Figure II-30 ECONOMIC INDICATORS IN URUGUAY

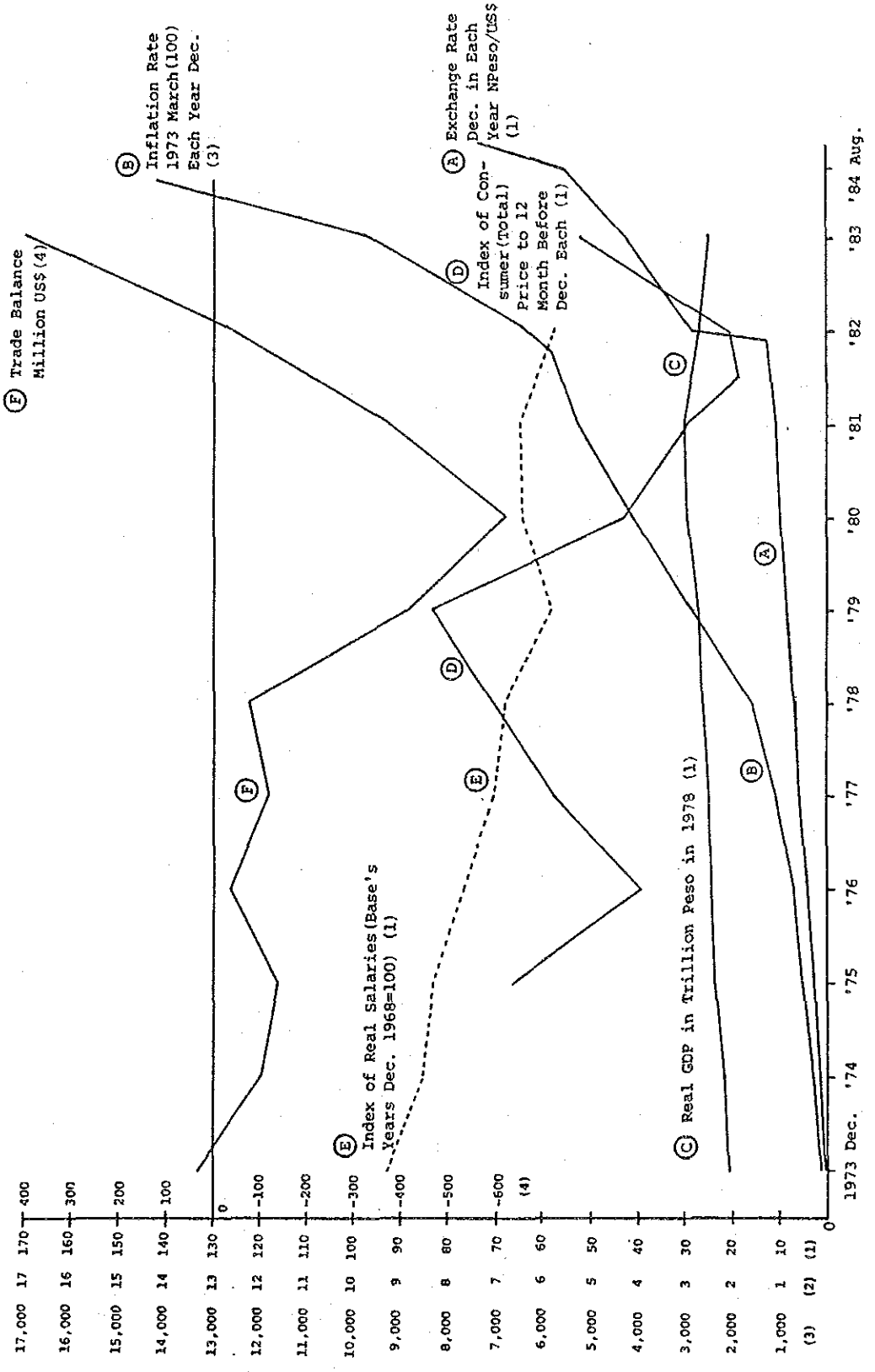
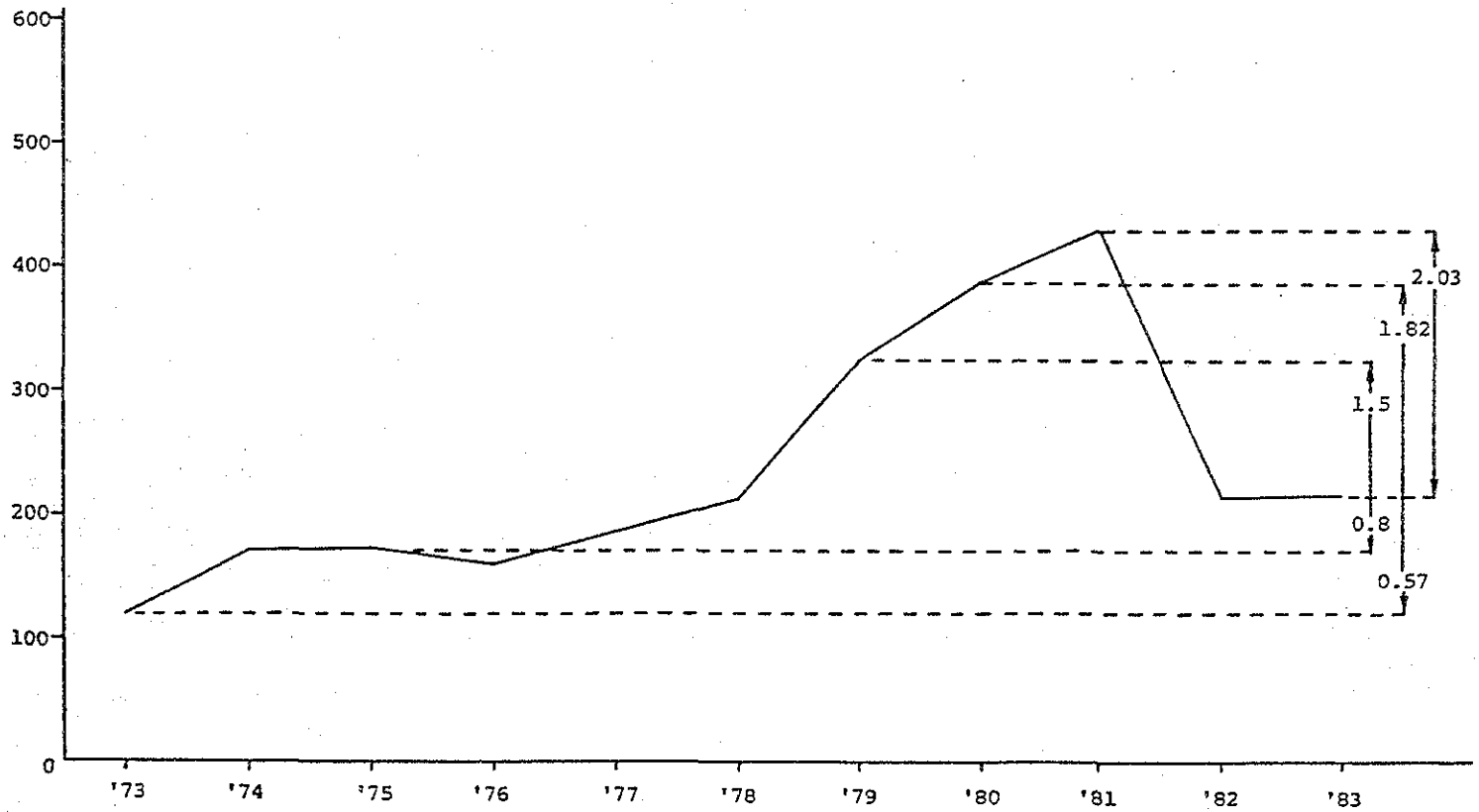


Figure II-31 INFLATION INDEX (1973 MARCH=100)/EXCHANGE RATE (1973=1) DEC. IN EACH YEAR



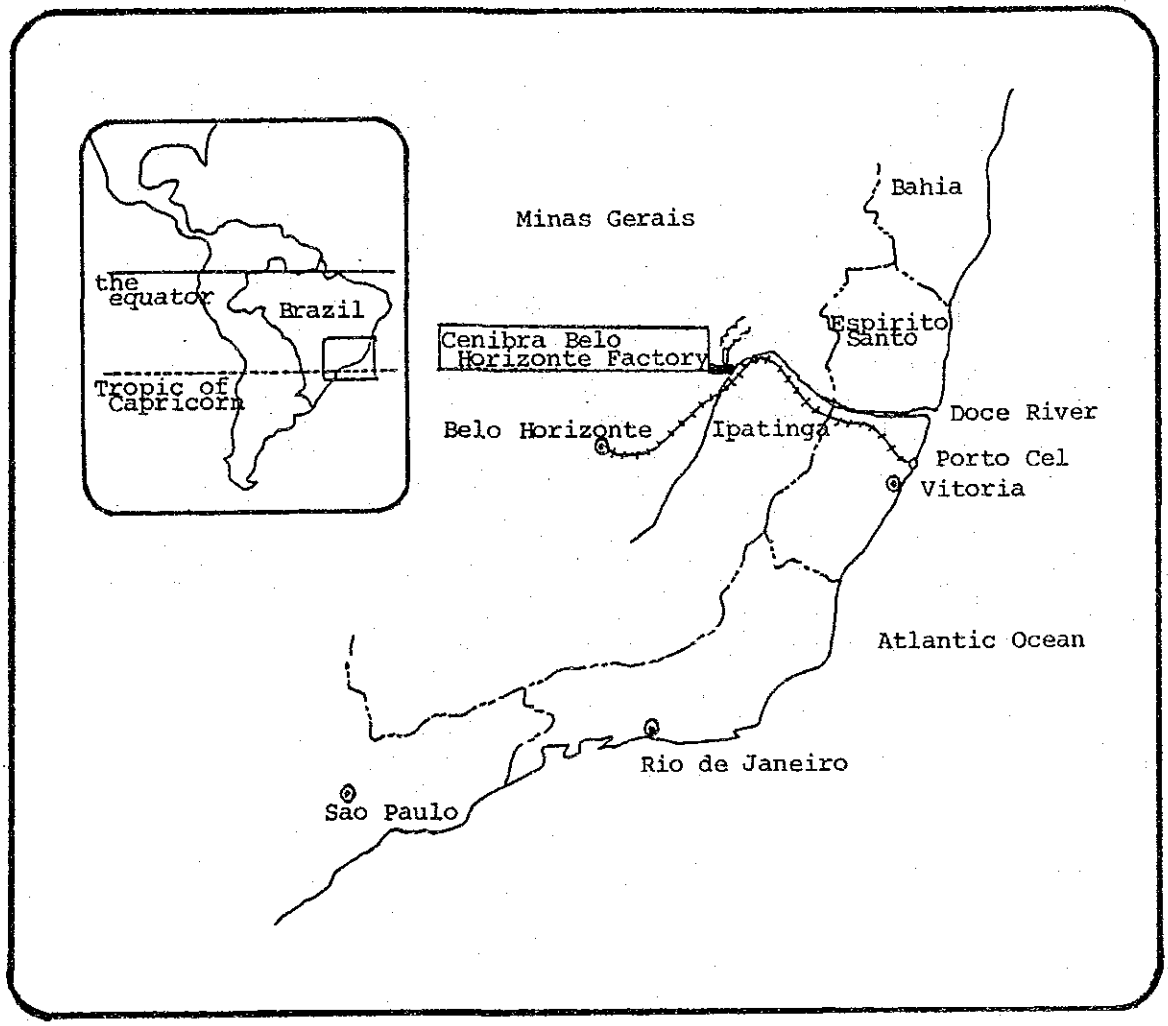


Figure II-32 LOCATION OF BELO HORIZONTE FACTORY

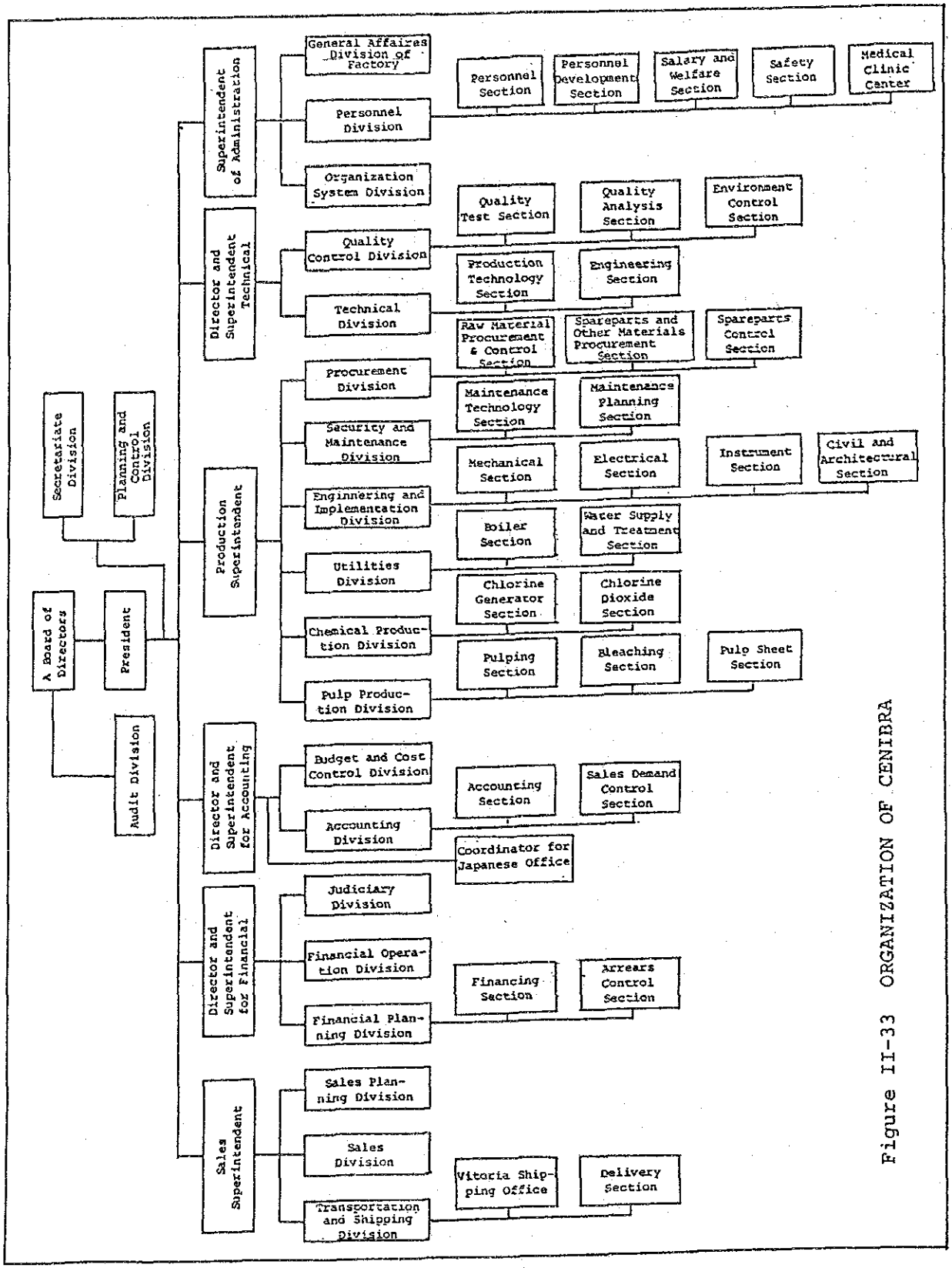


Figure II-33 ORGANIZATION OF CENIBRA

PART III

WOOD RESOURCES AND WOOD SUPPLY

Part III WOOD RESOURCES AND WOOD SUPPLY

Chapter 1 Present Status of Forestry in Uruguay

The following are outlines of present status of forestry in Uruguay.

1-1 Forest Area

Total forest area is only about 5% of total land area in Uruguay as shown in the table below, and artificial forest which has high productivity of woods is about 20% of total forest area. Natural forest is almost riparian forest which is spontaneously growing on river land, and woods produced from natural forest are utilized for fuelwood, but natural forest is unable to produce woods for industrial materials. And most present artificial forests were also not planted for the purpose of harvesting woods but sheltering livestock in stockfarms.

(in hectares)

Area of Uruguay	Area of forest land				
	Artificial forest	Natural forest			Total
		Forests	Palms	Sub-total	
17,621,500	170,140	590,831	70,484	667,315	837,455
(100.0)	(1.0)	(3.4)	(0.4)	(3.8)	(4.8)
(-)	(20.3)	(71.3)	(8.4)	(79.7)	(100.0)

Note: Figures in ( ) show percentage.

For further details, please refer to Table III-1 FOREST IN URUGUAY.

1-2 Volume of Timber on Artificial Forests

Forestry Agency (Direction Forestal) estimates the total volume of timber on artificial forests in Uruguay which have more than 10 hectares in area as follows.

(in 1,000 ha of area, 1,000 m^3 of volume)

Softwoods			Hardwoods			Total		
Area	m^3/ha	Volume	Area	m^3/ha	Volume	Area	m^3/ha	Volume
28	120	3,307	115	186	21,431	143	173	24,738
(20)	-	(13)	(80)		(87)	(100)		(100)

Note: Figures in ( ) shows percentage. The area shown in Total differs from that of the table shown in 1-1 because the table above is referred to more than 10 hectares in area.

For further details, please refer to Table III-2 WOOD VOLUME ESTIMATION PER PLANTATION AGE IN URUGUAY.

And Forestry Agency estimates the mean annual increment throughout the country to be 12 m^3 per hectare per year in softwoods and to be 15 m^3 per hectare per year in hardwoods. Therefore, the total of net annual growth of artificial forests is as follows.

(in 1,000 ha of area, 1,000 m^3 of increment)

Softwoods			Hardwoods			Total		
Area	m^3/ha	Increment	Area	m^3/ha	Increment	Area	m^3/ha	Increment
28	12	336	115	15	1,725	143	14.4	2,061

Note: The table shows the net annual growth of artificial forests having more than 10 hectares in area.

1-3 Annual Removals of Roundwoods

Table III-3 REMOVALS OF ROUNDWOODS IN URUGUAY shows the trend of annual removals of roundwoods in recent years. About 250,000 m^3 (on an average between 1978 and 1983) are cut for industrial uses such as sawlogs, plywood logs, railway sleeper logs and pulpwoods, etc..

The yearly production of fuelwood including logs for charcoal is about 1,556,000 m^3 (on an average between 1978 and 1982). Combined production volume a year is about 1,806,000 m^3 only.

1-4 Planted Area in Recent Years

According to "Situacion Actual de la Forestacion en el Uruguay" given by the Counterpart, the estimation of the plantation area by species as of 1978 was made by Forestry Agency as shown in the following table.

The following table also shows the estimation of the planted area by species as of 1983, added the planted area between 1979 and 1983 (please refer to Table III-4 REGISTERED PLANTATION AREA BETWEEN 1975 AND 1983) to the estimation as of 1978.

Species	Plantation area (As of 1978)		Planted area (1979-1983)		Total	
	ha	%	ha	%	ha	%
Eucalyptus ssp.	113,200	70.9	3,742	61.5	116,942	70.5
Pinus spp.	26,660	16.7	1,833	30.1	28,493	17.2
Salix and Populus spp.	13,330	8.3	509	8.4	13,839	8.3
Others	6,550	4.1	-	-	6,550	4.0
Total	159,740	100.0	6,084	100.0	165,824	100.0

Note: The total area differes from the area shown in 1-1. Pinus spp. include conifers other than Pinus.

The following table is the summary of Table III-4 REGISTERED PLANTATION AREA FROM 1975 TO 1983, showing the ratio of planted area of pines to total planted area. It also shows that the ratio of pines is gradually increasing though planting of Eucalyptus spp. is still dominant.

It is said that rapid drops in planted area since 1980 were influenced by the reform of taxation system in 1979 which stopped planters from receiving preferential treatment for plantation. (Since the reform of taxation system in 1979 had been effective retroactively to 1978, the drop in planted area was seen in 1978.)

Year	Planted area	Ratio of pines
	(ha)	(%)
1975	1,835.6	32.5
'76	2,901	25.8
'77	4,280	33.4
'78	2,664	37.8
'79	2,020.3	42.1
'80	734	23.8
'81	951.1	12.4
'82	1,362.2	21.8
'83	1,016.1	38.7
Total	17,764.3	31.6

1-5 Present Status of Forest Industries

1-5-1 Pulp and Paper Industry

The following tables show each production capacity of main pulp and paper companies and the trend of output.

Companies	Daily capacity	Output in 1975
	(t/d)	(t/year)
IPUSA	58	10,000
PAMER	85	13,000
CICSSA	50	8,000
FNP	155	21,000
CARTONERA PANDO	22	
Total	340	52,000

(Source: Direccion Forestal)

Trend of output

Year	Output
	t/year
1980	51,043
1981	47,700
1982	38,800
1983	42,200

(Source: Direccion Forestal)

1-5-2 Wood Products Industries

Production capacity of main wood products companies other than pulp and paper companies and the trend of output are as follows.

Production capacity (in m^3 per year)

Companies	Plywood	Particleboard	Fibreboard	Total
Madera del Norte	2,800	-	-	2,800
Ricardo Vazques	3,000	-	-	3,000
Samic	3,000	-	-	3,000
Bavosi	700	-	-	700
Clen	700	-	-	700
Osborne	600	-	-	600
Nogara	600	-	-	600
Adolfo Caig	600	-	-	600
Tablacurvi	-	1,500	-	1,500
Neoplac	-	12,000	-	12,000
Fibromadera	-	-	1,800	1,800
Ciccsa	-	-	3,000	3,000
Total	12,000	13,500	4,800	30,300

(Source: Ministerio de Industria y Energia, 1976)

Trend of output (in m^3 per year)

Year	Plywood and block board	Particleboard	Fibreboard	Total
1977	4,800	6,400	3,000	14,200
1978	4,500	6,000	2,950	13,450
1979	2,300	7,000	3,290	12,590
1980	6,500	6,000	4,000	16,500
1981	6,500	6,000	4,000	16,500
1982	3,000	4,000	3,000	10,000
1983	3,000	4,500	3,300	11,000

(Source: Direccion Forestal)

As outlined in above, the scale of forest industries including pulp and paper industry in Uruguay is rather small, so the present log production for industries is not so much.

1-6 Outline of Plantation Management

Forestry Agency has selected the following species as recommendable species and encouraged landowners to develop plantation through its technical guidance, showing the standard of plantation management which is described later.

1-6-1 Recommendable Species for Plantation

Plantings of pines and Eucalyptus species have been experienced for more than 100 years in Uruguay. The following have been selected for the development of plantation at present, based upon its record.

Recommendable species	Right places for plantation
Pinus taeda	Nationwide
Pinus elliottii	Nationwide
Pinus pinaster	Suitable for sand-dune fixation forest on the coastline of the Atlantic and the Plata river
Eucalyptus globulus	Nationwide
Eucalyptus grandis	Its growth is inferior to E. globulus in the southern part of Uruguay since it is easily damaged by frost
Populus (Alamo hibrido)	It shows good growth on the swampy land and on the riverside of the Uruguay river in the western part of Uruguay

1-6-2 Standard of Plantation Management

Forestry Agency puts emphasis on the following points for its technical guidance.

(1) Selection of good seeds, in particular selection of seed provenance

(2) Planting space

Recommending space planting (3m x 3m : 1,110 seedlings/ha, 3.5m x 3.5m : 800 seedlings/ha) rather than close planting (2m x 2m : 2,500 seedlings/ha, 2.5m x 2.5m : 1,600 seedlings/ha).

(3) Pruning and thinning

These treatments make grazing possible in the planted area.

(4) Short rotation

The following are samples of plantation management based upon the above-mentioned technical guidance.

Items \ Species	P. taeda P. elliottii	E. globulus E. grandis E. saligna	Alamo 63/51 " 74/D " 214
No. of planting seedlings per ha (spacing)	1,110 (3m x 3m)	1,110 (3m x 3m)	280 (6m x 6m)
Rotation	20 years	12 years	18 years
Mean annual increment	18 m^3/ha/y	25 m^3/ha/y	16 m^3/ha/y
Management standard			
Ant control	Year 1, 2 and 3	Year 1, 2 and 3	
Weeding	" " "	"	
Brush cutting	" " "	"	
Pruning & thinning:			
1st	Year 5 to 8		Year 7 to 9
Thinning rate	33%	-	-
Pruning	All trees after thinning	-	Low pruning
Volume from thinning	35 m^3/ha	-	-
2nd	Year 11 to 13		Year 11 to 13
Thinning rate	33%	-	-
Pruning	All trees after thinning	-	High pruning
Volume from thinning	70 m^3/ha	-	-
Final cutting volume	255 m^3/ha	300 m^3/ha	300 m^3/ha
Total yield volume	360 m^3/ha	300 m^3/ha	300 m^3/ha
Main usage of logs Produced from final cutting	Sawlog & veneer log: 80% Pulpwood: 20%	Sawlog & veneer log: 60% Pulpwood & fuelwood: 40%	Sawlog & veneer log: 80% Pulpwood: 20%

The above-mentioned standard management indicates difference from the plantation management described in Chapter 3 Plan for Plantation. Main different points are as follows.

	Pinus taeda Pinus elliottii		E. globulus E. grandis		Populus	
	Sample	Plan for Plantation	Sample	Plan for Plantation	Sample	Plan for Plantation
No. of planted trees per hectare	1,110	1,110	1,110	1,600	230	1,600
Rotation	20ys	11ys	12ys	Ave. 7.2ys	18ys	Ave. 7.2ys
Mean annual increment	$18m^3$/ha/y	$15m^3$/ha/y	$25m^3$/ha/y	Ave. $26.7/m^3$/ha/y	$16m^3$/ha/y	Ave. $26.7/m^3$/ha/y

(1) Pinus taeda and Pinus elliottii

The sample adopts 20 years of rotation in order to produce sawtimber size logs, but Plan for Plantation adopts 11 years of rotation to yield pulpwood of smaller sized diameters which are easily processed in a pulp mill.

It is likely that mean annual increment of 15 m^3 per hectare per year adopted in Plan for Plantation is reasonable.

(2) Eucalyptus globulus and Eucalyptus grandis

The sample adopts long-year rotation and space planting in order to produce sawtimber size logs like the case of pines. FNP and PAMER used to adopt close planting of 2,500 seedlings per hectare to produce pulpwood, but now they are adopting planting of seedlings from 1,600 to 1,670. So it seems to be proper for Plan for Plantation to adopt planting of 1,600 seedlings per hectare.

The mean annual increment in Plan for Plantation is judged reasonable since Eucalyptus's reproductive power from stump is very strong.

(3) Populus

Judging from some difficulty in carrying out tending operation in swampy land where Populus are usually planted, the sample seems to adopt extremely space planting. But Plan for Plantation adopts the same

management as the case of Eucalyptus because Populus would be planted on sandy soil where it seems to be possible to carry out normal tending operation even though water happens to come up temporarily.

1-7 Forest Policy

Forestry Agency was organized in Ministry of Agriculture and Fishery in December, 1964. Forestry Agency published "Guidelines of Forestry Promotion" as concrete measures of forest policy in November, 1971, on the basis of Forest Law (Ley Forestal No. 13,723) proclaimed in December, 1968.

Forestry Agency has executed the following policies based on the above-mentioned guidelines.

(1) Working out the development plan for plantation which intends to establish 200,000 hectares of plantation for ten years.

(2) Designation of forest fostering districts and drafting of preferential taxation system and financing aids to planters in forest fostering districts.

(3) Adoption of preferential taxation system which allows planters to deduct plantation costs from IMPROME (land productive tax).

(4) Classification of forest necessary for performing forest policy.

(5) Working out regulations of importation necessary for planting, forest protection and utilization of forest products.

(6) Obligatory planting on state land in forest fostering districts.

(7) Obligatory planting in the surrounding districts of Rinco de Baygorria dam and Rinco del Bonet dam.

(8) Obligatory planting on the dunes on the coastline of the Atlantic in Rocha Department.

1-7-1 Development Plan for Plantation

The performance of development plan for plantation described in 1-7-(1) is very poor as shown in 1-4 Planted Area in Recent Years and Table III-4 REGISTERED PLANTATION AREA FROM 1975 TO 1983.

1-7-2 Designation of Forest Fostering Districts

Soil Division, Ministry of Agriculture and Fishery, has classified the whole soil in Uruguay in 17 soil zones, dividing further them into subzones and groups.

Forestry Agency has designated districts consisting of Soil Zone 7, 8 and 9 as forest fostering districts since December, 1971, because soils of such zones are most suitable for the tree plantation.

Distribution per province (department) is shown in the following table.

The total area of forest fostering districts reaches to 1,800,000 hectares, corresponding to about 10% of the area of Uruguay, and Figure III-1 shows forest fostering districts, forming two masses in the west the north-central.

Department (Province)	Area of forest forestering districts	Ratio to area of Department
	ha	%
Paysandu	313,502	22.42
Rio Negro	259,208	28.23
Durezno	281,115	23.19
Rivera	248,439	26.41
Tacuarembo	319,212	20.49
Sub-total	1,431,476	
Others (including Soriano)	378,510 (122,548)	
Grand Total	1,809,986	

(Source: M.A.P. CONEAT)

Also, Forestry Agency is now studying on whether Zone 2 (about 2,750,000 hectares of hilly districts) is designated as forest fostering districts.

1-7-3 Preferential Taxation System to Planters

For the purpose of accelerating plantation, a new taxation system became effective in 1975, which included provisions that a considerable amount could be deducted from tax when a taxpayer planted recommended species on more than 10 hectares in forest fostering districts.

Namely, plantation costs on the planted area could be deducted from the tax of IMPROME (Impuesto a la Productividad Minima Exigible) up to 50 percent of IMPROME.

After the new taxation system became effective, planted area indicated a tendency to increase rapidly as shown in 1-4 Planted Area in Recent Years.

But, it is said that the intentions of planters declined rapidly after this preferential taxation system had been repealed in 1979 and had been effective retroactively to 1978.

At present, landowners who planted recommended species on more than 10 hectares in forest fostering districts can be deducted IMAGRO (a sort of land tax) from their taxes instead of the deduction of plantation costs.

There are big differences of amounts deducted from tax between the present taxation system and the former one.

1-7-4 Revision of Forest Law

Forest law (Ley Forestal No. 13,723) was revised in Congress in 11th December, 1984. Revised forest law does not include provisions concerning the restoration of the former preferential taxation system.

Revised main points are as follows.

(1) Establishment of Forest Fund

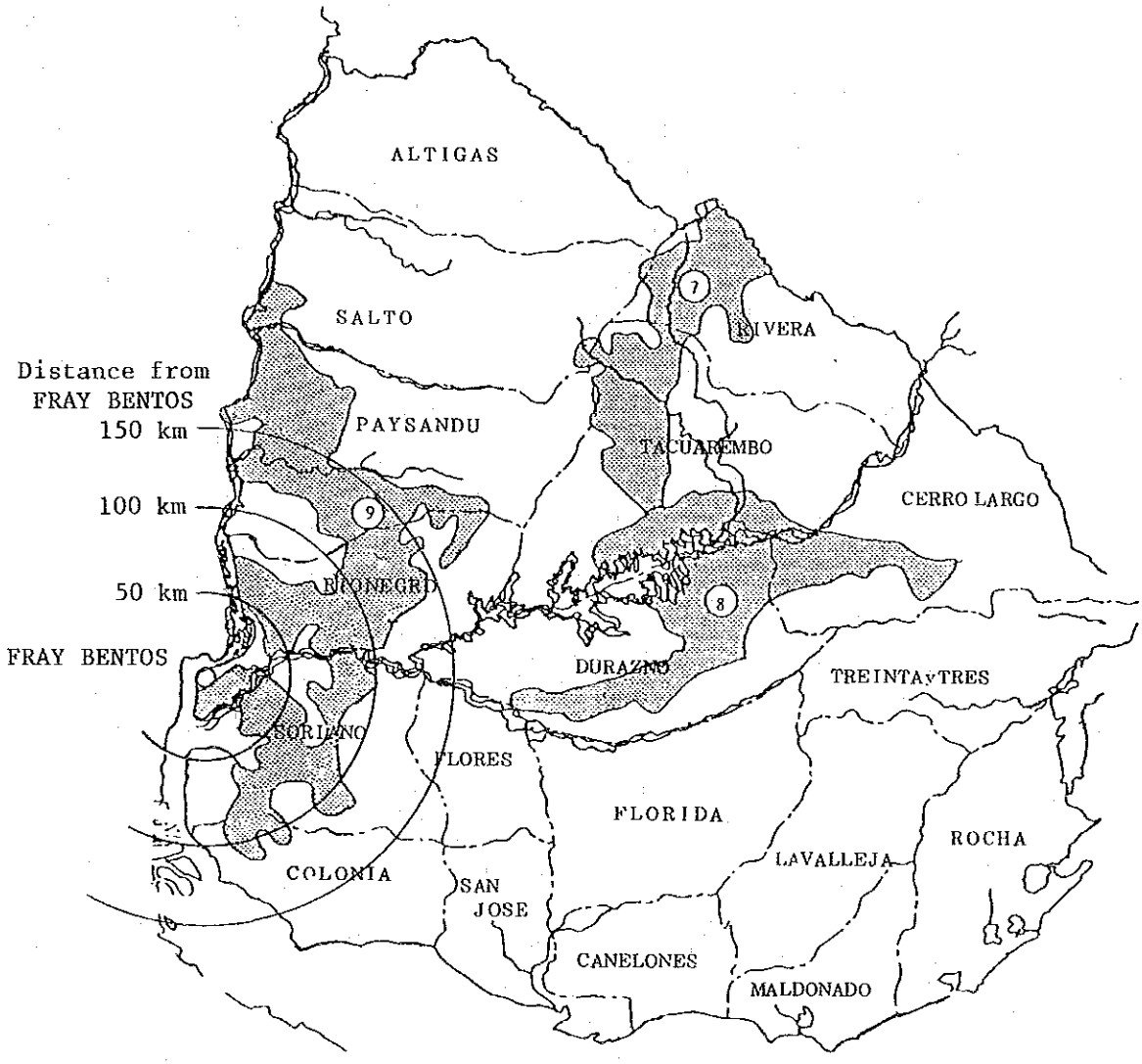
(2) Designation of national interest forest zones

(3) Provisions concerning surface right

(4) Provisions concerning mortgage on standing timber, and so on.

(Note: Revision of Forest Law which become effective in December, 1984, was repealed in 1985.)

Figure III-1 MAP OF FOREST FOSTERING DISTRICTS



Forest fostering districts that locates within 150 km far FRAY BENTOS are limited to 3 Departments (Province) as shown in the map, but there is enough area to plant even if only pine is planted.

Department	Area of forest fostering districts
	ha
Rio Negro	259,208
Soriano	122,548
Colonia	16,051
Total	397,807

Chapter 2 Present Status of Plantation Costs and Logging Costs

2-1 Plantation Works and Plantation Cost

Plantation works consist of planting operation and tending operation.

The following outlines the process of plantation works prevailing in Uruguay at present.

Items	Details of works	Employed equipment
(Planting operation)		
Ant control	Insecticide is poured into ant hills to exterminate ants which are the badest enemies of planted trees.	Manpower
Fence construction	Fence is constructed with poles, sticks and wire not to be entered by men and animals and also to make borders clear.	Manpower
Ploughing	Soil is cut and turned over by a tractor attached a plough.	Tractor and Plough
Harrowing	Soil is broken up after ploughing by a tractor attached a harrow.	Tractor and Harrow
Planting	Seedlings are planted in holes made with a hoe at regular intervals.	Manpower
Replanting	Dead seedlings are checked and replaced with new seedlings.	Manpower
(Tending operation)	Weedings and brush cuttings are made for three years after planted year.	Manpower and Tractor

The following are the tables showing present plantation cost by species.

Table III-5 PRESENT PLANTING AND TENDING COSTS OF EUCALYPTUS AND POPULUS

Table III-6 PRESENT PLANTING AND TENDING COSTS OF PINES

Table III-7 HOURLY COSTS OF MACHINES FOR PLANTATION WORKS

The outline of present plantation costs follows.

(as of January, 1984)

Items	Eucalyptus & Populus		Pines	
	N$/ha	US$/ha	N$/ha	US$/ha
Planting cost	7,498.40	163.50	5,461.50	119.09
Contingency	374.90	8.18	273.10	5.96
Overhead	629.90	13.74	458.90	10.00
Total	8,503.00	185.42	6,193.40	135.05
Tending cost				
First year	850.30	18.54	619.40	13.51
Second year	"	"	"	"
Third year	"	"	"	"
Cutting year	500.00	10.90	-	-

(1 US$ = 48.56 N$)

It is inevitable for a pulp mill to have a large scale of plantation of 5,000 to 10,000 hectares a year in order to supply the pulpwood continuously. Therefore, it is essential to construct forest roads, which are necessary for smooth transportation of seedlings, for tending operations and for patrolling against deseases and insect damages, as well as fire belts, which are necessary for fire break, besides working items mentioned in the previous table, especially to carry out such a large scale of plantation works efficiently.

Under such circumstances, plantation costs described in Chapter 3 Plan for Plantation include such costs as above-mentioned.

Although nursaries are very important facilities to obtain supperior grade of seedlings, this report does not include the description of nursary practice because costs of nursary practice can be maintained at the costs of seedlings which are included in plantation costs. But working items are shown in Process flow chart of 3-3-1-(2).

Table III-8 TREND OF PLANTATION COSTS written in U.S. dollars does not show the same trend as the increasing trend of plantation costs written in Peso, because of the irregular exchange rate of Peso to the U.S. dollar, especially in recent years.

For reference, the following show stumpage costs which are calculated based upon the above-mentioned plantation costs.

Species	In the case of 12% of discount rate	In the case of 8% of discount rate
Eucalyptus and Populus	3.47 US$/m^3	2.09 US$/m^3
Pines	7.75 "	4.67 "

For fur details, please refer to the following tables.

Table III-9 DISCOUNTED VALUE OF PLANTED EUCALYPTUS AND POPULUS (12% per year)
Table III-10 DISCOUNTED VALUE OF PLANTED EUCALYPTUS AND POPULUS (8% per year)
Table III-11 DISCOUNTED VALUE OF PLANTED PINES (12% per year)
Table III-12 DISCOUNTED VALUE OF PLANTED PINES (8% per year)

2-2 Logging Operation and Logging Cost

Plantation in Uruguay have been made on gently undulating terrains and the soils in forest fostering districts are sandy, so logging operations are rather easy.

Reflecting such favourable conditions, present logging costs are relatively inexpensive.

The following table is a summary of present logging costs which are analysed in the tables listed below.

(in US$/m^3)

	Eucalyptus *1	Populus *1	Pines *2
Logging cost	5.46	3.27	4.36

*1 : Including debarking cost
*2 : Excluding debarking cost

Table III-13 PRESENT LOGGING COST OF EUCALYPTUS
Table III-14 PRESENT LOGGING COST OF POPULUS
Table III-15 PRESENT LOGGING COST OF PINE
Table III-16 COST OF CHAIN SAW

As mentioned in 1-3 Annual Removals of Roundwoods, annual output of logs for industrial uses is about 250,000 m^3, which are very smale scale campared with the volume of raw materials required by the pulp mill planed for this report.

There is some concern about the constant supply of a huge amount of pulpwood only by the increment of the number of present logging camps.

Therefore, the logging method is prepared and described in Chapter 4 Plan for Logging Operation so as to meet such constant supply of a huge volume of pulpwood, and logging costs are also calculated according to such logging method.

Chapter 3 Plan for Plantation

3-1 Pulpwood Requirement and Required Land Area

The following table shows annual pulpwood requirement, necessary plantation area, required land area and annual planting area, calculated on the assumption that the pulp mill shall use one species only.

In this connection, 80% of land area is actually planted and 20% of land area is land unfit for planting such as river land, swampy land and land to be utilized as fire belt including forest road.

Species	Annual pulpwood requirement	Necessary plantation area *1	Required land area	Annual planting area
	m^3/y	ha	ha	ha/y
E. globulus	907,800	38,420	48,025	4,540 *2
E. grandis	1,206,150	51,030	63,788	6,030 *2
Populus	1,397,400	59,150	73,938	6,990 *2
P. taeda	1,558,050	103,950	129,938	9,450 *3
P. elliottii	1,723,800	114,950	143,688	10,450 *3

Note: *1 Refer to Table III-17 to III-21
*2 Showing annual planting area during the first 6 years only.
*3 Showing annual planting area during 11 years.

Also the relation between necessary planting area per year and cutting area per year is shown in the following tables.

Table III-17 PLANTING AND HARVESTING PLAN FOR E. GLOBULUS
Table III-18 PLANTING AND HARVESTING PLAN FOR E. GRANDIS
Table III-19 PLANTING AND HARVESTING PLAN FOR POPULUS
Table III-20 PLANTING AND HARVESTING PLAN FOR P. TAEDA
Table III-21 PLANTING AND HARVESTING PLAN FOR P. ELLIOTTII

3-2 Increment

Increment by species is essential to obtaining Plantation area and required land area. Needless to say the increment of trees varies remarkably with variety,

individual, tree age, productivity of soil and so on. In particular, the increment of artificially planted tree also varies with planting technique, tending operation after planting, fertilizing and so on, in addition to the above-mentioned factors.

The increment by species used in this chapter is the one agreed on the discussion with each party in Interim Report, which shows as follows.

Eucalyptus and Populus			Pines		
Age	Yield volume	Mean annual increment	Age	Yield voluem	Mean annual increment
	(m^3/ha)	(m^3/ha/y)		(m^3/ha)	(m^3/ha/y)
0	Planting		0	Planting	
1			1		
'			'		
'			'		
8	(1st) 200	25	'		
'			'		
'			11	165	15
14	(2nd) 180	30			
'					
'					
20	(3rd) 180	30			
'					
'					
28	(4th) 200	25			
'					
'					
36	(final) 200	25			

3-3 Plan for Plantation

3-3-1 Assumptions of Plantation Plan

The plantation plan is worked out on the assumptions described below.

(1) Land

It is the best for a pulp mill to have their own land and have plantation there, but the question of who have land is not discussed in this report though the land cost is used for the calculation of stumpage costs.

A Brazil-Japan joint pulp manufacturing company has the experience of spending supplementary expenses on surveying, registration and so on to 7% of land purchased price. However, 225 U.S. dollars per hectare which are mentioned in Interim Report are regarded as including such supplementary expenses in this report.

It is inevitable for a pulp mill to have enough land before the commencement of planting. However, in this report the calculation of stumpage costs is made on the assumption that the land being worth 225 U.S. dollars per hectare is used to plant without taking account of when the land was purchased.

And as mentioned in 3-1 Pulpwood Requirement and Required Land Area, 80% of land area is actually used for plantation.

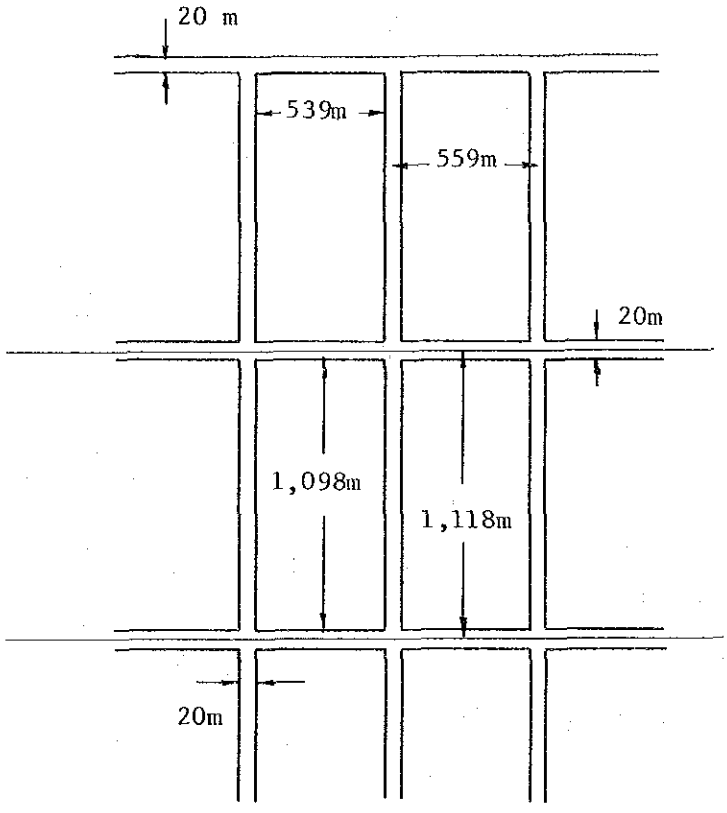
If 50 hectares of net plantation area is defined as a "Forest unit", the land area necessary for one Forest unit becomes 62.5 hectares (50 ha - 0.8). Let us define as a "Forest district" for the land area necessary for the supply of pulpwood required for one year by the pulp mill by integrating necessary number of Forest units, and also define as a "Forest region" for the land area necessary for the supply of pulpwood required eternally by the pulp mill.

Please take the following figure as a model of a Forest unit and each Forest unit has 10 metre wide of fire belt around it. Since a Forest unit is surrounded by other Forest units, each Forest unit is separated by 20 metres wide of fire belts from each other.

Forest roads with 5 metres in roadway width are constructed inside fire belts having 20 metres in width.

Forest roads are used for transportation of workers and materials during plantation works and for patrolling. And also forest roads are used for hauling logs, reinforced during logging operation.

Fire belts on forest borders have 20 metres in width.



The following table shows the outline of organized formation of Forest district and Forest region. (For further details, please refer to Table III-22 ORGANIZED FORMATION OF FOREST REGION.)

Species	Per Forest district			Per Forest region			
	No. of Forest units	Planted area	Required land area	No. of Forest districts	No. of Forest units	Planted area	Required land area
		ha	ha			ha	ha
E. globulus	128	6,403	8,000	6	768	38,420	48,000
E. grandis	170	8,505	10,625	6	1,020	51,030	63,750
Populus	197	9,858	12,313	6	1,182	59,150	73,875
P. taeda	189	9,450	11,813	11	2,079	103,950	129,938
P. elliottii	209	10,450	13,063	11	2,299	114,950	143,689

(2) Plantation works

Although the plantation works was explained in Chapter 2, the explanation showing process flow chart, is made here again, because there is a close relation to the calculation of plantation costs.

(Note: The explanation and process flow chart listed here show the case of planting Eucalyptus.)

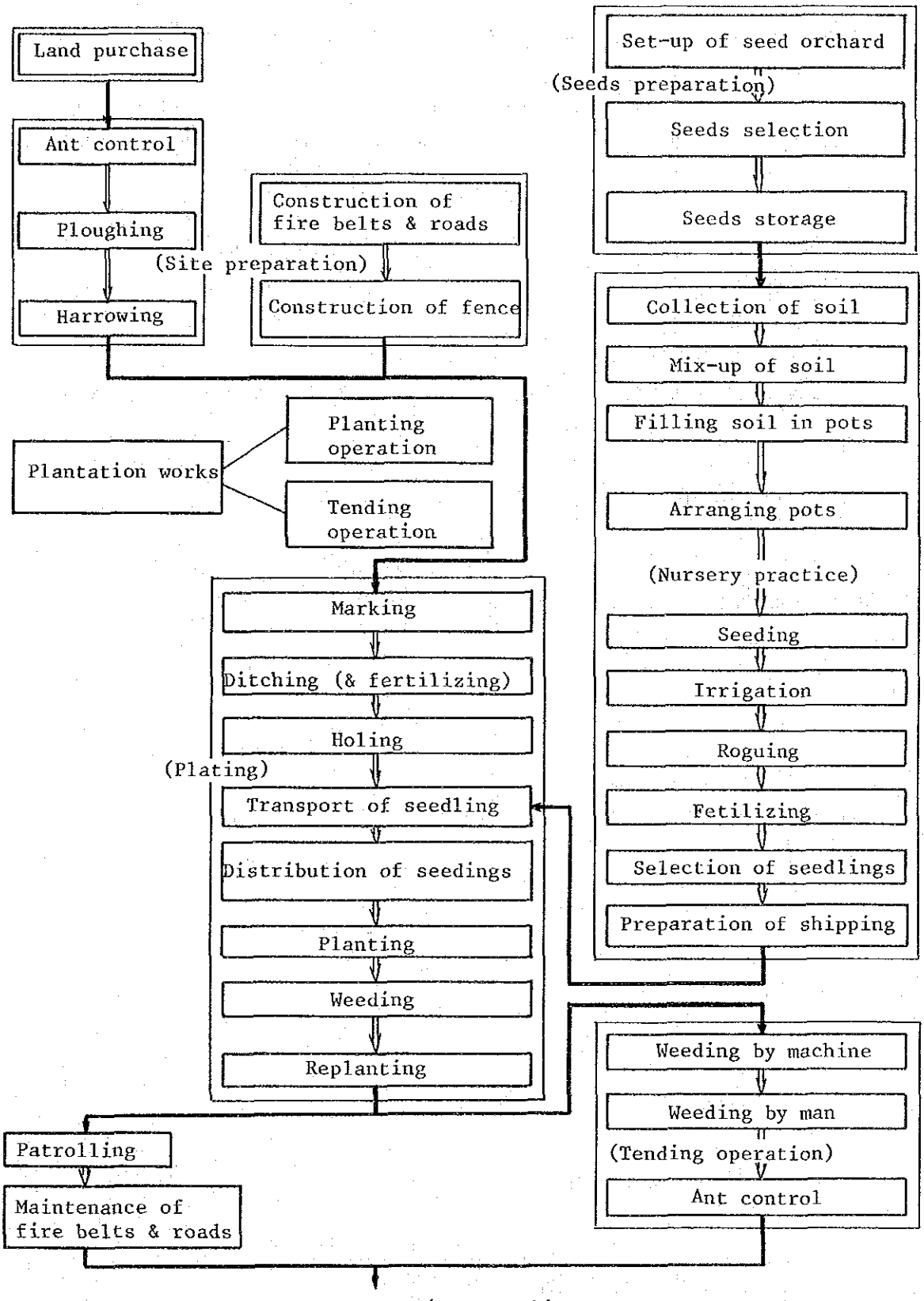
Items	Details of works	Employed equipment
(Site preparation)		
Construction of fire belts and forest roads	Fire belts having 20m in width and forest roads having 5m in roadway width are constructed around each mass of Forest units. Each Forest unit is surrounded by fire belts having 10m in width, and forest roads are constructed inside fire belts having 20m in width.	Bulldozer, Motor grader, Manpower.
Construction of fence	Please refer to 2-1	Manpower
Ant control	" "	Manpower
Ploughing	" "	Tractor and Plough.
Harrowing	" "	Tractor and Harrow
(Planting)		
Marking	Guide-marks to present targets for tractor's course are set up at regular intervals in every Forest unit.	Manpower
Ditching (and fertilizing)	Stiripes of ditches are made at planting intervals. In the case of fertilizing, a fixed quantity per ha of compound fertilizer are given with a fertilizing machine.	Tractor (and Fertilizing machine), Manpower
Holing	Holes to plant seedlings are made with a hoe at planting intervals.	Manpower
Transportation of seedlings	Plastic boxes filled with seedlings are transported from nursery to planting spots by trucks.	Truck
Distribution of seedlings	Plastic boxes filled with seedlings are brought to planting workers to keep continuous progress by a tractor attached a wagon and at the same time empty boxes are collected.	Tractor and Wagon, Manpower
Planting	Potted seedlings are planted in holes with a small hoe and at the same time pots of vinyl are removed.	Manpower
Weeding	Weeding between planted seedlings lines is done by a tractor with a harrow and weeding between seedlings is done by workers.	Tractor and Harrow, Manpower
Replanting	Dead seedlings are checked and replaced with new living seedlings after planting. (About 10% of planted seedlings is expected to replace.)	Manpower
(Tending operation)		
Weeding	Weedings are made in the first year after planting in the same way as mentioned above two to three times a year.	Tractor and Harrow, Manpower
Brush cutting	Brush cuttings are done by a tractor with a brush cutter two to three times a year in the second and third year respectively.	Tractor and Brush cutter, Manpower
Ant control	Granular or gaseous insecticide is used by specially trained workers	Manpower
Patrolling	Patrolling is made all the year round to watch fire, diseases, insect damages and so on.	Manpower
Maintenance of fire belts and forest roads	A motor grader and road menders are employed to mend fire belts and forest roads. In particular, weeding and debranching at forest boarders and fire belts are important to afford an unobstructed view. Forest roads are used for log-hauling during logging operation after being reinforced.	Motor grader, Manpower

3-3-2 Plantation Cost

The following tables show details of plantation cost by species calculated in accordance with the explanation given above.

Table III-23 PLANTING COST OF EUCALYPTUS AND POPULUS

Process flow chart of plantation works



(Note: This chart shows the case of planting Eucalyptus.)

Also Table III-35 and III-36 show each year's total cost as a table.

The plantation costs shown in the above tables differ from present plantation costs mentioned in Chapter 2. The reasons of the difference between them are outlined in the table below.

Items	Plantation costs stated in Chap.2 (A)	Plantation costs stated in Chap.3 (B)	Remarks
Wage of worker	N$16.30/h=US$0.36/h	US$0.68/h	(B):US$80/mon. 200hsx1.7 (including fringe benefits)=0.68
Wage of tractor operator	N$17.00/h=US$0.37/h	US$1.11/h	(B):US$130/mon 200hsx1.7 =1.11
Wage of bulldozer and motor grader operator	-	US$1.70/h	(B):US$200/mon 200hsx1.7 =1.70
(Machine cost) Delivered price			
* Bulldozer	-	US$130,000 (150HP)	(B):Useful life 12,000hs
* Motor grader	-	US$ 98,000 (125HP)	(B): " " "
* Tractor	US$20,000 (77HP)	US$ 18,000 (55HP)	(A): " " "
			(B): " " "
Interest	-	12%/year	(B):Interest and
Insurance	-	3%/year	insurance on average annual investment are charged.
Fuel consumption	0.15 1/HP/h	0.13 1/HP/h	
Fuel price	N$17.90/1=US$0.39/1	N$24.30/1=US$0.324/1	(B):According to revised price in Sep. 1984
Cost of lube oil, etc.			
* Bulldozer	-	Fuel cost x 20%	
* Motor grader	-	Fuel cost x 20%	
* Tractor	Fuel cost x 15%	Fuel cost x 15%	
Repair cost			
* Bulldozer	-	Depreciation costx100%	
* Motor grader	-	Depreciation costx100%	
* Tractor	Depreciation costx70%	Depreciation costx 70%	
* Plough	Depreciation costx40%	Depreciation costx 40%	
* Harrow	Depreciation costx50%	Depreciation costx 40%	
Construction of fire belts and forest roads	Being not listed	Being constructed around Forest unit	(B):Because of being necessary for protection of a large scale plantation.
Construction of fence	40m/ha, US$0.39/m	25m/ha, US$0.79/m	(A):50% of cost being charged (B):100% of cost being charged

Items	Plantation costs stated in Chap.2 (A)	Plantation costs stated in Chap.3 (B)	Remarks
Ploughting Harrowing			Refer to wage of tractor operator and machine cost in this table.
Marking Ditching Holing Transportation and distribution of seedlings Planting Weeding Replanting	(Example of Eucalyptus) Planting 42.67hs/ha Replanting 8.53hs/ha Total 51.20hs/ha Total cost N$834.50=US$18.20/ha If fringe benefits being added to labour cost, then 18.20x1.7=US$30.94/ha	(Example of Eucalyptus) Labour cost US$39.44/ha Machine cost US$34.44/ha Total US$73.88/ha Being added up each cost of the listed working items. Maintenance costs of fire belts and forest roads being charged every year. A watchman every 500 ha is posted for patrol.	(B):The following items are supplemented after the example of a pulp mill in Brazil which is planting to supply its own pulpwood requirement. Marking, Ditching, Transportation and Distribution of seedlings, and Weeding.
Tending operation	Charging 10% of planting cost per year in the lump during 3 years.		Prevention measures against disasters being important for a large scale plantation to grow into good forest as disigned.
Cutting year's operation	(Example of Eucalyptus) Charging N$500.00/ha =US$10.90/ha in the lump.	(Example of Eucalyptus) Being added up each cost of the listed working items. US$35.88/ha	

The following table shows the comparison between the two costs of Eucalyptus mentioned above.

(in US$/ha)

Items	(A)	(B)	(B)-(A)	Remarks
(Planting cost)				
Fire belt	-	12.41	12.41	
Forest road	-	8.03	8.03	
Fence	15.44	19.65	4.21	
Ant control	4.76	6.84	2.08	
Ploughing and harrowing	28.81	25.18	-3.63	Mainly due to increased cost of Marking, Ditching, Holing and Planting
Planting	95.41	122.95	27.54	
Transportation and Distribution of seedlings	-	15.93	15.93	
Weeding	-	12.20	12.20	
Replanting	19.08	10.80	-8.28	Increase due to
Sub-total	163.50	233.99	70.49	New working item 48.57 Fringe benefits 18.09 Others 3.83 Total 70.49
Contingency	8.18	11.70	3.52	
Overhead	13.74	19.66	5.92	
Total	185.42	265.35	79.93	
(Tending cost)				
1st year	18.54	51.33	32.79	Refer to Tables regarding tending costs.
2nd year	18.54	38.15	19.61	
3rd year	18.54	31.28	12.74	
4th year	-	7.87	7.87	Maintenance of fire belt and forest road, Patrol.
5th year	-	7.87	7.87	
6th year	-	7.87	7.87	
7th year	-	7.87	7.87	
(Plantation cost)				
Planting and tending costs	241.04	417.59	176.55	
Cost of cutting year	10.90	35.88	24.98	

Notes: (A); Plantation cost stated in Chapter 2 (cost as of Jan. 1984)

(B); Plantation cost stated in Chapter 3

The following are main reasons why plantation costs calculated in this Chapter are more expensive in comparison with plantation costs as of January, 1984. (Following figures show the case of Eucalyptus only.)

(1) Cost increase in adding working items which are not listed in plantation costs as of January, 1984.

	US$/ha
Construction of fire belts for protection of disasters	12.41
Construction of forest roads for transportation, patrol, etc.	8.03
Transportation and distribution of seedlings	15.93
Weeding	12.20
Sub-total	48.57

(2) Cost increase in adding fringe benefits to wage 18.09

Construction of fence	4.90 US$/ha
Ant control	4.35
Marking	3.40
Ditching	8.84
Planting	20.40
Replanting	2.04
Sub-total	$43.93 \times (1 - \frac{1}{1.7}) = 18.09$

(3) Cost increase in others 3.83

(4) Total 70.49

(5) Cost increase in contingency 3.52

(6) Cost increase in overhead 5.92

(7) Grand total 79.93

The tending costs calculated in this chapter are much higher than the tending costs as of January, 1984, because working items which seem to be necessary for assuring the growth of plantation are added after the study of plantation practice in Brazil.

Overhead expenses usually depend upon how to organize managing system, how to supervise plantation works, how to manage planted area and so on. Overheads shown in this chapter represent only field overhead expenses because overall management of plantation works and logging operation are to be left to Wood Division of the mill.

In this connection, there is an example that a plantation company in Brazil expends about 15% of field costs as overall overhead expenses in addition to about 15% of field costs as field overhead expenses.

3-3-3 Calculation of Stumpage Cost

Stumpage costs are calculated by the method of discounted cash flow with 12% of discount rate, inputting all costs such as land costs, planting costs, tending costs, etc. from the beginning to the final cutting year.

(1) Land cost

As mentioned before, although the acquisition of land should have been completed by the commencement of planting operation, land in the calculation of stumpage costs is regarded as having been obtained at the planting year and also land cost is regarded as including supplementary expenses. In the final cutting year, the remaining land value is deducted from the total of discounted value for the calculation of stumpage costs.

(2) Plantation cost

Plantation costs calculated in 3-3-2 are applied to the calculation of stumpage costs.

(3) Yield volume

Yield volumes mentioned in 3-2 are applied to the calculation of stumpage costs.

(4) Stumpage costs

The results of calculation follow.

	(in US$/m^3)
Eucalyptus and Populus	4.78
Pines	10.82

For further details, please refer to the following tables.

Table III-35 DISCOUNTED VALUE OF PLANTED EUCALYPTUS AND POPULUS

Table III-36 DISCOUNTED VALUE OF PLANTED PINES

(5) Stumpage costs for reference

For reference, stumpage costs are calculated on the following assumptions.

a) The same taxation system is still effective as mentioned in 1-7-3 Preferential Taxation System to Planters.

b) Taxpayers are able to enjoy the preferential taxation system mentioned in a) through the investment of the amount corresponding to an amount deducted from their tax in a pulp mill (or a plantation company) which is planting in a large-scale.

c) The pulp mill (or the plantation company) sets up plantations by the use of the money invested in b).

d) The pulp mill (or the plantation company) repays the money invested in b) together with the interest on the basis of 8% per annum to investors at the cutting year.

In other words, the results of calculation based upon the above-mentioned assumptions are the same results of calculation that 8% of discount rate is used instead of 12% in the calculation of stumpage costs mentioned in (4).

The following show the results together with stumpage costs of the case of 12%.

(in US$/$m^3$)

Species	8% of discount rate	12% of discount rate
Eucalyptus and Populus	3.03	4.78
Pines	6.83	10.82

For further details, please refer to the following tables.

Table III-37 DISCOUNTED VALUE OF PLANTED EUCALYPTUS AND POPULUS (8%)

Table III-38 DISCOUNTED VALUE OF PLANTED PINES (8%)

Chapter 4 Plan for Logging Operation

Logging operation is performed on relatively flat terrain and sandy soil which are good conditions for the work.

It is likely that the following logging method is suitable to such logging conditions.

Standing trees are felled and limbed and then bucked 2.2m in length by a chain saw.

A tractor equiped with a grapple crane enters cutting area, drawing a simple-structured wagon, and loads scattered logs on the wagon with its own crane and skids loaded logs to forest road side, and then unloads logs so as to make piling along forest road with its own crane.

Piled logs along forest roads are loaded on a large-sized truck by a tractor equiped with a grapple crane to haul logs to a pulp mill.

Debarking operation is not done in logging areas but in the wood room of a pulp mill. Barks and other waste from the wood room are utilized as fuel.

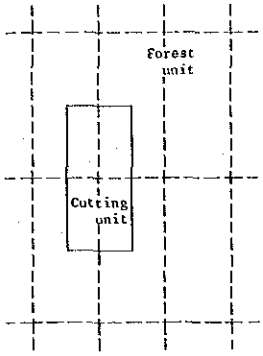
4-1 Logging Operation

4-1-1 Cutting Unit and Logging Operation Process

A Forest unit mentioned in 3-3-1 Assumptions of Plan for Plantation is about 560 metres in width and about 1,120 metres in length, having 62.5 hectares in area and surrounded with fire belts which include forest roads inside.

A Forest unit also becomes a unit of logging operation at the cutting year, so it is refered to as a Cutting unit in this chapter. But since logging operation is to be developed in a large area at the same time, it is convenient for us to think a Cutting unit to be such a shape shown in the following figure.

That is, a Cutting unit has cross-shaped forest roads as shown in the figure and its area is the same as a Forest unit. So a Cutting unit has about 27 metres per hectare of forest road density and about 100 metres of average skidding distance. [(560m + 1,120m) 62.5 ha = 27 m/ha]



The following chart shows process flow as well as employed crew and equipment.

And it is planned that hauling operation from forests to the mill woodyard is done by contract work.

Logging process flow chart

Flow sheet	Employed crew and equipment
Felling (Felling and bucking) Limbing Bucking	Chain saw 1 Operator 1 Worker 1
	Tractor equiped with grapple crane (100HP) 1 Wagon 3
Loading in forest (Skidding) Skidding Piling along forest road	Operator 1 Worker 2
(Loading) Loading on truck	Tractor equiped with grapple crane (100HP) 1 Operator 1 Worker 2
(Hauling) Hauling by truck	(Contract work)
Construction of main road	Motor grader 1 Operator 1
Maintenance of forest road	Road Mender 5

4-1-2 Standing Tree Conditions at Cutting Age

The following standing tree conditions at the first cutting age are made based upon the site survey results and data collected by Study Team because the standing tree conditions are necessary for working out the plan for logging operation.

(1) Eucalyptus and Populus

Number of planted trees per hectare	1,600
Number of harvesting trees per hectare	1,120
	(viability rate: 70%)
Average DBH	18 cm
Average height	16.5 m
Breast height form factor	0.533
Yield percentage in logging	80 %
Effective volume per tree	0.179 m^3
	(up to 7cm top)
Net yield volume per hectare	200 m^3/ha
Weight of log	
Eucalyptus	1,000 kg/m^3
Populus	800 kg/m^3

(2) Pine

Number of planted trees per hectare	1,110
Number of harvesting trees per hectare	720
	(viability rate: 65%)
Average DBH	24 cm
Average height	13 m
Breast height form factor	0.487
Yield percentage in logging	80 %
Effective volume per tree	0.229 m^3
	(up to 7cm top)
Net yield volume per hectare	165 m^3/ha
Weight of log	800 kg/m^3

4-1-3 Forest Road

Forest roads around Forest units are used for hauling during logging operation and are divided into main roads and branch roads.

It is anticipated that main and branch roads would suffer considerable damages because lots of heavy loads are transported over and over even though maintenance of forest roads are carried out once a year during plantation operation. However, as mentioned before, sandy soil in forest fostering districts is suitable enough to road construction, so it is judged that branch roads do not require gravelling as far as their surfaces are well finished by a motor grader if they are well drained.

(1) Main road

It is usual that cutting area shifts its location to the new location far from the mill year by year, so some part of forest roads used for the first year's hauling operation would become the second year's main roads.

If such parts of forest roads are maintained as main roads from year to year, main road network would be built up in Forest districts and Forest region until the second cutting comes to the same unit.

If such main roads are continuously constructed at the rate of about 1,120 metres in length per 6 Forest units, one line of main road is laid at intervals of 3,360 metres. That means about 3 metres per hectare of main road density seems sufficient for the first stage of main road network construction.

Main roads are used in good condition throughout the year and year means a good road always maintained for the work.

In making an estimate of main road construction, 4,000 U.S. dollars per kilometre are appropriated as costs of materials, for examples, gravelling, bridge, etc., and road menders are employed for the construction of main roads and for the maintenance of branch roads in common.

Surface improvement is made by a motor grader once every 10 days, namely 36 times a year.

(2) Branch road

If it is assumed that logs produced in one Cutting unit and piled up at forest roadside are hauled out during one month, required number of loaders and trucks have to be arranged as a group or a set.

Until such group has performed hauling operation, 5 road menders are always employed to maintain forest roads in good condition and not to cause hindrance during hauling operation.

4-2 Logging Cost

The following shows the results of logging costs calculated according to Logging process flow chart mentioned in 4-1-1 Cutting Unit and Logging Operation Process.

(in U.S.$/m^3)

Items	Eucalyptus & Populus	Pines
(Costs)		
Felling and bucking	2.70	2.47
Skidding	2.03	1.86
Loading	0.93	0.84
Sub-total	5.66	5.17
(Others)		
Contingency	0.28	0.26
Overhead	0.48	0.43
Total	6.48	5.86

For further details, please refer to the following tables.

Table III-39 LOGGING COSTS
Table III-40 HOURLY OWING AND OPERATING COST ESTIMATE OF LOGGING MACHINES

4-3 Transportation Cost

4-3-1 Forest Road Cost

The following tables show construction and maintenance costs of both main and branch roads.

Table III-41 CONSTRUCTION AND MAINTENANCE COSTS OF FOREST ROAD FOR E. GLOBULUS

Table III-42 CONSTRUCTION AND MAINTENANCE COSTS OF FOREST ROAD FOR E. GRANDIS

Table III-43 CONSTRUCTION AND MAINTENANCE COSTS OF FOREST ROAD FOR POPULUS

Table III-44 CONSTRUCTION AND MAINTENANCE COSTS OF FOREST ROAD FOR PINUS TAEDA

Table III-45 CONSTRUCTION AND MAINTENANCE COSTS OF FOREST ROAD FOR PINUS ELLIOTTII

Bases of unit prices used in the above tables follow.

(1) Main road

Main roads are built year by year at the rate of 3 metres per hectare to the land area on which forest is cut in a year. Construction of the whole main roads completes at the time that main road density has reached to 3 metres per hectare in Forest region.

4,000 U.S. dollars per kilometre are appropriated amount as material cost for construction of main roads. Maintenance of main roads are done 36 times a year by a motor grader on a full length of main roads which was constructed by each cutting year. 752 U.S. dollars per kilometre are appropriated amount as maintenance cost.

[1h/1km x 36 times/y x 20.58 US$/h (refer to Table III-34)
≒ 752 US$/km]

(2) Branch road

Maintenance cost of branch roads which is appropriated in this chapter is the amount spent during a cutting year only. Maintenance cost of branch roads except the cutting year is appropriated in plantation cost year by year.

Labour cost for maintenance of branch roads is 405 U.S. dollars per kilometre since 5 road menders are employed to maintain 1,680 metres for one month in a cutting unit.

[200 hs/mon. x 5 men x 0.68 US$/h ÷ 1,680 m = 405 US$/km]

Machine cost for maintenance is 63 U.S. dollars per kilometre since a motor grader is employed 3 times a month which is the same as the period of hauling operation in a cutting unit.

[1h/1km x 3 times x 20.58 US$/h = 63 US$/km]

(3) Forest road cost by species

Outline of forest road cost by species which is calculated according to the above formula is as follows.

(in US$/$m^3$)

	Eucalyptus and Populus	P. taeda	P. elliottii
Construction & maintenance cost of forest roads	0.19	0.27	0.27

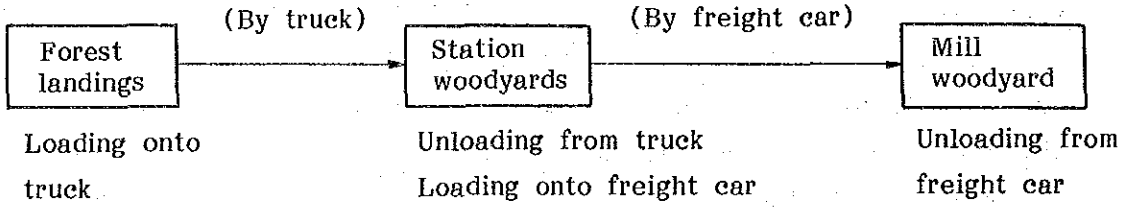
4-3-2 Hauling Cost

Hauling operation from forest landings (namely, pilings at forest roadside) to the mill woodyard is done by contract work using large-sized trucks.

50% of plantation locates within 100 kilometres far from the mill, having 75 kilometres of average distance, and the other 50% locates between 100 kilometres and 150 kilometres far from the mill, having 125 kilometres of average distance. Therefore, average hauling distance is 100 kilometres.

(75 km x 50% + 125km x 50% = 100km)

It is said that a through hauling operation from forest landings to the mill woodyard is cheaper than a two-stage transportation including a railway transportation because a two-stage transportation needs additional loading and unloading operations as shown in the following chart.



Needless to say that further study on railway transportation cost is needed for the comparison of total transportation costs. However, hauling operation by truck is adopted in this chapter.

The following shows hauling costs by species calculated by the use of the freight which is agreed to in Interim Report.

Freight : up to 150 km 3.00 N$/ton/km
more than 150 km 2.70 N$/ton/km

Hauling cost per ton : 3.00 N$/ton/km = 300 N$/ton/100km
= 4.00 US$/ton/100km
(1 US$ = 75 N$)

	E. globulus	E. grandis	Populus	P. taeda	P. elliottii
Weight of log (kg/m^3)	1,000	1,000	800	800	800
Hauling cost ($US\$/m^3$)	4.00	4.00	3.20	3.20	3.20

Chapter 5 Log Cost at Mill Woodyard

This chapter is composed of pulpwood costs and fuelwood.

5-1 Pulpwood Cost at Mill Woodyard

The following table shows summarized pulpwood cost by species at the mill woodyard.

Items	E. globulus	E. grandis	Populus	P. taeda	P. elliottii
Stumpage Cost	4.78	4.78	4.78	10.82	10.82
Logging cost	6.42	6.42	6.42	5.86	5.86
Forest road cost	0.19	0.19	0.19	0.27	0.27
Hauling cost	4.00	4.00	3.20	3.20	3.20
Total cost at mill woodyard	15.39	15.39	14.59	20.15	20.15
	t/m^3	t/m^3	t/m^3	t/m^3	t/m
BD ton/m^3	0.555	0.410	0.361	0.375	0.355
	US$/BDt	US$/BDt	US$/BDt	US$/BDt	US$/BDt
Cost/BD ton	27.73	37.54	40.42	53.73	56.76

5-2 Pulpwood Cost of Hardwood

The following table shows pulpwood cost of hardwood consumed by the Mill projected in this report.

Species	Annual requirement	Cost at mill woodyard	Remarks
	m^3/y	US$/$m^3$	
E. globulus	292,700	15.39	Average volume
E. Grandis	125,500	15.39	weight: 0.481 BDt/m^3
Populus	104,600	14.59	Cost per BD ton :
Total	522,800	15.23	31.64 US$/BDt

5-3 Pulpwood Cost of Softwood

The following shows pulpwood cost of softwoods consumed by the Mill.

Species	Annual requirement	Cost at mill woodyard	Remarks
	m^3/y	US$/$m^3$	
P. taeda	409,300	20.15	Average volume weight: 0.365 BDt/m^3
P. elliottii	409,300	20.15	Cost per BD ton :
Total	818,600	20.15	55.21 US$/BDt

5-4 Fuelwood

Since the cheapest species in the cost at mill woodyard is E. globulus. E. globulus is the best as fuelwood among 5 species.

However, fuelwood required by the Mill is only 1,200 BD tons a year. Under such circumstances, it seems to be better for the Mill to collect waste woods such as tree-tops, branches and so on in logged-out area rather than to get planted E. globulus.

Chapter 6 Plantation Area for the Project

6-1 Plantation Area and Required Land Area

The following shows necessary plantation area and required land area in accordance with pulpwood requirement for the projected Mill.

Species	Mill requirement			In the case of 1 species (C)		In this Project (D)	
	(A)	(B)	(B)/(A)	Plant. area	Land area	Plant. area	Land area
	m^3/y	m^3/y	%	ha	ha	ha	ha
E. globulus	907,800	292,700	32.24	38,420	48,025	12,387	15,483
E. grandis	1,206,150	125,500	10.41	51,030	63,788	5,312	6,640
Populus	1,397,400	104,600	7.49	59,150	73,938	4,430	5,538
P. taeda	1,558,050	409,300	26.27	103,950	129,938	27,308	34,135
P. elliottii	1,723,800	409,300	23.74	114,950	143,688	27,289	34,112
Total	-	1,341,400	-	-	-	76,726	95,908

Notes: (A); Mill requirement in the case that the Mill should use one species only.

(B); Mill requirement in this project.
plant. area: plantation area
land area: required land area
In the case of 1 species: Please refer to 3-1.

6-2 Annual Planting Area

The annual planting area by species necessary for the supply of mill requirement is as follows.

Year	E. globulus	E. grandis	Populus	P. taeda	P. elliottii	Total
	ha	ha	ha	ha	ha	ha
0	-	-	-	2,482.5	2,480.8	4,963.3
1	-	-	-	2,482.5	2,480.8	4,963.3
2	-	-	-	2,482.5	2,480.8	4,963.3
3	1,463.7	627.7	523.6	2,482.5	2,480.8	7,578.3
4	1,463.7	627.7	523.6	2,482.5	2,480.8	7,578.3
5	1,463.7	627.7	523.6	2,482.5	2,480.8	7,578.3
6	1,463.7	627.7	523.6	2,482.5	2,480.8	7,578.3
7	1,463.7	627.7	523.6	2,482.5	2,480.8	7,578.3
8	1,463.7	627.7	523.6	2,482.5	2,480.8	7,578.3
9	146.7	63.0	52.4	2,482.5	2,480.8	5,225.4
10	146.7	63.0	52.4	2,482.5	2,480.8	5,225.4
11	146.7	63.0	52.4	(2,482.5)	(2,480.8)	(5,225.4)
12	146.7	63.0	52.4	(2,482.5)	(2,480.8)	(5,225.4)
13	146.7	63.0	52.4	(2,482.5)	(2,480.8)	(5,225.4)
14	146.7	63.0	52.4	(2,482.5)	(2,480.8)	(5,225.4)
15	14.5	6.2	5.2	(2,482.5)	(2,480.8)	(4,982.2)
16	14.5	6.2	5.2	(2,482.5)	(2,480.8)	(4,982.2)
17	14.5	6.2	5.2	(2,482.5)	(2,480.8)	(4,982.2)
18	14.5	6.2	5.2	(2,482.5)	(2,480.8)	(4,982.2)
19	14.5	6.2	5.2	(2,482.5)	(2,480.8)	(4,982.2)
20	14.5	6.2	5.2	(2,482.5)	(2,480.8)	(4,982.2)
21	1,318.9	565.3	471.5	(2,482.5)	(2,480.8)	(7,319.0)
22	1,318.9	565.3	471.5	(2,482.5)	(2,480.8)	(7,319.0)
Total	12,387.2	5,312.0	4,430.2	27,307.5	27,288.8	76,725.7

It is necessary for the Mill to have plantation of 2,483 hectares of P. taeda and 2,481 hectares of P. elliottii year by year. And plantation of Eucalyptus and Populus begin at the third year after planting of pines and end at the 22nd year in accordance with the planting area shown in the table above. And the plantation of Eucalyptus and Populus shall be repeated again from the 39th year in accordance with the table above.

Such irregularity of plantation of Eucalyptus and Populus results from the reproductive ability of Eucalyptus and Populus that is possible to give us five harvesing cuts from the same stump.

Moreover, since the cost per BD ton of Populus is the highest, Populus should be limited to plant on swampy land only.

Chapter 7 Pulping Tests

7-1 Gathering of Samples and its Transportation

As described in the previous chapter the target of the pulping test is to select species of tree which shall satisfy the following terms.

(1) Suitable wood for paper pulp making
(2) Economical evaluation for pulping process
(3) Climate and natural features in Uruguay
(4) Effective afforestation in the short period

In accordance with above objects, we have discussed with the Uruguayan parties and finally selected the following 6 species of tree and collected samples.

Species		Gathered location and/or Owner
grandis	(Eucalyptus)	CAJA BANCARIA
globulus	(Eucalyptus)	FNP
Maidenii	(Eucalyptus)	FNP
taeda	(Pinus)	CAJA BANCARIA
Elliottii	(Pinus)	CAJA BANCARIA
Populus	(Pinus)	CAJA BANCARIA

These samples were collected during the period of Dec. 12 - 15, 1984, and packaged in Montevideo and dispatched to Japan via New York through VARIG AIR LINES Flight No. RG-966 on Dec. 23, 1984. The sample has arrived at Narita Air Port on Jan 4, 1985 and finally was received by Niigata Factory of Hokuetsu Paper Mills Ltd. on Jan. 7, 1985 after custom clearance.

At the time of checking of the samples, we have found some craks on the sample due to aridity, small extent of blue mold on "Pinus". However those were not interfered with pulping test.

7-2 Testing Method

7-2-1 Conditioning of Water Content of Sample Chips

By small Chipping Machine each sample wood was chipped and take cared to eliminate water contamination at Pulp Wood Section, Niigata Factory of Hokuetsu Paper Mills, Ltd., then sealed in sacks by each kind and pulping test was made at Research Institute of Hokuetsu Paper Mills, Ltd.

Sample chips needs uniformity with water content so that the weight of any portion of sample should have the same weight per volume.

For this purpose, samples shall be kept in the room of constant temperature and moisture at widespread condition, for several days, so that its temperature and moisture reaches to the equilibrium condition with the room. After that a small quantity of the samples of several lot were taken out for measuring of its moisture. Sample chips to be used for digest test is taken out by net weight 300g, (absolute weight) and it shall be compensated calculating with the moisture content. Because if the pulp wood is absolutely dry up in the oven, then it cannot be digested at all.

The sample chips of net 300g are conditioned its water content to 40% in the vessel of adjusted moisture again before digesting. (In actual operation usually chips are digested at the water content of 40%).

In this case, sample chips to be digested was taken out 300g as standard but in case of softwood and populous etc. which have lower cubage rate, 300g is too big for the testing autoclave, therefore, the testing weight shall be reduced. (ref. 7-2-2)

7-2-2 Digesting

Terms of digesting were decided by the following conditions, in accordance with the results of several times of preliminary tests so that to obtain of K value of near to 12 in case of Hardwood and 18 in case of Softwood.

Testing Nos.	1&2	3	4	5	6
Sample BDg	300	280	200	250	250
Chemical Rate AA%	16	16	16	18	18
Liquid Rate l/kg	3.6	4.0	4.5	4.5	4.5
Max. temp. °C	166	166	166	173	173
Heating time min.	70	70	70	60	60
Holding time min.	60	60	60	60	60
UKP K value	11.3	12	12	18.2	20.4
(Kappa No.)	17	18	18	29	36

Note: Test No. 1 Species of tree Maidenii
No. 2 globulus
No. 3 grandis
No. 4 Populus
No. 5 taeda
No. 6 Elliottii

7-2-3 Bleaching

Chlorination and extraction treatments at multiple stage bleaching are elimination process of lignin, therefore, annexing quantity of Chlorine and Alkali are decided referring K-value of UKP or Koppa No. and at that time to decide intermediate index of CEK.

In order to make the final whiteness GE 90 and exceed 87 at Hunter, it is necessary to make K-value (CEK) as near as L3.0 and N4.0 after the stages of Chlorination and extraction, therefore, we have done preliminary testing. From the result of it, the suitable annex quantities are as per hereunder.

	Chlorine annex	*NaOH* annex	CEK
Maidenii	2.1	1.6	2.9
globulus	2.1	1.6	2.9
grandis	2.45	1.7	2.9
Populus	2.95	1.8	3.0
taeda	5.7	2.9	3.9
Elliottii	6.4	3.2	3.9

We took the same terms regardless to the kind and checked the difference. The same terms we have decided are as under:

Terms of Bleaching (1)

		Chlorine C	Extruction E	Hypo H.	ClO_2 D
Pulp density	%	3 (2.5)	10	10	10
Temp.	°C	40	60	43	70
Time	min.	40	60	90	150

(Note) Pulp density: In case of soft wood we made it 2.5% because at the actual operation staple length of soft wood is longer than hard wood and uniform chemical treatment is difficult at the same pulp density with hard wood.

Terms of Bleaching (2)

The difference by each kind of wood at the terms of bleaching : annex of Hypo (2%/BD pulp) annex of ClO_2 (1%/BD pulp)

	HYPO				ClO_2	
	Annex %	Remainning Cl_2 CC/100	pH	Whiteness	Annex %	Whiteness
Maidenii	2	3.25	8.5	79.5	1	85.8
globulus	2	4.05	8.6	79.3	1	85.7
grandis	2	2.70	8.3	79.1	1	84.6
Populus	2	3.50	8.8	75.9	1	83.9
taeda	2	0.90	8.0	75.6	1	84.7
Elliottii	2	0.90	8.0	77.4	1	84.6

From the result of the above test, consumption of chemicals will be checked by the difference of pH and remaining Chlorine and by the difference of whiteness it can be compared the quality of finished color.

7-3 Resume Evaluation of Testing Result

The test result is shown in Table III-46 and from the table, content of terms of digesting and content of terms of bleaching, it can be evaluated roughly.

a) Digestibility

Species of tree	Yield	Chemical consumption	K. value	Viscosity	Integla-tion	Judge-ment
Maidenii	4	3	1	4	12	3
globulus	3	2	1	1	7	1
grandis	1	1	2	3	7	4
Populus	2	2	2	2	8	2
taeda	1	1	1	2	5	1
Elliottii	2	1	2	1	6	2

Digestibility of hard wood: There are almost same nature between globulus and grandis but we have judged globulus is better.

b) Bleachability

In order to evaluate bleachability we have checked reverse factor of fading nature, it is shown with PC value (Post color number). The result of whiteness test after heat aging at 105°C is as follows:

Species of tree	Whiteness % Before Fading	Whiteness % After Fading	Fading Rate	PC Value	Judge-ment
Maidenii	85.8	82.6	3.73	0.66	1
globulus	85.7	82.1	4.20	0.76	2
grandis	84.6	80.7	4.61	0.91	3
Populus	83.9	78.6	6.32	1.37	4
taeda	84.7	79.0	6.73	1.41	1
Elliottii	84.6	78.9	6.74	1.42	2

Note: Fading nature is decreased in case of whiteness is more than 8.8 (GE 90 in equivalent), even so fading is not suspended.

Glance at bleachability

Species	Annexed Q'ty	Salt remain	pH	Whiteness	Fading	Total	Judge-ment
Maidenii	1	1	1	1	1	5	1
globulus	1	2	1	2	2	8	2
grandis	2	3	2	3	3	13	3
Populus	3	1	1	4	4	13	3
taeda	1	1	1	1	1	5	1
Elliottii	2	1	2	2	2	9	2

Among of hard wood, Maidenii and globulus are at the better position while grandis and Populus are rather inferior position. Among of soft wood taeda is the better position.

c) Beatability

Figures in Table III-46 beating test is obtained from Canadian Freeness, which means that the volume of sample as it was 757 cc will become freeness of 515 cc after treated in PFI mill at 5000 rpm.

When we use pulp for paper making, usually beat it up with freeness upto order of 400 cc. To compare the number of revolution the pulp volume upto 400 cc is the convenience.

To decide the ranking by the smaller number of revolution to make the freeness upto 400 cc, order of hard wood is Populus, and grandis while globulus and Maidenii have 2 times of resistance against beating. Such nature will effect to the consumption of electric power at the process of beating.

Soft wood is easier to beat up than hard wood and among of soft wood taeda is easier than Elliottii.

At the work shop of paper mills there is conversion table to directly choice the consumption of electric power required for beating the revolution number of PFI mill to reduce 100 cc volume of freeness and use it as guide of operation procedure.

d) Properties of matter

Among of hard wood "Populus" and "grandis" are stronger but on the contrary specific volume and air permeability are smaller.

Among of soft wood, "taeda" is the better position except the surface strength.

e) Staple length

Among of hard wood "Populus" and "grandis" are slightly better (longer): others are shorter. In soft wood "taeda" is better.

f) Shape of vascular bandle

It is existing in hard wood only shape of "Populus" was good, it of others were inferior and "grandis" of it was worst.

In comparison of 4 kinds of hard wood, considering from the above data,

Good for digesting and bleaching are:
globulus and Maidenii

Good for beating are:
Populus and grandis

And among of 2 kinds of soft wood:
taeda is shown good result in general.

7-4 Consideration from Test Result

The above mentioned Pulping Tests for the selection of suitable species of 6 kinds of appointed items, were performed in according with the instruction.

Through the tests for 6 species, we have tried at the same conditions for common applicable tests on 6 species as much extent as possible and took the difference caused from each test.

In addition to the above comparison of test result other species of tree have also be done at the almost same conditions.

The Table III-46 shows the summary of test results of six pieces of the sample.

In the qualitative analysis for pulping, globulus in L.W and taeda in N.W were proved good results at digesting and bleaching.

TABLE III-1 FOREST IN URUGUAY (DISTRIBUTION PER FOREST AREA)(1)

As of 1980

Province	Forests of 1/4 ha		Forests of 1/2 ha		Forests of 1 ha		Forests of 2 ha		Forests of 3 ha		Forests of 4 ha		Wind breaks (Shelter belts)		Forests of more than 4 ha		Forests of more than 10 ha	
	No. of forests	ha	No. of forests	ha	No. of forests	ha	No. of forests	ha	No. of forests	ha	No. of forests	ha	No. of forests	ha	No. of forests	ha	No. of forests	ha
ARTIGAS	497	124.25	373	186.50	483	483	186	372	33	99	52	208	71	504.25	53	389	102	3,214
CANELONES	1,147	286.75	857	428.50	1,130	1,130	293	586	43	129	110	440	45	83.25	139	940.50	271	16,411.50
CERRO LARGO	858	214.50	608	304	1,063	1,063	288	576	108	324	62	248	101	185	13	87.50	125	3,212.50
COLONIA	791	197.75	592	296	812	812	279	558	131	393	124	496	55	88.75	38	253.50	128	2,103.25
DURAZNO	756	189	558	279	801	801	316	632	99	297	97	388	82	131.75	30	221	168	3,889.25
FLORES	548	137	404	202	545	545	115	230	46	138	67	268	47	104	109	463.50	107	1,764
FLORIDA	847	211.75	635	317.50	851	851	214	428	30	90	82	328	27	72.50	58	405	122	4,509.50
LAVALLEJA	578	144.50	393	196.50	598	598	172	344	24	72	39	136	42	90.25	36	246.50	77	3,118.50
MALDONADO	824	206	660	330	824	824	279	558	110	330	115	460	57	67.75	10	70.50	170	10,153
MONTEVIDEO	30	7.50	14	7	34	34	10	20	6	18	12	48	4	13	14	91	33	1,343.75
PAYSANDU	606	151.50	401	200.50	756	756	411	822	113	339	153	612	73	243.50	76	544	266	11,065.50
RIO NEGRO	537	134.25	397	198.50	577	577	227	454	86	258	79	316	62	165.25	31	212	232	12,299.50
RIVERA	649	162.25	490	245	692	692	215	430	86	258	111	444	68	389.50	49	348	173	7,915.75
ROCHA	891	222.75	663	331.50	901	901	239	478	86	258	70	280	107	260.50	11	77	184	11,546
SALTO	727	181.75	532	266	671	671	229	458	91	273	88	352	32	78.75	24	190	110	2,321.50
SAN JOSE	713	178.25	525	262.50	719	719	231	462	88	264	96	384	58	113.25	39	277	116	7,200.50
SORIANO	720	180	536	268	735	735	241	482	89	267	97	388	114	282.75	49	304.50	99	3,186.75
TACUAREMBO	1,039	259.75	992	496	1,273	1,273	460	920	136	408	182	728	113	184	101	667	220	11,238.75
TREINTA Y TRES	708	177	534	267	729	729	185	370	43	129	70	280	67	258.50	16	116.50	68	1,455.75
TOTAL	13,466	3,366.50	10,164	5,082	14,191	14,194	4,590	9,180	1,448	4,344	1,646	6,804	1,103	3,316.50	896	5,904	2,771	117,949.25
Percent of area (%)	0.4		0.6		1.7		1.1		0.5		0.8		0.4		0.7		14.1	

Notes:

1 - including artificial forests projects

2 - loss of area due to the construction of Paso del Palmar dam

3 - loss of area due to the construction of Salto Grande dam

4 - existing forest area planted between 1966-1975

Source: Direccion Forestal

TABLE III-1 FOREST IN URUGUAY (DISTRIBUTION PER FOREST AREA)(2)

As of 1980

Province	Subtotal of artificial forests	Natural forest		Grand total	Remarks
		Forests	Palms		
	(ha)	(ha)		(ha)	
ARTIGAS	5,580	60,290	485	66,355	3
CANELONES	20,435.50	6,618	-	27,053.50	1
CERRO LARGO	6,214.50	61,223	-	67,437.50	1
COLONIA	5,198.25	16,067	-	21,265.25	1
DURAZNO	6,828	17,382	-	24,210	1-2
FLORES	3,851.50	9,738	-	13,589.50	1-2
FLORIDA	7,213.25	17,984	-	25,197.25	-
LAVALLEJA	4,946.25	29,474	-	34,420.25	-
MALDONADO	12,999.25	19,803	-	32,802.25	1
MONTEVIDEO	1,582.25	362	-	1,944.25	-
PAYSANDU	14,734	56,082	1,490	72,306	1-4
RIO NEGRO	14,614.50	33,510	-	48.124.50	1-2
RIVERA	10,884.50	39,843	-	50,727.50	1
ROCHA	14,354.75	21.511	66,869	102,734.75	1-4
SALTO	4,792	34,670	-	39,462	3
SAN JOSE	9,860.50	16,003	-	25,863.50	1-4
SORIANO	6,094	30,450	-	36,544	1
TACUAREMBO	16,174.50	94,003	-	110,177.50	1
TREINTA Y TRES	3,782.75	31,818	1,640	37,240.75	1
TOTAL	170,140.25	596,831	70,484	837,455.25	
Percent of area (%)	20.3	71.3	8.4	100.0	

TABLE III-2 WOOD VOLUME ESTIMATION PER PLANTATION AGE IN URUGUAY

As of Nov., 1984

AGE	SOFTWOOD			HARDWOOD			TOTAL			REMARKS
	Area (ha)	Average density (m^3/ha)	Volume (m^3)	Area (ha)	Average density (m^3/ha)	Volume (m^3)	Area (ha)	Average density (m^3/ha)	Volume (m^3)	
Less than 10 years	14,910	60	894,600	45,203	75	3,390,225	60,113	71	4,284,825	Estimation was made for the volume of forestation having more than 10 ha by Direccion Forestal.
10 - 20 years	10,593	180	1,906,740	40,230	225	9,051,750	50,823	216	10,958,490	
More than 20 years	2,105	240	505,200	29,962	300	8,988,600	32,067	296	9,493,800	
Total	27,608	120	3,306,540	115,395	186	21,430,575	143,003	173	24,737,115	

Source: Direccion Forestal

TABLE III-3 REMOVALS OF ROUNDWOODS (ESTIMATED) IN URUGUAY

Unit: in 1,000 m^3

	1978			1979			1980			1981			1982			1983		
	Coni-fer-ous	Non-coni-ferous	Total	Con-fer-ous	Non-coni-ferous	Total	Coni-fer-ous	Non-coni-ferous	Total	Coni-fer-ous	Non-coni-ferous	Total	Coni-fer-ous	Non-coni-ferous	Total	Coni-fer-ous	Non-coni-ferous	Total
Sawlogs, Veneer logs and Sleepers	80	145	225	84	165	249	77	121	198	73	97	170	39	51	90	11.2	14.8	26
Pulpwood	15	35	50	16	39	55	8	111	119	7	101.5	108.6	4.9	89.1	94	7.4	107.1	114.5
Total (for industrial purposes)	95	180	275	100	204	304	85	232	317	80	198.5	278.5	43.9	140.1	184	18.6	121.9	140.5
* Fuelwood (including wood for charcoal)			1,772			1,872			1,322			1,422			1,434			N.A.
Grand-total			2,047			2,176			1,639			1,700.5			1,618			N.A.

Source: Direccion Forestal

*Source: FAO: Yearbook of Forest Products

TABLE III-4 REGISTERED PLANTATION AREA FROM 1975 TO 1983 (1)

Province	1975			1976			1977			1978			1979			1980		
	Pine	Eucal.	Poplar	Pine	Eucal.	Poplar	Pine	Eucal.	Poplar	Pine	Eucal.	Poplar	Pine	Eucal.	Poplar	Pine	Eucal.	Poplar
CANELONES	27	0.5	2	69	13	4	32	16.5	6	5	-	0.5	3	0.5	1	-	-	-
C. LARGO	-	38	-	-	20	-	-	-	-	-	-	-	78	-	-	11	-	-
COLONIA	-	-	-	6	5	-	28	23	-	30	-	-	-	-	-	-	-	-
DURAZNO	20	131	-	16	345	-	101	180	4	115	214	-	13.2	52	4.8	30.5	17	-
FLORES	-	-	-	-	57	-	8	48	-	-	41	-	-	-	-	-	-	-
PAYSANDU	316	136	45	44	270.5	169	237	459.5	227.5	74	123	112	30	423	186	38	197	28
R. NEGRO	10	239	10	62	309	53	133.5	489	184	76	189	405	39	38	4	42	85	-
RIVERA	17	253	56	80	503	118	549	508	105	568	386	6	415	115	-	-	221.5	-
ROCHA	157	52.6	-	364	54	-	40	60	-	-	-	-	-	-	-	-	-	-
SAN JOSE	-	26	-	17	13	-	19	24	-	26	-	-	-	-	-	-	-	-
SORIANO	22	26	4	15	-	-	-	-	-	-	-	-	79	6	5	-	-	-
TACUAREMBO	28	209.5	10	75	218.5	1	282	507	9	114	119	60.5	192.8	274	41	53	11	-
TREINTA Y TRES	-	-	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-
TOTAL	597	1,111.6	127	748	1,808	345	1,429.5	2,315	535.5	1,008	1,072	584	850.0	928.5	241.8	174.5	531.5	28
GRAND TOTAL		1,835.6			2,901			4,280			2,664			2,020.3			734	

Note:

Eucal. : Eucalyptus

Source: Direccion Forestal

TABLE III-4 REGISTERED PLANTATION AREA FROM 1975 TO 1983 (2)

(Unit: in ha)

Province	1981			1982			1983			Total			
	Pine	Eucal.	Poplar	Pine	Eucal.	Poplar	Pine	Eucal.	Poplar	Pine	Eucal.	Poplar	Total
CANELONES	-	-	-	-	-	-	-	-	-	136	30.5	13.5	180
C. LARGO	-	-	-	-	-	-	-	-	-	89	58	-	147
COLONIA	-	-	-	-	-	-	-	-	-	64	28	-	92
DURAZNO	25.5	-	-	-	-	-	-	-	-	321.2	939	8.8	1,269
FLORES	-	-	-	-	-	-	-	-	-	8	146	-	154
PAYSANDU	74	138	122	92	447.5	48	40	300	60.5	945	2,494.5	998	4,437.5
R. NEGRO	-	88	-	-	67	-	-	-	-	362.5	1,504	656	2,522.5
RIVERA	-	485.5	-	204.8	494.5	8.4	306	257	-	2,139.8	3,223.5	293.4	5,656.7
ROCHA	-	-	-	-	-	-	12	5	-	573	171.6	-	744.6
SAN JOSE	-	-	-	-	-	-	-	-	-	62	63	-	125
SORIANO	-	-	-	-	-	-	-	-	-	116	32	9	157
TACUAREMBO	18.1	-	-	-	-	-	35.6	-	-	798.5	1,339	121.5	2,259
TREINTA Y TRES	-	-	-	-	-	-	-	-	-	-	20	-	20
TOTAL	117.6	711.5	122	296.8	1,009	56.4	393.6	562	60.5	5,615	10,049.1	2,100.2	17,764.3
GRAND TOTAL		951.1			1,362.2			1,016.1			17,764.3		
								Percent of Species		31.6	56.6	11.8	100.0

Note:

Eucal. : Eucalyptus

Source: Direccion Forestal

TABLE III-5 PRESENT PLANTING AND TENDING COSTS OF EUCALYPTUS AND POPULUS (SPACING 2.5 m x 2.5 m)

as of Jan., 1984

(Unit: US$1 = N$48.56)

Items	Equipment				Labours				Materials				Grand Total N$	Grand Total US$
	Type	Hours/ ha	N$/Hour	Total N$	Type	Hours/ ha	N$/Hour	Total N$	Type	No./ha	N$/unit	Total N$		
Ant control					Manpower	6.40	16.30	104.30	Incecticide "Aldrin"	1.5 kg/ha	76.00/kg	114.00	218.30	4.76
Fence										40 m/ha	17.70/m	708.00	708.00	15.44
Soil preparation														
Ploughing	Tractor	2.25	347.90	782.80	Operator	2.25	17.00	38.30					821.10	17.90
"	Plough	2.25	9.10	20.50									20.50	0.45
Harrowing	Tractor	1.25	347.90	434.90	Operator	1.25	17.00	21.30					456.20	9.95
"	Harrow	1.25	18.90	23.60									23.60	0.51
Planting					Manpower	42.67	16.30	695.50	Seedlings	1,600/ha	2.30/ piece	3,680.00	4,375.50	95.41
Replanting					Manpower	8.53	16.30	139.00	Seedlings	320/ha	2.30/ Piece	736.00	875.00	19.08
Sub-total				1,261.80				998.40				5,238.00	7,498.20	163.50
Contingency (Sub-total x 5%)				63.10				49.90				261.90	374.90	8.18
Total				1,324.90				1,048.30				5,499.90	7,873.10	171.68
Overhead (Total x 8%)				106.00				83.90				440.00	629.90	13.74
Grand total				1,430.90				1,132.20				5,939.90	8,503.00	185.42
Tending cost for 1st year (Grand total x 10%)													850.30	18.54
2nd year (")													850.30	18.54
3rd year (")													850.30	18.54
Cutting year													500.00	10.90

Note: Calculation is made according to data given by Direccion Forestal

Table III-6 PRESENT PLANTING AND TENDING COSTS OF PINUS (SPACING 3 m x 3 m)

as of Jan., 1984

(Unit: US$1 = N$45.86)

Items	Equipment				Labours				Materials				Grand Total N$	Grand Total US$
	Type	Hours/ ha	N$/Hour	Total N$	Type	Hours/ ha	N$/Hour	Total N$	Type	No./ha	N$/unit	Total N$		
Ant control					Manpower	6.40	16.30	104.30	Incecticide "Aldrin"	1.5 kg/ha	76.00/kg	114.00	218.30	4.76
Fence										40 m/ha	17.70/m	708.00	708.00	15.44
Soil preparation														
Ploughing	Tractor	2.25	347.90	782.80	Operator	2.25	17.00	38.30					821.10	17.90
"	Plough	2.25	9.10	20.50									20.50	0.45
Harrowing	Tractor	1.25	347.90	434.90	Operator	1.25	17.00	21.30					456.20	9.95
"	Harrow	1.25	18.90	23.60									23.60	0.51
Planting					Manpower	29.33	16.30	478.10	Seedlings	1,100/ha	2.00/ piece	2,200.00	2,678.10	58.40
Replanting					Manpower	5.87	16.30	95.70	Seedlings	220/ha	2.00/ Piece	440.00	535.70	11.68
Sub-total				1,261.80				737.70				3,462.00	5,461.50	119.09
Contingency (Sub-total x 5%)				63.10				36.90				173.10	273.10	5.96
Total				1,324.90				774.60				3,635.10	5,734.60	125.05
Overhead (Total x 8%)				106.00				62.00				290.80	458.80	10.00
Grand total				1,430.90				836.60				3,925.90	6,193.40	135.05
Tending cost for 1st year (Grand total x 10%)													619.40	13.51
2nd year (")													619.40	13.51
3rd year (")													619.40	13.51

Note: Calculation is made according to data given by Direccion Forestal

TABLE III-7 HOURLY COSTS OF MACHINES FOR PLANTATION

as of Jan., 1984

Items	Tractor (77HP)		Plough		Harrow	
Delivered price	N$916,741.00		N$74,200.00		N$144,562.00	
Residual value	N$137,511.00 (15%)		N$22,260.00 (30%)		N$43,369.00 (30%)	
Value to be depreciated	N$779,230.00		N$51,940.00		N$101,193.00	
Useful life (hours)	12,000		8,000		8,000	
Owning costs	N$/h	Remarks	N$/h	Remarks	N$/h	Remarks
Depreciation cost	64.80		6.50		12.60	
Interest cost	-		-		-	
Insurance	-		-		-	
Taxes	-		-		-	
Total hourly owning cost	64.80		6.50		12.60	
Operating costs						
Fuel	206.70	0.15 ℓ/HP/h x 77HP x 17.90N$/ℓ	-		-	
Lube oils, filters, grease	31.00	Fuel cost x 15%	-		-	
Repair cost	45.40	Depreciation cost x 70%	2.60	Depreciation cost x 40%	6.30	Depreciation cost x 50%
Total hourly operating cost	283.10		2.60		6.30	
Operator's hourly wage	-	excluding from the cost	-		-	
Total owning and operating cost	347.90		9.10		18.90	
	US$/h		US$/h		US$/h	
in US$ (US$1 = N$45.86)	7.59		0.20		0.41	

Note: Calculation is made according to data given by Direccion Forestal

TABLE III-8 TREND OF PLANTATION COST (AVERAGE COST) PER HECTARE
(in N$/ha and US$/ha)

Items	1974/75	1975/76	1976/77	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	Costs *1	
											Pines	E. & P.
	N$	N$	N$	N$	N$	N$	N$	N$	N$	N$	N$	N$
Ant control	25.00	20.00	20.00	19.88	30.00	42.10	70.00	101.00	174.00	219.50	218.20	218.00
Fence	10.00	35.00	42.60	57.54	90.00	217.13	257.00	346.00	513.00	708.90	707.90	707.90
Soil preparation	34.50	45.00	65.00	89.84	150.00	209.00	312.00	377.00	727.00	1,322.80	1,321.80	1,321.80
Seedlings	60.00	165.00	187.00	220.00	330.00	605.00	1,100.00	1,375.00	1.980.00	2,530.00	2,200.00	3,680.00
Planting	5.00	25.00	32.00	57.69	70.00	138.76	204.00	322.00	370.00	479.30	478.10	695.50
Replanting	15.00	38.00	43.80	55.54	80.00	148.75	261.00	340.00	469.00	602.60	535.60	875.10
Contingency	15.00	16.40	19.50	25.02	37.50	61.08	111.00	143.00	212.00	293.90	273.10	374.90
Overhead	5.00	30.00	32.80	42.04	63.00	103.00	185.00	246.00	356.00	493.00	458.80	629.90
Total	(100) 169.50	(221) 374.40	(261) 442.70	(335) 567.55	(502) 850.50	(900) 1,524.82	(1,475) 2,500.00	(1,917) 3,250.00	(2,832) 4,801.00	(3,923) 6,650.00	(3,654) 6,193.50	(5,017) 8,503.30
Exchange rate to US$	1.20	2.26	3.34	4.68	6.06	7.86	9.10	10.82	13.91	34.54	45.86	45.86
Plantation cost in US$	(100) 141.25	(117) 165.66	(94) 132.54	(86) 121.27	(99) 140.35	(137) 194.00	(194) 274.73	(213) 300.37	(244) 345.15	(136) 192.53	(96) 135.05	(131) 185.42

Notes:

*1. Costs : Plantation costs being used in III-2-1
E.& P.: Eucalyptus and Populus
45.86 : Exchange rate in January, 1984
Figures in ( ) show index.

Source:

Direccion Forestal

TABLE III-9 DISCOUNTED VALUE OF PLANTED EUCALYPTUS AND POPULUS
(Discount rate: 12% per year)

Year	Land cost	Plantation cost	Total	Expecting yield volume	Coefficient of discounted value	Discounted value	Discounted yield value	Remaining land value	Remarks
	US$/ha	US$/ha	US$/ha	m^3/ha	12%/year	US$/ha	m^3/ha	US$/ha	
0	281.25	185.42	466.67		1.0000	466.67			
1		18.54	18.54		0.8929	16.55			
2		"	"		0.7972	14.78			
3		"	"		0.7118	13.20			
4					0.6355				
5					0.5674				
6					0.5066				
7					0.4523				
(8)		10.90	10.90	200	0.4039	4.40	80.78		25 m^3/ha/year
9					0.3606				
10					0.3220				
11					0.2875				
12					0.2567				
13					0.2292				
(14)		10.90	10.90	180	0.2046	2.23	36.83		30 m^3/ha/year
15					0.1827				
16					0.1631				
17					0.1456				
18					0.1300				
19					0.1161				
(20)		10.90	10.90	180	0.1037	1.13	18.37		30 m^3/ha/year
21					0.09256				
22					0.08264				
23					0.07379				
24					0.06588				
25					0.05882				
26					0.05252				
27					0.04689				
(28)		10.90	10.90	200	0.04187	0.46	8.37		25 m^3/ha/year
29					0.03738				
30					0.03338				
31					0.02980				
32					0.02661				
33					0.02376				
34					0.02121				
35					0.01894				
(36)				200	0.01691		3.79	4.76	25 m^3/ha/year
Total	281.25	284.64	565.89	960		519.42	148.14	4.76	

Notes:

Land cost : 225 US$/ha ÷ 0.8 = 281.25 US$
Number of planted trees : 1600 trees per ha
Cutting age : 8, 14, 20, 28 and 36 years old
Final yield : 180 - 200 m^3/ha
Number of regeneration by sprout : 4
Stumpage cost : (519.42 - 4.76)/148.14 = 3.47 US$/$m^3$

TABLE III-10 DISCOUNTED VALUE OF PLANTED EUCALYPTUS AND POPULUS
(Discount rate: 8% per year)

Year	Land cost	Plantation cost	Total	Expecting yield volume	Coefficient of discounted value	Discounted value	Discounted yield value	Remaining land value	Remarks
	US$/ha	US$/ha	US$/ha	m^3/ha	8%/year	US$/ha	m^3/ha	US$/ha	
0	281.25	185.42	466.67		1.0000	466.67			
1		18.54	18.54		0.9259	17.17			
2		"	"		0.8573	15.89			
3		"	"		0.7938	14.72			
4					0.7350				
5					0.6806				
6					0.6302				
7					0.5835				
(8)		10.90	10.90	200	0.5403	5.89	108.06		25 m^3/ha/year
9					0.5002				
10					0.4632				
11					0.4289				
12					0.3971				
13					0.3677				
(14)		10.90	10.90	180	0.3405	3.71	61.29		30 m^3/ha/year
15					0.3152				
16					0.2919				
17					0.2703				
18					0.2502				
19					0.2317				
(20)		10.90	10.90	180	0.2145	2.34	38.61		30 m^3/ha/year
21					0.1987				
22					0.1839				
23					0.1703				
24					0.1577				
25					0.1460				
26					0.1352				
27					0.1252				
(28)		10.90	10.90	200	0.1159	1.26	23.18		25 m^3/ha/year
29					0.1073				
30					0.09938				
31					0.09202				
32					0.08520				
33					0.07889				
34					0.07305				
35					0.06763				
(36)				200	0.06262		12.52	17.61	25 m^3/ha/year
Total	281.25	284.64	565.89	960		527.65	243.66	17.61	

Notes:

Land cost : 225 US$/ha ÷ 0.8 = 281.25 US$
Number of planted trees : 1600 trees per ha
Cutting age : 8, 14, 20, 28 and 36 years old
Final yield : 180 - 200 m^3/ha
Number of regenerations by sprout : 4
Stumpage cost : (527.65 - 17.61)/243.66 = 2.09 US$/$m^3$

Table III-11 DISCOUNTED VALUE OF PLANTED PINUS
(Discount rate: 12% per year)

Year	Land cost	Plantation cost	Total	Expecting yield volume	Coefficient of discounted value	Discounted value	Discounted yield value	Remaining land value	Remarks
	US$/ha	US$/ha	US$/ha	m^3/ha	12%/year	US$/ha	m^3/ha	US$/ha	
0	281.25	135.05	416.30		1.0000	416.30			
1		13.51	13.51		0.8929	12.06			
2		"	"		0.7972	10.77			
3		"	"		0.7118	9.62			
4					0.6355				
5					0.5674				
6					0.5066				
7					0.4523				
8					0.4039				
9					0.3606				
10					0.3220				
11				165	0.2875		47.44	80.86	15 m^3/ha/year
Total	281.25	175.58	456.83	165		448.75	47.44		

Notes:

Number of planted trees : 1100 trees per ha
Cutting age : 8 years old, no thinning
Final yield : 165 m^3/ha
Stumpage cost : (448.75 - 80.86)/47.44 = 7.75 US$/$m^3$

Table III-12 DISCOUNTED VALUE OF PLANTED PINUS
(Discount rate: 8% per year)

Year	Land cost	Plantation cost	Total	Expecting yield volume	Coefficient of discounted value	Discounted value	Discounted yield value	Remaining land value	Remarks
	US$/ha	US$/ha	US$/ha	m^3/ha	8%/year	US$/ha	m^3/ha	US$/ha	
0	281.25	135.05	416.30		1.0000	416.30			
1		13.51	13.51		0.9259	12.51			
2		"	"		0.8573	11.58			
3		"	"		0.7938	10.72			
4					0.7350				
5					0.6806				
6					0.6302				
7					0.5835				
8					0.5403				
9					0.5002				
10					0.4632				
11				165	0.4289		70.77	120.63	15 m^3/ha/year
Total	281.25	175.58	456.83	165		451.11	70.77	120.63	

Notes:

Number of planted trees : 1100 trees per ha
Cutting age : 8 years old, no thinning
Final yield : 165 m^3/ha
Stumpage cost : (451.11 - 120.63)/70.77 = 4.67 US$/$m^3$

TABLE III-13 PRESENT LOGGING COST OF EUCALYPTUS

Items	N$/ton	N$/$m^3$	US$/ton	US$/$m^3$	Remarks
Felling, Limbing & Bucking					
Labours	47.22				N$170.00/man/day, 20 trees/man/day x 0.18 m^3/tree = 3.6 m^3/man day, 1 t/m^3
Cost of chain saw	60.25				N$54.77/$m^3$ (refer to cost of chain saw) x 110% = N$60.25/$m^3$
Sub-total	107.47				
Skidding					
Labours	17.00				N$170.00/man/day, 60 m^3/6 men (including foreman & operator)/day = 10.0 m^3/man/day
Cost of tractor	46.39				N$347.90/hour x 8 hours = N$2,783.20, 60 m^3/8 hours (Refer to hourly cost of tractor)
Sub-total	63.39				
Debarking & Piling					
Labours	53.13				N$170.00/man/day, 3.2 m^3/man/day
Loading					
Labours	24.29				N$170.00/man/day, 7 tons/man/day
Total	248.28				
	(≒ 250.00)	(250.00)	(5.46)	(5.46)	US$1 = N$45.86 as of Jan., 1984

Note:

Calculation is made according to data given by Direccion Forestal.

TABLE III-14 PRESENT LOGGING COST OF POPULUS

Items	N$/ton	N$/$m^3$	US$/ton	US$/$m^3$	Remarks
Felling, Limbing & Bucking					
Labours		34.00			N$170.00/man/day, 20 trees/man/day x 0.25 m^3/tree = 5.0 m^3/man/day, 0.8 t/m^3
Cost of chain saw		54.77			Refer to cost of chain saw
Sub-total		88.77			
Skidding					
Labours		12.78			N$170.00/man/day, 80 m^3/6 men (including foreman & operator)/day = 13.3 m^3/man/day
Cost of tractor		34.79			N$347.90/hour x 8 hours = N$2,783.20, 80 m^3/8 hours (Refer to hourly cost of tractor)
Sub-total		47.57			
Loading					
Labours		17.00			N$170.00/man/day, 8 tons/man/day = 10 m^3/man/day
Total		153.34			
	(187.50)	(≒150.00)	(4.09)	(3.27)	US$1 = N$45.86 as of Jan., 1984

Note:

Calculation is made according to data given by Direccion Forestal.

Table III-15 PRESENT LOGGING COST OF PINUS

Items	N$/ton	N$/$m^3$	US$/ton	US$/$m^3$	Remarks
Felling, Limbing & Bucking					
Labours		37.78			N$170.00/man/day, 25 trees/man/day x 0.18 m^3/tree = 4.5 m^3/man/day, 0.8 t/m^3
Cost of chain saw		54.77			Refer to cost of chain saw
Sub-total		92.55			
Skidding					
Labours		12.78			N$170.00/man/day, 80 m^3/6 men (including foreman & operator)/day = 13.3 m^3/man/day
Cost of tractor		34.79			N$347.90/hour x 8 hours = N$2,783.20, 80 m^3/8 hours (Refer to hourly cost of tractor)
Sub-total		47.57			
Debarking & Piling					
Labours		42.50			N$170.00/man/day, 4.0 m^3/man/day
Loading					
Labours		17.00			N$170.00/man/day, 8 tons = 10.0 m^3/man/day
Total		199.62			
	(250.00)	(≒200.00)	(5.45)	(4.36)	US$1 = N$45.86 as of Jan., 1984

Note:

Calculation is made according to data given by Direccion Forestal.

TABLE III-16 COST OF CHAIN SAW

Items	N$/$m^3$	US$/$m^3$	Remarks
Owning Costs			
Delivered price			US$800.00 (estimated)
Residual value			-
Value to be depreciated			US$800.00
Useful life			5,000 m^3
Depreciation cost		0.16	
Interest cost		-	
Insurance		-	
Taxed		-	
Total owning cost		0.16	
Operating Costs			
Fuel		0.47	0.57 ℓ/m^3 x 0.82 US$/ℓ
Chain oils and others		0.18	0.11 " x 1.68 "
Repair cost		0.14	Depreciation cost x 75%
Total operating cost		0.79	
Cost of Chain Saw	54.77	0.95	US$1 = N$57.65 (at Sep. 1984)

Notes:

Fuel : Gasoline, Lub oil
Ratio : 13:1 I.I. IVA
N$/ℓ : 43.20, 97.02 (64.68 x 1.25 x 1.20)
Ave. N$/ℓ : 47.04 (Oil mixed gasoline)
US$/ℓ : 0.75, 1.68 (Exchange rate 57.65 N$/US$: Sep. 1984)
Ave. US$/ℓ : 0.82 (Oil mixed gasoline)

TABLE III-17 PLANTING AND HARVESTING PLAN FOR E. GLOBULUS (1)

Unit: in 1,000 m^3

Year	Area	X00	X01	X02	X03	X04	X05	X06	X07	X08	X09	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20	X21	X22	X23	X24	X25	X26	X27	X28	X29	X30	X31
	ha																																
X00	-																																
X01	-																																
X02	-																																
X03	4,540											908						817						817									908
X04	"												908						817						817								
X05	"													908						817						817							
X06	"														908						817						817						
X07	"															908						817						817					
X08	"																908						817						817				
X09	455																	91						82						82			
X10	"																		91						82						82		
X11	"																			91						82						82	
X12	"																				91						82						
X13	"																					91						82					
X14	"																						91						82				
X15	45																							9						8			
X16	"																								9						8		
X17	"																									9						8	
X18	"																										9						
X19	"																											9					
X20	"																												9				
X21	4,090																													818			
X22	"																														818		
Total	38,420	-	-	-	-	-	-	-	-	-	-	-	908	908	908	908	908	908	908	908	908	908	908	908	908	908	908	908	908	908	908	908	998
		(cutting plantation area)											(4,540)					(4,995)						(5,040)							(4,590)		(5,040)

Pulpwood requirement : 907,800 m^3/year

Harvesting age	:	8,	14,	20,	28,	36,	year old
Harvesting volume	:	200,	180,	180,	200,	200,	m^3/ha
Mean annual increment:		25,	30,	30,	25,	25,	m^3/ha/year

Harvesting age	:	8,	16,	24,	30,	36,	year old
Harvesting volume	:	200,	*1 230,	230,	*2 150,	150,	m^3/ha

in the case of plantation planted in X21 and X22

*1 30 m^3/ha x 6 ys + 25 m^3/ha x 2 ys = 230 m^3/ha

*2 25 m^3/ha x 6 ys = 150 m^3/ha

TABLE III-17 PLANTING AND HARVESTING PLAN FOR E. GLOBULUS (2)

Unit: in 1,000 m^3

Year	Area	X32	X33	X34	X35	X36	X37	X38	X39	X40	X41	X42	X43	X44	X45	X46	X47	X48	X49	X50	X51	X52	X53	X54	X55	X56	X57	X58
	ha																											
X00	-																											
X01	-																											
X02	-																											
X03	4,540								908																			
X04	"	908								908																		
X05	"		908								908																	
X06	"			908								908																
X07	"				908								908															
X08	"					908								908														
X09	455						91								91													
X10	"							91								91												
X11	"								91								91											
X12	"	82								91								91										
X13	"		82								91								91									
X14	"			82								91								91								
X15	45				8								9								9							
X16	"					8								9								9						
X17	"						8								9								9					
X18	"	8						8								9								9				
X19	"		8						8								9								9			
X20	"			8						8								9								9		
X21	4,090						941								941						614						614	
X22	"							941								941						614						614
Total	38,420	998	998	998	916	916	1,040	1,040	1,007	1,007	999	999	917	917	1,041	1,041	100	100	91	91	623	623	9	9	9	9	614	614
					(4,585)		(4,590)		(5,040)		(4,995)		(4,585)		(4,590)		(100)						(45)				(4,090)	

TABLE III-18 PLANTING AND HARVESTING PLAN FOR E. GRANDIS (1)

Unit: in 1,000 m^3

Year	Area ha	X00	X01	X02	X03	X04	X05	X06	X07	X08	X09	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20	X21	X22	X23	X24	X25	X26	X27
X00	-																												
X01	-																												
X02	-																												
X03	6,030											1,206							1,085						1,085				
X04	"												1,206							1,085						1,085			
X05	"													1,206							1,085						1,085		
X06	"														1,206							1,085						1,085	
X07	"															1,206							1,085						1,085
X08	"																1,206							1,085					
X09	605																		121						109				
X10	"																			121						109			
X11	"																				121						109		
X12	"																					121						109	
X13	"																						121						109
X14	"																							121					
X15	60																								12				
X16	"																									12			
X17	"																										12		
X18	"																											12	
X19	"																												12
X20	"																												
X21	5,430																												
X22	"																												
Total	51,030											1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206	1,206
												(cutting plantation area)(6,030)							(6,635)						(6,695)				

Pulpwood requirement : 1,206,150 m^3/year

Harvesting age	:	8,	14,	20,	28,	36, year old
Harvesting volume	:	200,	180,	180,	200,	200, m^3/ha
Mean annual increment:		25,	30,	30,	25,	25, m^3/ha/year
Harvesting age	:	8,	16,	24,	30,	36, year old
Harvesting volume	:	200,	*1 230,	230,	*2 150,	150, m^3/ha

in the case of plantation planted in X21 and X22

*1 30 m^3/ha x 6 ys + 25 m^3/ha x 2 ys = 230 m^3/ha

*2 25 m^3/ha x 6 ys = 150 m^3/ha

TABLE III-18 PLANTING AND HARVESTING PLAN FOR E. GRANDIS (2)

Unit: in 1,000 m^3

Year	Area	X28	X29	X30	X31	X32	X33	X34	X35	X36	X37	X38	X39	X40	X41	X42	X43	X44	X45	X46	X47	X48	X49	X50	X51	X52	X53	X54	X55	X56	X57	X58
	ha																															
X00	-																															
X01	-																															
X02	-																															
X03	6,030				1,206								1,206																			
X04	"					1,206								1,206																		
X05	"						1,206								1,206																	
X06	"							1,206								1,206																
X07	"								1,206								1,206															
X08	"	1,085								1,206								1,206														
X09	605		109								121								121													
X10	"			109								121								121												
X11	"				109								121								121											
X12	"					109								121								121										
X13	"						109								121								121									
X14	"	109						109								121								121								
X15	60		11						11								12								12							
X16	"			11						11								12								12						
X17	"				11						11								12								12					
X18	"					11						11								12								12				
X19	"						11						11								12								12			
X20	"	12						11						11								12								12		
X21	5,430		1,086								1,249								1,249						815						815	
X22	"			1,086								1,249								1,249						815						815
Total	51,030	1,206	1,206	1,206	1,326	1,326	1,326	1,326	1,217	1,217	1,381	1,381	1,338	1,338	1,327	1,327	1,327	1,327	1,382	1,382	133	133	121	121	827	827	12	12	12	12	815	815
			(6,095)		(6,695)				(6,090)		(6,095)		(6,695)		(6,635)				(6,095)		(665)		(605)		(5,490)		(60)				(5,430)	

TABLE III-19 PLANTING AND HARVESTING PLAN FOR POPULUS (1)

Year	Area	X00	X01	X02	X03	X04	X05	X06	X07	X08	X09	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20	X21	X22	X23	X24	X25	X26	X27
	ha																												
X00	-																												
X01	-																												
X02	-																												
X03	6,990												1,398						1,258						1,258				
X04	"													1,398						1,258						1,258			
X05	"														1,398						1,258						1,258		
X06	"															1,398						1,258						1,258	
X07	"																1,398						1,258						1,258
X08	"																	1,398						1,258					
X09	700																		140						126				
X10	"																			140						126			
X11	"																				140						126		
X12	"																					140						126	
X13	"																						140						126
X14	"																							140					
X15	70																								14				
X16	"																									14			
X17	"																										14		
X18	"																											14	
X19	"																												14
X20	"																												
X21	6,295																												
X22	"																												
Total	59,150	-	-	-	-	-	-	-	-	-	-	-	1,398	1,398	1,398	1,398	1,398	1,398	1,398	1,398	1,398	1,398	1,398	1,398	1,398	1,398	1,398	1,398	1,398
													(cutting plantation area) (6,990)						(7,690)						(7,760)				

Pulpwood requirement : 1,397,400 m^3/year

Harvesting age : 8, 14, 20, 28, 36, year old

Harvesting volume : 200, 180, 180, 200, 200 m^3/ha

Mean annual increment: 25, 30, 30, 25, 25, m^3/ha/year

Harvesting age : 8, 16, 24, 30, 36, year old

Harvesting volume : 200, 230, 230, 150, 150, m^3/ha

} in the case of plantation planted in X21 and X22

TABLE III-19 PLANTING AND HARVESTING PLAN FOR POPULUS(2)

Year	Area	X28	X29	X30	X31	X32	X33	X34	X35	X36	X37	X38	X39	X40	X41	X42	X43	X44	X45	X46	X47	X48	X49	X50	X51	X52	X53	X54	X55	X56	X57	X58
	ha																															
X00	-																															
X01	-																															
X02	-																															
X03	6,990				1,398								1,398																			
X04	"					1,398								1,398																		
X05	"						1,398								1,398																	
X06	"							1,398								1,398																
X07	"								1,398								1,398															
X08	"	1,258								1,398								1,398														
X09	700		126								140								140													
X10	"			126								140								140												
X11	"				126								140								140											
X12	"					126								140								140										
X13	"						126								140								140									
X14	"	126						126								140								140								
X15	70		13						13								14								14							
X16	"			13						13								14								14						
X17	"				13						13								14								14					
X18	"					13						13								14								14				
X19	"						13						13								14								14			
X20	"	14						13						13								14								14		
X21	6,295		1,259								1,448													944						944	
X22	"			1,259								1,448													944						944
Total	59,150	1,398	1,398	1,398	1,537	1,537	1,537	1,537	1,411	1,411	1,601	1,601	1,551	1,551	1,538	1,538	1,412	1,412	1,602	1,602	154	154	140	140	958	958	14	14	14	14	944	944
			(7,065)		(7,760)				(7,060)		(7,065)		(7,760)		(7,690)		(7,060)		(7,065)		(770)		(700)		(6,365)		(70)				(6,295)	

Table III-20 PLANTING AND HARVESTING PLAN FOR PINUS TAEDA (1)

(Unit: in 1,000 m^3)

Year	Area	X00	X01	X02	X03	X04	X05	X06	X07	X08	X09	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20	X21	X22	X23	X24
	ha																									
X00	9,450												1,559											(1,559)		
X01	"													1,559											(1,559)	
X02	"														1,559											(1,559)
X03	"															1,559										
X04	"																1,559									
X05	"																	1,559								
X06	"																		1,559							
X07	"																			1,559						
X08	"																				1,559					
X09	"																					1,559				
X10	"																						1,559			
Total	103,950	-	-	-	-	-	-	-	-	-	-	-	1,559	1,559	1,559	1,559	1,559	1,559	1,559	1,559	1,559	1,559	1,559	(1,559)	(1,559)	(1,559)

Pulpwood requirement : 1,558,050 m^3/year
Harvesting age : 11 years old
Harvesting volume : 165 m^3/ha
Mean annual increment : 15 m^3/ha/year

Table III-20 PLANTING AND HARVESTING PLAN FOR PINUS TAEDA (2)

Year	Area	X25	X26	X27	X28	X29	X30	X31	X32
	ha								
X00	9,450								
X01	"								
X02	"								
X03	"	(1,559)							
X04	"		(1,559)						
X05	"			(1,559)					
X06	"				(1,559)				
X07	"					(1,559)			
X08	"						(1,559)		
X09	"							(1,559)	
X10	"								(1,559)
Total	103,950	(1,559)	(1,559)	(1,559)	(1,559)	(1,559)	(1,559)	(1,559)	(1,559)

Table III-21 PLANTING AND HARVESTING PLAN FOR PINUS ELLIOTTII (1)

(Unit: in 1,000 m^3)

Year	Area	X00	X01	X02	X03	X04	X05	X06	X07	X08	X09	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20	X21	X22	X23	X24
	ha																									
X00	10,450												1,724											(1,724)		
X01	"													1,724											(1,724)	
X02	"														1,724											(1,724)
X03	"															1,724										
X04	"																1,724									
X05	"																	1,724								
X06	"																		1,724							
X07	"																			1,724						
X08	"																				1,724					
X09	"																					1,724				
X10	"																						1,724			
Total	114,950	-	-	-	-	-	-	-	-	-	-	-	1,724	1,724	1,724	1,724	1,724	1,724	1,724	1,724	1,724	1,724	1,724	(1,724)	(1,724)	(1,724)

Pulpwood requirement : 1,723,800 m^3/year
Harvesting age : 11 years old
Harvesting volume : 165 m^3/ha
Mean annual increment : 15 m^3/ha/year

Table III-21 PLANTING AND HARVESTING PLAN FOR PINUS ELLIOTTII (2)

(Unit: in 1,000 m^3)

Year	Area	X25	X26	X27	X28	X29	X30	X31	X32
	ha								
X00	10,450								
X01	"								
X02	"								
X03	"	(1,724)							
X04	"		(1,724)						
X05	"			(1,724)					
X06	"				(1,724)				
X07	"					(1,724)			
X08	"						(1,724)		
X09	"							(1,724)	
X10	"								(1,724)
Total	114,950	(1,724)	(1,724)	(1,724)	(1,724)	(1,724)	(1,724)	(1,724)	(1,724)

TABLE III-22 ORGANIZED FORMATION OF FOREST REGION

Species	Planted area per one forest district					Per forest district		Per forest region			Remarks
	1st (ha)	2nd (ha)	3rd (ha)	4th (ha)	Total (ha)	No. of forest units	Required land area (ha)	No. of forest districts	No. of forest units	Required land area (ha)	
E. globulus	4,540	455	45	(4,090 x 2 ÷ 6) 1,363	6,403	128	8,000	6	768	48,000	Refer to Table III-17 - III-21
E. grandis	6,030	605	60	(5,430 x 2 ÷ 6) 1,810	8,505	170	10,625	6	1,020	63,750	Required land area in this table differs from the area shown in the table in 3-1 Pulpwood Requirement and Required Land Area because required land area in this table is calculated on the basis of the rounded number of Forest units.
Populus	6,990	700	70	(6,295 x 2 ÷ 6) 2,098	9,858	197	12,313	6	1,182	73,875	
P. taeda	9,450	-	-	-	9,450	189	11,813	11	2,079	129,938	
P. elliottii	10,450	-	-	-	10,450	209	13,063	11	2,299	143,689	

TABLE III-23 PLANTING COST OF EUCALYPTUS AND POPULUS (SPACING 2.5 m x 2.5 m)

Items	Equipment				Labours				Materials				Grand total US$
	Type	Hours/ha	US$/h	Total US$	Type	Hours/ha	US$/h	Total US$	Type	Quantity /ha	US$/unit	Total US$	
Fire belt	Bulldozer	0.36	34.47	12.41									12.41
Forest road	Grader	0.12	20.88	2.51	Manpower	4.00	0.68	2.72	Drain pipe, etc.			2.80	8.03
Fence					Manpower	7.20	0.68	4.90	Wire, etc.	25/m	0.59/m	14.75	19.65
Ant control					Manpower	6.40	0.68	4.35	Incecticide	1.5/kg	1.66/kg	2.49	6.84
Ploughing	Tractor	2.25	6.87	15.46									15.46
"	Plough	2.25	0.24	0.54									0.54
Harrowing	Tractor	1.25	6.87	8.59									8.59
"	Harrow	1.25	0.47	0.59									0.59
Marking					Manpower	5.00	0.68	3.40					3.40
Ditching (and fertilizing)	Tractor	1.50	6.87	10.31									10.31
Holing					Manpower	13.00	0.68	8.84					8.84
Transportation of seedlings	Truck	0.90	10.31	9.28	Manpower	1.00	0.68	0.68					9.96
Distribution of seedlings	Tractor	0.70	6.87	4.81	Manpower	1.00	0.68	0.68					5.49
"	Wagon	0.70	0.69	0.48									0.48
Planting					Manpower	30.00	0.68	20.40	Seedlings	1,600/ pieces	0.05/ piece	80.00	100.40
Weeding	Tractor	1.20	6.87	8.24	Manpower	5.00	0.68	3.40					11.64
"	Harrow	1.20	0.47	0.56									0.56
Replanting	Tractor	0.10	6.87	0.69	Manpower	3.00	0.68	2.04	Seedlings	160/ pieces	0.05/ piece	8.00	10.73
"	Wagon	0.10	0.69	0.07									0.07
Sub-total				74.54				51.41				108.04	233.99
Contingency (Sub-total x 5%)													11.70
Total													245.69
Overhead (Total x 8%)													19.66
Grand total													265.35

Notes:

Fire belt : 6H/km x 0.06 km/ha = 0.36 h/ha
Forest road : 2H/km x 0.06 km/ha = 0.12 h/ha
Labour cost : US$80/mon. x 1.7 ÷ 200 h/mon = US$0.68/h

TABLE III-24 1ST YEAR'S TENDING COST OF EUCALYPTUS AND POPULUS

Items	Equipment				Labours				Materials				Grand total US$
	Type	Hours/ha	US$/h	Total US$	Type	Hours/ha	US$/h	Total US$	Type	Quantity /ha	US$/unit	Total US$	
Weeding	Tractor	3 x 1.2	6.87	24.73	Manpower	15.00	0.68	10.20					34.93
"	Weeder	3 x 1.2	0.47	1.69									1.69
Ant control					Manpower	2.00	0.68	1.36	Incecticide	0.2/kg	1.66/kg	0.33	1.69
Ranger					Manpower	4.40	0.68	2.99					2.99
Maintenance of fire belt and forest road	Grader	0.06	20.88	1.25	Manpower	4.00	0.68	2.72					3.97
Sub-total (1)				27.67				17.27				0.33	45.27
Contingency (2) = (1) x 5%													2.26
Overhead (3) = [(1)+(2)] x 8%													3.80
Grand total													51.33

Notes:

Maintenance of fire belt and forest road : 1 h/km x 0.06 km = 0.06 h/ha
Ranger : 1 person/500 ha

TABLE III-25 2ND YEAR'S TENDING COST OF EUCALYPTUS AND POPULUS

Items	Equipment				Labours				Materials				Grand total US$
	Type	Hours/ha	US$/h	Total US$	Type	Hours/ha	US$/h	Total US$	Type	Quantity /ha	US$/unit	Total US$	
Brush cutting	Tractor	3 x 0.8	6.87	16.49	Manpower	10.00	0.68	6.80					23.29
"	Brush cutter	3 x 0.8	0.71	1.70									1.70
Ant control					Manpower	2.00	0.68	1.36	Incecticide	0.2/kg	1.66/kg	0.33	1.69
Ranger					Manpower	4.40	0.68	2.99					2.99
Maintenance of fire belt and forest road	Grader	0.06	20.88	1.25	Manpower	4.00	0.68	2.72					3.97
Sub-total (1)				19.44				13.87				0.33	33.64
Contingency (2) = (1) x 5%													1.68
Overhead (3) = [(1)+(2)] x 8%													2.83
Grand total													38.15

TABLE III-26 3RD YEAR'S TENDING COST OF EUCALYPTUS AND POPULUS

Items	Equipment				Labours				Materials				Grand total US$
	Type	Hours/ha	US$/h	Total US$	Type	Hours/ha	US$/h	Total US$	Type	Quantity /ha	US$/unit	Total US$	
Brush cutting	Tractor	2 x 0.8	6.87	10.99	Manpower	10.00	0.68	6.80					17.79
"	Brush cutter	2 x 0.8	0.71	1.14									1.14
Ant control					Manpower	2.00	0.68	1.36	Incecticide	0.2/kg	1.66/kg	0.33	1.69
Ranger					Manpower	4.40	0.68	2.99					2.99
Maintenance of fire belt and forest road	Grader	0.06	20.88	1.25	Manpower	4.00	0.68	2.72					3.97
Sub-total (1)				13.38				13.87				0.33	27.58
Contingency (2) = (1) x 5%													1.38
Overhead (3) = [(1)+(2)] x 8%													2.32
Grand total													31.28

TABLE III-27 4TH - 7TH, 9TH - 13TH, 15TH - 19TH, 21ST - 27TH, 29TH - 35TH YEAR'S TENDING COST OF EUCALYPTUS AND POPULUS

Items	Equipment				Labours				Materials				Grand total US$
	Type	Hours/ha	US$/h	Total US$	Type	Hours/ha	US$/h	Total US$	Type	Quantity /ha	US$/unit	Total US$	
Ranger					Manpower	4.40	0.68	2.99					2.99
Maintenance of fire belt and forest road	Grader	0.06	20.88	1.25	Manpower	4.00	0.68	2.72					3.97
Sub-total (1)				1.25				5.71					6.96
Contingency (2) = (1) x 5%													0.35
Overhead (3) = [(1)+(2)] x 8%													0.56
Grand total													7.87

TABLE III-28 8TH, 14TH, 20TH, 28TH YEAR'S TENDING COST OF EUCALYPTUS AND POPULUS

Items	Equipment				Labours				Materials				Grand total US$
	Type	Hours/ha	US$/h	Total US$	Type	Hours/ha	US$/h	Total US$	Type	Quantity /ha	US$/unit	Total US$	
Brush cutting	Tractor	0.8	6.87	5.50	Manpower	10.00	0.68	6.80					12.30
"	Brush cutter	0.8	0.47	0.38									0.38
Ant control					Manpower	2.00	0.68	1.36	Incecticide	0.2/kg	1.66/kg	0.33	1.69
Nipping					Manpower	21.00	0.68	14.28					14.28
Ranger					Manpower	4.40	0.68	2.99					2.99
Sub-total (1)				5.88				25.43				0.33	31.64
Contingency (2) = (1) x 5%													1.58
Overhead (2) = [(1)+(2)] x 8%													2.66
Grand total													35.88

Table III-29 PLANTING COST OF PINUS (SPACING: 3 m x 3 m)

Items	Equipment				Labours				Materials				Grand Total US$
	Type	Hours/ha	US$/h	Total US$	Type	Hours/ha	US$/h	Total US$	Type	Quantity/ha	US$/unit	Total US$	
Fire belt	Bulldozer	0.36	34.47	12.41									12.41
Forest road	Grader	0.12	20.88	2.51	Manpower	4.00	0.68	2.72	Drain pipe, etc.			2.80	8.03
Fence					"	7.20	0.68	4.90	Wire, etc.	25 m	0.59/m	14.75	19.65
Ant control					"	6.40	0.68	4.35	Incecticide	1.5 kg	1.66/kg	2.49	6.84
Ploughing	Tractor	2.25	6.87	15.46									15.46
"	Plough	2.25	0.24	0.54									0.54
Harrowing	Tractor	1.25	6.87	8.59									8.59
"	Harrow	1.25	0.47	0.59									0.59
Marking					Manpower	4.20	0.68	2.86					2.86
Ditching	Tractor	1.25	6.87	8.59									8.59
Holing					Manpower	9.00	0.68	6.12					6.12
Transportation of seedlings	Truck	0.65	10.31	6.70	"	0.70	0.68	0.48					7.18
Distribution of seedlings	Tractor	0.50	6.87	3.44	"	0.70	0.68	0.48					3.92
" "	Wagon	0.50	0.69	0.35									0.35
Planting					Manpower	21.00	0.68	14.28	Seedlings	1,110 pieces	0.044/piece	48.84	63.12
Weeding	Tractor	0.85	6.87	5.84	"	3.50	0.68	2.38					8.22
"	Harrow	0.85	0.47	0.40									0.40
Replanting	Tractor	0.10	6.87	0.69	Manpower	2.10	0.68	1.43	Seedlings	110 pieces	0.044/piece	4.84	6.96
"	Wagon	0.10	0.69	0.07									0.07
Sub-total				66.18				40.00				73.72	179.90
Contingency (Sub-total x 5%)													9.00
Total													188.90
Overhead (Total x 8%)													15.11
Grand total													204.01

Table III-30 1ST YEAR'S TENDING COST OF PINUS

Items	Equipment				Labours				Materials				Grand Total US$
	Type	Hours/ha	US$/h	Total US$	Type	Hours/ha	US$/h	Total US$	Type	Quantity/ha	US$/unit	Total US$	
Weeding	Tractor	3x1.0	6.87	20.61	Manpower	10.50	0.68	7.14					27.75
"	Weeder	3x1.0	0.47	1.41									1.41
Ant control					Manpower	2.00	0.68	1.36	Incecticide	0.2 kg	1.66/kg	0.33	1.69
Ranger					"	4.40	0.68	2.99					2.99
Maintenance of fire belt and forest road	Grader	0.06	20.88	1.25	"	4.00	0.68	2.72					3.97
Sub-total (1)				23.27				14.21				0.33	37.81
Contingency (2) = (1) x 5%													1.89
Overhead (3) = [(1)+(2)] x 8%													3.18
Grand total													42.88

Table III-31 2ND YEAR'S TENDING COST OF PINUS

Items	Equipment				Labours				Materials				Grand Total US$
	Type	Hours/ha	US$/h	Total US$	Type	Hours/ha	US$/h	Total US$	Type	Quantity/ha	US$/unit	Total US$	
Weeding	Tractor	3x0.7	6.87	14.43	Manpower	7.00	0.68	4.76					19.19
"	Weeder	3x0.7	0.47	0.99									0.99
Ant control					Manpower	2.00	0.68	1.36	Incecticide	0.2 kg	1.66/kg	0.33	1.69
Ranger					"	4.40	0.68	2.99					2.99
Maintenance of fire belt and forest road	Grader	0.06	20.88	1.25	"	4.00	0.68	2.72					3.97
Sub-total (1)				16.67				11.83				0.33	28.83
Contingency (2) = (1) x 5%													1.44
Overhead (3) = [(1)+(2)] x 8%													2.42
Grand total													32.69

Table III-32 3RD YEAR'S TENDING COST OF PINUS

Items	Equipment				Labours				Materials				Grand Total US$
	Type	Hours/ha	US$/h	Total US$	Type	Hours/ha	US$/h	Total US$	Type	Quantity/ha	US$/unit	Total US$	
Weeding	Tractor	2x0.7	6.87	9.62	Manpower	7.00	0.68	4.76					14.38
"	Weeder	2x0.7	0.47	0.66									0.66
Ant control					Manpower	2.00	0.68	1.36	Incecticide	0.2 kg	1.66/kg	0.33	1.69
Ranger					"	4.40	0.68	2.99					2.99
Maintenance of fire belt and forest road	Grader	0.06	20.88	1.25	"	4.00	0.68	2.72					3.97
Sub-total (1)				11.53				11.83				0.33	23.69
Contingency (2) = (1) x 5%													1.18
Overhead (3) = [(1)+(2)] x 8%													1.99
Grand total													26.86

Table III-33 4TH-10TH YEAR'S TENDING COST OF PINUS

Items	Equipment				Labours				Materials				Grand Total US$
	Type	Hours/ha	US$/h	Total US$	Type	Hours/ha	US$/h	Total US$	Type	Quantity/ha	US$/unit	Total US$	
Ranger					Manpower	4.40	0.68	2.99					2.99
Maintenance of fire belt and forest road	Grader	0.06	20.88	1.25	"	4.00	0.68	2.72					3.97
Sub-total (1)				1.25				5.71					6.96
Contingency (2) = (1) x 5%													0.35
Overhead (3) = [(1)+(2)] x 8%													0.56
Grand total													7.87

TABLE III-34 HOURLY OWNING AND OPERATING COST ESTIMATE OF MACHINES

	Bulldozer (150 HP)		Motor Grader (125 HP)		Tractor (55 HP)		Plough		Harrow	
Delivered price	US$130,000		US$98,000		US$18,000		US$1,500		US$3,000	
Residual value	US$13,000		US$9,800		US$1,800		US$450		US$900	
Value to be depreciated	US$117,000		US$88,200		US$16,200		US$1,050		US$2,100	
Useful life (hours)	12,000		20,000		12,000		8,000		8,000	
Owning costs	US$/h	Remarks	US$/h	Remarks	US$/h	Remarks	US$/h	Remarks	US$/h	Remarks
Depreciation cost	9.75		4.41		1.35		0.13		0.26	
Interest cost *1	4.55	12%, N : 6 years	3.23	12%, N : 10 years	0.63	12%, N : 6 years	0.06	12%, N : 4 years	0.11	12%, N : 4 years
Insurance *1	1.14	3%	0.81	3%	0.16	3%	-		-	
Taxes	-		-		-		-		-	
Total hourly owning cost	15.44		8.45		2.14		0.19		0.37	
Operating costs										
Fuel *2	6.32	0.13 ℓ/HP x 150 HP x US$0.324/ℓ	5.27	0.13 x 125 x 0.324	2.32	0.13 x 55 x 0.324	-		-	
Lube oils, filters, grease	1.26	Fuel cost x 20%	1.05	Fuel cost x 20%	0.35	Fuel cost x 15%	-		-	
Repair cost	9.75	Depreciation cost x 100%	4.41	Depreciation cost x 100%	0.95	Depreciation cost x 70%	0.05	Depreciation cost x 40%	0.10	Depreciation cost x 40%
Total hourly operating cost	17.33		10.73		3.62		0.05		0.10	
Operator's hourly wage (include fringes)	1.70	US$200/mon x 1.7 ÷ 200 hs	1.70	200 x 1.7 ÷ 200	1.11	US$130 x 1.7 ÷ 200	-		-	
Total owning and operating cost	34.47		20.88		6.87		0.24		0.47	

Notes:

*1 (Delivered price) x $\frac{1}{2}$ (Interest rate or Insurance rate) (N+1) ÷ (Useful life)

N : The number of years of use.

*2 Consumption : 0.13 ℓ/HP/h
Price of kerosene : 24.30 N$/ℓ = 0.324

Hourly owning and operating cost estimate of

Truck : (Total owning and operating cost of tractor) x 150% = 10.31 US$/h
Wagon : (") x 10% = 0.69 "
Weeder : (Total owning and operating cost of harrow) x 100% = 0.47 "
Brush cutter: (") x 150% = 0.71 "

TABLE III-35 DISCOUNTED VALUE OF PLANTED EUCALYPTUS AND POPULUS

Year	Land cost	Plantation cost	Total	Expecting yield volume	Coefficient of discounted value	Discounted value	Discounted yield value	Remaining land value	Remarks
	US$	US$/ha	US$/ha	m^3/ha	12%/year	US$/ha	m^3/ha	US$/ha	
0	281.25	265.35	546.60		1.0000	546.60			
1		51.33	51.33		0.8929	45.83			
2		38.15	38.15		0.7972	30.41			
3		31.28	31.28		0.7118	22.27			
4		7.87	7.87		0.6355	5.00			
5		7.87	7.87		0.5674	4.47			
6		7.87	7.87		0.5066	3.99			
7		7.87	7.87		0.4523	3.56			
⑧		35.88	35.88	200	0.4039	14.49	80.78		25 m^3/ha/year
9		7.87	7.87		0.3606	2.84			
10		7.87	7.87		0.3220	2.53			
11		7.87	7.87		0.2875	2.26			
12		7.87	7.87		0.2567	2.02			
13		7.87	7.87		0.2292	1.80			
⑭		35.88	35.88	180	0.2046	7.34	36.83		30 m^3/ha/year
15		7.87	7.87		0.1827	1.44			
16		7.87	7.87		0.1631	1.28			
17		7.87	7.87		0.1456	1.15			
18		7.87	7.87		0.1300	1.02			
19		7.87	7.87		0.1161	0.91			
⑳		35.88	35.88	180	0.1037	3.72	18.67		30 m^3/ha/year
21		7.87	7.87		0.09256	0.73			
22		7.87	7.87		0.08264	0.65			
23		7.87	7.87		0.07379	0.58			
24		7.87	7.87		0.06588	0.52			
25		7.87	7.87		0.05882	0.46			
26		7.87	7.87		0.05252	0.41			
27		7.87	7.87		0.04689	0.37			
㉘		35.88	35.88	200	0.04187	1.50	8.37		25 m^3/ha/year
29		7.87	7.87		0.03738	0.29			
30		7.87	7.87		0.03338	0.26			
31		7.87	7.87		0.02980	0.23			
32		7.87	7.87		0.02661	0.21			
33		7.87	7.87		0.02376	0.19			
34		7.87	7.87		0.02121	0.17			
35		7.87	7.87		0.01894	0.15			
㊱				200	0.01691		3.38	4.76	25 m^3/ha/year
Total	281.25	749.99	1,031.24	960		711.65	148.03	4.76	

Notes:

Land cost : US$225/ha x 1.25 ha = US$281.25
Number of planted trees : 1600 trees/ha
Cutting age : 8, 14, 20, 28 and 36 years old
Final yield : 180 - 200 m^3/ha
Number of regeneration by sprout : 4
Stumpage cost : (711.65 - 4.76)/148.03 = US$4.78/$m^3$

Table III-36 DISCOUNTED VALUE OF PLANTED PINUS

Year	Land cost	Plantation cost	Total	Expecting yield volume	Coefficient of discounted value	Discounted value	Discounted yield value	Remaining land value	Remarks
	US$	US$/ha	US$/ha	m^3/ha	12%/year	US$/ha	m^3/ha	US$/ha	
0	281.25	204.01	485.26		1.0000	485.26			
1		42.88	42.88		0.8929	38.29			
2		32.69	32.69		0.7972	26.06			
3		26.86	26.86		0.7118	19.12			
4		7.87	7.87		0.6355	5.00			
5		7.87	7.87		0.5674	4.47			
6		7.87	7.87		0.5066	3.99			
7		7.87	7.87		0.4523	3.56			
8		7.87	7.87		0.4039	3.18			
9		7.87	7.87		0.3606	2.84			
10		7.87	7.87		0.3220	2.53			
11				165	0.2875		47.44	80.86	15 m^3/ha/year
Total	281.25	361.53	642.78	165		594.30	47.44	80.86	

Notes:

Land cost : US$225/ha x 1.25 ha = US$281.25
Number of planted trees : 1,110 trees/ha
Cutting age : 11 years old
Final yield : 165 m^3/ha
Stumpage cost : (594.30 - 80.86)/47.44 = US$10.82/$m^3$

TABLE III-37 DISCOUNTED VALUE OF PLANTED EUCALYPTUS AND POPULUS (8%)

Year	Land cost	Plantation cost	Total	Expecting yield volume	Coefficient of discounted value	Discounted value	Discounted yield value	Remaining land value	Remarks
	US$	US$/ha	US$/ha	m^3/ha	8%/year	US$/ha	m^3/ha	US$/ha	
0	281.25	265.35	546.60		1.0000	546.60			
1		51.33	51.33		0.9259	47.53			
2		38.15	38.15		0.8573	32.71			
3		31.28	31.28		0.7938	24.83			
4		7.87	7.87		0.7350	5.78			
5		7.87	7.87		0.6806	5.36			
6		7.87	7.87		0.6302	4.96			
7		7.87	7.87		0.5835	4.59			
⑧		35.88	35.88	200	0.5403	19.39	108.06		25 m^3/ha/year
9		7.87	7.87		0.5002	3.94			
10		7.87	7.87		0.4632	3.65			
11		7.87	7.87		0.4289	3.38			
12		7.87	7.87		0.3971	3.13			
13		7.87	7.87		0.3677	2.89			
⑭		35.88	35.88	180	0.3405	12.22	61.29		30 m^3/ha/year
15		7.87	7.87		0.3152	2.48			
16		7.87	7.87		0.2919	2.30			
17		7.87	7.87		0.2703	2.13			
18		7.87	7.87		0.2502	1.97			
19		7.87	7.87		0.2317	1.82			
⑳		35.88	35.88	180	0.2145	7.70	38.61		30 m^3/ha/year
21		7.87	7.87		0.1987	1.56			
22		7.87	7.87		0.1839	1.45			
23		7.87	7.87		0.1703	1.34			
24		7.87	7.87		0.1577	1.24			
25		7.87	7.87		0.1460	1.15			
26		7.87	7.87		0.1352	1.06			
27		7.87	7.87		0.1252	0.99			
㉘		35.88	35.88	200	0.1159	4.16	23.18		25 m^3/ha/year
29		7.87	7.87		0.1073	0.84			
30		7.87	7.87		0.09938	0.78			
31		7.87	7.87		0.09202	0.72			
32		7.87	7.87		0.08520	0.67			
33		7.87	7.87		0.07889	0.62			
34		7.87	7.87		0.07305	0.57			
35		7.87	7.87		0.06763	0.53			
㊱				200	0.06262		12.52	17.61	25 m^3/ha/year
Total	281.25	749.99	1,031.24	960		757.04	243.66	17.61	

Note:

Stumpage cost : (757.04 - 17.61)/243.66 = 3.03 US$/$m^3$

Table III-38 DISCOUNTED VALUE OF PLANTED PINUS (8%)

Year	Land cost	Plantation cost	Total	Expecting yield volume	Coefficient of discounted value	Discounted value	Discounted yield value	Remaining land value	Remarks
	US$	US$/ha	US$/ha	m^3/ha	8%/year	US$/ha	m^3/ha	US$/ha	
0	281.25	204.01	485.26		1.0000	482.26			
1		42.88	42.88		0.9259	39.70			
2		32.69	32.69		0.8573	28.03			
3		26.86	26.86		0.7938	21.32			
4		7.87	7.87		0.7350	5.78			
5		7.87	7.87		0.6806	5.36			
6		7.87	7.87		0.6302	4.96			
7		7.87	7.87		0.5835	4.59			
8		7.87	7.87		0.5403	4.25			
9		7.87	7.87		0.5002	3.94			
10		7.87	7.87		0.4632	3.65			
11				165	0.4289		70.77	120.63	15 m^3/ha/y
Total	281.25	361.53	642.78	165		603.84	70.77	120.63	

Note:

Stumpage cost : (603.84 - 120.63)/70.77 = 6.83 US$/$m^3$

TABLE III-39 LOGGING COSTS

Items	Eucalyptus and Populus		Pines		Remarks
	US$/m^3	Remarks	US$/m^3	Remarks	
Felling, Limbing and Bucking		Productivity: 1.10 m^3/h		Productivity: 1.20 m^3/h	
Labours	1.63	1 operator and 1 worker: 1.79 US$/h	1.49	1 operator and 1 worker: 1.79 US$/h	
Cost of chain saw	1.07	Refer to Table III-40 : 1.18 "	0.98	Refer to Table III-40 : 1.18 "	
Sub-total	2.70		2.47		
Skidding		Productivity: 11.00 m^3/h		Productivity: 12.00 m^3/h	
Labours	0.12	2 workers : 1.36 US$/h	0.11	2 workers : 1.36 US$/h	
Cost of tractor with crane	1.79	Refer to Table III-40 : 19.65 "	1.64	Refer to Table III-40 : 19.65 "	
Cost of 3 wagons	0.12	" : 1.37 "	0.11	" : 1.37 "	
Sub-total	2.03		1.86		
Loading		Productivity: 22.50 m^3/h		Productivity: 25.00 m^3/h	
Labours	0.06	2 workers : 1.36 US$/h	0.05	2 workers : 1.36 US$/h	
Cost of tractor with crane	0.87	Refer to Table III-40 : 19.65 "	0.79	Refer to Table III-40 : 19.65 "	
Sub-total	0.93		0.84		
Total (1)	5.66		5.17		
Contingency (2) = (1) x 5%	0.28		0.26		
Overhead (3) = [(1)+(2)] x 8%	0.48		0.43		
Grand total	6.42		5.86		

Notes:

Wages

Chain saw's operator : 130 US$/mon x 1.7 (incl. fringe benefits) ÷ 200 hs/mon = 1.11 US$/h
Worker : 80 " x 1.7 (") ÷ 200 " = 0.68 "

TABLE III-40 HOURLY OWNING AND OPERATING COST ESTIMATE OF LOGGING MACHINES

	Chain saw		Tractor (100HP) with grapple crane		3 Wagons	
Delivered price	US$800		US$80,000		US$9,000 (US$3,000 x 3)	
Residual value	-		US$8,000		- (")	
Value to be depreciated	US$800		US$72,000		US$9,000 (")	
Useful life (hours)	2,400 (one year)		12,000		12,000	
Owning costs	US$/h	Remarks	US$/h	Remarks	US$/h	Remarks
Depreciation cost	0.33		6.00		0.75	
*1 Interest cost	-		2.80	12%, N : 6 years	0.32	12%, N : 6 years
*1 Insurance	-		0.70	3%	-	
Taxes	-		-		-	
Total hourly owning cost	0.33		9.50		1.07	
Operating costs						
*2 Fuel	0.43	0.52 ℓ/h x 0.82 US$/ℓ	4.21	0.13 x 100 x 0.324	-	
Lube oils, filters, grease	0.17	0.10 " x 1.68 "	0.63	Fuel cost x 15%	-	
Repair cost	0.25	Depreciation cost x 75%	4.20	Depreciation cost x 70%	0.30	Depreciation cost x 40%
Total hourly operating cost	0.85		9.04		0.30	
Operator's hourly wage (include fringes)	-	excluded from the cost	1.11	US$130 x 1.7 ÷ 200	-	
Total owning and operating cost	1.18		19.65		1.37	

Refer to Table III-14

Notes:

*1 (Delivered price) x $\frac{1}{2}$ (Interest rate or Insurance rate) (N + 1) ÷ (Useful life)

N : The number of years of use

*2 Consumption : 0.13 ℓ/HP/h
Price of kerosene : 24.30 N$/ℓ = 0.324 US$/ℓ

Table III-41 CONSTRUCTION AND MAINTENANCE COST OF FOREST ROAD FOR E.GLOBULUS

Year	Cutting volume per year	Cutting plantation area / year	Cutting land areas / year	Construction length of branch road / year	Main road		Construction cost of main road	Maintenance cost of main road	Maintenance cost of branch road		Total	Coeffcient of discounted value(12%)	Discounted value of		Remarks
					Const. length / year	Accumulated length			by grader	by manpower			Amount	Volume	
	A	B	C=B/0.8	D=C*0.027	E	F=ΣE	G=E*4000	H=F*752	I=D*63	J=D*405	K=G～J	L	M=K*L	N=A*L	
	m³	ha	ha	km	km	km	us$	us$	us$	us$	us$		us$	m³	
X11	908,000	4,540	5,675	153.2	17.0	17.0	68,000	12,784	9,652	62,046	152,482	0.2875	43,839	261,050	
12	908,000	4,540	5,675	153.2	17.0	34.0	68,000	25,568	9,652	62,046	165,266	0.2567	42,424	233,084	
13	908,000	4,540	5,675	153.2	17.0	51.0	68,000	38,352	9,652	62,046	178,050	0.2292	40,809	208,114	
14	908,000	4,540	5,675	153.2	17.0	68.0	68,000	51,136	9,652	62,046	190,834	0.2046	39,045	185,777	
15	908,000	4,540	5,675	153.2	17.0	85.0	68,000	63,920	9,652	62,046	203,618	0.1827	37,201	165,892	
16	908,000	4,540	5,675	153.2	17.0	102.0	68,000	76,704	9,652	62,046	216,402	0.1631	35,295	148,095	
17	908,000	4,995	6,244	168.6	1.7	103.7	6,800	77,982	10,622	68,283	163,687	0.1456	23,833	132,205	
18	908,000	4,995	6,244	168.6	1.7	105.4	6,800	79,261	10,622	68,283	164,966	0.13	21,446	118,040	
19	908,000	4,995	6,244	168.6	1.7	107.1	6,800	80,539	10,622	68,283	166,244	0.1161	19,301	105,419	
20	908,000	4,995	6,244	168.6	1.7	108.8	6,800	81,818	10,622	68,283	167,523	0.1037	17,372	94,160	
21	908,000	4,995	6,244	168.6	1.7	110.5	6,800	83,096	10,622	68,283	168,801	0.09256	15,624	84,044	
22	908,000	4,995	6,244	168.6	1.7	112.2	6,800	84,374	10,622	68,283	170,079	0.08264	14,055	75,037	
23	908,000	5,040	6,300	170.1	0.2	112.4	800	84,525	10,716	68,891	164,932	0.07379	12,170	67,001	
24	908,000	5,040	6,300	170.1	0.2	112.6	800	84,675	10,716	68,891	165,082	0.06588	10,876	59,819	
25	908,000	5,040	6,300	170.1	0.2	112.8	800	84,826	10,716	68,891	165,233	0.05882	9,719	53,409	
26	908,000	5,040	6,300	170.1	0.2	113.0	800	84,976	10,716	68,891	165,383	0.05252	8,686	47,688	
27	908,000	5,040	6,300	170.1	0.2	113.2	800	85,126	10,716	68,891	165,533	0.04689	7,762	42,576	
28	908,000	5,040	6,300	170.1	0.2	113.4	800	85,277	10,716	68,891	165,684	0.04187	6,937	38,018	
29	908,000	4,590	5,738	154.9	15.3	128.7	61,200	96,782	9,759	62,735	230,476	0.03738	8,615	33,941	
30	908,000	4,590	5,738	154.9	15.3	144.0	61,200	108,288	9,759	62,735	241,982	0.03338	8,077	30,309	
31	998,000	5,040	6,300	170.1	0.0	144.0	0	108,288	10,716	68,891	187,895	0.0298	5,599	29,740	
32	998,000	5,040	6,300	170.1	0.0	144.0	0	108,288	10,716	68,891	187,895	0.02661	5,000	26,557	
33	998,000	5,040	6,300	170.1	0.0	144.0	0	108,288	10,716	68,891	187,895	0.02376	4,464	23,712	
34	998,000	5,040	6,300	170.1	0.0	144.0	0	108,288	10,716	68,891	187,895	0.02121	3,985	21,168	
35	916,000	4,585	5,731	154.7	0.0	144.0	0	108,288	9,746	62,654	180,688	0.01894	3,422	17,349	
36	916,000	4,585	5,731	154.7	0.0	144.0	0	108,288	9,746	62,654	180,688	0.01691	3,055	15,490	
37	1,040,000	4,590	5,738	154.9	0.0	144.0	0	108,288	9,759	62,735	180,782	0.0151	2,730	15,704	
38	1,040,000	4,590	5,738	154.9	0.0	144.0	0	108,288	9,759	62,735	180,782	0.01348	2,437	14,019	
39	1,007,000	5,040	6,300	170.1	0.0	144.0	0	108,288	10,716	68,891	187,895	0.01204	2,262	12,124	
TOTAL	27,071,000	140,180	175,228	4,730.9	144	144	576,000	2,444,601	298,048	1,916,023	5,234,672		456,040	2,359,541	0.19 us$/m³

Table III-42 CONSTRUCTION AND MAINTENANCE COST OF FOREST ROAD FOR E.GRANDIS

Year	Cutting volume per year	Cutting plantation area / year	Cutting land areas / year	Construction length of branch road / year	Main road		Construction cost of main road	Maintenance cost of main road	Maintenance cost of branch road		Total	Coeffcient of discounted value(12%)	Discounted value of		Remarks
					Const. length / year	Accumulated length			by grader	by manpower			Amount	Volume	
	A	B	C=B/0.8	D=C*0.027	E	F=ΣE	G=E*4000	H=F*752	I=D*63	J=D*405	K=G~J	L	M=K*L	N=A*L	
	m³	ha	ha	km	km	km	us$	us$	us$	us$	us$		us$	m³	
X11	1,206,000	6,030	7,538	203.5	22.6	22.6	90,400	16,995	12,821	82,418	202,634	0.2875	58,257	346,725	
12	1,206,000	6,030	7,538	203.5	22.6	45.2	90,400	33,990	12,821	82,418	219,629	0.2567	56,379	309,580	
13	1,206,000	6,030	7,538	203.5	22.6	67.8	90,400	50,986	12,821	82,418	236,625	0.2292	54,234	276,415	
14	1,206,000	6,030	7,538	203.5	22.6	90.4	90,400	67,981	12,821	82,418	253,620	0.2046	51,891	246,748	
15	1,206,000	6,030	7,538	203.5	22.6	113.0	90,400	84,976	12,821	82,418	270,615	0.1827	49,441	220,336	
16	1,206,000	6,030	7,538	203.5	22.6	135.6	90,400	101,971	12,821	82,418	287,610	0.1631	46,909	196,699	
17	1,206,000	6,635	8,294	223.9	2.3	137.9	9,200	103,701	14,106	90,680	217,687	0.1456	31,695	175,594	
18	1,206,000	6,635	8,294	223.9	2.3	140.2	9,200	105,430	14,106	90,680	219,416	0.13	28,524	156,789	
19	1,206,000	6,635	8,294	223.9	2.3	142.5	9,200	107,160	14,106	90,680	221,146	0.1161	25,675	140,017	
20	1,206,000	6,635	8,294	223.9	2.3	144.8	9,200	108,890	14,106	90,680	222,876	0.1037	23,112	125,062	
21	1,206,000	6,635	8,294	223.9	2.3	147.1	9,200	110,619	14,106	90,680	224,605	0.09256	20,789	111,627	
22	1,206,000	6,635	8,294	223.9	2.3	149.4	9,200	112,349	14,106	90,680	226,335	0.08264	18,704	99,664	
23	1,206,000	6,695	8,369	226.0	0.2	149.6	800	112,499	14,238	91,530	219,067	0.07379	16,165	88,991	
24	1,206,000	6,695	8,369	226.0	0.2	149.8	800	112,650	14,238	91,530	219,218	0.06588	14,442	79,451	
25	1,206,000	6,695	8,369	226.0	0.2	150.0	800	112,800	14,238	91,530	219,368	0.05882	12,903	70,937	
26	1,206,000	6,695	8,369	226.0	0.2	150.2	800	112,950	14,238	91,530	219,518	0.05252	11,529	63,339	
27	1,206,000	6,695	8,369	226.0	0.2	150.4	800	113,101	14,238	91,530	219,669	0.04689	10,300	56,549	
28	1,206,000	6,695	8,369	226.0	0.2	150.6	800	113,251	14,238	91,530	219,819	0.04187	9,204	50,495	
29	1,206,000	6,095	7,619	205.7	20.4	171.0	81,600	128,592	12,959	83,309	306,460	0.03738	11,455	45,080	
30	1,206,000	6,095	7,619	205.7	20.4	191.4	81,600	143,933	12,959	83,309	321,801	0.03338	10,742	40,256	
31	1,326,000	6,695	8,369	226.0	0.0	191.4	0	143,933	14,238	91,530	249,701	0.0298	7,441	39,515	
32	1,326,000	6,695	8,369	226.0	0.0	191.4	0	143,933	14,238	91,530	249,701	0.02661	6,645	35,285	
33	1,326,000	6,695	8,369	226.0	0.0	191.4	0	143,933	14,238	91,530	249,701	0.02376	5,933	31,506	
34	1,326,000	6,695	8,369	226.0	0.0	191.4	0	143,933	14,238	91,530	249,701	0.02121	5,296	28,124	
35	1,217,000	6,090	7,613	205.6	0.0	191.4	0	143,933	12,953	83,268	240,154	0.01894	4,549	23,050	
36	1,217,000	6,090	7,613	205.6	0.0	191.4	0	143,933	12,953	83,268	240,154	0.01691	4,061	20,579	
37	1,381,000	6,095	7,619	205.7	0.0	191.4	0	143,933	12,959	83,309	240,201	0.0151	3,627	20,853	
38	1,381,000	6,095	7,619	205.7	0.0	191.4	0	143,933	12,959	83,309	240,201	0.01348	3,238	18,616	
39	1,338,000	6,695	8,369	226.0	0.0	191.4	0	143,933	14,238	91,530	249,701	0.01204	3,006	16,110	
TOTAL	35,958,000	186,195	232,753	6,284.4	191.4	191.4	765,600	3,250,221	395,922	2,545,190	6,956,933		606,146	3,133,983	0.19 us$/m³

Table III-43 CONSTRUCTION AND MAINTENANCE COST OF FOREST ROAD FOR POPULUS

Year	Cutting volume per year	Cutting plantation area / year	Cutting land areas / year	Construction length of branch road / year	Main road		Construction cost of main road	Maintenance cost of main road	Maintenance cost of branch road		Total	Coeffcient of discounted value(12%)	Discounted value of		Remarks
					Const. length / year	Accumulated length			by grader	by manpower			Amount	Volume	
	A	B	C=B/0.8	D=C*0.027	E	F=ΣE	G=E*4000	H=F*752	I=D*63	J=D*405	K=G~J	L	M=K*L	N=A*L	
	m^3	ha	ha	km	km	km	us$	us$	us$	us$	us$		us$	m^3	
XII	1,398,000	6,990	8,738	235.9	26.2	26.2	104,800	19,702	14,862	95,540	234,904	0.2875	67,535	401,925	
12	1,398,000	6,990	8,738	235.9	26.2	52.4	104,800	39,405	14,862	95,540	254,607	0.2567	65,358	358,867	
13	1,398,000	6,990	8,738	235.9	26.2	78.6	104,800	59,107	14,862	95,540	274,309	0.2292	62,872	320,422	
14	1,398,000	6,990	8,738	235.9	26.2	104.8	104,800	78,810	14,862	95,540	294,012	0.2046	60,155	286,031	
15	1,398,000	6,990	8,738	235.9	26.2	131.0	104,800	98,512	14,862	95,540	313,714	0.1827	57,316	255,415	
16	1,398,000	6,990	8,738	235.9	26.2	157.2	104,800	118,214	14,862	95,540	333,416	0.1631	54,380	228,014	
17	1,398,000	7,690	9,613	259.6	2.6	159.8	10,400	120,170	16,355	105,138	252,063	0.1456	36,700	203,549	
18	1,398,000	7,690	9,613	259.6	2.6	162.4	10,400	122,125	16,355	105,138	254,018	0.13	33,022	181,740	
19	1,398,000	7,690	9,613	259.6	2.6	165.0	10,400	124,080	16,355	105,138	255,973	0.1161	29,718	162,308	
20	1,398,000	7,690	9,613	259.6	2.6	167.6	10,400	126,035	16,355	105,138	257,928	0.1037	26,747	144,973	
21	1,398,000	7,690	9,613	259.6	2.6	170.2	10,400	127,990	16,355	105,138	259,883	0.09256	24,055	129,399	
22	1,398,000	7,690	9,613	259.6	2.6	172.8	10,400	129,946	16,355	105,138	261,839	0.08264	21,638	115,531	
23	1,398,000	7,760	9,700	261.9	0.3	173.1	1,200	130,171	16,500	106,070	253,941	0.07379	18,738	103,158	
24	1,398,000	7,760	9,700	261.9	0.3	173.4	1,200	130,397	16,500	106,070	254,167	0.06588	16,745	92,100	
25	1,398,000	7,760	9,700	261.9	0.3	173.7	1,200	130,622	16,500	106,070	254,392	0.05882	14,963	82,230	
26	1,398,000	7,760	9,700	261.9	0.3	174.0	1,200	130,848	16,500	106,070	254,618	0.05252	13,373	73,423	
27	1,398,000	7,760	9,700	261.9	0.3	174.3	1,200	131,074	16,500	106,070	254,844	0.04689	11,950	65,552	
28	1,398,000	7,760	9,700	261.9	0.3	174.6	1,200	131,299	16,500	106,070	255,069	0.04187	10,680	58,534	
29	1,398,000	7,065	8,831	238.4	23.6	198.2	94,400	149,046	15,019	96,552	355,017	0.03738	13,271	52,257	
30	1,398,000	7,065	8,831	238.4	23.6	221.8	94,400	166,794	15,019	96,552	372,765	0.03338	12,443	46,665	
31	1,537,000	7,760	9,700	261.9	0.0	221.8	0	166,794	16,500	106,070	289,364	0.0298	8,623	45,803	
32	1,537,000	7,760	9,700	261.9	0.0	221.8	0	166,794	16,500	106,070	289,364	0.02661	7,700	40,900	
33	1,537,000	7,760	9,700	261.9	0.0	221.8	0	166,794	16,500	106,070	289,364	0.02376	6,875	36,519	
34	1,537,000	7,760	9,700	261.9	0.0	221.8	0	166,794	16,500	106,070	289,364	0.02121	6,137	32,600	
35	1,411,000	7,060	8,825	238.3	0.0	221.8	0	166,794	15,013	96,512	278,319	0.01894	5,271	26,724	
36	1,411,000	7,060	8,825	238.3	0.0	221.8	0	166,794	15,013	96,512	278,319	0.01691	4,706	23,860	
37	1,601,000	7,065	8,831	238.4	0.0	221.8	0	166,794	15,019	96,552	278,365	0.0151	4,203	24,175	
38	1,601,000	7,065	8,831	238.4	0.0	221.8	0	166,794	15,019	96,552	278,365	0.01348	3,752	21,581	
39	1,551,000	7,760	9,700	261.9	0.0	221.8	0	166,794	16,500	106,070	289,364	0.01204	3,484	18,674	
TOTAL	41,683,000	215,820	269,780	7,284.1	221.8	221.8	887,200	3,765,493	458,904	2,950,070	8,061,667		702,410	3,632,929	0.19 us$/$m^3$

Table III-44 CONSTRUCTION AND MAINTENANCE COST OF FOREST ROAD FOR P.TAEDA

Year	Cutting volume per year	Cutting plantation area / year	Cutting land areas / year	Construction length of branch road / year	Main road: Const. length / year	Main road: Accumulated length	Construction cost of main road	Maintenance cost of main road	Maintenance cost of branch road: by grader	Maintenance cost of branch road: by manpower	Total	Coefficient of discounted value(12%)	Discounted value of: Amount	Discounted value of: Volume	Remarks
	A	B	C=B/0.8	D=C*0.027	E	F=ΣE	G=E*4000	H=F*752	I=D*63	J=D*405	K=G~J	L	M=K*L	N=A*L	
	m^3	ha	ha	km	km	km	us$	us$	us$	us$	us$		us$	m^3	
X11	1,559,000	9,450	11,813	319.0	35.4	35.4	141,600	26,621	20,097	129,195	317,513	0.2875	91,285	448,213	
12	1,559,000	9,450	11,813	319.0	35.4	70.8	141,600	53,242	20,097	129,195	344,134	0.2567	88,339	400,195	
13	1,559,000	9,450	11,813	319.0	35.4	106.2	141,600	79,862	20,097	129,195	370,754	0.2292	84,977	357,323	
14	1,559,000	9,450	11,813	319.0	35.4	141.6	141,600	106,483	20,097	129,195	397,375	0.2046	81,303	318,971	
15	1,559,000	9,450	11,813	319.0	35.4	177.0	141,600	133,104	20,097	129,195	423,996	0.1827	77,464	284,829	
16	1,559,000	9,450	11,813	319.0	35.4	212.4	141,600	159,725	20,097	129,195	450,617	0.1631	73,496	254,273	
17	1,559,000	9,450	11,813	319.0	35.4	247.8	141,600	186,346	20,097	129,195	477,238	0.1456	69,486	226,990	
18	1,559,000	9,450	11,813	319.0	35.4	283.2	141,600	212,966	20,097	129,195	503,858	0.13	65,502	202,670	
19	1,559,000	9,450	11,813	319.0	35.4	318.6	141,600	239,587	20,097	129,195	530,479	0.1161	61,589	181,000	
20	1,559,000	9,450	11,813	319.0	35.4	354.0	141,600	266,208	20,097	129,195	557,100	0.1037	57,771	161,668	
21	1,559,000	9,450	11,813	319.0	35.4	389.4	141,600	292,829	20,097	129,195	583,721	0.09256	54,029	144,301	
22	1,559,000	9,450	11,813	319.0		389.4	0	292,829	20,097	129,195	442,121	0.08264	36,537	128,836	
23	1,559,000	9,450	11,813	319.0		389.4	0	292,829	20,097	129,195	442,121	0.07379	32,624	115,039	
24	1,559,000	9,450	11,813	319.0		389.4	0	292,829	20,097	129,195	442,121	0.06588	29,127	102,707	
25	1,559,000	9,450	11,813	319.0		389.4	0	292,829	20,097	129,195	442,121	0.05882	26,006	91,700	
26	1,559,000	9,450	11,813	319.0		389.4	0	292,829	20,097	129,195	442,121	0.05252	23,220	81,879	
27	1,559,000	9,450	11,813	319.0		389.4	0	292,829	20,097	129,195	442,121	0.04689	20,731	73,102	
28	1,559,000	9,450	11,813	319.0		389.4	0	292,829	20,097	129,195	442,121	0.04187	18,512	65,275	
29	1,559,000	9,450	11,813	319.0		389.4	0	292,829	20,097	129,195	442,121	0.03738	16,526	58,275	
30	1,559,000	9,450	11,813	319.0		389.4	0	292,829	20,097	129,195	442,121	0.03338	14,758	52,039	
31	1,559,000	9,450	11,813	319.0		389.4	0	292,829	20,097	129,195	442,121	0.0298	13,175	46,458	
32	1,559,000	9,450	11,813	319.0		389.4	0	292,829	20,097	129,195	442,121	0.02661	11,765	41,485	
33	1,559,000	9,450	11,813	319.0		389.4	0	292,829	20,097	129,195	442,121	0.02376	10,505	37,042	
34	1,559,000	9,450	11,813	319.0		389.4	0	292,829	20,097	129,195	442,121	0.02121	9,377	33,066	
35	1,559,000	9,450	11,813	319.0		389.4	0	292,829	20,097	129,195	442,121	0.01894	8,374	29,527	
36	1,559,000	9,450	11,813	319.0		389.4	0	292,829	20,097	129,195	442,121	0.01691	7,476	26,363	
37	1,559,000	9,450	11,813	319.0		389.4	0	292,829	20,097	129,195	442,121	0.0151	6,676	23,541	
38	1,559,000	9,450	11,813	319.0		389.4	0	292,829	20,097	129,195	442,121	0.01348	5,960	21,015	
39	1,559,000	9,450	11,813	319.0		389.4	0	292,829	20,097	129,195	442,121	0.01204	5,323	18,770	
TOTAL	45,211,000	274,050	342,577	9,251	389.4	389.4	1,557,600	7,027,895	582,813	3,746,655	12,914,963		1,101,913	4,026,552	0.27 us$/$m^3$

Table III-45 CONSTRUCTION AND MAINTENANCE COST OF FOREST ROAD FOR P.ELLIOTTII

Year	Cutting volume per year	Cutting plantation area / year	Cutting land areas / year	Construction length of forest road / year	Main forest road: Const. length / year	Main forest road: Accumelated length	Construction cost of main forest road	Maintenance cost of main forest road	Maintenance cost of forest road: by grader	Maintenance cost of forest road: by manpower	Total	Coefficient of discounted volume(12%)	Discounted volume of: Amount	Discounted volume of: Volume	Remarks
	A	B	C=B/0.8	D=C*0.027	E	F=ΣE	G=E*4000	H=F*752	I=D*63	J=D*405	K=G~J	L	M=K*L	N=A*L	
	m^3	ha	ha	km	km	km	us$	us$	us$	us$	us$		us$	m^3	
X11	1,724,000	10,450	13,063	352.7	39.2	39.2	156,800	29,478	22,220	142,844	351,342	0.2875	101,011	495,650	
12	1,724,000	10,450	13,063	352.7	39.2	78.4	156,800	58,957	22,220	142,844	380,821	0.2567	97,757	442,551	
13	1,724,000	10,450	13,063	352.7	39.2	117.6	156,800	88,435	22,220	142,844	410,299	0.2292	94,041	395,141	
14	1,724,000	10,450	13,063	352.7	39.2	156.8	156,800	117,914	22,220	142,844	439,778	0.2046	89,979	352,730	
15	1,724,000	10,450	13,063	352.7	39.2	196.0	156,800	147,392	22,220	142,844	469,256	0.1827	85,733	314,975	
16	1,724,000	10,450	13,063	352.7	39.2	235.2	156,800	176,870	22,220	142,844	498,734	0.1631	81,344	281,184	
17	1,724,000	10,450	13,063	352.7	39.2	274.4	156,800	206,349	22,220	142,844	528,213	0.1456	76,908	251,014	
18	1,724,000	10,450	13,063	352.7	39.2	313.6	156,800	235,827	22,220	142,844	557,691	0.13	72,500	224,120	
19	1,724,000	10,450	13,063	352.7	39.2	352.8	156,800	265,306	22,220	142,844	587,170	0.1161	68,170	200,156	
20	1,724,000	10,450	13,063	352.7	39.2	392.0	156,800	294,784	22,220	142,844	616,648	0.1037	63,946	178,779	
21	1,724,000	10,450	13,063	352.7	39.2	431.2	156,800	324,262	22,220	142,844	646,126	0.09256	59,805	159,573	
22	1,724,000	10,450	13,063	352.7		431.2	0	324,262	22,220	142,844	489,326	0.08264	40,438	142,471	
23	1,724,000	10,450	13,063	352.7		431.2	0	324,262	22,220	142,844	489,326	0.07379	36,107	127,214	
24	1,724,000	10,450	13,063	352.7		431.2	0	324,262	22,220	142,844	489,326	0.06588	32,237	113,577	
25	1,724,000	10,450	13,063	352.7		431.2	0	324,262	22,220	142,844	489,326	0.05882	28,782	101,406	
26	1,724,000	10,450	13,063	352.7		431.2	0	324,262	22,220	142,844	489,326	0.05252	25,699	90,544	
27	1,724,000	10,450	13,063	352.7		431.2	0	324,262	22,220	142,844	489,326	0.04689	22,944	80,838	
28	1,724,000	10,450	13,063	352.7		431.2	0	324,262	22,220	142,844	489,326	0.04187	20,488	72,184	
29	1,724,000	10,450	13,063	352.7		431.2	0	324,262	22,220	142,844	489,326	0.03738	18,291	64,443	
30	1,724,000	10,450	13,063	352.7		431.2	0	324,262	22,220	142,844	489,326	0.03338	16,334	57,547	
31	1,724,000	10,450	13,063	352.7		431.2	0	324,262	22,220	142,844	489,326	0.0298	14,582	51,375	
32	1,724,000	10,450	13,063	352.7		431.2	0	324,262	22,220	142,844	489,326	0.02661	13,021	45,876	
33	1,724,000	10,450	13,063	352.7		431.2	0	324,262	22,220	142,844	489,326	0.02376	11,626	40,962	
34	1,724,000	10,450	13,063	352.7		431.2	0	324,262	22,220	142,844	489,326	0.02121	10,379	36,566	
35	1,724,000	10,450	13,063	352.7		431.2	0	324,262	22,220	142,844	489,326	0.01894	9,268	32,653	
36	1,724,000	10,450	13,063	352.7		431.2	0	324,262	22,220	142,844	489,326	0.01691	8,275	29,153	
37	1,724,000	10,450	13,063	352.7		431.2	0	324,262	22,220	142,844	489,326	0.0151	7,389	26,032	
38	1,724,000	10,450	13,063	352.7		431.2	0	324,262	22,220	142,844	489,326	0.01348	6,596	23,240	
39	1,724,000	10,450	13,063	352.7		431.2	0	324,262	22,220	142,844	489,326	0.01204	5,891	20,757	
TOTAL	49,996,000	303,050	378,827	10,228.3	431.2	431.2	1,724,800	7,782,290	644,380	4,142,476	14,293,946		1,219,541	4,452,711	0.27 us$/$m^3$

Table III-46 TABLE OF THE PULP TEST

		EXAMPLE									
		Pinus taeda	Pinus elliottii	Eucalyptus saidenii	Eucalyptus globulus	Eucalyptus grandis	Poples	Japenesse beech	New Zealand beach	North American duglus fir	Australia Eucalyptus
Basic density (BDt/m³)		0.375	0.355	0.567	0.555	0.410	0.361	0.62	0.498	0.412	0.66
Cooking condition temp. (°C)		173	173	166	166	165	166	166	166	173	165
heating time(min)		70	70	60	60	60	60	70	70	60	70
holding time(min)		60	60	60	60	60	60	60	60	60	60
Active alkali(as Na_2O)(%)		18	18	16	16	15	16	16	15	20	16
Unbleached pulp yield											
fine (%)		43.66	41.98	49.94	50.56	51.86	50.80	47.14	43.85	42.02	44.3
knott (%)		0.30	0.21	0.12	0.16	0.02	0.05	0.41	0.74	1.03	0.9
total (%)		43.96	42.19	50.06	50.72	51.88	50.85	47.59	44.59	43.05	45.2
K value		18.2	20.4	11.3	11.3	12.0	12.0	12.2	12.7	18.5	17.3
Kappa No.		29	36	17	17	18	18	21	23	30	27
Waste liquor pH		12.9	12.9	12.6	12.4	12.2	12.4	12.51	12.21	11.2	
solid (%)		23.14	23.43	23.08	22.60	22.36	23.14	21.4	21.7		21.6
Bleaching condition											
	Cl_2 NaOH Hypo ClO_2										
pulp consistency	3 10 10 10 (Cl_2 2.5 % on W pulp)										
temp.(°C)	40 60 43 70										
time (min)	40 60 90 150										
Brightness by Hunter		84.7	84.6	85.8	85.7	84.6	83.9	86.9	84.3	84.0	74.6
Viscosity unbleached		7.9	5.8	7.2	10.5	9.1	10.4	9.8	12.4	7.0	9.6
bleached		4.2	4.3	4.4	5.8	4.9	5.5		5.5	4.1	5.2
Fiber length max.(mm)		5.7	5.1	1.3	1.3	1.3	1.5				
min.(mm)		0.7	0.7	0.3	0.3	0.3	0.3				
ave.(mm)		2.774	2.486	0.726	0.713	0.820	0.849	0.99	0.87		1.06
number of vessels/1000 fibers		0	0	16	13	12	70	43	312	0	11
Beating test											
PFI mill number of rotation											
0		757	750	640	649	655	670	718	710	760	750
5000		515	520	504	481	460	420	(10000) 468	(10000) 418	(5000) 560	(10000) 402
10000		290	349	415	405	370	319	(20000) 331	(20000) 285	(10000) 315	(20000) 212
Resistance for beating											
number of PFI mill rotation											
until CF 400 cc.		7500	8200	10900	10900	7500	5500	13900	10900		10000
reduce CF 100 cc.		2130	2490	4440	4100	3510	2850	4370	3520	2220	2860
Material test on hand made sheet											
Basic weight (g/m^2)		64.2	64.5	60.1	59.3	64.0	64.4	63.2	64.5	67.5	64.4
Thickness (mm)		0.081	0.072	0.086	0.079	0.078	0.076	0.0881	0.0867	0.089	0.1284
Specific volume		1.26	1.15	1.43	1.33	1.22	1.18	1.39	1.34	1.32	1.99
Breaking length(Km)		8.91	7.30	6.90	7.81	8.60	8.57	5.73	5.60	8.12	4.57
Tensile stretch(%)		2.6	3.3	3.4	4.0	3.8	3.9	4.44	4.00	4.5	3.1
Burst factor		7.37	5.39	5.04	5.65	7.17	5.93	5.8	4.6	6.51	2.62
Tear factor		91.4	91.8	95.6	86.3	93.3	87.1	84.8	73.3	117	99.4
Folding (times)		3500	3600	410	430	2100	1100	146	103	2171	13
Air permeability											
sec./100cc.air		110	180	13	15	55	170	23.5	51.6	78	3.3
Surface strength (wax No.)		11	14	9	9	9	9	11	9	10	7
CF cc. on this test sheet		380	391	415	405	411	420	402	398	360	402
Other economical index											
obtained this cooking test											
1) Cost unit of logs(m^3/ADt)	6.11	6.76	3.55	3.56	4.73	5.48	3.42	4.62	5.82	3.45	
2) Black liquor solid(t/ADt)	2.17	2.30	1.58	1.52	1.47	1.50	1.6			1.6	

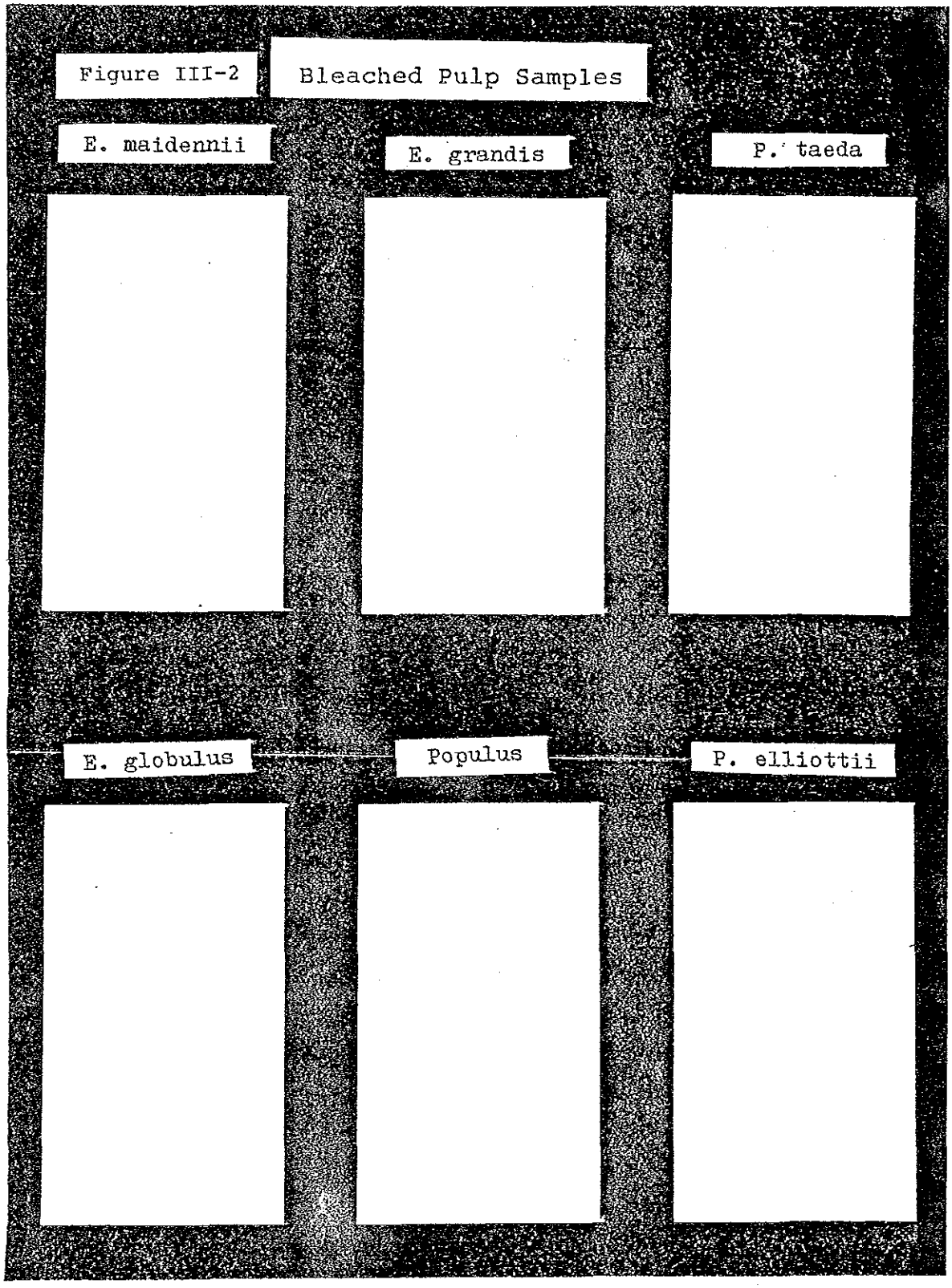


Figure III-2
Bleached Pulp Samples
E. maidennii
E. grandis
P. taeda
E. globulus
Populus
P. elliottii

PART IV

BASIC SCHEME OF THE PAPER PULP MILL PROJECT

Part IV BASIC SCHEME OF THE PAPER PULP MILL PROJECT

Chapter 1 Basic Consideration

1-1 Wood Species and Production Rate

1-1-1 Wood Species

The selection of wood species for pulp production is very important because it directly relates the quality, marketability of product pulp and also afforestation plan. In this study 50% of hard wood bleached pulp (HwBKP or L-BKP) and 50% of soft wood bleached pulp (SwBKP or N-BKP) are set to be produced using two species of soft wood and four species of hard wood as shown in Table IV-1.

Essential factors for BKP production are (i) basic density derived from wood density, (ii) pulping yield which is caused from the quality of product pulp, and (iii) wood's own characteristics. These figures are based on the pulping test of which samples were collected in the Uruguay country.

(1) Wood species and basic density

Basic density of wood has usually a certain range and fractuates even taking same species and same log. However, pulp factory possibly knows average and representative basic density of woods species according to their operational experience. Table IV-1 shows woods species to be used in this study and their basic density.

(2) Feature of log

Logs for chips are delivered into the planned factory with bark. This bark will be burned as bark boiler fuel.

Log feature is as follows:

Length : 2.2m $\pm$ 0.2m

Diameter : Less than 40cm and more than 7cm

1-1-2 Production Rate

The nominal production capacity of the planned paper pulp mill is bleached kraft pulp (BKP) 750 ADt/D which is considered to be the standard size of production and competitive among the export-oriented pulp mills.

In this project it is planned to produce softwood bleached kraft pulp (N-BKP) and hardwood bleached kraft pulp (L-BKP) by 50% and 50% respectively. Therefore, annual production rates for N-BKP and L-BKP are the same amount of 127,500 ADt/y.

As shown in Table IV-2, daily production rates and period of N-BKP and L-BKP are 705 ADt/D for 181 operation days and 805 ADt/D for 159 operation days respectively.

Since N-operation and L-operation require different amount of digesting chemicals and bleaching chemicals, each operation continues for a certain period in order to increase operating efficiency. On a month base, this period is 16 days for N-BKP and 14 days for L-BKP production respectively.

1-2 Quality of Product Pulp

In this study all of product pulp are planned to export to the European market. Therefore export prices and pulp quality are necessarily competitive internationally. Pulp quality of this study is set up as shown in Table IV-3. To prepare this product pulp specification, followings are taken into account:

(1) Pulp import experience by the Hokuetsu Paper Co.

(2) Pulp specification exported from the Japan-Brazil Pulp Co. in Brazil (CENIBRA).

(3) Pulping Test using logs of Uruguay

Among the specification of the Table, brightness is the most important and its specification, 91 $\pm$ 1 (GE) might be enough acceptable internationally.

1-3 Discussion on Pulping Process

As start-up of the planned pulp mill is supposed in the middle of 90's, it is necessary to select modern and efficient processes taking account of the technology trend of the world. In this section, is described the trend of technology and facility on Digesting, Washing and Bleaching.

1-3-1 Cooking Process

Recently newly installed chemical pulp mill is mostly kraft pulp and the reasons are as follows:

(1) Establishment of chemicals recovery and heat recovery techniques.

(2) Application for all of wood, conferous tree (soft wood), deciduous wood (hard wood) and tropical wood, and production of good quality pulp.

(3) Improvement of facility which makes it possible to shorten cooking time, to operate easily and to produce continuously and massively.

(4) Advance bleaching technology for kraft pulp such as multi-stage bleaching and chloric dioxide.

Although the purpose of continuous digester is just same as batch digester, the adoption of continuous type digester increases year by year by following reasons:

(1) Facilities become compact.

(2) As the work for chip loading and blow is deleted and facilities is controlled providing to be equipped with full automation and instrumentation, the requirement of operator becomes small.

(3) Easier operational control and uniform quality of pulp product provided with automation and instrumentation.

(4) Reduction of digesting steam.

These are three types of continuous digester in the world as follows:

(1) Kamyr's continuous digester which was firstly commercially developed in the world.

(2) Esco's continuous digester.

(3) C-E Bauer's M&D continuous digester.

1-3-2 Washing Process

The main purpose of washing process is to remove hemicellulose, lignin, resin, organic acid and remained digesting chemicals which are resolved in cooking process. There is two types of washing facility, (a) drum washer type and (b) Kamyr's diffusion washer type. Recently the latter type is remarked by following reasons:

(1) Possible long washing time compared with drum washer.

(2) Possible reduction of pulp degradation and bad odor as pulp does not contact with air directly.

(3) Less soda loss, consequently reduction of BOD load in the waste water treatment.

1-3-3 Bleaching Process

The main purposes of bleaching are to remove or to decolorize colored materials, and produce suitable pulp for its application provided with the chemical and physical characteristics.

There are two types of bleaching processes, (a) conventional bleaching and (b) displacement bleaching. Conventional bleaching is composed of bleaching tower, vacuum filter etc. Recently the latter process, the displacement bleaching process has been developed and commercially used. This special feature is to shorten bleaching time compared with the conventional process though its operation is likely a little bit difficult. Other remarkable points are as follows:

(1) Less space because this process is usually composed of only one displacement bleaching tower.

(2) Less waste water, consequently smaller load of waste water treatment.

(3) Less building as the facility is installed outdoor.

(4) Less utility as pump is less installed.

1-4 Selection Criteria for BKP Plant Site

The plant site selection is essential to produce internationally competitive pulp which should be basically high quality and low cost.

As this projected pulp mill is export-oriented and raw woods for pulp production is procured in the country, the criteria stated-below are set up.

1-4-1 General Criteria for Plant Site

The plant site conditions for pulp mill should be as follows:

(1) In case of export-oriented pulp mill, it is necessary to locate at the proximity to a river taking into consideration of transportation of chemicals, consumable materials and, of course, product pulp.

(2) Availability of factory yard and future expansion area.

(3) Better nature of terrain and higher soil bearing capacity, consequently lower civil work cost.

(4) No natural calamity such as flooding.

(5) Good quality and cheap labor source.

(6) Easy expropriation of land.

(7) No need of big investment for infrastructure.

(8) Possible response to environmental control and resident conditions.

(9) To meet with regional development policies and industrial development policies.

1-4-2 Principles for BKP Plant Site

Since the production cost is highly affected by the selection of plant site in an export-oriented BPK mill especially, the site selection is carefully made taking consideration of international competitiveness and cost reduction.

In case of this project, the port condition for pulp export and log transportation from forest area are basically and principally deliberated for plant site selection. Principles for BKP pulp mill site selection are as follows:

(1) Proximity to a River

A pulp mill requires a large quantity of water having good quality for washing, bleaching and sheet formation etc. Subsequently the pulp mill discharges effluent water of similar quantity of water-intaken. Therefore the pulp mill must be located near a big river to dilute waste effluent.

(2) Good port conditions for freighters

The pulp mill must be located near the good port for ocean freighters which can be moored alongside the quay considering the transportation cost for product pulp and consumable materials.

(3) Proximity to the afforestation area

Proximity to the afforestation area within the range of 100 to 150km from the viewpoint of log transportation and stable supply.

(4) Large plant site

The BKP mill is composed of log yard, wood preparation, pulping and pulp machine, and further includes chemical recovery, power plant, water treatment and waste water treatment and so on. Besides the production area, roads, sidetracks and other auxiliary facilities need considerably extensive area of land.

(5) Possible response to environmental problem

It is necessary to take measures easily against environmental problems as the pulp mill has a possibility of pollutants emission such as waste water, stink, dusts, noise, if not equipped with pollution control facilities.

Chapter 2 Basic Design for Pulp Production Process

2-1 Process Selection and Function

This section describes on the outline of process flow and its function for pulp production. Block flow of pulping process is shown on Figure IV-1, and process flow sheets and their description are attached in Annex IV-1.

2-1-1 Log Yard and Wood Preparation

Log having 2.2 m in length are brought to the mill yard by means of trucks. Logs are classified into each wood species and piled at the yard. The logs are debarked by the dry system drum barkers. Debarked logs are chipped by chippers into the size of 25mm x 25mm x 5mm, and screened. Accepted chips are sent to chip silos and stored. Chip dust and slivers are sent to a bark boiler to be fired.

2-1-2 Cooking

Chips discharged from silos are fed to the digester and cooked with white liquor under regulated temperature and pressure after the chip meter. The digester is Kamyr continuous type and is provided with three-hour counter-current washing zone, so-called "hi-heat washing", to make it possible to wash efficiently. Cooking process of softwood and hardwood is operated in block-out mode. The extracted liquor from "hi-heat zone" is sent to the evaporator via the flash tank and black liquor filter.

2-1-3 Washing

The pulp from the digester is directly brought into the diffuser at atmospheric pressure, temperature of approximately 100°C and pulp consistency of approximately 10%.

The pulp is washed by displacement with wash water and fallen straight down into the storage tank. Its consistency is same as diffuser inlet. After washing some knots contained in the washed pulp are screened by the knotter and returned to the digester.

The black liquor in pulp is displaced by wash water and become the diluted black liquor, which is backed into the bottom of the digester as "hi-heat washing".

2-1-4 First Screening

The washed pulp is pumped to the screens and the centrifugal cleaners after diluted to 1.5 - 2.0% pulp consistency with dilution water. The contaminant dusts and particles are rejected from the pulp by the screens and the centrifugal cleaners.

They are set up with several stages in series to minimize fiber loss in the rejects.

2-1-5 Bleaching

The screened pulp is pumped to the displacement bleach tower after concentrated to approximately 10% pulp consistency. The pulp is bleached in turn through five stages C/D, E_1, D_1, E_2, D_2. Wash water is added to the last diffuser washer after the D_2 stage to eliminate residual bleach chemicals.

2-1-6 Second Screening

The bleached pulp is pumped to the screen after diluted to 1.5 - 2.0% pulp consistency. On the other hand, the contaminant dusts are rejected from the pulp by the screen. Then the pulp is pumped to the centrifugal cleaners after diluted under 1.0% pulp consistency.

The fine contaminant particles from the pulp are rejected by the centrifugal cleaners. The cleaners are set up with several stages in series to minimize fiber loss in the rejects.

2-1-7 Pulp Drying Machine

Bleached and cleaned pulp is sent to the pulp machine and dewatered, dried and cut into standard sheet size by the sheet-cutter. Pulp sheets are packed by the automatic baling system to become the final product.

The drying of pulp sheet is carried out by air-borne hot air drying system.

2-1-8 Recovery Process of Cooking Chemicals from Black Liquor

The black liquor of about 18% solids extracted from the hi-heat washing zone of the digester is concentrated to around 70% solids and called concentrated black liquor. Concentrated black liquor is fired in the recovery boiler to generate steam and to regenerate chemicals. The thickening of dilute black liquor is

carried out by the sextuple effect evaporator. Steam generated by the recovery boiler and the bark boiler is led to the steam turbine-generator for power generation then sent to the pulp mill processes. At the bottom of recovery boiler furnace, sodium compounds composed of sodium carbonate, sodium sulphide and a small amount of sodium sulphate are molten and recovered as "smelt".

Smelt from the smelt spou is dissolved in weak liquor to be green liquor. Green liquor is sent to causticizing process and converted to white liquor.

Salt cake obtained as the by-product of chlorine dioxide generation is fed to make up the chemical loss in the preceding process.

2-1-9 Causticizing Process

Sodium carbonate contained in the green liquor is converted to caustic soda in the continuous causticizing system by adding quick lime.

Calcium carbonate generated in causticizing process is separated by settling from white liquor, dewatered by the lime filter and then calcinated in the lime kiln to generate quick lime again.

Make-up lime is about 6,900 tons per year as lime stone. At the discharged end of flue gas of kiln, flash dryer of lime cake is provided to recover waste heat.

2-2 Material Balance for Pulping Process

Basic material balance for pulping process is shown in Figure IV-2. To prepare this material balance, following information are referred:

(1) Kamyr's information

(2) Pulping test results

(3) Technical experience and know-how from Japanese paper compannies.

Table below shows basic material balance for this project.

	N-Operation	L-Operation
- Wood (m^3/D)	4,581	3,341
- Pulp (ADt/D)	705	805
- Cooking Yield (%)	43	51
- Bleaching Loss (%)	7	7

The capacity difference of N-Operation (705 ADt/D) and L-Operation (805 ADt/D) is caused by making uniformity of machines and equipments for the displacement bleaching unit and chemicals recovery unit (causticizing unit, evaporation unit, kiln etc.).

2-3 Bleaching Chemicals Supply System

The brightness of product pulp in this study is 91 $\pm$ 1 GE. The requirement of bleaching chemcials to get the above specification is shown in Table IV-4. The Kamyr's displacement bleaching system is adopted in this study and the bleaching sequence is C/D-E_1-D_1-E_2-D_2. Figure IV-3 shows the supply system for required bleaching chemcials and Table IV-5 shows the required amount of raw materials for bleaching chemical production and supplemental lime stone.

2-4 Utility Supply System

The utility requirements for N-Operation and L-Operation in this plan is shown in Table IV-6 and its supply is shown in Figure IV-4 and IV-5.

2-4-1 Steam Supply

There are two different pressures steam, middle pressure 12 kg/cm^2G, and low pressure 3 kg/cm^2G used for process and heating in BKP plant. These steam are derived from the turbine which generates electricity by 65 kg/cm^2G steam from the bark boiler and recovery boiler. The recovery boiler burns black liquor from the evaporator, and the bark boiler uses bark, knots and supplementary fuel wood as its fuel.

Boiler feed water is fed from the Demineralizer unit and recovered steam condensate.

2-4-2 Electricity Supply

Total electric consumption of this plant is approximately 27,000 kW which includes electricity for the salt electrolysis unit of the bleaching chemical production. In principle all of electrical requirement is self-generated inside this plant. Howerver, in the period of start-up and shut-down, necessary electricity is introduced from UTE.

2-4-3 Water Supply

Water in-taken from the Rio uruguay is treated by the water treatment unit and supplied to units of BKP plant. Especially water is treated by Aluminium Potassium Sulphate (alum.) for the reduction of iron of water in order to prevent the color degradation of bleached pulp.

2-5 Log Treating and Product Pulp Shipping System

2-5-1 Log Treating Yard

(1) Log yard

Logs, raw material of pulp, are carried into the plant by trucks. There are mainly log yard, log treating lines, chip yard, chip silos in the log treating area.

The log yard occupies large area in the plant site, and holds the storage volume (inventory) for almost one month. The logs carried into the plant are occasionally fed to the log treating line directly.

(2) Chipping

There are same two log treating lines (2 trains) which mainly consist of the barker, the chipper, and four chip screens. And there are two kinds sub-lines, (i) carrying bark from the barkers and dust from the screens to bark yard, and (ii) recrashing oversized chip from the chip screens and returning to above the screens. The sub-lines are installed by one for two log treating line.

Normal size chip producted by the log treating lines is sent to the chip yard. The capacity of yard is three days' operation inventory, and the yard absorps the fluctuation of volume supplied by the log treating lines.

(3) Chip silo

Chip sent from the yard is held in the chip silos. It also can be carried directly to the silo from the log treating lines. The lines and the yard are operated for fourteen hours per day, but the silo and its down parts in the process are fully operated in twenty-four hours per day. The silos have usually enough capacity for night's operation as the log treating line stop for night time.

(4) Bark

Bark from the log treating lines are used as fuel of a Bark boiler, but in the case of shortage of bark, it is possible to supply chip to the bark yard.

2-5-2 Product Pulp Shipping System

(1) Pulp bale

The Pulp machine room and the product warehouse are in the same building, and the product is carried from the room to the house directly.

The pulp from the pulp machine has a shape, $600^{W}x800^{L}x750^{H}$ (200kg weight) as a bale. There are two pulp machines (2 trains), and after the machines the pulp is weighed, pressed, and wired a bale by bale by two trains. Furthermore 8 bales are tied up in a bundle and wired again as one unit.

(2) Bale cramp

The unitized pulps are carried to the warehouse by bale cramps (a kind of forklift). The house has enough running space (passage way) for the bale cramps and the storage capacity for product pulp is for one month operation. It is decided by the shipping frequency and this discussion is described later.

(3) Shipping frequency

The product shipment is two or three times a month, loading ten thousand ton (10,000) a time. The depth of the Rio uruguay allows ten thousand ton capacity freighters navigation. It seems that this class of freighters are suitables considering arrangement and sailing on ocean.

(4) Loading

When shipping, mobiles carry the pulp bales from the pulp warehouse to the shipping berth, and cranes equipped on a freighter lift pulp bales onto the ship. Usually a big freighter has some three or four tons capacity cranes. In case of using four cranes on the ship, the shipping completes three or four days a time.

The berth has also three truck cranes for shipment to a small freighter equipped no crane, so that it can be used for public purpose.

(5) Container

Recently containers are sometimes used for pulp transportation. In this case, container's cranes for loading and unloading on the berth and also container freighters are required. However resulting from the investigation on the adoption of container freighters, the planned project adopts the conventional loading method such as wired pulp unit loading. The outline of above discussion is described in Figure IV-6.

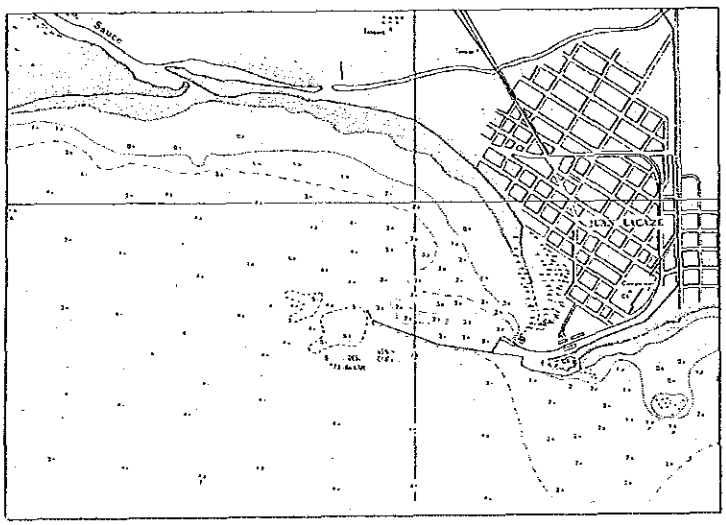
Chapter 3 Site Selection and Infrastructure

3-1 Comparison of Plant Site

The plant sites for paper pulp mill such as Juan Lacaze, Fray Bentos, Casa Blanca (Paysandu) and Nueva Palmira are nominated in the report of Master Plan (Feb. 1981, JICA) and the report of the contact mission (Sept. 1984, JICA).

The result of comparison study based on the site survey (from Nov. 1984 to Dec. 1984) is described in this paragraph.

3-1-1 Outline of Juan Lacaze



Juan Lacaze is located at the coast side of Rio de la Plata and 120km west of Montevideo. In this city the biggest paper & pulp factory, FNP is under operation. The climate condition seems to be moderate and annual average temperature is between 16°C and 17°C.

Juan Lacaze

Annual average rainfall is about 900mm which is less than those in northern part of uruguay and annual average relative humidity is about 75%.

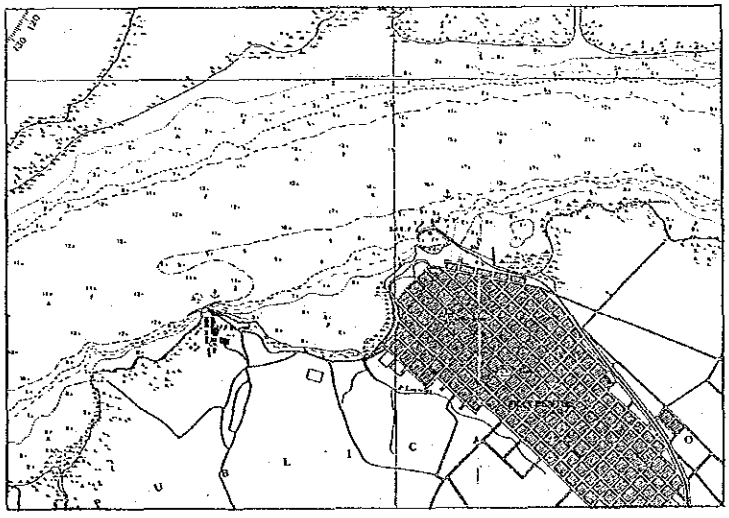
Wind direction is superior to south and south-east and average velocity is about 20 km/hr through the year. The otherside, the river condition around Juan Lacaze is unsuitable for anchoring because the average water depth is too shallow.

There is a wharf in FNP factory, but it is not applied for loading. The water depth at the wharf is approximate 5m, then the cargo vessel more than 3,000

DWT is not available for anchoring.

Industrial area including paper pulp mill is not planned in this area, and it is impossible to provide the site at this area because there are many private houses around FNP. From the viewpoint of collecting raw wood, this area is rather far from the afforestation area.

3-1-2 Outline of Fray Bentos



Fray Bentos is located at 290km north-west of Montevideo, 20km west of Mercedes and faced to the Rio Uruguay. The climate condition seems to be moderate and annual average temperature is between 17°C and 18°C. Annual average rainfall is about 1,000mm, it is average value of north and south part of Uruguay.

Fray Bentos

Annual average relative humidity is about 70% and less than Juan Lacaze the south of Uruguay.

Wind direction is superior to south-east and average velocity is about 15 km/hr through the year. As for river condition, average water flow velocity is around 1 to 2 knot and no influence is estimated for anchoring. The water depth is getting deeper from shore line to center of river.

There are two existing berthes in Fray Bentos, one is the berth for public use such as cereals and livestock. This berth is approx. 125m x 25m and the water depth is 7.5m. Large cargo of 52,000 DWT (named Euthalia, 18,350 ton loaded) have anchored before.

The other berth is for the old meat factory named ANGLO and the water depth is approx. 17m. This meat factory and the berth is not operated at this moment.

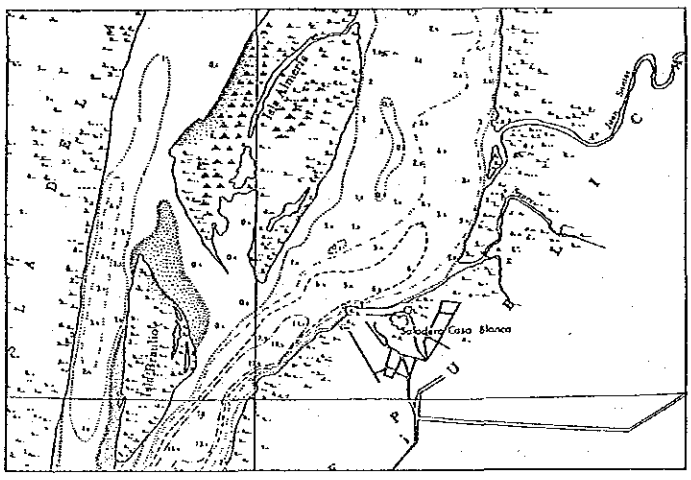
The soil of the river bottom is consisted of sandy soil. No flooding have been reported around this area. Therefore, it seems to have good conditions for anchoring.

The other side, industrial site is planned west of the old meat factory. The site faced to the Rio Uruguay and site elevation is approx. 10m higher than the river water surface. The site is open area and posture land at present. It seems to be terrace and sloped to the river side. No housing is located around the proposed area. This site seems to be suitable for the project.

Industrial complex is planned for 90ha of the meat factory and 140ha of open area. When the proposed project is planned at this area, 140ha open area will be available.

In view of raw wood collection this site is more preferable.

3-1-3 Outline of Casa Blanca

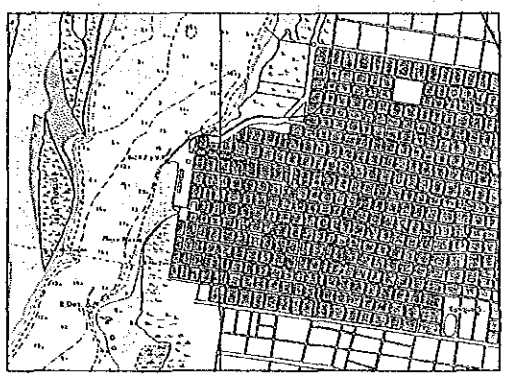


Casa Blanca

Casa Blanca is located 350km north-west of Montevideo, 5km south of Paysandu and faced to the Rio Uruguay. Casa Blance is 70km upstream along the Rio Uruguay from Fray Bentos. Annual average temperature is 18°C and annual average rainfall is 1,100mm.

Annual average relative humidity is 70%, same as Fray Bentos. Wind direction is superior to south-east and average flow velocity is about 10km/hr, through the year.

Average water flow velocity of the river is quite minor but as for flooding it is recorded that there is a high frequency of flooding and had recorded that highest water level is 8m above normal water level. There is a existing timber jetty in FRICASA, which was constructed about 70 years ago.

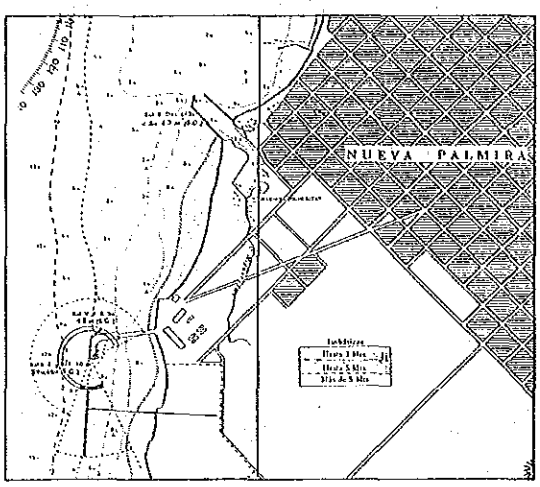


The water depth is approx. 10, however there are small islands and shallows. Therefore it seems difficult to navigate large cargo vessel. The other side, industrial site has been planned with 150ha, 8km from south of Paysandu.

Paysandu

However, the definite site facilities such as road etc., have not been provided yet. Also, this site is not located along the river. There is a existing wharf for public use at Paysandu, handling those wool, foods and cement, etc., the water depth around the berth is 7m to 10m. The anchoring record of large cargo vessel is between 6,000 and 10,000 DWT. In view of raw wood collection, it is the same condition as Fray Bentos.

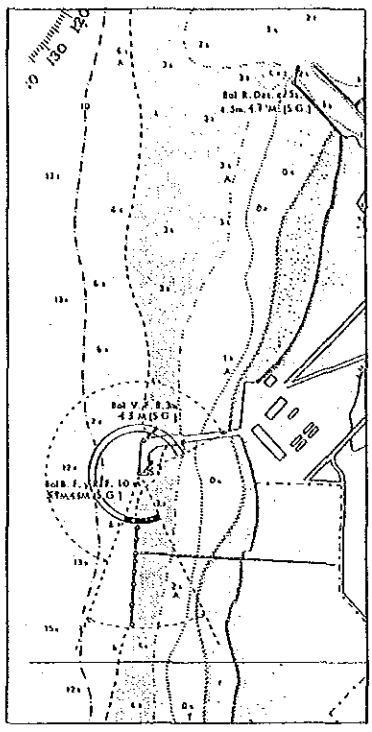
3-1-4 Outline of Nueva Palmira



Nueva Palmira is located 270km west of Montevideo and 80km south of Mercedes. The city is located at the junction of Rio de la Plata and Rio Uruguay. The climate condition of Nueva Palmira is quite same as of Juan Lacaze and Fray Bentos. Annual average temperature and rainfall are 17°C to 18°C and 1,000mm respectively. Annual average relative humidity is between 70% and 75%.

Nueva Palmira

Wind direction is superior to south-east and average flow velocity is about 20 km/hr, through the year.



Port of Nueva Palmira

As for river condition, average water flow velocity at normal condition is quite minor, flooding has not been reported and water depth is between 10m and 15m. There are two existing berthes. One is berth for public use such as cereals and meat. The other berth is used for the grain factory. Large cargo vessel is able to anchor to both berth. There is 100ha free zone area behind the port facility, but it is already occupied by the other parties. No expansion of site is planned. Other than the free zone area, it seems not to be planned for new industrial complex area.

On the way to city from the shore, Volks Wagen's factory of West Germany is in operation. In view of raw wood collection, this site is far from the afforestation area.

During the meeting with SEPLACODI, Uruguay, the site survey for Nueva Palmira was requested additionally. When a new industrial complex is planned along the river in future, it is recommended to conduct site survey in detail.

3-1-5 Comparison Table on Candidate Site

Based on various evaluation herein before, the summary of comparison table is prepared in Table IV-7.

3-2 Infrastructure and Future Plan

3-2-1 General Circumstances

(1) Communication and Transportation

In Uruguay, there are no geological obstructions for the construction of transportation system, because land features of uruguay is generally flat. All the traffic network are radiated from Montevideo.

a) Railway System

Railway network extends fan-shaped from Montevideo to the north part of the country, with a total length is 3,005 km as of 1979. Almost all railway truck is broad gauge. Double truck is provided 11km around Montevideo and single truck operation is conducted in other area. No electrification is provided, and diesel powered operation is conducted. A part of railway is connected to Brazil at the town Artigas and Rivera, and to Argentina at Salto Grande.

The railway operation had been conducted by the British railway company until 1948. After the operation was nationalized, AFE (Administration of State Railway) is managing it as a public enterprise. AFE was founded in 19th September 1952 and organized under MTOP (Ministry of Transport and Public Works) after 1967.

Railway offers its service not only for the transportation of passengers but also of meat and other cargos. The most representative items in the transportation of cargo are limestone, cement, fuel, cereals, drinks, vegetable and fruits.

Major railway network is as follows:

Montevideo - Maldonado - Rocha	214.6km
Montevideo - Minas	125.2km
Montevideo - Nico Pérez - Treintay Tres - Rio Branco	456.5km

Nico Pérez - Melo	190.2km
Montevideo - Florida - Sarandi del Yi - Km 329	329.0km
Florida - Durazno - Chamberlain - Tres Arbeles	333.5km
Chamberlain - Piedra Sola - Tacuarembo - Rivera	563.1km
Tres Arbeles - Algorta - Paysandu - Salto - Baltasar Brum	368.6km
B. Brum - Cuareim	63.8km
B. Brum - Artigas	114.2km
Algorta - Ombucito - Fray Bentos	140.5km
Montevideo - Mal Abrigo - Mercedes - Ombucito	317.8km
Mal Abrigo - Colonia	114.8km

b) Road system

Road system is also expanded radiately from Montevideo to the northern part of Uruguay and its' total extension length is 50,000km. National road is 10,000km and maintained by MTOP and other road is maintained by each prefecture.

The 1st-grade national road is composed of route 1,2,3,5,8,9,10, 11,17,18,21,24,26,3,93 and 99. Total length of these 16 routes is 3,430km. Components of the 1st-grade national road is as follows:

Concrete Pave	120km
Asphalt Concrete Pave	660km
Asphalt Pave	2,350km
Unpaved	300km

Total of 2nd-grade national road is 4,100km and 3rd-grade national road is 2,270km. Components of 2nd and 3rd grade national road is as follows:

Concrete or Asphalt Concrete Pave	50km
Asphalt Pave	1,940km
Unpaved	4,380km

The road transportation shared 88% (approx. 1,300,000,000 ton) among total transportation weight in 1955 and reached to 90% in 1965. (Remains of 10% is transported by railway). In 1974, the ratio increased to 94.3%. According to another measure, figures in terms of transporting distance in ton/km, increased from 76.7% (approx. 153,000 ton/km) in 1955 to 85% in 1974.

Total numbers of truck is approx. 40,000 Nos. in uruguay and approximately, thousand (1,000) trucks among them have loading capacity more than 10 ton. The major road bridges are connected to the 1st-grade national road and three international bridges are connected to Argentina such as San Martín. There are five connection road to Brazil and three of them are connected at Artigas, Rio Branco and Bella Union by bridges. The truck loading capacity is limited less than 37 ton.

c) River and marine transport

Harbors along the Rio Uruguay, like Nueva Palmira, Fray Bentos, Colonia and Paysandú, allow the entry of vessels with a draft up to 6m. These harbors are important in transportation for minerals, cereals and livestocks.

d) Commercial flights

The principal airport of the country is the International Airport of Carrasco in the surroundings of Montevideo, playing the country's center of international air traffic. An alternative airport is located in Durzauno.

There are regular and direct flights to various countries of Europe, United States of America, Paraguay and Chile, and daily flights to Brazil. There are also several daily flights to Argentina. TAMU operates regular flights to the principal towns as domestic flight.

(2) Electric Power

The electric services in uruguay are administered by UTE (Administración Nacional de Usinas y Transmisiones Eléctricas), a public entity that is a monopoly all over the country. Total electric power of hydraulic and thermal system is 1,916 MW in 1984.

Major hydraulic and thermal power plant is as follows:

Dr. Gabriel Terra	(128 MW)	Hydraulic system
Bay goria	(108 MW)	"
Salt Grande	(945 MW)	"
Palmira	(300 MW)	"
Battle plant	(330 MW)	Thermal system

Furthermore, there is one gas turbine generator plant. (31 MW)

(3) Telephone and Telecommunication

Administración Nacional de Telecomunicaciones (ANTEL) is the public entity in charge of the telephone and telecommunication services.

The principal services offered by ANTEL are the following:

a) Telephone services, which include local, long distance, and international calls. The main towns of the interior of the country are connected with an automatic exchange to Montevideo.

b) Telegram services, local and international direct connections with world.

c) Telex service in Montevideo, Punta del Este and Paysandú.

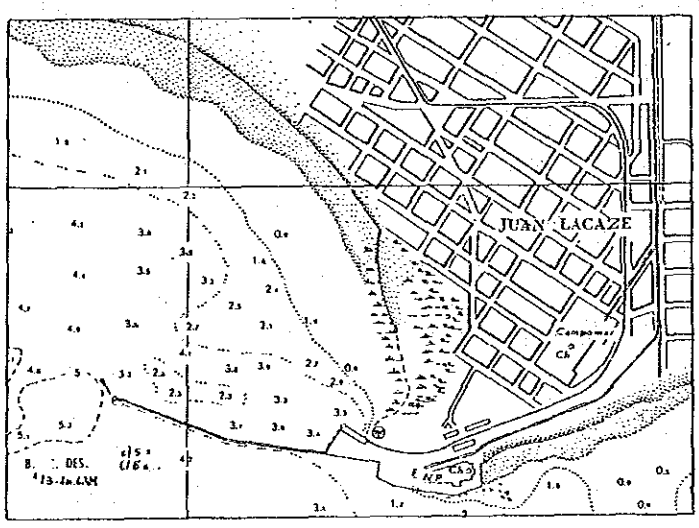
d) Coastal service, that allows the connection of telephones with ships.

(4) Potable Water and Drainage

All important centers in the country have an adequate service of potable water and drainage administrated by Obras Samitarias del Estado (OSE). At present, there is no modernized water treatment system but sanitary water is discharged to the Rio de la Plata and Rio Uruguay with natural permeation system.

3-2-2 Infrastructures of Candidate Site

(1) Juan Lacaze

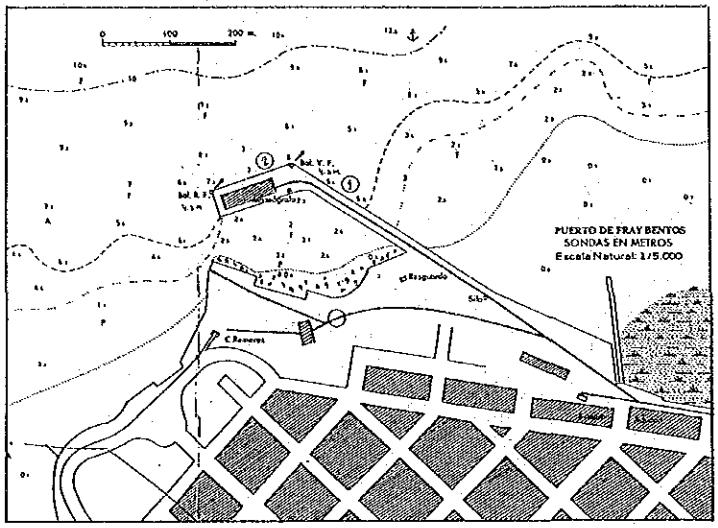


As described in 3-2-1, General, basic infrastructures have been provided in Juan Lacaze, because FNP is now operating. Railway, roads and marine facility, shown in the figure, are provided, but marine facility is not sufficient because of shallower water depth.

Marine facility and railway in Juan Lacaze

The supply of electric power and industrial water is available. The marine facility is one of problem for the decision of the plant site.

(2) Fray Bentos



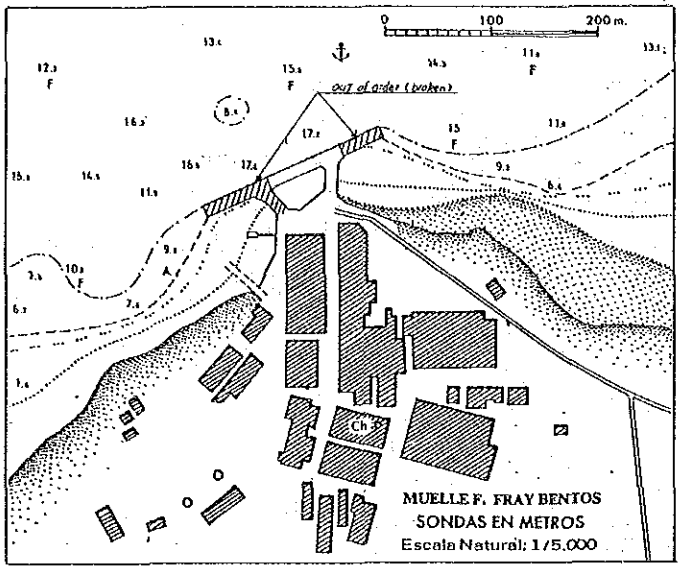
The public berth in Fray Bentos, shown in the figure, consists of Conexion, Cabotaje and Transatlántico divided based on operation.

The scale of Cabotaje (1) is 224m length, 25m width and draft of berth is approx. 4m to 6m.

Public wharf in Fray Bentos

Transatlántico (2) is 125m length, 50m width and draft of berth is approx. 7m to 8m depth. The wharf is built up of reinforced concrete and furnished with a 4,000 ton capacity warehouse, three sets of 3 ton and one set of 5 ton electric cranes. And there are railway branch from the station to the wharf and a 3,000 ton capacity grain silo at the root of the berth.

On the other hand, there is a existing jetty for ANGLO which had been operated as a meat factory.



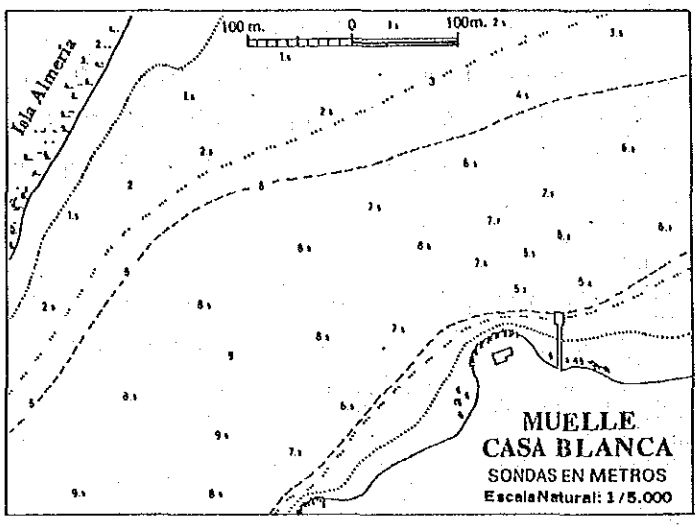
This jetty seems to be used for small oil tanker. (There is a oil storage tank in ANGLO factory.)

The water depth of this berth is approx. 17m, therefore large cargo vessel will be possible to be anchored.

The jetty of ANGLO factory

Railway is provided to Montevideo from Fray Bentos and it takes about 8 hours. But there is no railway branch in ANGLO. Except industrial water supply, this area is well provided for infrastructure such as electricity, potable water, telegraph and telecommunication. Industrial water should be taken from the Rio Uruguay. Road condition is almost furnished and the 1st-grade national road is connected to San Martín Bridge.

(3) Casa Blanca (Paysandu)

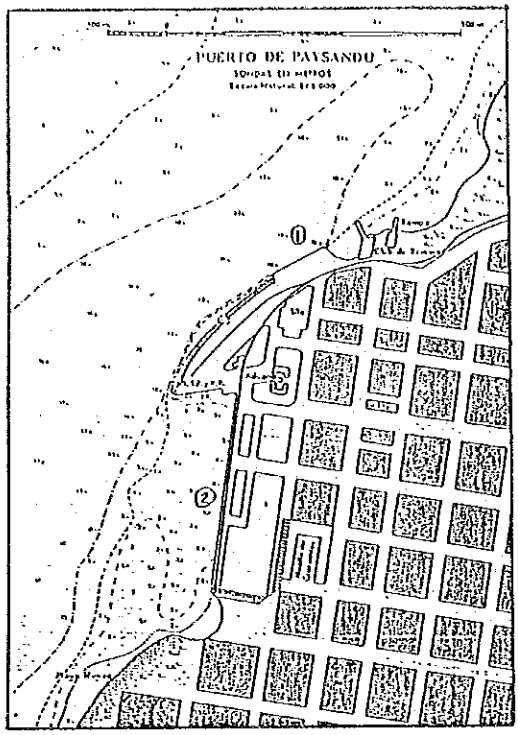


As mentioned in the preceding paragraph, there is an Frisca's existing wooden jetty, which is out of order now.

However, water depth is 5m to 10m this area, it seems to be enough for the access of cargo vessel.

The jetty of Casa Blanca

The meat factory, Fricasa is operating now, then utilities such as electricity and industrial water are available. However, conditions of roadway is not well and no railway is provided to this area.



On the other hand, the port and railway of Paysandu are well provided as shown in the figure. The berth are consisted of Transatlántico ① and Cabotaje ②. Transatlántico berth is 100m length and 10m to 12m water depth. Cabotaje berth is 360m length but the water depth is shallow. (4 to 5m)

This berth is equiped with warehouses, silos and railway are connected to the main line, 3 sets of 5 ton electric crane.

Wharf of Paysandu

The supply of electric power, industrial and potable water would be expected sufficiently from Pay Sandu, the biggest town next to Montevideo. And road network is well arranged and provided.