmilling, plywood, and composite board industry, was worth an estimated 5.53 billion $US in 1986 (as shown in the previous chapter). While production in this sector has a higher total value than the pulp and paper sector (5.53 versus 2.61 billion $US), it has developed at a slower rate. During the 1970's this sector grew at an average annual rate of 5% in constrast to the 11% average annual rate of growth in the pulp and paper sector (USDC, 1985a). It was affected more by the 1982 world recession when depressed world markets, high interest rates and reduced domestic business activity reflected through poor housing starts caused a considerable depression in this cyclical demand-linked industrial sector. By 1986 however, the sector experienced good growth in response to the Cruzado Plan-induced explosion of consumer demand. Growth slowed in 1987, but increased again in 1988 (USDA/FAS, 1988).

1.2 Change in Production from 1975 to 1987

The percent change of production over the twelve year period between 1975 and 1987 for each of the major solid wood product categories is listed in Appendix 12 (FAO 1988a data). In descending order of magnitude the average annual change in production are: Non-coniferous (NC) sawnwood (9%), plywood (8%), composites (hardboard and particleboard - 5% each), veneer (4%), and coniferous (C) sawnwood (4%).[1]

1.3 Trade

The 1986 value of exports was approximately 311 million $US whereas the value of imports was roughly 32 million $US; an overall positive trade balance of 279 million $US was achieved in this sector. Table V-1. exhibits the 1986 trade balance with export and import values for the individual wood-based products. Treated lumber received the highest export revenue (92.5 million $US) followed by plywood (67.3 million $US), non-coniferous lumber (57 million $US) and hardboard (45.7 million $US). United States is the most important market for sawnwood, veneer and hardboard whereas the United Kingdom is the most important market for plywood (Nahuz, 1988).

Table V-1. Trade Balance for Solid Wood Products: 1986 (units in 1000 $US).

Product	EXPORTS	IMPORTS	BALANCE
Treated Wood	92,351	870	+91,481
Untreated Lumber	69,549	16,615	+52,934
non-coniferous	57,033	na	na
coniferous	12,516	na	na
Plywood	67,348	17	+67,331
Hardboard	45,678	–	+45,678
Veneer	31,730	6,916	+24,814
Particleboard	2,102	243	+1,859
Logs	1,847	7,430	-5,583
TOTAL	310,605	32,091	+278,514

SOURCE: CACEX/IBDF (pers.com. deBarros, 1989).

Important imports were sawnwood (16.6 million $US), logs (7.4 million $US) and veneer (6.9 million $US). Oak from the United States, mahogany and ipe from Paraguay dominate the log imports. Peroba, ipe

1 As noted in the sawmilling section (2.), production data for NC and C sawnwood are very different between Brazilian and FAO sources. Thus it might be expected that the change in production for, in particular, C-sawnwood (using FAO data) is suspect.

and cedro lumber were imported from Paraguay as was cedro veneer. The large import volume from Paraguay is reflective of the fact that Brazil owns most of that country's forest-related industry (Nahuz, 1988 and Laarman *et al.*, 1987).

Particleboard and plywood exports have experienced rapid annual growth averaging 55% and 51% respectively (see Appendix 12). Overall, average annual wood-based panel exports increased by 15% and non coniferous sawnwood by 12%; coniferous sawnwood exports deceased reflecting the depleted native parana pine forests. As shown in Appendix 13 in 1984, the majority of sawnwood, treated lumber and veneer exports were shipped from Northern ports while Southeastern ports dominated the departure points for plywood.

1.4 Roundwood Demand

Roundwood demand in this sector is approximately 60% of total industrial roundwood (ABRACAVE, 1988)[1], thus roughly 22.4 million m^3 were used to produce solid wood products. (Data for roundwood demand by the individual products was not available.) Over 40% of the roundwood is derived from the Amazon forest.

1.5 Tropical Hardwood: All Products

Of the tropical hardwood species used in exported wood products, mahogany is by far the most significant wood both in terms of volume and value of exports . Other species important in the production of wood products include: American oak, virola, imbuia and jatoba (see Appendix 14). Notable countries of destination are: United States, United Kingdom, Puerto Rico and West Germany (see Appendix 15).

1.6 Log Exports

In 1970 log exports were banned in Brazil (Saman, 1983). Later however, in 1986 Resolution 86 of the National Council on Foreign Trade (CONCEX) and Circular 53 of Brazil's Foreign Trade Office (CACEX) allowed for exports of logs from certain species of tropical hardwoods if they originated from settlement projects (USDA/FAS, 1988). Presently, it appears that there is a total ban on log exports from any origin or species (USDA/FAS, 1988).

In 1986, 16,906 tonnes of logs were exported from Brazil valued at a total of 1.8 million $US (see Table V-1.). They were exported to Portugal, Japan, Greece and Spain. China, in 1985, received an experimental shipment of logs from the clearing for a large Amazonian hydroelectric project (Nahuz, 1988). Quiri was the major broadleaf species exported; louro, freijo and andiroba were also included.

1.7 Background for Individual Wood Product Sections

The following sections deal with each industry within the solid wood product sector:

2. Sawmilling
3. Plywood
4. Veneer
5. Composite Boards - Particlebrd, Hardbrd & Fiberbrd.

Several general tables will be refered to within each section including:

Table V-1. Trade Balance for Solid Wood Products: 1986
Appendix 12. Change in Production and Exports of Solid Wood Products: 1975 to 1987.
Appendix 11. Exports and Imports for All Forest Products: 1986.

Appendix 4. is useful to check Latin, common and trade names of the various tropical species.

1 FAO data indicates that roughly 72% of industrial roundwood is used in this sector.

2. SAWMILLING

2.1 Production

There are approximately 14,000 sawmills in Brazil. This number fluctuates according to demand, availability of logs and market prices of sawnwood (Nahuz, 1988). Production figures are thus rather difficult verify. While the FAO (1988a) reports 1987 production of NC and C sawnwood to be 9.7 million m^3 and 8.4 million m^3 respectively, the USDA Foreign Agricultural Service attache (USDA/FAS, 1987/88) reports 8 million m^3 and 2.1 million m^3 respectively.

Production, capacity, degree of mechanization and type of equipment vary widely throughout the country. Increases in production over the past twelve years have averaged 9% per year for NC sawnwood and a much lower 4% per year for C sawnwood. Total wood demand in this industry in 1987 was 16.9 million m^3 or 6.3% of the entire wood demand (ABRACAVE, 1988).

2.11 Amazon Production With the continued depletion of the Southern Araucaria forests, the sawmilling industry is moving North and increasingly utilizing the Amazonian forests for their wood supply (Nahuz, 1988). Only 100 sawmills were operating in the greater Amazonian region in 1952; by 1982 there were 1650 and by 1986 there were 2231 (Peck, 1983; Correa de Lima and Mercado, 1985; and Rezende and Neves, 1988).

Table V-2. compares the number of sawmills and wood production per sawmill size for 1982 and 1986. Sawmill size composition (number of small, medium and large sawmills) has changed little over this four year interval but the medium-sized sawmills are producing a larger percentage of total lumber. This implies that medium-sized sawmills have increased their efficiency. Production, as discussed above, is very difficult to trace. Table V-2. indicates a NC sawnwood production figure of 13.9 million m^3; this is a good deal larger than the FAO or USDA/FAS figures.

Table V-2. Number of Sawmills and Lumber Output by Sawmill size for Amazon region: 1982 & 1986.

Sawmill Size by Annual Prod.(m3)	Number of Sawmills				Lumber Output($1000m^3$)			
	1982	%	1986	%	1982	%	1986	%
<5,000	1050	64	1451	65	1544	29	3800	27
5,001-10,000	459	28	620	28	2267	42	7400	53
>10,000	131	8	160	7	1582	29	2700	19
Total	1640		2231		5393		13900	

SOURCE: IBDF (from Rezende and Neves, 1988).

Within this region, the most important state for lumber production is Para followed by Rondonia. These two states together account for 96% of the total regional production. Apppendix 16 lists the number of sawmills and wood production for five states in the Amazonian region. whereas Para has 1,244 sawmills producing 7.1 million m^3 of sawnwood, Rondonia has 696 producing 6.4 million m^3 of sawnwood. This suggests that Rondonia has larger mills than Para. Of the total sawnwood produced in this region, 33% is consumed locally, 55% is consumed in other parts of Brazil and 12% is exported (Rezende and Neves, 1988).

2.2 Trade

Sawnwood exports from Brazil by country of destination for 1985 and 1986 are presented in Appendix 17. A total of 164 thousand tonnes of non-coniferous lumber, with a value of 57 million $US, was exported primarily to United Kingdom and the United States. Argentina imported the highest volume (13,739 tonnes) of C sawnwood, a total export volume worth 12.5 million $US, followed by United Kingdom and

Uruguay. Mahogany accounted for 53.5% of the aggregate sawnwood export values in 1986, pine held 18% and virola had 9.5%. Treated wood[1] exports fell from a value of 115 million $US in 1985 to 92.4 million $US in 1986. Principle countries of destination were again United Kingdom and United States (see Appendix 18).

Whereas in the South only parana pine, and to a lesser extent imbuia and canela, contribute to Brazil's sawnwood exports, a number of northern tropical hardwoods are sawn for export (Rezende and Neves, 1988). Appendix 19 lists hardwood lumber exports from the Amazon by species for 1986 and 1987. The total value of exports in million $US was 37.1 in 1985, 57.0 in 1986 and 97.0 in 1987. Mahogany is by far the most important sawnwood export accounting for at least 50% of the total volume exported in all three years. Virola and sucupira together sum to another 20% total export volume. United States imports the majority of these products, United Kingdom, Spain and Canada are also significant importers (FAO, 1988a; and UNECE and FAO, 1988a).

Over the past twelve years, exports of NC sawnwood have increased by an average annual rate of 12%, but C sawnwood exports have fallen at an average annual rate of -7% (see Appendix 12). This reflects the decreased supplies of parana pine.

Table V-3. Principle Solid Wood Imports by Product & Major Species: 1986 (t=tonnes).

Species	Logs		Sawnwood		Veneers	
	t	1000 $US(FOB)	t	1000 $US(FOB)	t	1000 $US(FOB)
Cedro	1,565	66	4,833	461	19,382	3,504
Peroba	1,306	21	103,869	4,958	–	–
Mahogany	11,786	1,222	–	–	–	–
Ipe	10,710	245	16,302	1,629	–	–
Oak	17,250	4,620	–	–	–	–
Others	18,368	1,242	166,735	9,567	22,085	3,412
Total	60,985	7,416	291,739	16,615	41,467	6,916
(FAO)		(7,299)		(16,985)		(7,289)

SOURCE: IBDF/CACEX (pers.com. deBarros, 1989).

According to FAO 1986 figures (FAO, 1988a), Brazil ran a trade deficit for volume of NC sawnwood importing more than it exported (424,300 versus 374,700 m^3 respectively). However, the value of the exports far exceeded the imports (97 million $US versus 16.9 million $US).[2] The total sawnwood import value was between 16.6 and 16.9 million $US in 1986 (Table V-3.). Species imported, in descending order of value are: Peroba, Ipe and Cedro.

2.3 Global Position

Brazil has the largest tropical humid forest of any one country in the world, roughly 30% of the global total (Rezende and Neves, 1988). Production of tropical hardwood lumber increased from 13.8% of the world share in 1970 to 22.5% in 1981 (see Appendix 20). In 1970, Brazil was ranked second in production behind Japan, but in 1981, it was well above other producing countries (by % of total production). However, Brazil ranked fourth for global export share of tropical hardwood lumber with a slim 8.2% participation (Appendix 21). Indeed, while Malaysia, the top ranked exporter, exported 54% of its production, Brazil only exported 7% of its production. Brazil's small share of world exports has been attributed to, among other aspects, its difficulty in meeting technical requirements and specifications, inconsistent supply of products and inade-

1 This term is not well defined in the Brazilian literature. As suggested in Chapter IV, 5.1, it probably refers to treated or planed lumber.

2 Note that the FAO value for NC sawnwood exports exceeds the Brazilian value for all sawnwood exports (see Table V-1 and Appendix 11.)

quate marketing of tropical products (pers.com. deBarros, 1989; Rezende and Neves, 1988; and Saman, 1983).

2.4 Utilization of the Amazon Forest

It has been estimated that there are approximately 6000 species growing in the Amazon region. Of these, approximately 400 have been fully identified. Commercialization is limited to 100 and those exported to international markets number around 15 (Peck, 1983). A maximum of 45 species are used by sawmills (Santos, 1988).

Table V-4. presents a cost analysis for the production of sawn Ucuuba (*Virola surinamensis*), an important commercial species from the varzea (bottom land) forests. Transportation costs are one third of the total costs reflecting one of the limitations to Amazonian species utilization.

Table V-4 Cost Estimates for Wood Sawn from Ucuuba(Virola), Originating from Varzea Forests in Para State, Tranported to Sao Paolo (April 1987).

Activity	Cost (US$/m^3)	Percentage %
Felling,squaring-off,and transport to stocking yard	20.28	11.11
Raft trasport to wood processing site(400 km)	6.08	3.33
Processing,sawing,drying and preservation treatment	95.33	52.22
Truck transport to Sao Paulo	60.85	33.34
Total	182.54	100.00

SOURCE: Marques and Rezende (1988)

Maintenance of quality control, a problem plaguing many Amazonian wood industries, is an important factor limiting sawnwood exports. To improve the standard and quality of production, grading rules for Brazilian tropical sawn hardwoods were introduced in 1983 (USDC, 1985a). Based on the work of the ATIBT (Association Technique International des Bois Tropicaux) and the CTFT (Centre Tecnique Forestier Tropical), these rules provide a system of grading appropriate for the highly varied species mix and acceptable to the international market. In addition, a system of cooperative timber warehouses (or *Entrepostos*), operated by the IBDF have been established. These *Entrepostos* function as collecting centres where lumber is accumulated, graded and packaged (USDC, 1985a). The objective is to increase the total timber harvest by encouraging smaller lumber producers to participate in exports and to promote hitherto lesser-known species internationally. It was hoped that the centres would help to increase the volume of exports through increased reliability of shipments (Peck, 1983; Correa de Lima and Mercado, 1985).

Technical assistance requirements of the Amazonian sawmilling industry include:

- machine maintenance and cutting techniques
- log handling, storage and grading
- treatment to prevent timber degrade

Appropriate action in these areas would lead to a better and more consistent product, and higher utilization and recovery from the existing resource (Peck, 1983).

2.5 Use of Plantation Wood

At present, the contribution of the fast-growing Pinus and Eucalyptus species to lumber production is rather low. However, as the costs for harvest and transport of native hardwoods increase with the increased distances between the forests and centres of consumption, it is expected that the native species will be substituted for by these planted exotics. Indeed laboratory test results suggest that *Pinus* spp and *Eucalyptus* spp wood from plantations exhibits phyiscal and mechanical properties which compare favourably with

traditional native woods (Freitas de and Watai, 1988). The lumber industry, however will face stiff competition for plantation wood from the charcoal and the pulp and paper industry (Bethel *et al.*, 1982).

3. PLYWOOD

3.1 Production

Within the solid wood sector, the plywood industry has shown the largest percent increases in both production and exports over the past twelve years (see Appendix 12). The 1988 performance of this industry was impressive with very close to full capacity in production (1.5 million m^3). This after slightly lower productions of close to 1.45 million m^3 in 1986 and 1.4 million m^3 in 1987 (USDA/FAS 1987/88; and USDA/FAS, 1988). Increases in demand by the furniture industry, the housing market and the international market account for the improved performance of this sector.

Species utilization is 70% tropical hardwoods, 30% softwoods (Knight, 1988). The major species are:

Coniferous - parana pine
Non-coniferous - virola, muiratinga, sumauma and acacu

Mahogany is primarily used for 1.2 mm outer plys on the best grades. Product thickness ranges from 3 to 21 mm. Traditionally, the construction industry has been the largest user of plywood domestically. In the past several years however, the furniture industry has challenged this domination and, according to 1988 statistics cited by the Timber Trade Journal, this sector accounted for 70% of domestic plywood use (Knight, 1988).

3.2 Location of Industry

The Brazilian plywood industry developed in the 1960s through utilization of parana pine. In spite of the present extensive depletion of these forests, most of the 250 mills are still located in Southern states of Parana (most important state), Santa Caterina and Rio Grande do Sul. As the amount of raw material utilization from the Amazon increases, wood has to be transported distances some 4000 to 5000 km. Accordingly, an increasing number of companies are locating plants in the North (Knight, 1988; and Nahuz, 1988).

3.3 Trade

In recent years, 30 to 40 percent of plywood production has been exported. This figure dropped to just above 20% in 1986 when the total volume exported was approximately 274,000 m^3 with a value of 67.3 million $US (USDA/FAS, 1988).[1] The strong domestic demand and the longer than usual rainy season in the Amazon (making wood extraction difficult) explain this reduction in exports. However, with lower domestic demand due to high domestic plywood price, and good Amazon harvest, 1987 exports were reported to have increased to 50% of production producing an export revenue of approximately 90 million $US $US (Knight, 1988).

Plywood produced from tropical broadleaf timber accounts for 45% of exports (USDA, 1988). The major markets are:

United Kingdom - 29%
Puerto Rico - 20%
United States - 10%

Appendix 22 indicates export volumes and values by country of destination.

3.4 Use of Plantations

Few Southern producers that had the foresight to establish pine plantations. As a result, only a very few firms are presently meeting up to three quarters of their wood requirements via pine plantations. Results of

1 The FAO (1988a) figure for exports is a good deal lower (218,000 m^3) as is their production figure (902,000 m^3).

a Southern Brazil wood product industry survey conducted by Garca, Hoeflich and Haliski (1988) indicate wood consumption to be 72% from native forests and 28% from plantations within the plywood industry. Indeed, even this figure is probably rather optimistic. There has been considerable difficulty in cultivating parana pine; when established however, the normal rotation is 20 to 30 years.

3.5 Problems Faced by the Plywood Industry[1]

Wood supply is secured through a large number of small producers; the resulting lack of producer control over their suppliers often leads to quality control problems. Types of difficulties encountered include inconsistency of gauge and type of wood, fungus, dryness, discoloration and knots. Inconsistency of product limits exportability; only approximately 20 plywood mills currently sell to the export market (Knight, 1988). Other sector problems:

- high wood costs
- difficulty in Amazonian wood utilization as the wood density is often either too low or too high
- increased price of glue and resin due to the shortage of Brazilian production
- high transportation costs -- both of wood traveling to producers and of product heading to market.

4. VENEER

4.1 Production

There are about 300 companies producing veneers. Within the Amazonian region, there are 70 plywood and veneer mills. The majority of these (50%) are located in Para, 36% are situated in Rondonia and 13% in Amazonas. Total production is roughly 285,000 m^3/year (Mercado and Campagnani, 1988).[2]

Veneer production and exports have grown 52% and 59% over the past twelve years respectively. Tropical hardwood (from which the vast majority of Brazilian veneers are made) veneer production has increased steadily over the last three years due to a high demand in the export market (see Table V-5.). Production for 1987 is estimated at 230,000 m^3 (USDA/FAS, 1988).

Table V-5. Non Coniferous Veneer Production and Exports: 1985 to 1988 (volume = m^3 & value = 1000$US).

Year	Production	Exports		percent
	volume	value	volume**	exports/product.
1985	210,000	33,982	52,000	25
1986	220,000	31,396	50,000	23
1987	230,000	29,791*	66,000	27
1988	240,000	na	na	na

* January to November

** FAO volumes are not broken down in NC & C, therefore this figure is slightly high.

SOURCE: USDA/FAS, 1988 (production figures)
CACEX/IBDF,pers.com.deBarros, 1989(value of exports)
FAO, 1988a (volume of exports).

1 It is probable that part or all of these problems apply to all the industries within the solid wood sector.

2 It is unclear whether the USDA data includes American oak as "tropical hardwood", but, for the sake of simplicity, it is here assumed that "tropical hardwood" is synonymous with "non-coniferous". This is consistent with the IBDF/CACEX data.

4.2 Trade

Export volume for 1987 was 66,000 m^3 (FAO, 1988a). This represents approximately one quarter of the total production. Export percent share of production has remained relatively stable for 1985, 1986 and 1987. The major NC species exported (value-wise) over these three years were mahogany, American oak, imbuia, pau-ferro. While jacaranda and cedro appear to be decreasing in importance, cerejeira and virola are emerging (see Appendix 23).

Over half the veneer exports by volume go to the United States. In terms of value however, West Germany, which, in 1986 imported 14% by volume but 30% by value, appears to be importing a higher quality product than that imported by the United States (see Appendix 24). Parana pine, the major conifer-made veneer, is primarily exported to Uruguay.

5. COMPOSITE BOARDS

5.1 Production

The composite board sector, in particular, the particleboard industry, has experienced rather large increases in exports and, to a lesser extent, in production over the past decade.[1] FAO (1988a) estimates for 1987 production of particleboard, hardboard and fiberboard are 660, 550 and 200 thousand m^3 respectively. Some medium density fiberboard is also produced but production figures do not appear to be available. Plantation wood, such as Eucalyptus, is the commonly used fiber (USDC, 1985a).

5.2 Location of Industry

Almost all the composite board producers have been traditionally located in Southern Brazil. Recently however, firms in this sector are also looking at moving to the North. Duratex, a large building material producer, announced last year that it will rehabilitate an inactive particleboard plant in Bahia, a city located in the impoverished Northeast region (World Wood, 1988a). It appears that there is a rather strong demand for this product in the region; up until now it was shipped on from the South.

5.3 Trade

Exports in this sector are limited to particleboard and hardboard. According to the CACEX/IBDF information (see Appendix 11), 186,964 tonnes of hardboard worth 45.7 million $US were exported in 1986. Sixty one percent of this was imported by the United States, 25% by Europe and 11% went to Canada. For particleboard exports, 10,916 tonnes worth 2.1 million $US were shipped.

1 Very little IBDF production data appears to be available for this sector; FAO volume figures, though consistently lower than those from the USDA/FAS, are reported here to provide a relative times series.

CHAPTER VI. PULP AND PAPER

1. CONTRIBUTION TO ECONOMY AND GLOBAL POSITION

The total value of production within the pulp and paper sector is about half that of the solid wood sector.

The balance of trade however is heavily in the pulp and paper sector's favor; net export revenue values were 525 million $US for pulp and paper products and 279 million $US for solid wood products (see Table IV-3.). As a result, the sector's 674 million $US overall contribution to total Brazilian exports (in 1986) was three percent as opposed to the 1.4% contribution (311 million $US) from the solid wood sector.

Brazil has been described as the largest potential competitor in the global pulp and paper market (Murakami, 1987). For example, in 1984, Brazilian producers generated 48% of the world's eucalyptus market pulp (Hall, 1987a). Indeed, their percent share of global production has increased from 1.3% in 1976 to 3.4% in 1986 for chemical wood pulp, and from 1.3% to 2.2% for paper and paperboard (same years). Export percent share too has increased between 1976 and 1986: from less than 1% to 4.0% for chemical pulp; and from less than 1% to 1.6% for paper and paperboard. Brazil now ranks seventh in the world for chemical wood pulp production and exports (by volume), and eleventh and thirteenth for paper/paperboard production and exports respectively (FAO, 1988a).

2. RAW MATERIAL

2.1 Wood Demand

The pulp and paper industry used 17 million m^3 of wood in 1987 or 6.4% of the total wood demand in Brazil (ABRACAVE, 1988). Of this, approximately 95% originated in plantations and 5% came from native forests (Graca *et al.*, 1988). As described in the Chapter III, these plantations consist primarily of eucalyptus and pine. The penetration of world markets reflects the success of these plantations (USDC, 1985a).

2.2 Eucalyptus

The Brazilian pulp and paper industry is based on the creation of plantation forest with ever increasing yields and potential (Hall, 1987a). Over a two week period, one might observe 30 cm per tree worth of new height growth in some of the faster growing eucalytus plantations. These rapid growth rates form the basic economic rationale for the use of plantation eucalyptus in the pulp and paper industry. Rapid growth rates mean low-cost wood production as, among other factors, only a small area of land is required to supply a particular volume of production (Woodbridge Reed, and Associates, 1986). For example, 50,000 ha of plantation forest is reportedly sufficient area to provide enough wood production to supply a pulp production line of 500,000 tonnes/year (Hall, 1987b). In comparison, a northern forest growing at 1.75 m^3/ha would require 1.43 million ha to supply a softwood mill of similar size (based on five m^3/tonne) (Woodbridge Reed, and Associates, 1986).

The growth increments of eucalyptus hybrids in south and southeast areas of Brazil have increased from 33 to 70 m^3/ha/year over the past ten years (Kellison, 1988). Many eucalyptus species can be vegetatively propagated thus allowing easier genetic manipulation to improve volume production and, at the same time, to capture specific attributes such as wood density (Kellison, 1988).

Originally eucalypts were introduced and used due to their low cost. Now they are also considered important in terms of the excellant properties they impart (Sidway, 1988). Desirable characteristics include the homogenity of fibers and lack of growth rings - a result of continous year-round growth (Hall, 1987a). Research, focused on the selection of species and determination of correct rotation lengths, has allowed for vastly improved cooking, washing, bleaching and refining (Murakami, 1987). As a result, the present day fiber properties of eucalyptus furnish yield pulp that is well suited for the manufacture of all papers which do not require high strength. It is particularily effective for the production of sanitary paper, and produces high quality printing and writing paper (Gomide, 1988). Indeed, eucalyptus now provides 100% of the fiber furnish utilized in the production of all domestic white printing and writing paper in Brazil (Hall, 1987a).

The good fiber formation and uniformity of the raw material are effected through the use of even age and genetically superior plantation trees (Paoliello, 1987). The resultant pulp has high brightness, good opacity

and bulk, characteristics which are favored in world markets. Consequently, Brazil has emerged in the eighties as one of the largest producers in the world (Murakami, 1987).

These eucalyptus plantations and corresponding large net export revenues are however, a relatively recent phenomena. The Brazilian pulp and paper sector only achieved a positive balance of trade in 1975 for pulp and in 1981 for paper.

2.3 Other Species

Growth increments in pine plantations are not as impressive as those for eucalyptus. They are however, still rather large in comparison with other northern countries; growth rates in the pine plantations of Brazil are reported to exceed those of the U.S. by 100 to 150 % (Kellison, 1988).

The perceived inferiority of Brazilian-grown pine results from the high proportion of short, thin-walled spring and juvenile wood. These characteristics may result in lower chemical pulp yield per unit dry weight of wood and low tear values. However, the pulp industry has overcome many of these difficulties through controlled single-age pulp runs thus vastly improving yields from juvenile wood (Kellison, 1988).

3. PRODUCTION

3.1 Evolution of the Industry

In the 1950's the industry, which had traditionally relied upon native pine for furnish in its mills, began to experience a wood shortage. The Araucaria forests within economical distances of the mills were in short supply. Eucalyptus plantations, established starting at the beginning of the twentieth century by railroad and steel companies, were however in relatively abundant supplies. Up until this time, eucalyptus wood was considered to be inadequate for most pulp production and was only accepted as a filler to reduce costs in the traditional long fiber pulp production. These factors resulted in a particular situation: large pulp and paper mills in need of raw materials surrounded by an ample supply of "inferior" wood. Thus began the development of new technology to utilize eucalyptus wood in the manufacturing of high quality pulp suitable for the production of, in particular, printing and writing papers (Gomide, 1988).

It was during the fifties that Brazil's, and thus the world's, first industrial-scale eucalyptus pulp line was established (Paoliello, 1987). As eucalyptus pulp production began to increase, so too did the need to establish more plantations. In 1966 the Brazilian government set up its fiscal incentive scheme[1] to encourage reforestation and afforestation (Kengen, 1987; Murakami, 1987).

Forecasts made at the beginning of the seventies predicted that there would be a 15 million tonne and 20 million tonne global shortage of pulp and paper respectively by 1980. Knowing the potential difficulty to import these products and, at the same time, aware of the Brazil's comparative ability to produce these products, the government launched its First National Program of Pulp and Paper in 1974 (Colodette, 1988; Kengen, 1987). This ambitious and farsighted plan encouraged the industrial use of the eucalyptus forests for large scale pulp production (Paoliello, 1987). The objective was to achieve self-sufficiency in pulp and paper, and to export the surplus by the year 1980 (Murakami, 1987; Colodette, 1988). Although only part of the original plan was accomplished, it was enough to provide the basis for the rapid development of the pulp and paper industry in the country (Paoliello, 1987).

3.2 Evolution of Production

3.21 Pulp The evolution of production in the Brazilian pulp[2] and paper industry is presented in Appendix 30. Although still exceeded by long fiber pulp production in 1956, short fiber pulp production was, from 1960 on, the greater of the two. From 1956 to 1966, pulp production increased by almost six times. Over this ten-year period, short fiber generation increased ten fold while long fiber increased four fold. In the eleven-year period 1966 to 1977, total pulp manufacture more than tripled; short pulp and long pulp

1 This scheme is discussed in detail in the Forest Resource chapter.

2 Evolution of pulp production data was only available for chemical and semi-chemical pulp as the ANFPC do not provide over-time data for other pulp types.

production quadrupled and doubled respectively. The industry experienced a period of very rapid growth between 1977 and 1980 when manufacture of both pulp fiber types approximately doubled. The annual average growth rate over this period was approximately 30% reflecting the results of the National Pulp and Paper program. During the eighties, production growth has slowed considerably; the annual average growth rate has been approximately 5% over the past six years. The low increment in pulp production during 1984-1985 was due to the exhaustion of capacity. Interestingly, in this period, long fiber pulp generation has increased by 50% while short fiber production has only increased by 25%. This would indicate the commencement of pine plantation utilization and the introduction of more long fiber pulp manufacturing centers.

3.22 Paper Growth in the paper industry has been slower than in the pulp industry through the fifties, sixties and seventies. The reverse of this situation is true for the eighties. Between 1956 and 1966, paper production doubled. From 1966 to 1977, production almost tripled. Over the three year period between 1977 and 1980, the average annual growth rate was approximately 17%. During the eighties, the growth rate has averaged 6% per year (versus the 5% average for total pulp).

3.3 Present Production

3.31 Overall Volume and Value of Pulp and Paper Production Total pulp production, including chemical and semi-chemical, mechanical (all types) and dissolving pulps, reached nearly four million tonnes in 1986 (see Table VI-1). In this year the industry was reported to have been operating at around 95% capacity (Rezende and Neves, 1988; Gomide, 1988). Chemical pulp accounted for the majority (84%) of production and together with semi-chemical, made up 89% of overall pulp production. As described in Table VI-2., production of these two types of pulp[1] had an approximate value of 1.31 billion $US. The other pulp types were relatively unimportant; listed in decreasing percentage share of total production they are: mechanical pulp (7%), thermo-mechanical pulp (2%) and dissolving pulp (2%).

Table VI-1. Overall Pulp Production in Brazil: 1986 & 1987 (units in tonnes).

Type of Pulp	1986		1987	
	Total	%	Total	%
"Celulose"				
Chemical	3,393,219	85	3,520,120	85
Semi-chemical	162,188	4	144,341	4
Subtotal	3,555,407	89	3,664,461	89
Others				
Mechanical	276,841	7	300,795	7
Thermo-mech.	72,259	2	82,316	2
CTM	9,230	–	7,360	–
Subtotal	358,330	9	390,471	9
Dissolving	83,641	2	82,831	2
TOTAL	3,997,378	100	4,137,763	100

SOURCE: ANFPC (1987).

Paper production amounted to 4.5 million tonnes in 1986. The calculated value of this production is 2.27 billion $US.

3.32 Chemical and Semi-chemical Pulp Production Pulp production, broken down by fiber length and amount of bleaching, is presented in Table VI-3. Of the total 1986 production, short fiber pulp made up 68% and long fiber made up the remaining 32%. Overall, short fiber, bleached pulp is the most important

1 Value of production was only possible for chemical and semi-chemical pulp due to insufficient data.

pulp product; it accounted for 61% of total production. Unbleached long fiber, the next most important pulp, accounted for 26.5% of total production for 1986. Whereas the short bleached fibers are used in the manufacture of printing and writing (P&W) papers, long unbleached fibers are usually consumed in the production of wrapping and packaging (W&P) papers (Gomide, 1988).

Table VI-2. Value of Pulp and Paper Production: 1986 & 1987.

Product Year	Amt. of Prod. (million tonnes)	Per Unit Export Value ($US per tonne)	Value of Prod. (billion $US)
PULP			
1986	3.56	367.90	1.31
1987	3.66	488.79	1.79
PAPER			
1986	4.53	501.07	4.53
1987	4.71	598.65	4.71

SOURCE: ANFPC (1987).

Table VI-3. Chemical and Semi-chemical Pulp Production by Fiber Origin: 1986 (t=tonnes).

Fiber Type	Production (t)	% by fiber length	% of total
Short Fiber			
Bleached Eucalypts	2,120,148	87	60
Unbleached Eucalypts	197,483	8	5
Total Eucalypts	2,317,631	95	65
Others	118,008	5	3
Subtotal:	2,435,639	100	68
Long Fiber			
Bleached Pine	189,460	17	5
Unbleached Pine	867,213	77	25
Total Pine	1,056,673	94	30
Others	63,095	6	2
Subtotal:	1,119,768	100	32
TOTAL	3,555,407	–	100

SOURCE: ANFPC (1987).

3.321 Fiber Source and Processes Although the Brazilian climate conditions would provide for a wide diversity of pulp fiber sources, wood accounts for more than 97% of the total pulp production. As indicated earlier, the short-fibered (1mm) eucalyptus is the most important wood utilized in pulp production; pine is the most common long-fibered wood. Table VI-4. presents a breakdown of chemical and semi-chemical pulp by fiber origin. Eucalyptus, which is normally bleached, provided the raw material for 95% of all short fiber pulp. Pine, generally unbleached, provided 94% of the furnish for all long fiber pulps. By comparing Tables VI-3. and VI-4., one may observe that, in 1986, eucalyptus bleached pulp made up 98% of total short fiber bleached pulp and pine unbleached pulp made up 95% of total long fiber unbleached pulp.

The more important species are: *Eucalyptus saligna, E. urophylla,* and *E. alba* (Rezende and Neves, 1988). Other short fibers of minor importance include hardwoods such as *Gmelina arborea* and *Acacia negra*, and other fibers such as sugar cane bagasse (Gomide, 1988). Long fibered pulp is made from

softwoods -- *Pinus elliottii, P. taeda, P. caribaea* and *Araucaria angustifolia* (parana pine) -- and other fibers including bamboo, sisal and cotton linter (Rezende and Neves, 1988).

Table VI-4. Chemical and Semi-chemical Pulp Production: 1986 & 1987 (in tonnes).

Type of Pulp	1986		1987	
	Product.	%	Product.	%
Short Fibre				
Bleached	2,168,858	61	2,201,216	60
Unbleached	266,781	7	299,190	8
Subtotal	2,435,639	68	2,500,406	68
Long Fibre				
Bleached	207,794	6	193,436	5
Unbleached	911,974	26	970,619	27
Subtotal:	1,119,768	32	1,164,055	32
TOTAL	3,555,407	100	3,664,461	100

SOURCE: ANFPC (1987).

The production of chemical and semi-chemical pulps is dominated by the kraft (sulphate) process. It accounted for 93% of total pulp production in 1986. Several minor pulp mills use the soda process mainly due to cost and air pollution problems. Other processes of minor importance are sulphite, calcium hydroxide and neutral sulphite (Gomide, 1988).

3.33 Paper Production Paper production by product is described in Table VI-5. The two more significant products are wrapping & packaging papers (46% of total production - 2.2 million tonnes) and printing & writing (28% - 1.3 million tonnes). Other papers, in decreasing order of importance are: paperboard (11%), sanitary papers (7%), newsprint (5%) and special papers (3%).

Up until 1983, newsprint was only produced by one major producer. The 1985 approximate doubling of production resulted from the contribution by PISA-Papel de Imprensa SA, a second newsprint mill which began production in 1984 (Rezende and Neves, 1988). Production in 1986 reached 218,000 tonnes.

Table VI-5. Brazilian Paper Production, Exports, Imports and Consumption: 1975 to 1987 (units in 1000 tonnes).

Type of Paper	1975	1980	1984	1985	1986	1987
PRODUCTION						
Newsprint	125	105	109	208	218	232
Printing & Writing	416	870	1067	1146	1306	1310
Wrapping & Packing	107	1600	1770	1807	2066	2174
Sanitary	214	232	274	288	294	334
Paperboard	55	422	396	457	499	524
Special		132	126	115	142	138
TOTAL	1688	3361	3742	4021	4525	4712
Total Imports	203	258	180	121	280	268
Total Exports	13	190	703	543	692	609
Apparent Consumpt.	1878	3429	3219	3599	4114	4371
Consumpt./Capita	17.7	28.3	24.2	26.5	29.7	30.9

SOURCE: ANFPC (1987).

3.4. Producers

3.41 Major Producers There are an estimated 14,000 industry establishments most of which are small-scale, older manufacturing units. Of these, approximately twenty have an annual capacity of 50,000 tonnes or more per year (USDC, 1985a). Tables VI-6. and VI-7. list the major pulp and paper producers in Brazil

Brazil and their participation in the total national production. The top ten pulp producers account for 86% of the total production; the top ten paper producers generate 64% of the entire paper production. Most of the larger firms have fully integrated pulp and paper facilities. However, a number of units are geared in part or entirely for the manufacture of market pulp for sale domestically or abroad (USDC, 1985a; ANFPC, 1987).

Table VI-6. Major Brazilian Pulp Producers in 1986.

Industries	Production (1000 tonnes)	Percent of Total Prod.
Grupo Klabim(3 mills)	761	21.4
Aracruz Celulose S/A	476	13.4
Cenibra S/A	345	9.7
Cia Suzano de Papel e Celulose	332	9.3
Champion Papel e Celulose Ltda	273	7.7
Ripasa S/A Celulose e Papel	215	6.0
Cia Florestal Monte Dourado(Jari)	226	6.4
Ind. de papel Simao S/A	182	5.1
Monville Prod. Florestais Ltda.	143	4.0
Rigesa Celulose, Papel e Emb.Ltda	121	3.4
TOTAL	3,074	86.0

SOURCE: ANFPC (1987).

Table VI-7. Major Brazilian Paper Producers in 1986.

Industries	Production (1000 tonnes)	Percent of Total Prod.
Grupo Klabim(6 mills)	743	16.4
Grupo Suzano (3 mills)	457	10.1
Champion Papel e Celulose Ltda	305	6.7
Grupo Simao (3 mills)	257	6.4
Grupo Ripasa (4 mills)	236	5.9
Rigesa Celulose,Papel e Emb.Ltda	209	5.2
Manville Prod. Florestais Ltda.	179	4.4
Grupo Trombine (3 mills)	135	3.4
Pisa-Papel de Imprensa S/A	123	3.1
Papirus Ind. de Papel S/A	80	2.0
TOTAL	2,724	63.6

SOURCE: ANFPC (1987).

3.42 Location The pulp and paper industry is concentrated in the southern and southeastern states (see Appendix 26) close to the necessary infrastructure services and markets. The only mill located in the North is the Cia Florestal Monte Dourado pulp mill, better known perhaps by its previous title "Jari"[1] in the state of Para. Sao Paulo is the most important state for this sector: 50% of the nation's paper is produced there as well as 33% of the nation's pulp production.

For mechanical pulp, the vast majority (83%) of production takes place in the state of Parana. The two biggest producers, Klabin de Papel e Celulose SA and Pisa - Papel de Imprensa SA, accounted for 38% and

1 The Jari project is discussed briefly in the Forest Resource chapter.

24%, respectively, of total production. Mechanical, thermo-mechanical and chemothermo-mechanical pulp currently account for only nine percent of overall pulp production.

3.43 Ownership Under the Pulp and Paper Industry Development Plan, direct and joint foreign investment were encouraged (USDC, 1985a). Thus several of the larger pulp and paper companies have joint ownership with multinationals. For example, Aracruz Cellulose has joint Brazilian, Japanese, Norwegian, Swedish ownership (as of 1983). Nipo Brasileira SA Celulose (CENIBRA) is under joint Brazilian-Japanese control (USDC, 1985a). Fletcher Challenge Ltd., a New Zealand-based multinational corporation purchased 50% ownership in Papel de Impresa (PISA) in May, 1988 (Bus.Latin Amer., 1988; World Wood, 1988b).

Although foreign ownership/joint-ownership is still common, a number of companies have recently come under Brazilian ownership. Such is the case with Cia Florestal Monte Dourado, formally known as Jari Florestal e Agropecuaria. The ownership of this company was transfered from the founder, Daniel Ludwig, to a group of Brazilian business men in 1982 (Truitt, 1985).

As with many large, private Brazilian firms, a number of pulp and paper companies are still wholly owned by their founding families (Bus.Latin Amer., 1987; Hall, 1987a). However, the search for investment capital in recent years has resulted in more and more of these shares going public and thus the open participation of individual or corporate shareholders.

3.5 Advantages and Disadvantages of Pulp and Paper Production

3.51 Advantages The main comparative advantage for Brazil in pulp and paper production is its low wood costs. This inexpensive wood production is effected by the relatively low land costs, high growth increments of plantation eucalyptus, favorable climatic conditions and plantations located within an economical distance from the mill (deBarros, 1989a). The growth increments from man-made forests in Brazil are higher than those of plantations in northern hemisphere countries and a great deal higher than those of the indigenous species found in these northern countries (Kellison, 1988). Table VI-8. presents a comparison between pulpwood costs in the eight major pulp producing countries. As wood costs is one of the larger components of total pulp production costs, Brazilian pulp manufactures have a strong competitive edge (Paoliello, 1987).

Table VI-8. Pulpwood Costs by Country.

Country	Pulpwood Cost (US$/m3 at Mill Gate)	
	Softwood	Hardwood
Finland	45	40
France	42	38
Sweden	40	35
Spain	26	28
Canada (East)	24	28
USA (SE)	21	25
Portugal	15	17
Brazil	12	10

SOURCE: Siuko (1987).

The mid to low densities of eucalyptus wood make it reasonably easy to bleach (Zobel, 1988). Therefore, less investment per tonne is necessary in the manufacture of bleached hardwood pulp as it requires less cooking time than that required for bleached softwood. For example, the total investment required to produce 525,000 tonnes of bleached eucalyptus pulp including capital and fixed costs is approximately 700 million $US. This size of investment in a bleached softwood pulp operation would yield only 420,000 tonnes (Hall, 1987a). Thus the investment for softwood bleached pulp is about 25% higher than that required for hardwood.

3.52 Disadvantages Although Brazil maintains various distinct advantages over its northern competitors in pulp and paper production, there are also several problems facing producers. For example, the interest rates on capital are a good deal higher in Brazil versus those in the more traditional suppliers' countries. Infra-structure and distribution costs, too, are sizable. Difficulties in obtaining investment funds for upgrading and building new capacity appear to be a major deterrent to increasing production.

4. TRADE

4.1 Domestic Consumption

4.11 Pulp Consumption Close to 75% (2.67 million tonnes) of the total 1986 chemical and semi-chemical pulp production of 3.56 million tonnes was consumed domestically. Total consumption, domestic production consumption (2.67 million tonnes) plus imports (0.07 million tonnes), thus equalled 2.7 million tonnes (see Appendix 27). In 1987 percent domestic consumption of total production increased to equal approximately 78% or 2.85 million tonnes making total consumption 2.9 million tonnes. The average annual growth of consumption has been close to 10% in the past five years (1983 to 1987). In contrast to this, the average annual growth of production, over the same period, is half that or approximately 5%. The high levels of consumption reflect the increased levels of paper production in this period.

4.12 Paper Consumption Whereas overall paper consumption increased at a slower rate than production over the period 1975 to 1985, consumption grew faster than production in the last two years. The average growth was 10.8% per year for consumption versus 8.5% per year for production (1985 to 1987). In 1986 more than 15% of total production was consumed domestically. The large increases in paper consumption reflects the government policy of emphasis on education (Paoliello, 1987).

Newsprint showed the largest increases in consumption; the rate jumped by 50% between 1985 and 1986 (278,000 tonnes to 418,000 tonnes). As a consequence of rising paper consumption, domestic demand for pulp has also increased. The domestic market for printing and writing papers has also increased rapidly in the past few years (deBarros, 1989a). There was a 39% increase in consumption between 1984 and 1987.

The rapidly rising domestic pulp and paper consumption characteristic of the past several years poses balance of trade concerns for government officials. Export capacities decrease, and import requirements may well increase, correspondingly with domestic consumption increases (Paoliello, 1987).

4.13 Paper Per Capita Consumption Despite Brazil's relatively high total consumption, the per capita consumption, is rather low in comparison with other South American countries such as Argentina (36.5 kg) and Venezuela (31.1 kg). Canada, with a population of 25 million, has a total consumption of 4.4 million tonnes/year (per capita = 176 kg) Brazil, in contrast, with more than 140 million inhabitants, only consumes 3.2 million tonnes/year (per capita = 23 kg) (Rezende and Neves, 1988; deBarros, 1989a).

Per capita consumption figures are listed in Table VI-5. Considering the 1985 value of 26.5 kg and the 1987 value of 30.9 kg, it would appear that per capita consumption is rising, albeit slowly. As this figure increases, the domestic demand for pulp would increase correspondingly.

4.2 Trade Balance

Up until the early seventies, Brazil imported almost all its pulp but from 1975 on, it became a net exporter (Rezende and Neves, 1988). As for paper, it was not until 1981 that Brazil showed a positive balance of trade in overall paper products. With the notable exception of newsprint and a relatively small amount of specialty papers, the Brazil's exports of paper products have exceeded imports since at least 1979.[1] Although Brazil began exporting newsprint in 1986, it still exhibits a negative export/import ratio. This in spite of the aforementioned increase in production resulting from the operation commencement of PISA's newsprint facility in 1984.

The total pulp and paper sector showed an increase in net exports (value basis) between 1986 and 1987 (see Table VI-9.). Thus the already positive trade balance increased from 5.11 billion $US to 5.69 billion $US. The pulp sector exhibited a positive increase in net exports with the trade balance increasing from 3.09 bil-

1 Export/import data was only available from 1979 on.

lion $US to 3.71 billion $US. Within the paper sector however, there was a decrease in net exports; the trade balance decreased from 2.03 billion $US to 1.98 billion $US. Accordingly, the 1987 balance of trade for pulp was almost twice as large as that for paper.

4.3 External Trade

4.31 Overall Trade The leading exports in 1986 were bleached chemical pulp and printing & writing papers. Approximately 73% (497 million $US) of the export revenues were accounted for by the international sales of these two products. Bleached chemical pulp, newsprint and printing & writing papers are the key imports (see Table VI-10). Together these products made up approximately 81% (134 million $US) of the total import values in 1986.

Table VI-9. Exports, Imports and Trade Balance Values for the Pulp and Paper Sector: 1986 and 1987 (units in 1000 $US).

Year	Pulp	Paper	Total
Exports			
1986	330,708	346,810	677,518
1987	399,369	364,779	764,148
Imports			
1986	21,791	144,248	166,039
1987	28,300	166,489	194,788
Balance of Trade			
1986	+308,917	+202,562	+511,479
1987	+371,069	+198,290	+569,360

SOURCE: ANFPC (1987).

Table VI-10. Imports of Pulp and Paper Products: 1986 and 1987 (t=tonnes).

Product	1986			1987		
	1000 t	1000 $	%	1000 t	1000 $	%
Pulp			of $			of $
Bleached Chemical	30.3	14,273	65	38.8	21,405	76
Dissolving	–	–	–	6.1	3,575	13
Clippings/Shreds*	31.8	2,528	12	25.0	2,021	7
Paper			of t.			of t.
Newsprint	213	na	76	184	na	69
P. & W.	50	na	18	57	na	21
Specialty	14	na	5	21	na	8
Others	4	na	1	6	na	2

* direct translation from the Portugese term "aparas"

SOURCE: ANFPC (1987).

4.32 Chemical Bleached Pulp Chemical bleached pulp comprises 97% of all pulp exports. Very little exported pulp is unbleached (made from pine) or mechanical. Although the ANFPC export data does not break down exports by fiber origin, one may assume, knowing that most (92%) chemical bleached pulp is made from eucalyptus, that exports are comprised almost entirely of eucalyptus pulp with a very small percentage derived from pine. Indeed, of the 3,370 million tonnes of eucalyptus pulp exported globally in 1986, Brazil accounted for 40% of the total (Kellison, 1988).

Four mills specialize in bleached short fiber pulp in Brazil. These four, CENIBRA, Riocell (a Klabin Group member), Aracruz and Jari together make up the Brazilian Pulp Exporters Association known as ABECEL. As these mills are non-integrated, their production is either sold domestically to paper mills or exported (ie. their production is all market pulp. Of the total hardwood (ie. eucalyptus) pulp exported in 1986, this group exported very close to the entire amount (Paoliello, 1987).

Pulp exports, and corresponding share of world markets have decreased between 1983 and 1987. Hardwood pulp exports, for example, have decreased from 17% of world market shares in 1980, to 14% in 1985 (Paoliello, 1987). As previously mentioned, this reflects the increase in domestic demand for papers brought about partially through a political policy emphasis on education. It also reflects an increase in paper exports over the same period.

4.33 Direction of Trade Imports of chemical pulp originate primarily in Chile and Argentina. Other countries from which Brazil obtains pulp include U.S.A., Canada, West Germany and Bolivia. The majority of newsprint is imported from Canada with a minor amount being imported from Chile, Finland and South Africa.

Pulp and paper products are exported to a number of countries (see Appendices 28 and 29). The major destinations for pulp are United States (27% of total exports by value), Belgium (24%) and Japan (19%). The leading paper products importers are United States (14% of total exports by value), West Germany (7%), United Kingdom (6%) and Italy (5%).

5. FUTURE OUTLOOK

5.1 Overall Situation

In 1982, Brazil's Foreign Trade Foundation was already pointing out the difficulty Brazil would face in maintaining its world share of exports in the pulp and paper sector in consideration of the rapidly increasing domestic demand. Given that sector investments in the 80's were not sufficient, that the industry was operating at close to full capacity, and that the lag period between mill start-up and full production is relatively long, domestic demand is predicted to exceed supply in the near future (Rezende and Neves, 1988).

The pulp and paper industry is capital-intensive. The FAO document "The Outlook for Pulp and Paper to 1995" points out the major constraint to development in the pulp and paper industry as the difficulty in capital mobilization due to major debt servicing and balance-of-payment problems (FAO, 1986). Indeed, export volumes are limited by capacity problems resulting from a lack of capital investment as opposed to insufficient raw materials (deBarros, 1989a).

According to a survey by the National Council for Industrial Development (CDI), Brazil can expect a shortage of pulp and paper in the domestic market if large investments are not made. Should this be the case, Brazil may have to regress to being an importer of pulp and paper (Gomide, 1988).

Current forecasts of global increases in demand for pulp and paper, and the growing domestic deficit for pulp used in paper manufacturing, together with the great potential of this industry have encouraged the Economic Development Council (CDE) to assign special priority to this sector in the Program for National Development. Additionally, this sector is considered important as it requires few imported materials and equipments (Hall, 1987a). A newly approved program, the Second Pulp and Paper National Program, has the objective of doubling pulp and paper between the years 1987 to 1995, at an approximate cost of 6.8 billion $US (Colodette, 1988; deBarros, 1989a). According to a recent survey from the Brazilian Bank for Development, this twinning of production will be principally focused on eucalyptus pulp (Gomide, 1988).

5.2 New Projects

The Brazilian pulp and paper industry will undergo several significant changes over the next 10 years. For example, Brazil has the largest expansions plans for bleached eucalyptus pulp production of any country in the world (Sidway, 1988). Presently there are five ambitious eucalyptus pulp production projects planned (see Table VI-11.). These consist of either converting existing plants, doubling existing mills, or constructing new units (Paoliello, 1987). Total yield from these projects would be some 1.5 million tonnes/year. Announced new capacity, for initiation in the mid 1990s, would increase the total capacity to almost five million tonnes, 70% of which would be market pulp.

Table VI-11. Eucalyptus Pulp Projects in Brazil. (t=tonnes).

Project	Capacity (t/yr)	Startup	State/Location
Duplication of CENIBRA	350,000	1992 ?	Minas Gerais
Duplication of Aracruz	550,000	1990 ?	Espirito Santo
Duplication of Riocell	250,000	1992 ?	Rio Grande do Sul
Conversion of CCB	80,000	1989 ?	Bahia
New Mill: (CVRD/ SUZANO)	250,000	1992 ?	Bahia
Total	1,480,000		

SOURCE: Paoliello (1987).

ANFPC and FAO pulp capacity projections to 1992 are even more optimistic. They predict a capacity increase of 2.2 million tonnes in chemical pulp (see Table VI-12.). The increase forecast for chemical pulp represents the largest absolute increase, however, in terms of percentage growth, mechanical pulp capacity projections are larger. Whereas the ANFPC percent growth for chemical pulp is projected to be 66%, for mechanical it is forecast at 90% (ANFPC, 1987). ANFPC paper capacity forecasts project an 85% gain of one million tonnes/year by 1992.

Table VI-12. Pulp and Paper Capacity Projections: 1987 to 1992 (million tonnes/yr).

Product	ANFPC*			FAO			% change 1987-1992	
	1987	1990	1992	1987	1990	1992	ANFPC	FAO
Pulp	4.75	5.24	6.97	4.21	4.72	6.41	68	66
chem & semichem.	4.20	4.67	6.36	3.69	4.16	5.85	66	63
mechanical (all types)	0.55	0.57	0.61	0.52	0.56	0.56	90	93
Paper	6.04	6.33	7.07	5.37	6.03	6.26	85	89

* Does not include capacity to be installed in that year.
SOURCE: ANFPC (1987); FAO (1988b)

High-yield pulp production, especially chemi-thermo-mechanical, is predicted to increase substantially by the year 2000. Small units (300 tonnes/day) will be installed initially in various parts of the country to make use of established plantations. The resultant pulp will then be used as a substitute for chemical pulps in the manufacture of a number of paper grades (Gomide, 1988).

Although the projections suggest that exports will expand in the future, much of the increase in expansion of eucalyptus pulp production will remain in the country to satisfy domestic demands (Sidway, 1988). Certainly the current low per capita consumption rates in Brazil suggest that this country will be having to supply a large and growing domestic market before it can export. Indeed, the biggest challenges facing this sector today are to meet the future domestic demand and maintain international market position (deBarros, 1989a).

5.3 Opinions

It is clear that Brazil needs to overcome its weakening export position and must therefore increase capacity. However, will Brazil be able to undertake all the proposed increases in sectoral growth? If so, would not the proposed capacity changes and subsequent increases in output cause an over-supply of eucalyptus pulp in the international market?

5.31 Paoliello Paoliello (1987) is optimistic. He believes the outlook for the pulp and paper industry is "rosy" emphasizing the cost competitiveness of Brazilian eucalyptus pulp, the ability of the Brazilian pulp industry to fulfill all the necessary conditions in implementation of these projects, and the ability of the world market to absorb increased amounts of eucalyptus pulp.

The low cost of wood production together with the wide variety of eucalyptus species available and rapid application of research yielding genetic improvements reinforce the cost competitiveness of eucalyptus pulp.

Industrial capability, exhibited through the significant expansion which occurred during the seventies when eucalyptus pulp was yet to be accepted in the international marketplace, has already been verified. The present proposed capacity additions occur when the sector already has a basic research and development foundation in addition to its proven market experience. The only problem is the financial situation. The government, however, in recognizing the future possibilities and export potentials of this industrial sector, have given it special priority. The fact that investments in plantations have continued, even with the conclusion of the fiscal incentive scheme, emphasize the viability of this industrial sector (deBarros, 1989a).

Will the world demand for eucalyptus pulp continue to grow? In Paliello's opinion, it will. The world pulp market is increasingly converting to short fibers and eucalyptus pulp has proven itself in the international market. Table VI-13. presents Paoliello's (1987) rough projection of world demand for eucalyptus pulp to 1990. The 1984 world demand for bleached hardwood pulp was 8.2 million tonnes, 31.5% of this (2.6 million tonnes) was for eucalyptus. The 1984 European demand for eucalyptus pulp however was higher - 42%. Using an annual growth rate of 3% for world world bleached-hardwood demand, yields an increase in global demand of 1.6 million tonnes for a total bleached hardwood demand of 9.8 million tonnes. Applying the 1984 European percent eucalyptus of total (42%), Paoliello (1987) reported a projected increase in eucalyptus market pulp demand of 1.5 million tonnes by 1990.

Table VI-13. Forecast of Eucalyptus Pulp Demand for 1990 (million tonnes).

	1984	1990	Amount increase
World demand for bleached hardwood market pulp	8.2	9.8	1.6
Eucalyptus share	31.5	42.0	
Market Eucalyptus pulp	2.6	4.1	1.5

SOURCE: Paoliello (1987).

Brazil's capacity increases forecast an increase of approximately 1.5 million tonnes by the mid-1990s. Few other large expansion projects are planned for other countries and in any case, most pulp suppliers in the Norcan (Nordic and Northern America) countries are fully integrated. Thus Paoliello (1987) believes that the world market for eucalyptus pulp will not be saturated, and that, considering its cost competitiveness in wood production, Brazil has a good opportunity to expand its exports.

5.32 Zobel Bruce Zobel (1988) takes a less optimistic viewpoint than that of Paoliello. Although he believes that the short term future is "bright", he argues against implementing large forestry operations which grow mass quantities of eucalpytus wood and mills designed solely to produce market pulp.

Presently the prices for eucalyptus pulp are good as supply is lower than demand. While it was previously thought that softwoods were the only suitable fiber for the manufacture of certain grades of paper, with improved pulping technologies, eucalyptus pulp is now widely used to make many of these products. As a result, world demand is positive.

However, for the long term, Zobel (1988) predicts a much less positive picture for world demand for eucalyptus pulp. He gives several reasons for caution:

1. Large expansions planned for not only Brazil but also in other areas of South America, Africa, Asia, the Caribbean, Indonesia, India, and Southern Europe (in particular, Spain and Portugal), are such that the supply will inevitably catch up with demand in the not-too-distant future.

2. Competition from other hardwoods. Gmelina will grow in areas which are unsuitable for eucalyptus plus it has fibers which are very suitable for pulping. Under-utilized northern hardwoods will also compete as the technology for the utilization of these fibers is developing quickly in response to the favorable world price.

3. Competition from fast-growth softwoods. As the technology develops to use juvenile wood, this wood could replace eucalyptus wood in many applications.

4. Environmental concerns with growing eucalyptus. Although the biological basis for the arguments are often faulty, nevertheless, there exist very negative attitudes towards these species. For example, in the state of Espirito Santo, a law was recently passed which forbids the planting of eucalyptus on new ground. This restriction was effected regardless of the fact that the pulp mills form the major economic base in that area.

Zobel (1988) does state, however, that the caution is not intended for producers of high quality, relatively low-cost pulp or those integrated operations using eucalyptus.

5.33 Siuko Taavi Siuko (1987), of Klabin do Parana SA, points out that Brazil, like other so-called "non-traditional" suppliers of pulp and paper, has the greatest comparative advantage in products where:

1) the wood cost as a percentage of the total cost is high, and

2) product quality is not of major importance.

Consequently, Siuko believes that the most promising products for export from Brazil are bleached kraft pulp made from eucalyptus. Additionally, he feels that value-added products will be less successful as the wood cost share of the sale price is not significantly different from that of "traditional" suppliers and as now the product quality is important. This thus suggests that vertical integration may not be successful (Siuko, 1987).

Siuko (1987) predicts that Brazil will have an additional 20 million m^3/yr wood available for harvesting by year 2000 thus increasing the annual productive pulp capacity to five million tonnes. Domestic demand is projected to account for three million tonnes leaving two million tonnes available for export. These would be comprised of 1.5 million tonnes bleached hardwood kraft (ie. eucalyptus) pulp and 0.5 million tonnes kraft liner.

Siuko (1987) points to some of the problems facing "nontraditional" suppliers such as Brazil:

- unstable politics
- lack of long-term capital
- lack of managerial and technical skills
- lack of industrial and public infrastructure
- lack of adequate transportation and distribution facilities.

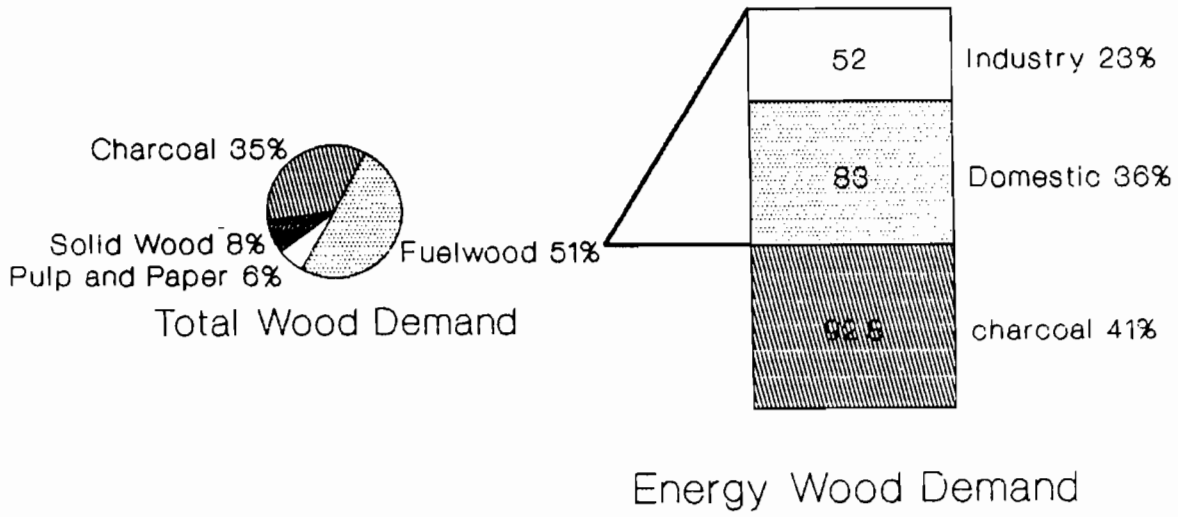
Brazil however has overcome a number of these problems. Certainly their eucalyptus pulping technology and genetic work for the improvement of both growth and pulp fiber qualities among eucalyptus species is among the best in the world. Lack of long term capital still remains a problem.

CHAPTER VII. ENERGY WOOD—CHARCOAL AND FUELWOOD

1. OVERVIEW

The production of energy in Brazil utilizes a large percentage of total wood demand. Figure 1. indicates that fuelwood and charcoal together accounted for 86% of the total wood demand in 1987. The energy wood demand is divided into three sections: charcoal (41%), and industrial and domestical fuelwood (total equals 59%). Industrial fuelwood includes wood used as an oil energy substitute in non-forestry industrial purposes, and wood used as an energy source in the drying of wood products (ABRACAVE, 1988).

Figure 1. Energy Wood Demand (1987)
showing percent and mil. m3



SOURCE: Celulose a Papel, Jul-Ago/87...

The Brazilian Charcoal Association (ABRACAVE) indicates the total firewood (i.e. energy wood) consumption has increased by 35.6 million tons over the period from 1970 to 1986 (ABRACAVE, 1988). This represents a 40% increase in total energy wood consumption. However, domestic consumption of fuelwood decreased by 25% in this period, thus the increase in total energy wood consumption occurred as a result of a large increase (304%) in charcoal consumption of energy wood. While fuelwood consumption of total energy wood decreased, charcoal consumption of total energy wood increased.[1]

More specifically, for the ten-year period between 1976 and 1986, the Brazilian Charcoal Association indicates:

1 This contradicts statements made, with regard to FAO data, in Chapter IV, section 7.2.

- total wood consumption for energy increased by 14%
- charcoal consumption of energy wood increased by 128%
- domestic consumption of energy wood for fuel decreased by 29%
- industrial consumption of energy wood for fuel increased by a slight 5%.

Thus, charcoal consumption of energy wood has increased by a very large percentage in comparison to total wood consumption for energy (ABRACAVE, 1988).

There is a rather large amount of data available in terms of Brazilian charcoal production, for example, through ABRACAVE. However, information on Brazilian fuelwood production is sparce in spite of the fact that fuelwood is the largest end use of roundwood in Brazil. The lack of reliable estimates of fuelwood production is a result of the fact that much of this product does not go through the market but rather is cut by the consumer and utilized directly. The remaining portion of this section will thus concentrate on the charcoal sector of energy wood.

2. ECONOMIC IMPORTANCE OF CHARCOAL

Brazil is the largest charcoal producer in the world accounting, in 1986, for 27% of the total world production (Magalhaes, 1988; FAO, 1988a). In terms of the Brazilian forest industry, charcoal is important because its production demands 35% of total roundwood, a significantly higher proportion than that utilized by other forest industry sectors.

From a total Brazilian economic point of view, charcoal is of little direct importance as, for example, very little charcoal is exported. However, charcoal is used as a thermoreducing agent in steel-making (de Beijer, 1982) and thus it is important to the Brazilian steel industry (Rezende and Neves, 1988). The indirect savings and gains to the trade balance as a result of the utilization of charcoal in the sidero[1] industry, represent a significant contribution to the overall economy. Were domestically-produced charcoal not utilized for the sidero industry, Brazil would have had to import 570 million $US worth of coal in 1986 to fire their furnaces (deBarros, 1989c). With approximately one-third of the world's iron ore reserves, the sidero industries are very important to the economy of Brazil (Rezende and Neves, 1988; Foster, 1986). Sidero-related industrial exports contributed more than half a billion $US to the trade balance in 1986 (Rezende and Neves, 1988). Just over one-third and therefore approximately 16.5 million $US worth of these exports were produced using charcoal.[2]

Charcoal is the third most important energy source in Brazil. In 1986, charcoal accounted for 9% of the total energy consumed in the industrial sector. By comparison, the most important source, electricity, accounted for 50% and the second most important source, fuel oil, accounted for 10% (Rezende and Neves, 1988). In addition to the use of charcoal as a thermo-reducing agent in the sidero industry, mentioned above, it is also used as a substitute energy source for imported fuel oil in the cement and ceramics industries (Rezende and Neves, 1988).

3. RAW MATERIAL FOR CHARCOAL

3.1 Overview

The two primary sources of wood for charcoal production are the "cerrado", or native forests, and eucalyptus plantations. The majority (80% or more) of the charcoal is still made from wood originating from native forests with only a small portion of the wood being derived from plantations (deBarros, 1989b). For example, in 1986, only 17% (6.7 million m^3) of the total charcoal production of 39 million m^3 was made from plantation wood. However, the use of plantation wood for charcoal production is increasing at a faster pace than that of the native forest (Rezende and Neves, 1988). While charcoal production using wood from na-

1 Of or pertaining to iron.

2 Based on the percentage of pig iron that was produced in 1986 using charcoal (see Table VII-4., section 5.21).

tive forests increased at an average rate of 10.7% per year over the ten-year period from 1976 to 1986, production using plantation wood increased at an average rate of 31.9% per year.

3.2 Deforestation

There is a lack of accurate data regarding the condition and volume of the native forest in charcoal-producing states. There is, however, fairly accurate data regarding the forest resource of Minas Gerais.[1] According to data from the Forest Institute of Minas Gerais (IEF), forest cutting for charcoal production reduced forested areas by almost 38% in the period 1982 to 1985. At this rate, the native forests of Minas Gerais will be exhausted in about 5 years (deBarros, 1989b). Other sources indicate deforestation rates in Minas Gerais to be around 800,000 to one million ha per year (Rezende and Neves, 1988).

Accordingly, wood supply must be "imported" from other states. "Imported" charcoal must be transported further distances and will thus increase the delivered cost of charcoal. It is therefore vital that steps be taken to increase plantation numbers and conserve native forests (deBarros, 1989b).

3.3 Plantations

Steel plants in Minas Gerais commenced charcoal wood plantations in the 1950s (Magalhaes, 1988). These plantations were made with the objective of replacing native forest utilization, and subsequent destruction, for charcoal production. Eucalyptus species were chosen due to their good growth under Brazilian climatic conditions. Unfortunately, few studies of ecological characteristics and wood properties were carried out prior to initial planting. As a result, the species planted were often inappropriate not only in terms of ecological adaptations but also in terms of desirable characteristics for energy wood. Indeed, the majority of the reforestation (or afforestation) projects planted species which were not suitable for energy-related uses as the wood was of too low a density (Magalhaes, 1988).

By the beginning of the 1970s, however, research into both edaphic-climatic and wood properties led to a number of higher density eucalyptus species being planted. These included: *Eucalyptus citriodora*, *E. cloeziana*, *E. pilularis*, and *E. pyrocarpa* (Magalhaes, 1988).

The ABRACAVE indicates that by 1986, approximately 1.8 million ha of plantations with wood destined for charcoal production (for use in the sidero industry) had been funded through the fiscal incentive plan (ABRACAVE, 1988). Pereira and Rezende (1983) state that approximately 50% of the 1.5 million ha of fiscal incentive-funded eucalyptus plantations in the state of Minas Gerais end up as charcoal which is, in turn, used by the steel and iron industries.

4. PRODUCTION OF CHARCOAL

The traditional method of charcoal production utilizes masonary ovens which have external combustion chambers (Magalhaes, 1988). These ovens, commonly 5m in diameter, are packed with a particular volume of wood. The contents are then cooked (reduced) for a 96-hour carbonization period and subsequently cooled for the same length of time. Approximately two steres[2] of wood produce one m^3 of charcoal (Magalhaes, 1988).

This traditional method, common to almost all the production facilities, does not recover the by-products of carbonization. As a result, potentially useful volatile materials, such as tar, are wasted. This tar, according to Magalhaes (1988), has been shown to have satisfactory characteristics as a fuel to replace fuel oil.

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1 This is the state which has the largest production of sidero-industry products (as discussed in section 5.21).

2 A "stere" (s) is a measure of capacity that is equivalent to one cubic metre.

Table VII-1. Production* of Charcoal by Wood Origin: 1976 to 1986 (in m^3).

Year	Native Forest	Plantation	TOTAL
1976	15,604,956	1,617,627	17,222,583
1977	15,164,600	1,779,844	16,944,444
1978	14,797,058	2,036,276	16,833,334
1979	16,825,852	2,431,002	19,256,854
1980	18,764,813	3,090,107	21,854,920
1981	17,315,881	4,061,761	21,377,642
1982	16,590,163	4,147,541	20,737,704
1983	20,475,886	4,542,344	25,018,230
1984	27,340,431	5,568,506	32,908,937
1985	28,999,008	6,115,351	35,114,359
1986	32,287,703	6,741,686	39,029,389

* Note that production values listed here do not sum to equal the consumption plus export values shown in Table VII-6.

SOURCE: ABRACAVE (1988).

Production of charcoal by wood source for the ten-year period between 1976 and 1986 is presented in Table VII-1. The total charcoal production has increased at an average rate of 12.7 % per year during this period. As discussed previously, charcoal made from plantation wood is increasing at a faster rate than that produced from native forests. The total charcoal production in 1986 was 39 million m^3; this production was comprised of charcoal made from a ratio of approximately 5 to 1, native to plantation wood.

5. CONSUMPTION OF CHARCOAL

5.1 Overview

Charcoal has long been important in the production of steel. Steel making in Brazil commenced in the 16th century and up until the 18th century, charcoal was the only reducing agent used in production (deBarros, 1989c). At the beginning of the 1900's, coke began to replace charcoal as a reducing agent. However, charcoal remains very important to this industry.

Total charcoal consumption was 34.7 million m^3 in 1986 (deBarros, 1989c). The vast majority (91.5%) of the total charcoal production in 1986 was destined for industrial use (deBarros, 1989b). Domestic (home) consumption only accounted for 8.6% (in 1986) of production. As described in Table VII-2, the percent charcoal consumption by the industrial sector has increased by around 6% over the past ten years. A corresponding decrease has occurred in the percent charcoal consumption by the non-industrial sector.

5.2 Charcoal Consumption for Industrial Production

Within the industrial sector, the largest increase (over the ten-year period from 1976 to 1986) in percent consumption of total charcoal consumption has occurred in the cement industry; percent use of charcoal has risen from zero to 11% (see Appendix 30). Otherwise, the percent consumption of total consumption has changed little over the past ten years. The production of iron alloys still uses under 10% of the total charcoal consumption.

Table VII-2. Evolution of Percent Charcoal Consumption by End Use: 1976 - 1986.

Year	ENERGY		NON-ENERGY
	Non-Industrial	Industrial	
1976	14.5	85.3	0.2
1977	14.3	85.5	0.2
1978	13.9	85.9	0.2
1979	11.6	88.2	0.2
1980	9.5	90.3	0.2
1981	10.3	89.5	0.2
1982	9.4	90.4	0.2
1983	8.9	91.1	–
1984	8.7	91.3	–
1985	8.7	91.3	–
1986	8.5	91.5	–

SOURCE: Ministerio das Minas e Energia. Balanco Energetico Nacional, 1987 (original not available; cited by ABRACAVE, 1988).

Steel and pig iron production consume the largest percentage of charcoal. The percent consumption, however, has decreased from a high of 85% in 1979 to between 67% and 70% in the 1980's. This decreased share of charcoal consumption reflects an increase in the variety of industries utilizingcharcoal. A breakdown of industrial consumption of charcoal in 1987 is shown in Table VII-3.

Table VII-3. Industrial Consumption of Charcoal and Percent of Production of Industrial Product Using Charcoal: 1987.

Industrial Product	Consumption (tons)	% of Production using Charcoal
Steel	3,470,422	16.3
Iron (independ. prod.)	4,421,483	21.9
Iron (integrated prod.)	3,129,050	98.5
Cement	4,854,422	19.2
Whitewash (lime)	706,950	35.3
TOTAL	16,582,327	

SOURCE: Programa Nacional de Carvao Vegetal - Ministerio das Minas e Energias. Brasilia, D.F. 1987. (original not available; cited by deBarros, 1989c).

Charcoal is very important to iron producers having integrated mills. Almost all (98.5%) of their production is made using charcoal. Total iron consumption is recorded as 7.6 million tons, thus iron production is the most important consumer of charcoal. According to this reference, the cement industry consumes the second highest amount of charcoal.

Magalhaes (1988) presents 1987 charcoal consumption data:

15.4 million m^3 -- independent pig iron producers
11.4 million m^3 -- integrated steel plants
2.8 million m^3 -- iron alloy plants
2.6 million m^3 -- cement plants
minor amount -- other consumer sectors (eg. ceramics industry)

This suggests that the cement industry is not as large a charcoal consumer as the steel industry. However, a comparison between these two sets of industrial charcoal consumption data is difficult due to the difference in units (tons versus m^3) and product terms. Nevertheless, it is clear that the most important consumption of charcoal occurs in the production of pig iron; charcoal is produced mainly to support this industry (Magalhaes, 1988).

5.21 Charcoal Consumption for Pig Iron Production In 1987, 34% of the total pig iron production was made using charcoal while the other 66% of production utilized coke (see Table VII-4.). Over the nine-year period from 1978 to 1987, pig iron production has more than doubled. The ratio of coke to charcoal utilization in this production has remained approximately the same over this period.

Table VII-4. Evolution of Pig Iron Production by Energy Reducing Agent: 1978 - 1986 (in tonnes).

Year	Charcoal	%	Coke	%	Total Prod.
1978	3,844,109	38	6,198,938	62	10,043,047
1979	4,431,534	38	7,281,880	62	11,713,414
1980	4,941,396	39	7,743,887	61	12,685,283
1981	4,370,015	40	6,425,515	60	10,795,530
1982	4,124,643	38	6,702,699	62	10,827,342
1983	4,853,510	37	8,091,011	63	12,944,521
1984	6,488,965	38	10,744,429	62	17,233,394
1985	6,839,896	36	12,131,550	64	18,971,446
1986	7,641,400	38	12,618,396	62	20,259,796
1987	7,221,541	34	13,714,441	66	20,935,982

SOURCE: ABRACAVE, Anuario Estatistico - 1988 (original not available; cited in ABRACAVE, 1988).

5.3 Charcoal Consumption in Minas Gerais

As the state of Minas Gerais produces the largest amount of pig iron and steel, it is not surprizing that it is also the state with the largest charcoal consumption (deBarros, 1989c). In the ten year period from 1976 to 1986, the sidero industries of Minas Gerais which utilized charcoal as an intermediate in the their production process consumed an average 80% of the total Brazilian charcoal production (deBarros, 1989c). However, the percent of total charcoal consumption by the state of Minas Gerais is dropping. While in 1978, this state consumed 89% of the total, by 1986 consumption had dropped to 78% (see Table VII-5.).

The drop in percentage consumption of charcoal in the state of Minas Gerais as compared to that of the total country may reflect an increase in the sidero industry in other states.

Table VII-5. Charcoal Consumption in the State of Minas Gerais in Comparison to Total Brazilian Consumption: 1978 - 1986 (in m^3).

Year	Consumption inas Gerais	Percent of Total	Total Consumption* Brazil
1978	13,029,409	89	14,680,800
1979	15,215,850	89	17,071,200
1980	17,982,369	89	20,185,200
1981	16,249,576	87	18,612,000
1982	15,134,045	74	20,329,200
1983	16,985,827	75	22,593,600
1984	21,737,991	73	29,624,400
1985	24,906,101	79	31,381,200
1986	27,055,236	78	33,807,600

* The volume of consumption data listed in this table does not match the consumption data presented in Table VII-6.

SOURCE: Ministerio das Minas e Energia - Balanco Energetico Nacional, 1987 (original not available; cited by ABRACAVE, 1988).

It may also be the result of deforestation, and subsequent lack of local charcoal, in this state. As the wood resources necessary for charcoal production are located at increasingly further distances from the plant sites, the use of charcoal as a reducing agent in sidero production is less economically feasible. Indeed, the viability of utilizing charcoal for energy is threatened by the high costs of transporting "imported" wood or charcoal from other Brazilian states (Pereira and Rezende, 1983). If more of the wood used in the production of charcoal were to originate from conveniently-located plantations, the ratio of coke to charcoal use in pig iron production would no doubt decrease.

6. EXPORTS

6.1 Charcoal

There is very little direct exporting of charcoal. As shown in Table VII-6, the percent of exports in relation to that of total consumption is very low (less than half a percent). According to this table, the largest volume of charcoal, a mere 31,169 m^3 was exported in 1979. The IBDF reported that the 11,558 tons of charcoal exported in 1986 had a value of 1.8 million $US (IBDF/CACEX, pers.com. deBarros, 1989).

6.2 Sidero Products

Of much more importance in terms of the Brazilian economy are the exports from sidero-related industries. As mentioned in section 2, these totalled more than half a billion $US in 1986. Of this, 214 million $US was received from exports of 2 million tons of pig iron, 189 million $US resulted from the export of 310,000 tons of alloy, and 148 million $US resulted from the export of 370,000 tons of steel (Rezende and Neves, 1988).

Table VII-6. Exports of Charcoal by Wood Origin in Relation to Brazilian Charcoal Consumption: 1976 -1986(in m^3).

Year	CHARCOAL EXPORTS **Wood Source:** Native	Plantation	Total	Total Consumpt.*	% Exports of Total Consumpt.
1976	–	–	–	15,500,000	–
1977	–	–	–	15,250,000	–
1978	–	–	–	15,150,000	–
1979	27,234	3,935	31,169	17,300,000	0.18
1980	21,833	3,595	25,428	19,644,000	0.13
1981	7,642	1,793	9,435	19,230,443	0.05
1982	2,535	634	3,169	18,660,765	0.02
1983	5,330	1,182	6,512	22,509,895	0.03
1984	9,122	1,858	10,980	29,607,063	0.04
1985	13,659	2,880	16,539	31,586,384	0.05
1986	10,081	2,135	12,216	35,114,234	0.03

* The charcoal consumption volumes listed here differ from those listed for consumption in Table VII-5. and Appendix 30. Also, as noted at the bottom of Table VII-1, production values (from Table VII-1.) do not equal the exports plus consumption shown here.

SOURCE: ABRACAVE (1988).

7. FUTURE

7.1 Overview

The sidero industry is of great importance to the economy of Brazil. As Brazil possesses one third of the world's iron ore reserves, the sidero industry has the potential to remain important in the future. Indeed, as the world price for pig iron is increasing with increasing demand, Brazilian production is expected to increase (Rezende and Neves, 1988). Projections for the increases in pig iron, steel and iron alloy production by the year 2000, indicate a requirement of 55 million m^3 of charcoal (Rezende and Neves, 1988). Current production of charcoal is approximately 39 million m^3.

However, as pointed out in section 5.3, the raw wood material used to produce charcoal is found at increasing distances from the plants. Thus, the economic feasibility of utilizing charcoal as an energy source decreases with increased costs of transportation. Indeed, even at the present time, transport costs constitute up to 50% of the delivered costs of charcoal (Pereira, 1983). In addition to transport costs, it is also important to consider the environmental costs of the deforestation that is taking place in Minas Gerais (and other states).

It is therefore apparent that if Brazil is to continue and increase production of sidero industry products, attention must be paid to the provision of adequate sources of wood which would be located within an economically feasible distance from the mills without increasing ecological damage resulting from deforestation. Rezende and Neves (1988) estimate that approximately 4.3 million additional ha. must be planted over the next twenty years to meet the above-stated increase in charcoal demand.

7.2 Silvicultural Aspects of Charcoal Plantations

The wood resource for charcoal production must increasingly originate from plantations. With the advent of biotechnology, reproduction of high density, and thus higher quality, eucalyptus silviculture is made much easier. For example, *E. citriodora* and *E. paniculata*, two high density eucalypts which are very difficult to propagate by conventional methods, may be propagated on a large scale through micro-propagation techniques. In addition, "in vitro" embryo rescue will facilitate the hybridization of previously incompatible species. Thus, the production of hybrid species which have both high density and rapid growth rates is made possible. This is particularly important considering that species having higher density tend to grow at a slower rate (Magalhaes, 1988).

Improvements in wood quality and quantity are a function of the positive results of genotype-environment interaction. Ecologically suitable and genetically superior material is ideally located with attention to site preparation, fertilization in accordance with soil requirements, proper spacing, weeding and thinning at the correct intervals as well as rigorous insect and disease control (Magalhaes, 1988).

7.3 Expected Cost Benefits

Improved returns are possible through increased charcoal quality and better recovery of the by products of the carbonization process.

Charcoal quality is improved through the utilization of wood originating from higher density species. These gains in charcoal quality in turn lead to a reduction in the amount of charcoal consumed per ton of pig iron produced and thus a reduction in the total cost of pig iron production. Magalhaes (1988) reports that with wood density improvements of 55% and subsequent charcoal consumption reductions of 73%, a cost reduction of 7.4 million $US per 1 million ton of pig iron is possible.

Additional savings are also available through more complete recovery of the volatile products of the carbonization process. Studies made by Acesita Energetica indicate a 25% return on investment through the utilization of a continuous charcoal-making process which recovers tar, methanol and ethyl acetate (Magalhaes, 1988). This process not only increases profits, but, in addition, it demands less man-power, produces less pollution and taps the full energy of the wood biomass.

CHAPTER VIII. CONCLUSION

1. THE FOREST RESOURCE

Brazil holds between 10-15% of the total global forest area. Moreover, the country possesses the largest continuous block of tropical closed forest, the Amazon forest (28% of the world's total). The total forest area represents an overall growing stock of roughly 56.1 billion m^3. Of this, only 4% is considered to be commercially important. This low percent utilization for the whole country is explained on the basis of low commercial use (between 5 and 10 m^3/ha) of the Amazon tropical closed forest.

Whereas approximately 90% of the total growing stock are located in the sparsely populated Amazon region, the population and industries are concentrated in the south and southeast where native forest cover is very limited. Plantations provide a simple attractive alternative to native forests in terms of their high productivity (in relation to the total area occupied), ease of management and flexibility of establishment location.

A fiscal incentive scheme for plantation establishment commenced in 1966 with the combined goal of improving Brazil's energy balance and forest products trade balance. By 1987, approximately six million ha of primarily eucalyptus and pine were established. Volume for eucalyptus ranges from 5-35 m^3/ha/yr with a rotation age between 8 and 21 years. Pine produces less volume (8-24 m^3/ha/yr) at a longer rotation age (20-35 years). These rapid growth rates and short rotations result in high yields over a short period resulting in low-cost wood production. The total production for eucalyptus and pine is approximately 96 million m^3/yr. There exists good potential to increase this value through the use of genetically superior stock.

Approximately one third of the total plantations are energy plantations, another one third are pulp and paper plantations, roughly 20% are for other forest industries and the remaining 14% are used for other purposes such as food production. Eucalyptus is more commonly used for charcoal, fuelwood, pulp and reconstituted panel production, whereas pine is usually used for pulp, particleboard and sawnwood.

The increased population of Brazil has resulted in increased demands on the land base. The accelerated removal of the country's native forest in both the southern and southeastern regions and, more recently, the Amazon area, reflects increased agricultural and industrial activity. Government resettlement programs, involved the paving of several Amazonian roads and the encouragment of agricultural colonizers to settle the new areas opened up by these highways. These, together with fiscal incentives aimed at supporting cattle ranching, have lead to the large-scale clearing of roughly 20-30% of the Amazon tropical closed forests at a rate of between 3 and 7 million ha/yr. Despite recent cessation of resettlement programs, cutbacks in other fiscal incentives which encourage the removal of forest cover, and the more rigorous environmental legislation, deforestation continues.

Much attention has focused upon the destruction of the Amazon forest and the Brazilian government has received tremendous international criticism for their development policies. While insisting upon their sovereign rights over this region, the government has taken steps to minimize the deforestation. If successful in combating the uncontrolled clearing of forest areas, and managing their tropical timber resources, Brazil has the potential for becoming a leading producer and exporter of increasingly valuable tropical wood products. However, due to the difficult economic situation in the country, it is expected that deforestation will continue (at a possibly increasing rate) and that the potential for the wood product industry will decrease.

Deforestation (and the resulting decrease in commercial growing stock) in southern and southeastern areas of Brazil, though perhaps less publicized than that in the Amazon, appears to be more immediately serious for the economy of Brazil given the reliance on wood-based energy fuel of a number of important industries. While the plantations will supply a portion of the roundwood demand by both the forest and other industries, it is expected that removal of the native forest will continue. This is especially relevant with the cessation of fiscal incentives for the establishment of plantations.

2. THE FOREST INDUSTRY

2.1 Sector Comparison

The contribution of total forest output (all wood and non-wood products) to the national economy of Brazil was roughly 4% of GDP in 1987; the contribution of the solid wood, and pulp and paper sectors was approximately 3% of GDP. Value of production in these two sectors (for 1986) was estimated at 5.53 billion $US for solid wood and at 2.61 billion $US for pulp and paper. In contrast, the pulp and paper sector provided a positive trade balance of 525 million $US, roughly double the 279 million $US share for the solid wood. Together, the two sectors produced 985 million $US worth of exports, or roughly 3% of the total Brazilian trade. The percent share of total roundwood is 6% for pulp (17 million m^3) and 8% for solid wood (23 million m^3).

Brazil ranks second behind the USSR in the world for total area of forest, yet the country ranks fifth for total and industrial roundwood production. The recent increased efforts in plantations are reflected by recent increases in the country's share of global wood production. Although it is expected that industrial roundwood production will increase in the future, the percent share contribution from the Amazon is not expected to increase significantly but rather this increase will come largely from plantations.

Whereas Brazil ranks (1986) among the top ten globally for most forest products in terms of amount produced, there are only five products where Brazil ranks within the top ten for export value. These are: hardboard, veneer sheets, NC sawnwood, plywood and chemical pulp.

2.2 Solid Wood Sector

The solid wood sector has developed at a relatively slow rate of 5% (ave./yr) during the 1970's. In the early eighties the sector suffered as a result of high interest rates and reduced domestic business activity reflected through poor housing starts. Experiencing positive growth in 1986 in response to the Cruzado Plan-induced explosion of consumer demand, growth slowed in 1987, but increased slightly in 1988. Within the sector, the plywood industry has shown the highest recent growth rates both in terms of production and exports. No large expansions in capacity are planned for this sector and it is expected that growth will continue to be dependent largely on the ability of the Brazilian government to control inflation thus assisting domestic consumption. Exports of panel products, in particular, are expected to increase in response to increasing international prices.

As wood supply in the southern regions of Brazil becomes increasingly limited due to the depletion of native forests, plantation wood, where available, will be increasingly utilized. Also, operators will continue to move to northern locations. With the increased demand placed on the forest resource, it is expected that there will be more emphasis both on better utilization of logs in the mills and of the variety of lesser-known species in the forest. Problems faced by the industry include: high wood costs due to a decreased accessible supply and thus higher transportation costs, increased cost of materials and machinery, and depressed domestic demand reducing prices.

2.3 Pulp and Paper

Brazil has been described as the largest potential competitor in the global pulp and paper market. Certainly the recent record has been impressive. Global export share of pulp has increased from less than 1% to over 4% (1976 to 1987). Net export revenues for this sector were 525 million $US. Total pulp production reached nearly four million tonnes in 1986 worth an estimated value of 1.3 billion $US; paper production was 4.5 million tonnes valued at 2.3 billion $US.

The pulp and paper industry is based on the creation of plantation forest with ever increasing yields and potential. These plantations provide the main comparative advantages for Brazil in terms of the global pulp and paper industry. The country is on the forefront for technological knowledge regarding the use of eucalyptus. This species, though chosen originally for its suitability to the Brazilian temperate south and hence rapid growth, is now highly regarded for the excellent properties it imparts. Eucalyptus fiber properties yield pulp that is well suited for the manufacture of papers all which do not require high strength. It is particularily effective for the production of sanitary paper, and high quality printing and writing paper.

The leading exports in 1986 were bleached chemical pulp and printing & writing papers. Approximately 73% (497 million $US) of the export revenues were accounted for by the international sales of these two

products. Bleached chemical pulp, newsprint and printing & writing papers are the key imports. Together these products made up approximately 81% (134 million $US) of the total import values in 1986. Trade balances have been positive for pulp products since 1975 and for paper products since 1981. The trade balance (in 1987) was 5.7 billion $US for pulp, and 3.1 billion $US for paper.

Domestic demand for pulp and paper products is expected to increase substantially over the next several years. As a result, and despite planned expansion capacity, Brazil's export position is weakening. The major constraint to development in the pulp and paper industry is the difficulty in capital mobilization due to major debt servicing and balance-of-payment problems. Whether Brazil can overcome its weakening export position through attraction of new investment depends at least partially on the government's ability to improve the difficult economic situation.

2.4 Energy Wood Sector

A third forest industry sector, that of energy wood, is arguably the most important sector in terms of its indirect contribution to Brazil's economy and large demand on roundwood. Wood-based fuel provides an energy source to industries which are essential to the economy of Brazil. The indirect savings and gains to the trade balance as a result of, for example, the use of charcoal in the sidero industry represent a signicant contribution to the overall economy in that 16.5 million $US worth of sidero-based exports were produced using charcoal (1986). More importantly, charcoal demand for roundwood was approximately 35% (92.8 million m^3) of the total roundwood demand. The total roundwood demand by the energy wood sector (charcoal and fuelwood) was 86% (227.4 m^3) of 1987 total wood demand.

The sidero industry is of great importance to the economy of Brazil. As projected increases in production occur, greater pressure will be placed on the country's ever decreasing supply of native forests. In addition, as other wood-based industries experience raw material shortages, the demand on plantation wood will increase. Such increased pressures on both native and plantation forests may decrease the economic advantage of low raw material cost now experienced.

The cessation of the fiscal incentives scheme to encourage the establishment of plantations is of great concern to both industrialists and environmentalists. Without these programs there is a fear that wood-based industries will suffer from reduced economic viability and that the environmental condition of the land will decrease.

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APPENDICES

Appendix 1. Forest Area of Brazil: A Comparison of Literature Sources (areas in mil. ha).

Author/Year	Grouping	Tropical Forest		Open Wood.	Scrub Form.	Coniferous
		Amazon	Non-Amaz.	(cerrado)	(caatinga)	
Lanly, 1981	Closed, Open, Conifer, Fallow, Scrub "p"-Productive "unp"-Unproductive	p=286.1 unp=45.7	p=14.6 unp=10.0 p.total=300.7 unp.total=55.7 Total = 356.4	p=117.2 unp=94.1 Total = 211.2	p=22.7 unp=38.5 Total = 61.2 80 originally	p=0.28 unp=0.92 Total=1.2 16-17 orig.
Persson, 1974 (as cited by Evans, 1982)	Open, closed, man-made	Total closed = 240		80	–	–
Kengen, 1985	Tropical, sub-trop., Araucaria, cerrado, caatinga, other	Total = 320		140	46	classed w/ tropical
Nahuz, 1988	Amaz., Atlantic, Araucaria mixed	280	3	–	–	0.27
Fishwick, 1975 est. from 1970	Amaz. (delta & higher elevation), coast, cerrado, sertao Araucaria, man-made	250	not given	70 – 80	not given	5 to 6
USDC, 1985a	Tropical, semi-trop., commercial grade	260	–	no other numbers given	–	–
Bianchetti, 1987	Amaz., Non-amaz, cerrado, caatinga, coniferous	260	very little	180	90	very little

Author/Year	Other	Native Total	Overall Total
Lanly, 1981	Fallow=46.4 Plantation=6.1	630 +Fallow=676.4	682.5 (80% of total area
Persson, 1974 (as cited by Evans, 1982)	Plantation=1.4	320	321.4
Kengen, 1985	Plantation=6 other=4	510	516 (61% of total)
Nahuz, 1988	Plantation=5.6	283.3	288.9
Fishwick, 1975 est. from 1970	not given	est. that 38% of land is forested	therefore 323.4
USDC, 1985a	commercial grade=301	est. 80% land is forested to some degree	but tropical, semi-trop. & commercial only 45% therefore=383
Bianchetti, 1987	–	530	–

SOURCE: As given

Appendix 2. Growing Stock Calculations by Productivity Class within Forest Type – 1980 (end).

Forest Type	TOTAL GROWING STOCK			COMMERCIAL GROWING STOCK		
	m^3/ha	Area (mil.ha)	VOB (mil.m^3)	m^3/ha	Area (mil.ha)	Vol.Act.Comm (mil.m^3)
I. Closed Tropical						
1. Productive-unlogged						
Amazon	155	281.06	43,565	5	281.0	1,405
Non-Amazon	195	7.56	1,475	10	7.5	75
2. Productive-logged						
Amazon	145	5.0	725	–	–	–
Non-Amazon	175	7.0	1,225	–	–	–
3. Unproductive						
Amazon	80	45.69	3,655	–	–	–
Non-Amazon	95	10.0	950	–	–	–
TOTALS						
1. Productive-unlogged	–	282.62	45,040	–	288.5	1,480
2. Productive-logged	–	12.0	1,950	–	–	–
3. Unproductive	–	55.69	4,605	–	–	–
4. OVERALL TOTAL	–	356.31	51,595	–	–	1,480
II. Open Woodlands	50	117.2	5,860	5	117.0	585
III. Coniferous						
1. Productive-unlogged	350	0.28	98	50	0.28	14
2. Productive-logged*	–	–	–	–	–	–
3. Unproductive*	100	0.92	92	–	–	–
4. TOTAL	–	1.2	190	–	0.28	14
IV. OVERALL TOTAL	–	474.71	57,645	–	405.78	2,079

* Productive – logged and unproductive are grouped together for coniferous forests.

SOURCE: Lanly (1982).

Appendix 3. Growing Stock of Brazil: A Comparison of Various Literature Sources

Author	Production Figures	Potential Total (m^3)	Currently Utilizable/ Marketable
Bianchetti 1987	–	total n.a. cerrado=6 caatinga=1	Amaz wp trade 15 $bilm^3$
USDA/FAS 87/88	–	tropical=45	–
Rezende & Neves 1988	–	tropical=50	30% is commercial
USDC 1985a	–	47-52	–
Eden 1982	–	tropical=45 timber	–
Pandolfo 1978 (cited by Correa de Lima & Mercade 1985)	varzea=90 m^3/ha upland=170 m^3/ha	43.7	15.4 $bil.m^3$ (currently utilized)
Bodig & Sa Ribeiro 1983	–	50 (est.)	18 bil. m^3 (comm. timber)
Lanly/FAO 1982	50 – 350 m^3/ha	tropical=51.8 cerrado=5.9 conifer=0.19	2.1 $bil.m^3$ (vol. actually comm.)

SOURCE: Various

Appendix 4. Common Commercial Species in Brazil.

Forest Type Occurrence	Species Name (Latin)	Common Name Trade Name (Caps.)	Uses and Other Information
terra firme coastal plain	Vochysia maxima	cedroma, Yemeri, Quaruba	substitute for cedrela carpentry, utility plywd
terra firme (+plantations)	Swietenia macrophylla	caoba, magno, acajou Mahogany (Honduras)	fine furniture, cabinets
terra firme	Ceiba pentandra	Sumauma, silk-cotton tree, Kapok-tree	plywd (disappeared from world mrkts when log exports were banned)
terra firme (drier hillsides)	Cedrela sp.	cedrovermelho, c. femea cedro, S.American cedar Spanish cedar	millwork, cabinets, fine furniture, music instruments, sliced & rotary cut veneer, decorative & util. plywd.
terra firme	Goupia glabra	cupiuba, Kopie, Kabukalli	heavy construct, indust. flooring, furniture components
terra firme (ridges, slopes)	Hymenaea courbaril (Legume)	courbaril, jatahy, jatoba	tool handles (high density), flooring, furniture, cabinets, seed pods, gum
terra firme (ridge tops)	Tabebuia spp. Lapacho group)	greenhart, ipe Bethabara, Lapacho	railrd cross-ties, heavy construction
varzea (?)			decorative veneers
terra firme	Carapa guianensis	carabwood Andiroba	construction (not very durable) furniture, cabinets, veneer, plywd
terra firme (lower Amaz)	Euxylophora paraensis	satin wood Pau Amarello	furniture, parquet flooring, cabinets
terra firme	Diplotropis purpurea	sapupira, supupira Sucupira	heavy construction, boats, flooring, furniture components
terra firme +Atlantic	Bowdichia spp.	sucupira parda Sucupira	heavy construction, railway ties, (high density)
terra firme +Atlantic	Peltogyne spp.	guarabu Pau roxo, Purple heart, Amaranth	cabinets, fine furniture, flooring, tool handles, billiard que butts, carving, specialties
terra firme +Atlantic	Ocotea rubra	louro vermelho Determa, Red Louro	furniture, gen. construction, boat planks, gen. utility
varzea coastal	Virola sp. Virola surinamensis	ucuuba, bicuiba, virola Banak, Baboen	veneer, plywood, composite brds oil from seeds, soap & candles
varzea plywd.	Hura crepitans	assacu, acacu, aresiro Hura, Possumwood	gen. carpentry, boxes, veneer, fiberbrd., particle brd.
varzea (+plantations)	Hevea brasiliensis	seringa, seringuera Para rubber tree	Latex, gen. construction, p&p, composite boards
Amaz (varied)	Micropholis spp.	apixuna Grumixava, Riemhout	furniture components, gen. construct., decorative (dec.) veneer, etc.

Appendix 4. Continued

Forest Type Occurrence	Species Name (Latin)	Common Name Trade Name (Caps.)	Uses and Other Information
Coastal	Dalbergia nigra	jacaranda Brazilian Rosewood	dec. veneers, fine furniture, cabinets, musical instruments, (scarce in more accessible regions)
SE/Coastal	Machaerium spp.	jacaranda, jacarando Caviuna, Pau Ferro	fine furniture, decorative veneers, specialty items, cabinets
Araucaria (coniferous)	Podocarpus spp.	pinho bravo [Podocarp]	joinery, furniture components, gen. construction, veneer, plywd., p&p
Araucaria +other areas	Nectandria sp.	Canelo, Laurel	furniture, cabinets, planking, flooring, veneer, plywd, mill-work
Araucaria	Araucaria angustifolia	Parana pine	framing lumber, sash & door stock, veneer, p&p, plywd, furniture
Araucaria	Phoebe porosa	Imbuia, Brazilian-walnut	fine furniture, cabinets, panelling, gunstocks, decorative veneer

SOURCE: USDA/FS (1984) + deBarros (1975); Carlos and Rezende (1988); Chudnoff (1984); Erfurth and Rusche (1978); Guest *et al.* (1976); Nahuz (1988); Nascimerto and deCosta (1988).

Appendix 5. Area Approved for Afforestation with Resources from the Fiscal Incentive Scheme by Species and State: Years 1967–1986 (area in ha.).

Year/Species	Pinus	Eucalyptus	Araucaria	Natives	Fruit Trees	Palms	Others	TOTAL
1967	18,159	13,877	1,729	822	173	–	–	34,759
1968	60,899	30,057	7,330	1,892	2,063	–	669	102,910
1969	96,798	53,800	7,670	2,717	1,278	–	120	162,383
1970	119,913	83,609	12,029	4,451	1,179	26	196	222,005
1971	98,053	129,053	8,080	3,843	2,410	3,350	3,689	248,478
1972	101,059	172,441	7,756	3,448	9,089	3,266	7,298	304,357
1973	86,181	161,132	7,828	6,536	7,023	21,802	3,651	294,153
1974	83,245	188,336	7,530	3,804	8,857	28,088	4,519	324,379
1975	94,222	222,718	6,618	5,891	6,816	58,519	3,456	398,240
1976	87,001	262,337	4,845	4,502	11,345	73,193	6,024	449,249
1977	99,277	194,352	758	851	30,278	20,043	876	346,432
1978	140,726	228,068	902	1,036	29,799	10,000	1,206	411,737
1979	117,944	282,420	1,332	228	49,621	10,650	11,523	473,718
1980	88,650	271,550	200	–	50,275	5,800	19,100	435,575
1981	117,160	229,675	350	–	43,990	–	26,700	417,875
1982	158,335	186,820	500	–	54,640	–	30,690	430,985
1983	73,565	91,035	230	–	31,518	–	18,652	215,000
1984	70,750	124,360	500	–	54,800	–	35,790	286,200
1985	65,236	130,718	700	–	56,562	–	31,816	285,032
1986	85,220	174,320	1,000	–	100,535	–	47,940	409,015
1967/86	1,862,393	3,230,678	77,887	40,021	552,843	234,742	253,915	6,252,483

Source: IBDF (original not seen; cited by Kengen, 1987)

Fruit trees: apple, mango, cashew, coconut, palm, Brazilian nut and citrus

Others: dende, algaroba, bambu, erva-mate and acacia negra

Appendix 6. Area Approved for Afforestation with Resources from the Fiscal Incentive Scheme by Species and State: Years 1967–1986 (area in ha.).

State/Species	Pinus	Eucalyptus	Araucaria	Natives	Fruit Trees	Palms	Others	TOTAL
Acre	–	–	–	–	1,479	–	–	1,479
Amapa	29,660	1,500	–	–	600	–	1,140	32,900
Amazonas	–	800	–	–	29,065	13,632	500	43,997
Para	7,500	4,000	–	–	20,507	42,260	10,900	85,167
Rondonia	–	–	–	–	150	–	–	150
Roraima	–	–	–	–	970	–	–	970
Alagoas	–	2,800	–	–	8,415	–	8,040	19,255
Bahia	295,427	203,792	–	1,306	25,495	5,200	3,710	534,930
Ceara	–	–	–	–	104,368	–	8,511	112,879
Maranhao	6,300	19,040	–	1	55,509	–	6,200	87,050
Paraiba	–	1,000	–	–	9,115	–	66,940	77,055
Pernambuco	–	4,800	–	3	14,047	–	32,810	51,660
Piaui	–	32,100	–	–	116,955	–	–	149,055
Rio Grande do Norte	–	3,450	–	–	77,932	–	36,424	117,806
Sergipe	–	500	–	–	1,899	–	–	2,399
Distrito Federal	9,091	16,125	–	468	1,249	–	–	26,933
Goias	34,370	88,601	1,400	3,068	14,996	–	6,007	148,442
Mato Grosso	961	20,250	–	11	950	–	–	22,172
Mato Grosso do Sul	66,026	459,728	–	2,212	1,196	–	1,345	530,507
Espirito Santo	1,213	147,571	45	2,126	686	–	126	151,767
Minas Gerais	190,540	1,606,757	560	14,693	15,799	–	570	1,828,919
Rio de Janeiro	2,551	22,845	15	1,039	1	55	–	26,506
Sao Paulo	193,118	434,632	3,204	7,241	21,783	37,314	3,503	700,795
Parana	572,784	68,170	49,969	4,773	12,166	131,294	2,059	841,215
Santa Catarina	290,162	38,828	14,773	1,230	7,245	3,759	798	365,795
Rio Grande do Sul	162,689	53,391	7,921	1,852	10,266	1,228	64,333	301,680
Brasil	1,862,393	3,230,678	77,887	40,021	552,843	234,742	253,915	6,252,483

SOURCE: IBDF (original not seen; cited by Kengen, 1987)

Fruit Trees: apple, mango, cashew, coconut palm, Brazilian nut and citrus.

Others: dende (*Elaeis guineensis*), *algaroba* (*Prosopis* sp.), bambu (*Bambusa* sp.), erva-mate (*Ilex paraguariensis*), *acacia negra* (*Acacia* sp.)

Appendix 7. Deforestation—Causes and Rates: A Comparison of Various Literature Sources.

Author	Background of Study	Rate and Location	Cause
Lanly 1981	INPE Landsat satellite imagery 1972 to 1978 (est. for 1981 to 1985)	1. cerrado 900,00 ha/yr 2. cerrdo 150,00 ha/yr 1.5 mil ha/yr ~same as above 3. parana pine 120,000 ha/yr 4. closed brd leaf 1,360,000 ha/yr1 TOTAL: 2.53 Total closed +prod woodlands	land clearing for Ag and charcoal assumes 1/4th area converted to Ag/yr reverts to "forest fallow"; steady increase in deforestation in last yrs due to cattle ranching and swidden (shifting) Ag.
Denevan 1981	projeto RADAMBRASIL 1979 NRC Norman Myers 1980 1) INPA (Kerr) 2) IBDF 3) SUDAM Myers 1979 Kerr 1979	100,000 km2/yr (Amaz) 10 mil ha/yr tropical forests 1.3 mil ha/yr 1960-1980 1.04 mil ha/yr 1966-1977 1.28 mil ha/yr 1966-1975 1/3rd Amaz already cleared 10%, at most 25% Amaz cleared	–
Eden 1982	–	~15 mil ha Braz.Amaz, 1966-1978 X = 1.25 mil ha/yr	clearing
Peck 1983	–	< 5% total Amaz area, but now increasing	population pressures
Truitt 1985	–	5% Amaz forest converted 1966-75: 11.5 ha cleared 1975 : 28.6 mil ha cleared	most clearing for highways 20% by peasants
Shoumatoff 1986	cited Dr. P.N. Neto Minister of Envir.	10% Amaz rain forest deforested	–
Bianchetti 1987	–	6 mil ha/yr	main clearing for Ag expansion; shortage of wood supplied from man-made forests
Kengen 1987	% estimated from rate of change in Amaz forest cover	1.9 mil ha/yr	–
Vesilind 1987	–	1.3 mil ha/yr Amaz deforested	colonizers
Nahuz 1988	3.1 mil ha/yr in S. Amer.	1/2 in Brazil, therefore, 1.55 mil ha/yr	–
SBS 1988	Sociedate Brasilera de Silvicultura	6 mil ha cut/yr	–
USDA/FAS 1988	–	10-12% Amaz natural vegetation lost in past 10 yrs	–
Maduro 1989	Interview with Dr. Stetzer, 1988	est. 70 mil ha in past 10 yrs, however, 20-30% increase/yr area deforested	small & large farms, mining

SOURCE: Various.

Appendix 8. Growing Stock Calculations by Productivty Class within Forest Type – 1985 (end).

Forest Type	TOTAL GROWING STOCK			COMMERCIAL GROWING STOCK		
	m^3/ha	Area (mil.ha)	VOB (mil.m^3)	m^3/ha	Area (mil.ha)	Vol.Act.Comm (mil.m^3)
I. Closed Tropical						
1. Productive-unlogged						
Amazon	155	276.87	42,915	5	277.0	1,385
Non-Amazon	195	4.62	900	10	4.5	45
2. Productive-logged						
Amazon	145	6.0	870	–	–	–
Non-Amazon	175	7.49	1,310	–	–	–
3. Unproductive						
Amazon	80	49.35	3,948	–	–	–
Non-Amazon	95	4.65	442	–	–	–
TOTALS						
1. Productive-unlogged	–	281.49	43,815	–	281.50	1,430
2. Productive-logged	–	13.49	2,180	–	–	–
3. Unproductive	–	54.00	4,390	–	–	–
4. OVERALL TOTAL	–	345.98	50,385	–	281.50	1,430
II. Open Woodlands	50	112.00	5,600	5	112	560
III. Coniferous						
1. Productive-unlogged	350	0.	0	50	0	0
2. Productive-logged*	100	0.72	72	–	–	–
3. Unproductive*						
4. TOTAL		0.72	72		0	0
IV. OVERALL TOTAL	–	461.70	56,057		393.5	1,990

* Productive – logged and unproductive are grouped together for coniferous forests.

SOURCE: Lanly (1982).

Appendix 9. Acronyms for Brazilian Organizations Involved in Forestry

Acronym	Explanation
ABCP	Associacao Tecnica Brasileira de Celulose e Papel
ABECEL	Associacao Brasileira de Exportadores de Celulose (Braz. Assoc. of Pulp Exporters)
ABIMCE	(Braz. Assoc. of Plywood Industries)
ABRA	(Brazilian Assoc. of Reforestation Co.)
ABRACAVE	Associacao Brasileira de Carvao Vegetal. (Braz. Assoc. of Charcoal)
ANFPC	Associacao Nacional dos Fabricantes de Papel Celulose (National Assoc. of Pulp and Paper Industries)
ATIBT	Association [sic] Technique Internationale des Bois Tropocaux
APFPC	Associacao Paulista dos Fabricantes de Papel e Celulose
BINAGRI	Ministerio da Agricultura, Secretaria National de Planajamento Agricola
BNDES	Banco Nacional do Desenvolvimento Economico e Social (National Bank of Econ. Develop.)
CACEX	Carteira de Comercio Exterior do Brasil (Foreign Trade Department)
CPPF	(Tropical Forest Products Research Center)
CDE	Economic Develop. Council)
CDI	(Industrial Develop. Council)
CEPLAC	(Executive Commission of Cocoa Crop)
CICEPLA	Conferacao Industrial de Celulose e de Papel Latino-Americana
CNPF	Pesquisadores do Centro Nacional de Pesquioa de Florestas (National Forest Res. Center)
CNPq	(National Counsel of Technology and Scient. Development)
COPLAN	Comissao de Planejamento (Planning Coordination Unit of the IBDF)
CPATSA	(Agricultural Research Center of the Semiarid Tropics)
CTFT	Centre Technique Forestier Tropicaux
DC	(Forest Products Laboratory)
ECLA	(Economic Commission for Latin America)
EMBRAPA	Empresa Brasileira de Pesquisas Agropecuarias (Braz. Co. of Agric. Research)
EPUSP	Escola Politecnica da Universitade de Sao Paulo
ESALQ	Escola Superior de Agricultura "Luiz de Queiroz"
FUNAI	(National Foundation for the Indian)
FUPEF	(Paran State Forestry Research Foundation)
IAC	Instituto Agronomico de Campinas
IBDF	Instituto Brasileira de Desenvolvimento Florestal
IBGE	Instituto Brasileiro de Geografia e Estatistica (Braz. Institute of Geography and Statistics)
IF-SP	Instituto de Florestas (Sao Paulo Forestry Institute)
INCRA	(Government land-settlement agency)
INP	Instituto Nacional do Pinho (old)
INPA/CDPF	Instituto Nacional de Pesquisas da Amazonia (National Institute for Research of the Amazon Region, Center for Forest Products Research)

Appendix 9. Continued

Acronym	Explanation
INT	Instituto Nacional de Tecnologia
IPEA	Instituto de Planejamento Economico e Social (Social and Economic Planning Institute)
IPEF	Instituto de Pesquisas e Estudos Florestais (Institute of Forest Research and Studies)
IPF	Instituto de Pesquisas Florestais (Forest Research Institute)
IPT S/A	Instituto de Pesquisas Tecnologicas do Estado de Sao Paulo, Cidade universitaria (Forest Research Institute)
MIRAD	Ministerio da Reforma Agraria e Esenvolvimento
PNPC	(National Program of Pulp and Paper)
PNPF	(National Forest Research Program)
?	(National Program of Charcoal-Based Siderugy)
SBS	Sociedade Brasileira de Silvicultura
SIF	(Society of Forest Investigation)
SUDAM	Superintendencia de Desenvolvimento da Amazonia (Superintendency for Development of the Amazon)
SUDENE	Superintendencia de Desenvolvimento da Norte East (Superintendency for Development of the NE)
UFRJ	Universidade Federal de Rio de Janeiro (Federal University of Rio de Janeiro)
UFRRJ	Universidade Federal Rural de Rio de Janeiro (Federal Rural University of Rio de Janeiro)
UFPR	Universidade Federal do Parana (Federal University of Parana)
UFV	Universidade Federal de Vicosa (Federal University of Vicosa)
USP	Universidade de Sao Paulo (Sao Paulo University)

SOURCE: Various.

Appendix 10. Calculation for the Total Value of Production in the Solid Wood, and Pulp and Paper Sectors: 1986.

The total value of production is calculated by multiplying the total production per product by the export unit value for that product. To simplify this procedure, two FAO product groupings for solid wood products are used: sawnwood and sleepers, and wood-based panels. Value of paper production is also calculated. Then the sawnwood and sleepers, woodbased panels and paper value of productions are totalled. To complete the calculation of total value of production, the value of pulp exported (i.e. the value of pulp which is not used in paper production) must be added.

Data used:

1) Solid Wood – FAO data as complete data from Brazil for production was not available.

2) Pulp & Paper – Brazilian data was available from the Associacao Nacional dos Fabricantes de Papel e Celulose (ANFPC).

1. Export Unit Values

The export unit value is the total value of exports divided by the export volume.

Solid Wood – numbers from FAO forest product yearbook

Paper – 346,810,00 $US/692,00 m^3 = 501.17 $US/$m^3$

2. Value of Production

Major Product Group	Product ($1000\ m^3$)	Export Unit Value ($US/$m^3$)	Value of Product. ($US)
Sawnwood & Sleepers	18,063	263	4.75 bil.
Wood-based Panels	2,546	306	0.78 bil.
TOTAL SOLID WOOD			5.53 bil.
Paper (all types)	4,545	501	2.28 bil.
Pulp Export Value			0.33 bil.
TOTAL PULP AND PAPER			2.61 bil.
OVERALL TOTAL			8.14 bil.

SOURCE: FAO (1988a) and ANFPC (1987) (see above discussion)

Appendix 11. Exports and Imports for all Forest Products: 1986 ($ = US, all in FOB; t = tonnes).

	EXPORTS		IMPORTS	
	t	$1000	t	$1000
A. Basic Products	63,058	46.494	142,174	74,002
Brazil Nuts	19,629	21,875	275	38
Tea	13,058	17,011	–	–
Raw Rubber	8	15	77,607	61,772
Raw Cork	–	–	2,406	2,680
Others	–	4,326	–	2,082
Charcoal	11,558	1,420	–	–
Logs & Sleepers	16,906	1,847	61,059	7,430
B. Semi-Manufac. Products	1,119,866	432,865	350,909	37,666
Extract. & Tannins	–	–	940	879
Veg. Wax	–	–	–	–
Others	–	36,581	–	87
Sawnwood	193,027	69,549	291,739	16,615
Pulp	890,214	326,735	58,197	20,085
C. Manufac. Products	1,261,865	639,415	280,102	140,742
Palmheart Consrv.	–	23,860	–	–
Aromatic oils	–	7,148	73	672
Veg. Oil (proc.)	–	269	–	–
Resins & Acids	–	3,056	730	1,721
Others	–	874	–	1,205
Treated Wood	165,351	92,351	4,830	870
Plywood	141,604	67,348	3	17
Fiberwood	186,964	45,678	–	–
Furniture	9,351	18,211	5	53
Particlebrd.	10,916	2,102	218	243
Veneer	37,304	31,730	41,467	6,916
Paper	692,132	346,788	232,233	129,045
TOTAL	1,118,774 $US		252,410 $US	

SOURCE: CACEX and IBDF (pers. com. deBarros, 1989).

Appendix 12. Change in Production and Exports of Solid Wood Products: 1975 to 1987 (units in m^3).

	1975	1987	1975–1987 Total Chg. (simple %)	1975–1987 Ave. Chg/per yr.
SAWNWOOD (NC)				
– exports	187,000	460,000	146%	
– production	4,659,000	9,679,000	108%	
SAWNWOOD (C)				
– exports	307,000	67,000	–78%	
– production	5,469,000	8,384,000	53%	
WOOD-BASED PANELS				
– exports	185,000	526,000	184%	
– production	1,725,000	2,546,000	48%	
VENEER SHEETS				
– exports	41,600	66,000	59%	5%
– production	154,000	234,000	52%	4%
PLYWOOD				
– exports	31,600	225,000	612%	51%
– production	660,000	1,300,000*	97%	8%
PARTICLE BOARD				
– exports	2,000**	14,000	600%	55%
– production	407,000	660,000	62%	5%
HARDBOARD				
– exports	111,600	221,000	98%	8%
– production	340,000	550,000	62%	5%
FIBERBOARD				
– exports	164,000	200,000	22%	2%

SOURCE: FAO (1988a) except *ed figure. It comes from the USDA Foreign Agricultural Service, Wood Market Reports (USDA/FAS 1987/1988).

Appendix 13. Export Volume by Port Location – 1984 (t = tonnes)

Location	Sawnwood		Treated Wood		Plywood		Veneer	
	t	%	t	%	t	%	t	%
North	47,974	47	145,798	49	39,809	30	21,587	55
Northeast	755	1	228	–	–	–	–	–
Southeast	13,986	14	31,810	10	23,182	17	11,329	29
South	38,556	38	122,597	41	70,717	53	6,199	16
TOTAL	101,271	100	300,448	100	133,708	100	39,155	100

SOURCE: CACEX/IBDF (pers. com. deBarros, 1989).

Appendix 14. Principle Hardwood Species Exported (All Wood products): 1986 & 1987. (t = tonnes)

Species	1986			1987*		
	t	%	1000 US$ FOB	t	%	1000 US$ FOB
Mahogany	86,001	13.2	44,410	170,874	24.5	111,218
Virola	29,013	4.5	6,651	46,262	6.6	11,565
Jatoba	–	–	–	7,930	1.1	2,048
Sucupira	4,639	0.7	831	6,241	0.9	1,467
Andiroba	65	–	17	6,149	0.9	1,405
Imbuia	3,169	0.5	2,099	4,372	0.6	3,901
Ipe	4,554	0.7	962	3,336	0.5	1,197
Cedro	3,749	0.6	1,347	2,699	0.4	1,289
American Oak	4,355	0.7	8,837	2,334	0.3	4,699
Cerejeira	446	0.1	485	2,058	0.3	1,059
Angelim Ver.	–	–	–	1,669	0.2	328
Pau-marfim	–	–	–	1,455	0.2	590
Quiri	2,918	0.4	598	1,087	0.2	985
Cedrorana	574	0.1	142	872	0.1	304
Quaruba	170	–	43	808	0.1	152
Muiratinga	1,538	0.2	439	673	0.1	245
Freijo	1,014	0.2	178	347	–	128
Jacaranda	538	0.1	1,016	331	–	502
Pau Ferro	279	–	837	310	–	780
Tatajuba	–	–	–	283	–	74
Louro	117	–	136	190	–	387
Assacu	47	–	8	50	–	31
Jacareuba	8	–	10	1	–	1
Peroba	34	–	12	–	–	–
Others	507,209	78.0	176,363	437,609	62.7	190,657
TOTAL	650,437	100.0	245,421	697,940	100.0	335,010

SOURCE: CACEX/IBDF (cited by Mercado and Campagnani, 1988).

* January to November

Appendix 15. Hardwood Wood Products Exports by Country of Destination—1986 & 1987. (t = tonnes)

Country	1986			1987*		
	t	%	1000 US$ FOB	t	%	1000 US$ FOB
U.S.A.	226,001	34.7	73,351	289,311	41.5	121,930
United Kingdom	115,888	17.8	57,127	103,138	14.8	68,940
Puerto Rico	46,522	7.2	19,411	55,256	7.9	34,629
Canada	35,442	5.4	8,513	50,370	7.2	11,354
West Germany	66,256	10.2	16,118	21,820	3.1	14,823
Italy	9,893	1.5	3,416	15,730	2.3	6,562
Netherlands	19,888	3.1	5,110	14,635	2.1	5,213
Spain	12,216	1.9	3,194	11,472	1.6	3,553
Belgium	14,047	2.2	6,217	8,801	1.3	5,211
Saudi Arabia	10,362	1.6	4,008	7,927	1.1	3,381
Ireland	7,907	1.2	3,527	6,504	0.9	3,917
Trinidad	5,680	0.9	2,624	5,619	0.8	3,296
Others	80,335	12.3	12,743	107,357	15.4	52,201
TOTAL	650,437	100.0	245,421	697,940	100.0	335,010

SOURCE: CACEX/IBDF (pers. com. deBarros, 1989).

Appendix 16. Number of Sawmills and Wood Production in the Amazon Region: 1986.

State Territory	Number of Sawmills	Annual Production ($1,000m^3$)
Para	1,244	7,052
Amazonas	141	313
Amapa	45	75
Rondonia	696	6,359
Roraima	32	36
Acre	73	83
Total	2,231	13,918

SOURCE: IBDF (from Rezende and Neves, 1989).

Appendix 17. Sawnwood Exports from Brazil by Country of Destination—1986 & 1985. (t = tonnes)

Country	1986			1987*		
	t	%	1000 US$ FOB	t	%	1000 US$ FOB
Softwood	**28,473**	**15**	**12,516**	**23,507**	**17**	**9,911**
Argentina	13,739	7	5,362	9,396	7	3,288
United Kingdom	9,053	5	4,586	9,516	7	4,566
Uruguay	4,238	3	1,952	3,087	3	1,469
Hardwood	**164,554**	**85**	**57,033**	**116,696**	**83**	**37,096**
United Kingdom	42,862	22	22,085	23,338	17	10,855
United States	53,263	28	16,366	39,560	28	11,821
Canada	9,346	5	2,407	6,107	4	1,691
Spain	7,197	4	1,783	7,403	5	1,583
Argentina	5,746	3	1,719	3,399	3	1,098
Portugal	8,831	5	1,602	7,454	5	1,270
France	7,001	4	1,573	4,020	3	713
Ireland	3,413	2	1,553	2,099	1.5	991
South Africa	3,157	2	1,062	621	0.5	253
West Germany	1,976	1	942	4,368	3	1,645
Saudi Arabia	2,568	1	835	2,026	1.5	736
Others	19,194	10	5,106	16,301	12	4,440
TOTAL	193,027	100	69,549	140,203	100	47,007

SOURCE: CACEX/IBDF (pers. com. deBarros, 1989).

Appendix 18. Treated Wood Exports by Country of Destination—1986 & 1985 (t = tonnes).

Country	1986			1985*		
	t	%	1000 US$ FOB	t	%	1000 US$ FOB
United Kingdom	51,561	31	30,701	62,416	25	32,922
U.S.A.	42,784	26	22,320	96,477	39	36,813
Puerto Rico	15,027	9	10,903	14,830	6	9,254
West Germany	5,103	3	3,472	5,712	2	3,554
Japan	3,955	2	2,915	4,535	2	2,939
South Africa	7,929	5	2,864	3,094	1	1,368
Canada	7,796	5	2,660	6,309	3	2,386
Italy	3,987	2.5	2,095	5,184	2	1,968
Ireland	3,144	2	1,721	6,027	2.5	3,054
Netherlands	2,599	1.5	1,578	2,571	1	1,391
Angola	1,595	1	1,513	3,984	2	3,263
France	2,061	1	1,320	4,457	2	2,282
Spain	4,485	3	1,150	7,188	3	1,907
Belgium	1,666	1	1,040	1,660	0.5	837
Others	11,659	7	6,099	23,793	9.5	11,063
TOTAL	165,351	100	92,351	248,237	100	115,001

SOURCE: CACEX/IBDF (pers. com. deBarros, 1989).

Appendix 19. Hardwood Lumber Exports from Amazon by Species—1986 & 1987 (t = tonnes).

Species	1986		1987*	
	t	%	t	%
Mahogany	80,944	49.2	113,973	54.3
Virola	28,864	17.5	36,200	17.2
Sucupira	4,639	2.9	6,241	3.0
Andiroba	–	–	6,149	2.9
Jatoba	–	–	5,445	2.6
Imbuia	2,355	1.4	3,409	1.6
Cedro	3,303	2.0	2,302	1.1
Ipe	4,554	2.8	1,787	0.9
Others	39,886	–	34,577	–
TOTAL	164,545		210,083	
100 US$	57,020		95,049	

* January–November

SOURCE: CACES/IBDF (pers. com. deBarros, 1989)

Appendix 20. Principal Producers of Tropical Hardwood Lumber—1970 & 1981 (% = % of world share).

Country	Production 100 m^3		
	1970	1981	%
Brazil	3,500	7,738*	22.5
Malaysia	3,100	5,147*	15.0
Japan	4,650	3,437	10.0
Indonesia	1,662	3,400*	9.9
Nigeria	566	2,681*	7.8
Philippines	1,341	1,219	3.6
Thailand	1,162	1,079	3.1
Ecuador	700	984	2.9
Columbia	1,080	936	2.7
SUBTOTAL	17,770	26,631	77.5
Others	7,652	7,714	22.5
TOTAL	25,422	34,345	100.0

* FAO estimate.

SOURCE: FAO (1983; cited by Rezende & Neves, 1988)

Appendix 21. Principle Exporters of Tropical Hardwood Lumber—1970 & 1981 (% = % of world share).

Country	Export 100 m^3		
	1970	1981	%
Malaysia	1,356	2,800	40.3
Indonesia	44	1,112	16.0
Singapore	721	916	13.2
Brazil	147	569	8.2
Philippines	185	547	8.0
Ivory Coast	183	266	3.8
Paraguay	86	121	1.7
Burma	116	118	1.7
SUBTOTAL	2,838	6,449	92.9
Others	926	491	7.1
TOTAL	3,764	6,940	100.0

SOURCE: FAO (1983; cited by Rezende & Neves, 1988)

Appendix 22. Plywood Exports by Country of Destination—1986 & 1985 (t = tonnes).

Country	1986			1985*		
	t	%	1000 US$ FOB	t	%	1000 US$ FOB
United Kingdom	41,098	29	18,715	41,418	28	15,991
Puerto Rico	28,748	20	15,334	23,554	16	12,914
U.S.A.	14,883	10.5	6,260	15,741	10.5	6,833
West Germany	5,732	4	3,735	4,716	3	2,525
Belgium	5,387	4	2,573	4,889	3	1,838
Egypt	5,404	4	2,288	3,443	2	1,430
Trinidad	4,567	3	2,262	9,417	6	4,129
Saudi Arabia	4,736	3	1,940	8,207	5.5	3,186
Denmark	3,626	3	1,477	2,294	2	990
Barbados	2,624	2	1,401	1,999	1	966
Netherlands	2,111	1.5	1,155	3,897	3	1,587
Ireland	2,677	2	1,124	2,563	2	1,022
Sweden	2,152	1.5	1,035	1,359	1	577
Others	17,859	12.5	8,049	25,276	17	10,433
TOTAL	141,604	100	67,348	148,773	100	64,421

SOURCE: CACEX/IBDF (pers. com. deBarros, 1989).

Appendix 23. Exports of Veneer—1986 & 1987 (t = tonnes).

Species	1986			1987*		
	t	%	1000 US$ FOB	t	%	1000 US$ FOB
Coniferous	**830**	**2.0**	**334**	**NA**	**NA**	**NA**
Parana Pine	830	2.0	334	NA	NA	NA
Non-Coniferous	**36,474**	**98.0**	**31,396**	**31,688**	**98.0**	**29,791**
Mahogany	5,056	14.0	7,295	6,037	19.1	10,224
American Oak	4,353	12.0	8,836	2,334	7.4	4,698
Imbuia	813	2.5	1,199	973	3.0	2,122
Pau Ferro	280	1.0	840	310	1.0	780
Cerejeira	447	1.0	488	429	1.4	501
Louro	66		132	190	0.6	387
Virola	148	0.5	70	1,038	3.2	365
Cedro	445	1.0	340	397	1.2	314
Jacaranda	84		802	48	0.2	250
Muiratinga	1,539	4.0	441	673	2.1	247
Jacareuba	8		10	1		1
Others	23,235	62.0	10,943	19,268	60.8	9,903
TOTAL	37,304	100.0	31,730	31,688	100.0	29,791

SOURCE: CACEX/IBDF (pers. com. DeBarros, 1989).

* January to November

Appendix 24. Exports of Veneer by Country of Destination—1986 & 1985 (t = tonnes).

Country	1986			1985		
	t	%	1000 US$ FOB	t	%	1000 US$ FOB
Coniferous	**830**	2	**334**	**827**	2	**306**
Uruguay	760	2	303	785	2	288
	70		31	42		18
Non-Coniferous	**36,474**	**98**	**31,396**	**38,213**	**98**	**33,982**
United Kingdom	47,044	64	13,775	22,852	58.5	12,101
West Germany	5,386	14	9,453	6,897	16.5	12,675
South Africa	840	2	1,207	748	2	1,099
Italy	1,115	3	1,200	1,756	4	1,774
Argentina	1,291	3	978	639	1.5	495
Belgium	489	1	914	105		262
United Kingdom	396	1	889	627	1.5	1,318
Venezuela	971	3	540	1,536	4	1,378
Others	2,772	7	2,774	3,880	10	2,880
Jacareuba	8		10	1		1
Others	23,235	62	10,943	19,268	60.8	9,903
TOTAL	37,304	100	31,730	39,040	100	34,288

SOURCE: CACEX/IBDF (pers. com. DeBarros, 1989).

Appendix 25. Evolution of the Brazilian Pulp and Paper Industry—1956 to 1987 (t = tonnes).

Year	Paper 100 t	Annual Growth Percent	Pulp* (100 ton) Long Fiber	Short Fiber	Total	Annual Growth Percent
1956	395	–	52	26	78	–
1966	813	–	214	238	452	–
1977	2,235	9	509	993	1,502	20
1978	2,534	13	540	1,274	1,814	21
1979	2,979	18	607	1,841	2,448	35
1980	3,362	13	556	2,117	2,873	17
1981	3,103	–8	742	2,054	2,796	–3
1982	3,329	7	799	2,095	2,895	4
1983	3,417	3	892	2,166	3,058	6
1984	3,742	10	938	2,427	3,364	10
1985	4,021	7	1,058	2,345	3,403	1
1986	4,526	13	1,120	2,436	3,555	4
1987	4,712	4	1,164	2,500	3,664	3

* Chemical & semichemical only

SOURCE: ANFPC (1987).

Appendix 26. Brazilian Pulp and Paper Production by State—1986 (t = tonnes).

State	PULP		PAPER	
	Product. (1000 t)	Contrib. (% of total)	Product. (1000 t)	Contrib. (% of total)
Sao Paulo	1,139	33	2,236	50
Parana	522	15	983	22
Santa Catarina	417	12	599	13
Espirito Santo	476	13	–	–
Minas Gerais	371	10	141	3
Rio Grande do Sul	273	7	122	3
Para	226	6	–	–
Rio de Janeiro	–	–	196	4
Pernambuco	–	–	105	2
TOTAL	3,425	96	4,382	97

SOURCE: ANFPC (1987).

Appendix 27. Brazilian Pulp Exports, Imports and Consumption—1971 to 1987 (in tonnes).

Year	Exports	Imports	Consumption
1971	33,348	68,675	756,827
1972	140,714	118,866	876,492
1973	194,198	119,221	896,710
1974	133,801	229,604	1,225,329
1975	153,392	115,353	1,151,569
1976	140,644	68,209	1,818,349
1977	94,630	63,318	1,475,958
1978	267,931	70,980	1,617,043
1979	582,540	75,643	1,914,854
1980	890,745	67,813	2,049,764
1981	769,512	26,781	2,053,059
1982	776,738	18,160	2,136,192
1983	988,484	13,551	2,082,830
1984	982,004	27,734	2,410.115
1985	940,462	38,792	2,501,794
1986	898,903	71,593	2,728,097
1987	817,064	71,336	2,918,733

SOURCE: ANFPC (1987).

Appendix 28. Pulp Exports by Country of Estination—1986 (t = tonnes).

Country	t	%	1000 US$ FOB	%
United States	239.741	27	87.434	27
Belgium	206.51	23	79.843	24
Japan	181.737	20	62.891	19
West Germany	69.229	8	26.165	8
France	28.734	3	11.990	4
Argentina	33.831	4	11.002	3
China	27.582	3	10.588	3
Italy	22.626	2.5	7.822	2
Mexico	12.762	1.4	4.663	1.5
South Korea	8.248	1	3.147	1
Colombia	8.339	1	3.135	1
Canada	8.776	1	3.071	1
Peru	7.770	1	2.909	1
Venezuela	8.628	1	2.611	1
Formosa	6.354	1	2.386	1
United Kingdom	3.900	0.5	1.719	0.5
Uruguay	3.240	0.3	1.179	0.5
Others	12.216	1.3	4.180	1.5
Total*	890.214	100	326.735	100

* Numbers do not agree completely with ANFPC data

SOURCE: CACEX/IBDF (pers. com. DeBarros, 1989).

Appendix 29. Paper Product Exports by Country of Estination—1986 (t = tonnes).

Country	t	%	1000 US$ FOB	%
United States	80.681	12	49.494	14
West Germany	62.796	9	22.873	7
United Kingdom	47.499	7	21.737	6
Italy	54.091	8	15.669	5
Chile	23.888	3	14.172	4
Pakistan	25.149	4	11.831	3.5
Australia	18.628	3	11.669	3
Nigeria	17.600	2.5	10.676	3
Belgium	21.439	3	10.479	3
Saudi Arabia	16.215	2	10.205	3
Egypt	19.027	3	9.987	3
China	28.386	4	9.204	3
Argentina	10.360	1.5	7.972	2
Hong Kong	13.467	2	7.961	2
Netherlands	16.728	2	7.349	2
Canada	10.635	1.5	6.657	2
Equador	11.290	2	6.602	2
France	10.937	1.5	5.892	2
Lebanon	11.184	2	5.703	2
Puerto Rico	9.685	1	5.212	2
Others	182.447	26	95.444	28
TOTAL	692.132	100	346.788	100

SOURCE: CACEX/IBDF (pers. com. DeBarros, 1989).

Appendix 30. Evolution of Charcoal Consumption by End Use—1976 – 1986.

PERCENT CHARCOAL CONSUMPTION

END USE	1976	1977	1978	1979	1980	
ENERGY (non-industrial)						
Residential	14.3	14.1	13.7	11.5	9.4	
Commercial/Public	0.2	0.2	0.2	0.1	0.1	
TOTAL NON-INDUSTRIAL	14.5	14.3	13.9	11.6	9.5	
ENERGY (industrial						
Steel and Pig Iron	79.5	80.4	80.8	85.5	81.6	
Iron Alloy	4.9	4.2	4.1	2.2	3.5	
Cement	–	–	–	–	2.9	
Non-iron/other metal	1.1	0.9	0.9	0.5	1.6	
Other	–	–	–	–	0.7	
TOTAL INDUSTRIAL	85.3	85.5	85.9	88.2	90.3	
NON-ENERGY	0.2	0.2	0.2	0.2	0.2	

END USE	1981	1982	1983	1984	1985	1986
ENERGY (non-industrial)						
Residential	10.2	9.3	8.8	8.6	8.6	8.4
Commercial/Public	0.1	0.1	0.1	0.1	0.1	0.1
TOTAL NON-INDUSTRIAL	10.3	9.4	8.9	8.7	8.7	8.5
ENERGY (industrial)						
Steel and Pig Iron	77.1	69.0	69.7	69.9	67.8	70.6
Iron Alloy	4.4	9.9	7.5	7.4	7.5	7.3
Cement	5.1	7.9	10.1	11.0	12.9	11.1
Non-iron/other metal	2.1	1.9	2.5	2.3	2.2	1.9
Other	0.8	1.7	1.3	0.7	0.9	0.7
TOTAL INDUSTRIAL	89.5	90.4	91.1	91.3	91.3	91.5
NON-ENERGY	0.2	0.2	–	–	–	–

TOTAL CONSUMPTION* of Charcoal (in CUM)

YEAR	AMOUNT
1976	14,929,200
1977	14,695,200
1978	14,680,800
1979	17,071,200
1980	20,185,200
1981	18,612,000
1982	20,329,200
1983	22,593,600
1984	29,624,400
1985	31,381,200
1986	33,807,600

* The consumption volumes listed here differ slightly from those listed in Table VII-1.

SOURCE: Ministerio das Minas e Energia. Balanco Energetico Nacional, 1987 (original not available; cited by ABRACAVE, 1988).