3. FOREST CHARACTERISTIC SURVEY

3-1 Trend of Land Use and Forest Development

(1) Trend of land use

A considerable decrease of forest is a conspicuous trend in recent years due to uncontrolled cutting and conversion to agricultural or livestock farming land.

(2) Forest trend analysis by Landsat data

To fully understand this situation, change in forest area and composition occured in recent two years has been analyzed by using Landsat data taken in March, 1981 and March, 1983, which are the continuation of the previous studies.

(3) Trend of forest development on the bais of Landsat data

Resultantly, forest has disappeared at annual rate of 2.6% with deterioration of remaining forests due to partial cutting of large diameter trees.

Decrease of forest stock, as a result, is estimated to be as many as 750,000 m^3 per year in terms of usable volume.

3-2 Cutting Volume and Disposition

Cutting volume and disposition were surveyed by means of recording the number of lumber carrying track and species and quantity of carried lumber on main roads. The survey was carried out in 1982 and 1983 to know their change over time. Major findings are as follws:

(1) Cutting species mainly consist of Peroba, which constitutes 88% of total cutting volume. Percentage of Peroba appears to have declined duing the survey period.

Among the rest of species, A + B class constitutes about a half of remaining share, and C class for the rest, which is higher that expected.

(2) Diameter of lumbers became smaller compared to the previous year. This implies the decline of diameter class of trees for cutting. And this trend seems to continue in future.

(3) As a result of estimate of cutting volume in a whole part of the planning area was estimated at 697,000 m^3 in a year, and for Peroba at 523,000 m^3.

(4) As to trend of cutting volume, the increase is observed after 1979.

3-3 Wood Processing and Marketing

Products of Paraguay forestry sector are divided to fuel wood, lumber and processed wood.

Fuel wood is mainly consumed in the country for brick production as main use. A most of log is used for lumber and processed wood. Domestic consumption of lumber is relatively low, with large share of the export to neighboring countries including Brazil and Argentine. However, because of change of economy condition in these countries, the export was repeatedly subject to large flactuation, so that unstable management environment, such as closing of lumber factories and irregular operation, became inevitable.

Among the exported wood products, lumber products, mainly wood board have a relatively large share. Among processed wood products, flooring material and veneer sheet have a large share in terms of both volume and value. Both types are products with low degree of processing.

There is no paper or pulp mill in the country and a few factories to produce regenerated paper from used paper, and thus a most of paper product supply is dependent on import. Import of the paper products has increased 2.5 times in volume between 1978 and 1982, with large floactuation therein. Among imported paper products, newsprint has a largest share of 57% and printing paper a second largest share of 20%; these two items constitute nearly 80%.

Wood marketing system is not well developed. General marketing system for log and lumber is. Woodcutter – Middleman – Sawmill – Distributer – Consumer. Actual marketing practice is often simpler partly because of small scale of operation; direct deal without middleman or distributor is sometimes observed. 60% of log consumed by sawmills is purchased from forest owners, and the rest of the supply is estimated as 30% from sawmill owned forests and 10% for job sawing.

Industrial demand for fuel wood comes from brick manufacturers, who make purchase either directly or through middlemen. Firewood for residential use in urban areas has been replaced by gas, whereas use of firewood in rural area is still dominant with most of the supply relying on self labor, though firewood retailers seem to operate in recent years.

Chaccoals are not produced at large scale due to an absense of quantity users such as steelmills, and are mainly consumed by residences and restaurants.

4. QUESTIONNAIRE

4-1 Survey Method

For one of basic information to prepare the guideline for forest development plan, a questionnaire was carried out by means of interview with concerned groups, so as to understand their opinion on forest and forestry as well as their association. The number of surveyed samples for each group is as follows:

Category of surveyed group	Number of surveyed samples
Forest owner	11
Local resident	9
Sawmill operator	25
Key persons in the department, municipalities	3
Total	48

4-2 Survey Result

Opinions of the interviewed groups are summarized as follows:

(1) Future land use

There is few basic or actual plan on future land use prepared by public administrative bodies. Many forest owners (owner of large track of land) are thinking about a conversion of their forest to agricultural or livestock farming land after cutting of useful trees.

(2) Usefulness of forest

① Usefulness of forest for environment conservation is highly valued. Particularly, an effect of forest on prevention of erosion and weather alleviation is highly expected probably because of timing of the questionnaire immediately after disaster by torrential rain in 1983. There are many opinions on need for retention or development of protective forest in slope area and riverside, with some people who has already started such measures.

② There are many opinions on need for national park, although concerns over recreational use of forest and wild animal protection are not urgent.

(3) Forest as economic resource

① Forestry is highly valued as source of income and employment opportunity. But only 30% of forest owners plan to continue forest management after cutting.

② There are many complaints about difficulty to obtain firewoods.

(4) Reforestation

① There are a significant number of persons who feel a need for reforestation and some of them is doing it on experimental basis. There is an agreed opinion on need for strong assistance by the government, in the area of administrative guidance as well as financial and technical assistance, toward those who are seriously implementing such project.

② Financial feasibility of reforestation is recognized as a primary condition.

(5) Situation on progress of forest cutting

① Although many persons recognize a rapid disappearance of forest, a most of them do not consider this as serious matter; even sawmill operators, who are supposedly concerned about reserve of wood resource, appear to be rather optimistic.

② Many sawmill operators are Brazilian, and have an intention to relocate the sawmills when the resource is exhausted.

(6) Labor problem

As unemployment is growing due to chronic depression, opinions are voiced for stable employment opportunity.

(7) Forest law

Many persons do not recognize an existence of Forest Law.

4-3 Summary of Questionnaire Result

As a conclusion of the questionnaire, the followings could be pointed out:

(1) As an absense of recognition on rapid decrease of forest resources and an existence of Forest Law is conspicuous, educational and informational activity on the existing condition is essential.

(2) Strong initiative and assistance by government is required for promotion of reforestation projects.

5. ECONOMIC AND SOCIAL SURVEY

In economy and society of Paraguay, improvement of social organization and development of national economy has been progressed on sound foundation since 1960.

5-1 Population

(1) Paraguay has 3,030,000 population in 1982, with density of 7.4 persons/km^2. In east region where 98% of the total population is concentrated, the population density is 18.6 persons/km^2, which is 60% below world average.
Annual averaeg rate of the population growth between 1972 and 1982 was 2.5%, 1.4 times of world average.
(2) As to the employment for industrial sector, primary sector including agriculture, livestock farming and forestry has a high share of 41.3%, with declining rate of 10% in recent 10 years which was shifted to service sector.
(3) The planning area has estimated population of 100,000 with population density of 6 – 7 persons/km^2. Population growth rate in past ten years is only 0.5%, with concentration in urban areas.

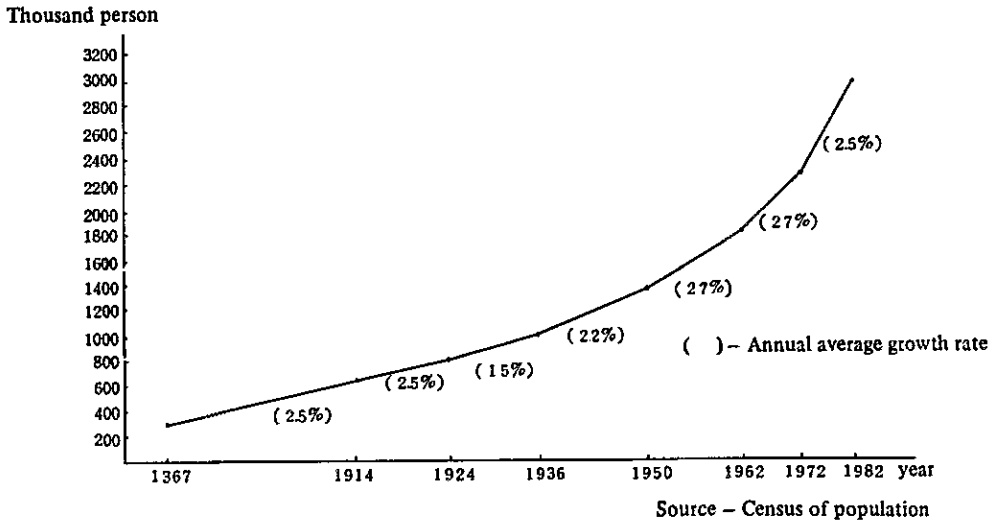


Fig. 0-2-6 Population trend of Paraguay

(4) Total employment in the planning area is estimated at 40,000 – 50,000, and high growth rate of the employment is projected.

5-2 Gross National Product

(1) Gross national product of Paraguay is US$4,110 million in 1980, ranked 9th among 12 countries in South America; 1/60 of Brazil, 1/16 of Argentina and 1/280 of Japan.

(2) The economy has been steadily growing; annual average growth rate of 5.2% was recorded for the period between 1965 and 1975, and the growth rate of more than

10% was achieved for the period between 1977 and 1980 by aid of an increase of overseas demand and large scale project such as Itaipú power plant. And relatively stable economy has been maintained after 1981 when serious depression and inflation were progressed in neighboring countries

(3) Sectoral composition of gross nation product is 54.1% for production sector and 45.9% for service sector Production sector is composed of agricultural sector with share of 20.5%, industrial sector with share of 16.6% and forestry sector with share of 3.2%. Agricultural, livestock farming and forestry sectors have a share of 30.3%, and still maintain a position of major sectors of Paraguay economy, although the share is in declining trend in recent years with development of construction sector.

5-3 External Trade

(1) Having kept balance up until 1977, the balance of trade has turned into deficit thereafter; the deficit in 1981 was amounted to US$2,100 million.

(2) Characteristic of the external trade is a typical structure of primary product export and industrial product import. According to export record in 1981, total export value of US$296 million consists of cotton and textile with share of 43%, grains such as beans with share of 17.8% and wood products with share of 12.5%, along with vegetable oil mainly of oil paulownia with share of 7.6% and Quebracho extract with share of 1.9%, both of which are forest byproducts.

Import items mainly consist of machineries, suels and vehicles. Import value of paper, paper board and wood processed products is approximately US$10 million in 1981, to constitute 1.9% of the total import value

(3) The largest trade partners are countries in LAFTA (Latin American Free Trade Association), particularly Brazil and Argentina .Export value and share by major importing country are US$69 million and 23.2% for Argentina, US$40 million and 13.6% for Brazil. US$33 million and 11.1% for West Germany, US$25 million and 8.4% for Japan, and US$15 million and 5.2% for U. S. A. On the other hand, import value and share by major exporting country are US$131 million and 25.9% for Brazil, US$100 million and 19.8% for Argentina, US$49 million and 9.7% for U. S. A., US$42 million and 8.3% for Japan, and US$41 million and 8 1% for West Germany.

5-4 Forestry Production

(1) Although forestry sector has a small share in Gross Domestic Product, 3.2% in 1981. its share in total export value is 21.4% in 1980 and 12.5% in 1981, to be a major export item.

(2) Logs were exported to foreign countries, particularly Argentina until 1973 when export of crude wood was totally prohibited, and then supplied only to domestic consumption. Thus the export of wood products is limited to processed products at present.

(3) Among domestic consumption, firewoods for domestic use and industrial fuel are most used item, to indicate that they are still important fuel. 2.8 million tons of firewood were produced in 1981, with 30% increase in 1974.

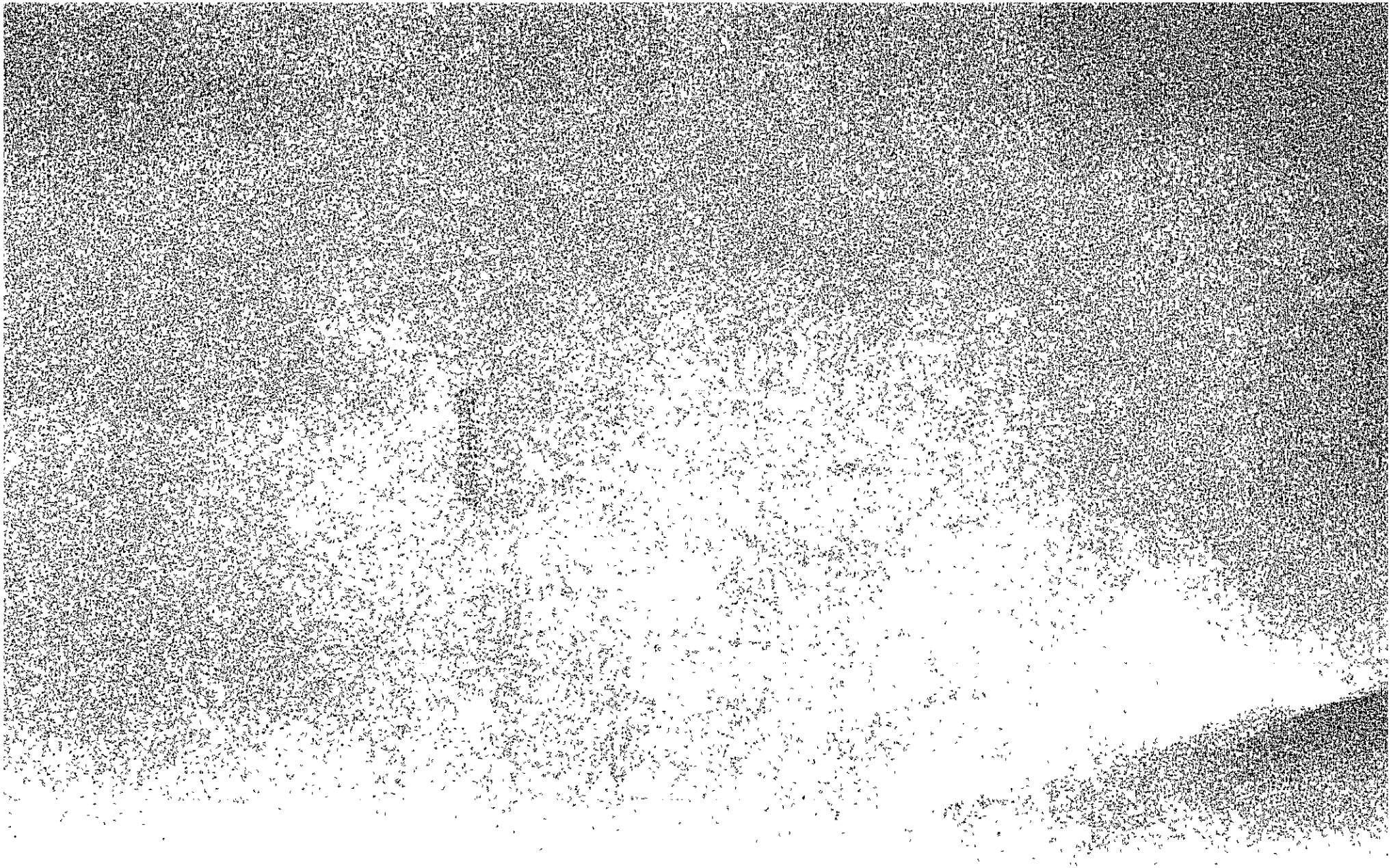
(4) Log production showed twofold increase between 1974 and 1981, particularly one for industrial use was produced at significant amount of 1.5 million tons partly because of large consumption by Itaipu dam construction work. Production of railroad sleepers is very small due to small scale of railroad in the country.

(5) Major export market of the product is traditionally Argentina, and demand from Brazil has decreased in recent years.
Especially, many products from the northeast region under the survey is thought to be exported to Brazil. Also, edible Palmito, or palm cores, is exported to Argentina and Uruguay, although the production has decreased in recent years.
Tannin, which is collected from bark of Quebracho in Chaco area, is exported to U. S. A. and Uruguay.

Table 0-2-8 Proc Table 0-2-8 Production by forestry sector

Item		Production (tons)			Production (1,000Gs 1977 value)		
		1981 year	1977 year	1974 year	1981 year	1977 year	1974 year
Log	Industrial	1,510,765	722,575	650,780	4,834,450	2,312,240	2,082,496
	Agricultural and livestock farming	236,755	164,690	112,640	453,150	315,217	215,593
	Tannin	43,510	43,550	20,800	203,020	203,204	97,053
Pile pillar	Export	78	1,241	1,720	1,180	18,714	25,938
	Agricultural and livestock farming	292,770	253,260	203,630	380,600	329,238	264,719
Railroad sleeper	Export	208	255	2,605	1,540	1,887	19,277
	Domestic consumption	4,761	2,870	5,050	21,000	12,657	22,271
Firewood charcoal	Residential	1,119,534	1,014,814	928,750	551,630	500,034	457,623
	Industrial	1,526,453	1,400,450	1,062,482	4,243,540	3,893,251	2,953,700
	Charcoal	154,063	139,580	127,000	816,530	739,774	673,100
Palm product	Export	—	1,205	970	—	11,640	9,370
	Domestic consumption	11,317	13,815	12,620	31,120	35,739	331,895
	Palmito	880	1,020	2,510	164,820	191,046	470,123
	Others				736,700	25,694	21,969
	Total				12,439,280	8,590,335	7,345,127

ORIGINAL



INTRODUCTON

1. OBJECTIVE AND BACKGROUND OF SURVEY

Paraguay has a land area of 406,752 km^2, and the area for forestry is 150,000 km^2 to constitute around 37% of the total land area, according to land use survey (1979) by FAO. When national park and protective forest are included, the forest area is approxmately 163,000 km^2, to constitute 40% of the total land area. 77% of the forest is located in the west side of Paraguay river and 23% in the east side.

Despite of its small proportion, the forest in the east side area has a composition of large stock in which a most of useful species is concentrated, and, together with its favorable economic/social environment, has been developed in early time.

Among the forest in this area, FAO carried out forest survey between 1967 and 1971 in the southern part which mainly contains the Department of Alto Paraná and the Department of Itapua.

On the other hand, in the northeast part mainly containing the Department of Amambay the condition of forest resources was not studied except for aerial photographing in 1968 (scale: 1/60,000), while uncontrolled development was underway.

Furthermore, the forest development was progressed at acceralated rate in 1970's in response to an increase of demand for wood products in neighboring countries, and it has become apparent that uncontrolled forest cutting and the conversion to agricultural and livestock farming land is prevailing trend in the area. If such uncontrolled development continues without understanding the condition of forest resources securing of forest resources on long term view of national interest will become difficult, and ominous future of the forest is anticipated from the standpoint of soil conservation, water resource development and environment conservation.

To cope with this situation, the surveys such as preparation of aerial photograph map, forest resources survey and soil survey were carried out in past three years, starting from 1980, and from which the condition of the forest resources and the characteristics of the woodland were revealed.

Progress of the surveys is as follows:

July, 1980 – March, 1981

Aerial photographing and preparation of mozaic photo for the northern part of the survey area, preliminary survey on the forest in a part of the area

June, 1981 – March, 1982

Aerial photographing and preparation of mozaic photo for the southern part of the survey area, preliminary forest resources survey of the northern part

June, 1982 – March, 1983

Forest resources survey, soil survey and other surveys for a whole part of survey area

The above survey results, after necessary analysis and study, were compiled to the following reports:

March, 1981	Report on The Landsat Analysis, The Forest Resources Inventory in The North-eastern Region, The Public of Paraguay
March 1982	Report on The Forest Inventory in The Northeastern Region, The Public of Paraguay in 1981
March 1983	Inventarió Forestal Zona Noreste de la Region Oriental Republica del Paraguay

1982 report (March, 1983) is a comprehensive report which compiled the results of forest resources surveys between 1980–1982 in a final form.

As the long period of time is required for the development of forest, an effect of retarded action is gradually accumulated until problems surface, to make difficult appropriate measures to be taken. Henceforth it is necessary to promptly study optimal form of forest and forestry on the basis of long term and overall viewpoint while looking into economy and society of Paraguay toward 21st century, and thereby to clearly identity the direction of forest and forestry management in the country.

Under such understanding and objectives, this study is to prepare the guideline for forest development plan in the northeast region of the country on the basis of results of the surveys between 1980–1982.

2. LIST OF SURVEY TEAM AND PERIOD OF FIELD SURVEY

List of survey team and period of field survey

Classification	Responsibility	Name	Period of field survey
Basic study for forest development plan	Team leader	Yasuo Muramatsu	24/VI/1983~07/VIII/1983
	Economic/Social analysis	Kuniyasu Wakamori	"
	Land plan	Katsutarou Kato	"
	Forest plan	Atsushi Hisamichi	"
Field consultation	Leader Development plan	Yasuo Muramatsu	25/XI/1983~24/XII/1983
	Land use plan	Kuniyasu Wakamori	"
	Forest management plan	Atsushi Hisamichi	"

List of National Forestry Service of Paraguay (SFN) director, deputy director, chief district forest

Title	Name
Eng. Agriculture & Forestry, Director	Pedro. F. Calabrese
Eng. Agriculture & Forestry, Chief Department of National Parks, Forest and Preserves	Hilario Moreno
Eng Agriculture, Chief District Forest, Amambay	Milciades Valdes

List of Counterpart in National Forestry Service of Paraguay (SFN)

Responsibility	Title	Name
Basic study for forest development plan	Eng. Agr.	Luciano Cabral
	Eng. Agr.	Carlos Barboza
	Tech, Ft.	Carmelo Rodriguez B.
	Tech Ft.	Raul Alonso
	Tech. Ft.	Rosalino Vargas
Field consultation	Eng. Agr.	Luciano Cabral
	Eng. Agr.	Milciades Valdes
	Tech. Ft.	Carmelo Rodrigues B.

3. DESCRIPTION OF THE SURVEY AREA

3-1 Geographical Location and Land Area

The survey area is located in northeast part of Paraguay, bounded by 22° and 24° South Latitude, and 55°30' and 56°30' West Longitude, extending on east side of national road route 3 to an international border with Brazil. (Fig. 0-3-1). The area contains the Department of Amambay and a part of three ajacent departments, Concepción, San Pedro and Canendiyu, covering approximately 15,000 km^2.

The land area of the states included in the survey is as follows:

Department	Survey area
Amambay	8,736 km^2
Concepción	1,820
San Pedro	3,282
Canendiyu	1,850
Total	15,688

3-2 Topography and Geology

The area is made up of Amambay Mountain Range (Cordillera de Amambay), which runs roughly from north east to south east and has a dividing ridge along an international border with Brazil, and undulating landscape with gentle hills in southwest side continued from the mountain range. The elevation of the area is ranged from 200 m to 600 m. Also, the area is dotted with manadnock (Cerro) made up of basalt and sand stone, standing out at 50–300 m high on the hills.

Watershed of the area belongs to branch system of Paraguay river, on which Apa river, Aquidabán river, Ypané river, Aguaray-Guazú river and Itanará river are running from north to roughly east or southeast direction; the area constitutes the up-stream headwaters of the river system.

Geology of the area consists of debris type consolidated sediment made up of sand stone, mud stone shale and conglomerate which are contained in Paraná basin widely distributed from Brazil to the area. Paraná basin is a large basin made up of marine and land sediments which were formed between the Lower Devon and the Cretaceous, and widely distributed in Brazil. A most of the surface layer in central and southern part is covered by coarse Cera Geral extrusion. The basin along an east boundary is considerably affected by fault.

3-3 Stand Condition

The forest in the area is mainly composed of natural/subtropical broad leaved forest with insignificant extent of planted forest.

Many climbers, roots and ground floor vegetations are growing in the forest, to form a dense forest with a number of species. Symbolic species for forestry in the area is Peroba (Aspidosperma Polyneuron), constituting about 19% of the total stock on average. Other major useful species are Yvyrá pytá, Kupa ý and Kurupay, with mix ratio of approximately 50% in total.

3-4 Climate

According to data recorded for ten year period between 1961 and 1970, P.J. Caballero, a city in the center of the area, recorded annual mean temperature of 21.3°C, with 24.1°C in January as highest and 17.2°C in July as lowest, to show relatively small variation.

Annual rainfall is 1,537 mm, with monthly rainfall of more than 100 mm except for the period between July through September. Rainy season is between October and March, with monthly rainfall of 150–180 mm without extreme fluctuation.

Table 0-3-1 Temperature and rainfall

(1961~1970 Mean: P.J. Caballero)

Temperature \ Month	1	2	3	4	5	6	7	8	9	10	11	12	Mean
Highest mean temperature (°C)	28 6	28 4	27.9	26 3	23 9	22.1	22 5	25.4	26 0	27.2	27.8	28 3	26.2
Lowest mean "	19 7	19 7	18.9	16 8	14.3	12 8	12 0	13 7	15.4	17.0	18 0	19.3	16.5
Mean "	24 1	24 0	23 2	21.4	19 0	17.3	17.2	19.4	20.9	22 3	23.2	23 9	21.3
Absolute highest "	34 0	34.0	33 2	31.5	31.4	29 0	30.0	32.2	34.8	34 8	35.4	34.8	35.4
Absolute lowest "	13.0	14 3	10.0	7.0	1.2	22.3	−1.0	−1.0	3.0	8.0	8 9	11.8	−1.0
Rainfall (mm)	177.1	151 2	163 0	113 6	114.3	108.3	46.4	41.0	96.7	170.9	168.5	185 8	153 7

Meteological statistics 1961 ~ 1970 FAO project 71/520

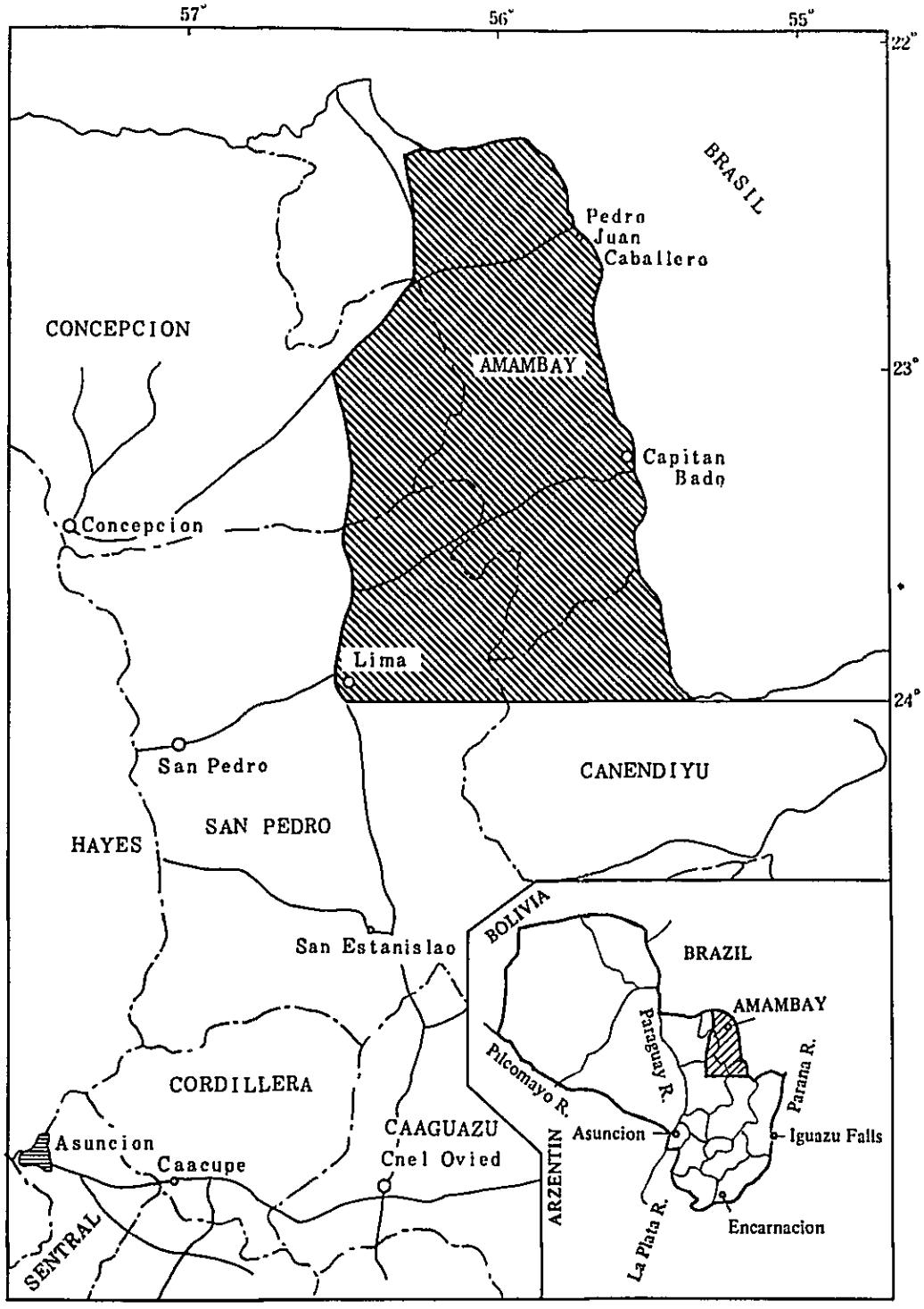


Fig. 0-3-1 Location map of survey area

PART I

GUIDELINE FOR FOREST DEVELOPMENT PLAN

1. BASIC PRINCIPLE

1-1 Characteristics of the Forest

The characteristics of the forest in the area, which is a subject of the present plan, are discussed in detail in the reports on forestry resources survey carried out in past three years since 1980 as well as in this report, "PART 2 BASIC SURVEY". This section is to summarize the characteristics of the forest for elements which are directly related to preparation and implementation of the guideline for the forest development plan in the subject area.

Element	Characteristics
(a) Geographical Location and Land Area	a) The survey area covers the Department of Amambay and a part of adjacent three departments, Concepción, San Pedro and Canendiyu in northeast parts of Paraguay. b) The area has a land area of approximately 15,000 km^2.
(b) Topography, Geology and Climate	a) The area is located in undulating landscape with gentle hills continued from a dividing ridge in northeast along an international border with Brazil. Topography is generally open and level with elevation ranging from 200 m to 600 m; high in the east and low in the west. b) The area belongs to Paraguay river system, to constitute upstream head-waters area for the branch streams. c) The area is made up of consolidated sediment containing sandstone, mud stone, shale and conglomerate as well as basalt extrusion. d) The area has annual mean temperature of 21.3°C and annual rainfall of 1,537 mm with rainy season between October through March.
(c) Stand Condiition and Forest Resources	a) Forest coverage constitutes approximately 60% of the total area, with high forest to cover 35% b) The forest is of natural/subtropical broad leaved type with a great variety of species. Extent of planted forest is minimal. c) Total stock in the area is approximately 28 million m^3, of which class A + B accounts for 54%, or approximately 15 million m^3, and Peroba accounts for 19%, or approximately 5 million m^3.
(d) Increment in Natural Forest	a) Estimated from a survey result of annual rings of trees cut in the area, increment of all species is 2.13 m^3 per ha. b) Increment of class A + B and Peroba is 0.55 m^3 and 0.21 m^3 respectively. c) The rate of the increment for all species is estimated at around 3.3% annually.
(e) Natural Regeneration	a) Determined from a result of a survey on sapling growth in the natural forest, the number of sapling for each forest type is as follows:

Forest type	Tree height 0.3m ~ 1.3m		DBH ~4cm		DBH 5cm ~ 9cm	
	Peroba	A + B	Peroba	A + B	Peroba	A + B
A_1	1,083	750	83	250	0	0
A_2	333	944	111	167	56	0
M	0	200	100	0	0	0
M_2	125	542	125	42	0	0
DA_2	1,556	611	444	167	56	56
DA_3	2,000	375	625	250	250	125

b) From the number of sapling for classified size, 67–92% of Peroba sapling disappears before reaching diameter breast height (DBH) of 4 cm, and over 83% of decrease rate for 5–9 cm class, while 67% and 91% for same classes in A + B class.
This indicates that a majority of saplings produced disappears before reaching diameter breast height of 4 cm.

c) A tendency is observed in the number of saplings to decrease with crown density of upper trees in excess of a certain degree. This seems to be attributable to luminous intensity in the forest to be affected by the crowns.

(f) Soil Condition in the Forest

a) From a result of profile survey, the soil in the forest is classified into sand (Type S), sand/loam (Type S·L), loam (Type L), clay loam (Type CL), clay (Type C) and gley soils (Type C).

b) Type S soil is good for natural regeneration and have potential for reforestation, albeit low productivity. Type S·L, L and CL soil is suitable for reforestation, particularly type L soil has the highest productivity.

c) Type S and S·L soil are highly subject to decreasing fertility and top soil erosion after cutting, to require careful treatment.

(g) Disappearance of the Forest

a) According to a result of Landsat data analysis, the forests have disappeared at annual average rate of around 1.3% in five year period between 1972 and 1977.

b) This tendency is progressing faster recently. The analysis results of the same data in the latest two years from March 1981 to March 1983 indicate that 2.6% of the forest disappear each year, and the contents of remained forests are becoming poorer affected by selection cutting of bulky trees.

1-2 Economic and Social Characteristics of the Area

Economic and social characteristics of the area is discussed in Part 2 of this report 'Basic Study' which has been produced on the basis of a result of basic study for forest development plan carried out in this year. The summary of the basic characteristics is listed as follows:

Item	Major Characteristics
(a) Concern about forest and forestry	a) Level of recognition on rapid decrease of forest resource as well as Forest Act is generally low. b) Strong governmental assistance and guidance are required to promote reforestation project. c) Desperate demand for stable employment opportunity is voiced among residents in the area.
(b) Population	a) The eastern region contains 98% of the total population, with population density of 18.6 persons/km^2. The population growth rate in the region is 2.5% in the recent years, in contrast to the world average of 1.4%. b) The total population in the planning area is approximately 100,000 with the growth rate of 0.5%, along with conspicuous trend of being concentrated into urban areas. c) The total working population in the planning area is estimated 40,000–50,000 with considerable high growth rate to be estimated.
(c) Gross National	a) Gross National Product of the country is amounted to US$ 4,110 million, being ranked 9th in South America. b) The country has shown a steady rate of growth, more than 10% on the annual average between 1977 – 1980 and relatively stable growth after 1981. c) In terms of sectoral composition, agriculture;livestock farming; forestry sector constitutes a share of 30.3%, to be a dominant sector in Paraguay economy; among which forestry section constitute 3.2% of the total GNP.
(d) External Trade	a) Balance of trade recorded a deficit of US$ 2.1 billion in 1981. b) The trade structure is typically of primary product export and industrial product import. According to export record in 1981, wood products constitute 12.5%, and vegetable oil, mainly consisting of oil paulownia, 7.6% and Quebracho extract 1.9%, as forest related products. c) Dominant share of external trade is done within LAFTA (Latin American Free Trade Association), particularly a large share by Brazil and Argentina.
(e) Forestry Production	a) Forestry sector constitutes 21.4% of the total export value in 1980 and 12.5% in 1981, to be a major export item of the country. b) Domestic consumption is largely of firewood for household and industrial fuel, 2.8 million tons produced in 1981.

c) Production of logs has been rapidly growing in recent years, to reach 1.5 million tons for industrial logs.
d) As to overseas market, a large share of export from the north-east region goes to Brazil.

1-3 Objective of Forest Development Planning Guideline

The planning area contains vast forest, 60% of the total area, to form a largest forest zone in the eastern part of Paraguay. Recently cutting and development of the forests in the area is progressed rapidly, and it is urgent matter to formulate forest development plan so as to conserve and nurture the forest resource under orderly development and to aim for intensive land use.

The area is estimated to contain approximately 100,000 population, around 3% of the total population of Paraguay. The population is in process of being concentrated in urban areas, and level of recognition on forest and forestry is still low.

On the other hand, Paraguay economy continues a relatively stable growth among neighboring countries which are subject to inflation, being led by agriculture/livestock farming/forestry sector which constitutes about 30% of Gross National Product.

Forestry sector constitutes over 3% of Gross National Product, but has a share of 22% in 1981 export value, mainly wood products and forestry related products, and coupled with supply of firewood for household and industrial use as well as production of industrial and agriculture/livestock farming logs the sector occupies a very important posittion in the national economy.

Neverthless, a most of export of wood product is done in the form of lumber or sawed timber, with low degree of processing. As it is advantageous for an inland country like Paraguay to maximize the degree of processing so as to export high value added wood products, it is necessary to promote wood consuming industries such as furniture, woodcraft, pulp and paper manufacturing by effectively utilizing abundant forest resource, water resource and electric power in the country.

This forest development planning guideline has been prepared on the basis of peculiar characteristics of the area in terms of economic and social structure and forest resource, as well as the study results to the previous year, to aim for conserving and fostering forest resource with consideration to coordination with total land use planning, to aim for regional development and improvement of local people welfare by means of continuous and stable supply of forest products such as woods and increase of employment opportunity, and to aim for conservation and strengthening of public functions of forest such as soil conservation, fostering of water resource, and conservation and creation of natural environment.

1-4 Basic Principles on Forest Development Planning Guideline

In order to efficiently achieve the above objectives, basic principles on preparing guideline for forest development planning are established as follows;

(1) To clarify define land use classification and to aim for intensive use of land
(2) To clarify define forest management classification and to aim for standardization of forest management
(3) To attempt to estimate and maintain appropriate cutting volume and to aim for conservation and fostering of forest resource

(4) To promote reforestation and thereby to develop forest resource in active manner
(5) To aim for intensive use of forest resource such as use and development of unused materials
(6) To aim for conservation and upgrading of public functions of forest such as soil conservation, fostering of water resource and conservation and creation of natural environment
(7) To aim for coordination with other industries, particularly agriculture and livestock farming

2. LAND USE CLASSIFICATION

2-1 Present Land Use and its Problem

Statistics of land use pattern in Paraguay as of 1979, prepared by Forest Services Ministry of Agriculture and Livestock is presented in Table 1-2-1.

According to this, composition of land used by area is 19% for agriculture, 38% for livestock farming, 37% for forestry, 3% for national park and reserved forest, and 3% for other land uses; total area of forest, including forestry land and national park/reserved forest, constitutes 40% of the total area.

In east region, agricultural land accounts for 5,940,000 ha (37%), livestock farming land 5,660,000 ha (35%) and forest land 3,730,000 ha (23%), to show relatively large share of agricultural land. The forest land of 3,730,000 ha constitutes about 23% of the total forest land.

Composition of land use by potential area is presented in Table 1-2-2. According to this, for a whole part of the east region, which combines southeast part and northeast part, land suitable for agriculture accounts for 5,240,000 ha (33%), land suitable for livestock farming 5,490,000 ha (34%), land suitable for productive forest 4,050,000 ha (25%), land suitable for protective forest 880,000 ha (6%), and land suitable for other uses 320,000 ha (2%) Land suitable for forest, combining productive forest and protective forest, accounts for 4,930,000 ha (31%).

When present land use data and potential area were compared for each land use, in 1979 agricultural and livestock farming land have already exceeded their potential area, while forest land is 1.2 million ha less than its potential area, to indicate that potential forest land has been already developed and used as agricultural and livestock farming land. This means that at present inbalance between land uses is existing as a result of excessive development of potential forest land. Moreover, the inbalance will be increasingly widened due to further development of present forest land when found very suitable for agricultural and livestock farming land, and likelihood of this situation is very high. As such inbalance will have a considerable impact on economy and society in this region, it is considered to be an important subject on economic and social development that rational land use plan will be formulated on the basis of overall and long term viewpoint in the region and will be appropriately implemented.

Table 1-2-1 Present land use pattern

Land use classification	Western part		Eastern part		Country total	
	Area		Area		Area	
	ha	%	ha	%	ha	%
Agriculture	1,719,000	6.96	5,936,000	37.14	7,655,000	18.82
Livestock farming	10,000,000	40.50	5,662,300	35.43	15,662,300	38.51
Forestry	11,290,000	45.72	3,710,000	23.21	15,000,000	36.88
National park · reserved forest	1,283,000	5.20	20,900	0.13	1,303,900	3.20
Other	400,500	1.62	653,500	4.09	1,054,000	2.59
Country total	24,692,500	100.00	15,982,700	100.00	40,675,200	100.00

Source: Project FAO/SFN, PAR/76/005

Table 1-2-2 Estimate of potential area by land use

Land use classification	Southeast (1)		Northeast (2)		West (3)		Country total	
	Area		Area		Area		Area	
	ha	%	ha	%	ha	%	ha	%
Agriculture	2,977,100	43.00	2,264,300	25.00	1,975,600	8.00	7,217,000	17.74
Livestock farming	2,769,400	40.00	2,717,100	30.00	10,124,700	41.00	15,611,200	38.38
Productive forest	969,400	14.00	3,079,400	34.00	9,630,800	39.00	13,679,600	33.62
Protective forest	69,200	1.00	815,100	9.00	2,469,400	10.00	3,358,800	8.26
Other	138,500	2.00	181,200	2.00	494,000	2.00	813,600	2.00
Country total	6,923,600	100.00	9,057,100	100.00	24,694,500	100.00	40,675,200	100.00

(1) Including Dep : Central, Paraguari, Ne embucú, Misiones, Itapua, Caazapá, Cuaira, 25% del sur de Alto Parana y 10% de Caaguazú.

(2) Including Dep : 75% Alto Parana, 90% Caaguazú, San Pedro, Cordillera, Amambay, Concepción y Canendiyu.

Source: project FAO/SFN, PAR/76/005. Working report No. 24.

2-2 Principle and Definition of Land Use Classification

On classifying land uses, and attempt was made to bring about optimum classification based upon trend of land use pattern and natural, economic and social characteristics of the region, while taking into consideration the integration with overall land use plan, trend and function of the forest as watershed conservation, and present land use pattern. Also, the consideration was given to comprehensive land use which should cover agriculture, livestock farming and forestry. Under above principles, a whole part of the area was classified into the following seven zones:

a. Urban zone
b. Agricultural zone
c. Livestock farming zone
d. Forest zone
e. Mixed zone
f. Conservative zone
g. Swamp and others

(1) Urban zone

Urban zone is defined as an area suitable for overall development, improvement and conservation as an integrated urban system.

(2) Agricultural zone

Agricultural zone is defined as an area where potential agricultural land is largely available and which is suitable for overall agricultural development.

(3) Livestock farming zone

Livestock farming zone is defined as a area where potential livestock farming land including pastures is largely available and which is suitable for overall livestock development.

(4) Forest zone

Forest zone is defined as an area where potential forest land is largely available and which is suitable for development of forestry as well as securing and upgrading of the various functions of forest.

(5) Mixed zone

Mixed zone is defined as an area where land for multiple use of agriculture, livestock farming and forest is available and which is suitable for regional development through combined management of agriculture, livestock farming and forest.

(6) Conservative zone

Conservative zone is defined as an area which is designated by law as national park or land required for securing of public purpose such as natural environment conservation, or an area which is suited to be preserved for the purpose of serving special uses.

(7) Swamp and others

This is defined as an area, such as swamps, wasteland, and lakes and marshes, which will be excluded from an object of ordinary land uses.

2-3 Method of Land Use Classification

2-3-1 Unit of Classification

Each division of forest plan map (scale: 1/100,000) was equally divided to 15 sections in both vertical and horizontal direction to construct 225 meshes, and which were used as unit of classification.

Dimension of each mesh is 2 minutes of Longitude by 2 minutes of Latitude, with average area of approximately 1,248 ha. (approximately 3,420 x 3,650 m)

2-3-2 Criteria for classification

To improve the intensity of land use and to achieve an increase of overall productivity of land, optimal land use system should be determined in terms of natural condition, including local climate, topography, geology and soil, and economic/social condition. On classifying the land use in the area, the first step was to prepare combination table of indexed land productivity based on data obtained in soil survey and scaled gradient which serve as index of land conservation such as susceptibility to erosion.

At next step, the combination table was divided into three classes in accordance with local condition, to prepare land condition index table below (Table 1-2-3) which then was used as criteria for classification in terms of natural condition.

Table 1-2-3 Land condition index table

Gradient / Productivity of land	1 ~3°	2 3°~6°	3 6°~9°	4 9°~12°	5 12° ~	Remarks
1 Type L	1	2	3	4	5	Incl. type CL
2 Type S-L	2	3	4	5	6	
3 Type S	3	4	5	6	7	
4 Type others	4	5	6	7	8	Type C,G and Others

2-3-3 Description of land classification

Land in each mesh was classified into the following zones in accordance with the land condition index table, with consideration to present land use pattern and future trend, distance from urban and village settlement, and other economic and social condition.

(1) Urban zone

Urban zone includes an area mainly consisting of urban and other major settlements and their surrounding areas which should be integrated in overall development, improvement and conservation.

(2) Agricultural zone

Agricultural zone

Agricultural zone includes an area having land condition index of 2 or less or agricultural land of more than 50% of the total area.

(3) Livestock farming zone

Livestock farming zone includes an area having land condition index of 3 – 4 or livestock farming land of more than 50% of the total area.

(4) Forest zone

① Forest zone includes an area having land condition index of 5 or more of forest land of more than 50% of the total area.

② Also the zone includes an area which is suitable for forest land in need for securing and upgrading the various functions of forest such as land conservation and water resource development.

(5) Mixed zone

Mixed zone includes an area in mixture of land condition index suitable for agriculture,

livestock farming or forest, or mainly consisting of multiple land use for agriculture, livestock farming and/or forestry.

(6) Conservative zone

Conservative zone includes an area minaly consisting of national park, conservative land for conservation of natural environment or other public use, and reserved land required by laws or for specific use.

(7) Swamp and others

These include an area mainly consisting of swamp, wasteland, lakes and marshes, and other which are not an object of ordinary land use.

2-4 Result of Land Use Classification

In accordance with the above criteria, a whole part of the planning area was classified into the zones, and the result was presented in accompanied Forest Plan Map.

Area for each land classification and geographical distribution of the zones are as presented in Table 1-2-4 and Fig. 1-2-1 respectively.

Table 1-2-4 Area by land use classification and department

Department / Land use classification	AMAMBAY		CONCEPCIÓN		SAN PEDRO		CANENDIYU		Total	
	Area		Area		Area		Area		Area	
	ha	%	ha	%	ha	%	ha	%	ha	%
Urban Zone	8,700	1			3,300	1	3,700	2	15,700	1
Agricultural Zone	26,200	3			6,600	2			32,800	2
Livestock Farming Zone	218,400	25	34,600	19	29,500	9	27,700	15	310,200	20
Forest Zone	436,800	50	111,000	61	242,900	74	148,000	80	938,700	60
Mixed Zone	148,500	17	36,400	20	32,800	10	5,600	3	223,300	14
Conservative Zone	35,000	4							35,000	2
Swamp and Others					13,100	4			13,100	1
Total	873,600	56	182,000	11	328,200	21	185,000	12	1,568,800	100

In addition, comparison was made between area by the above land use classification and by the present land use (see 1982 report), as shown in the table thereafter.

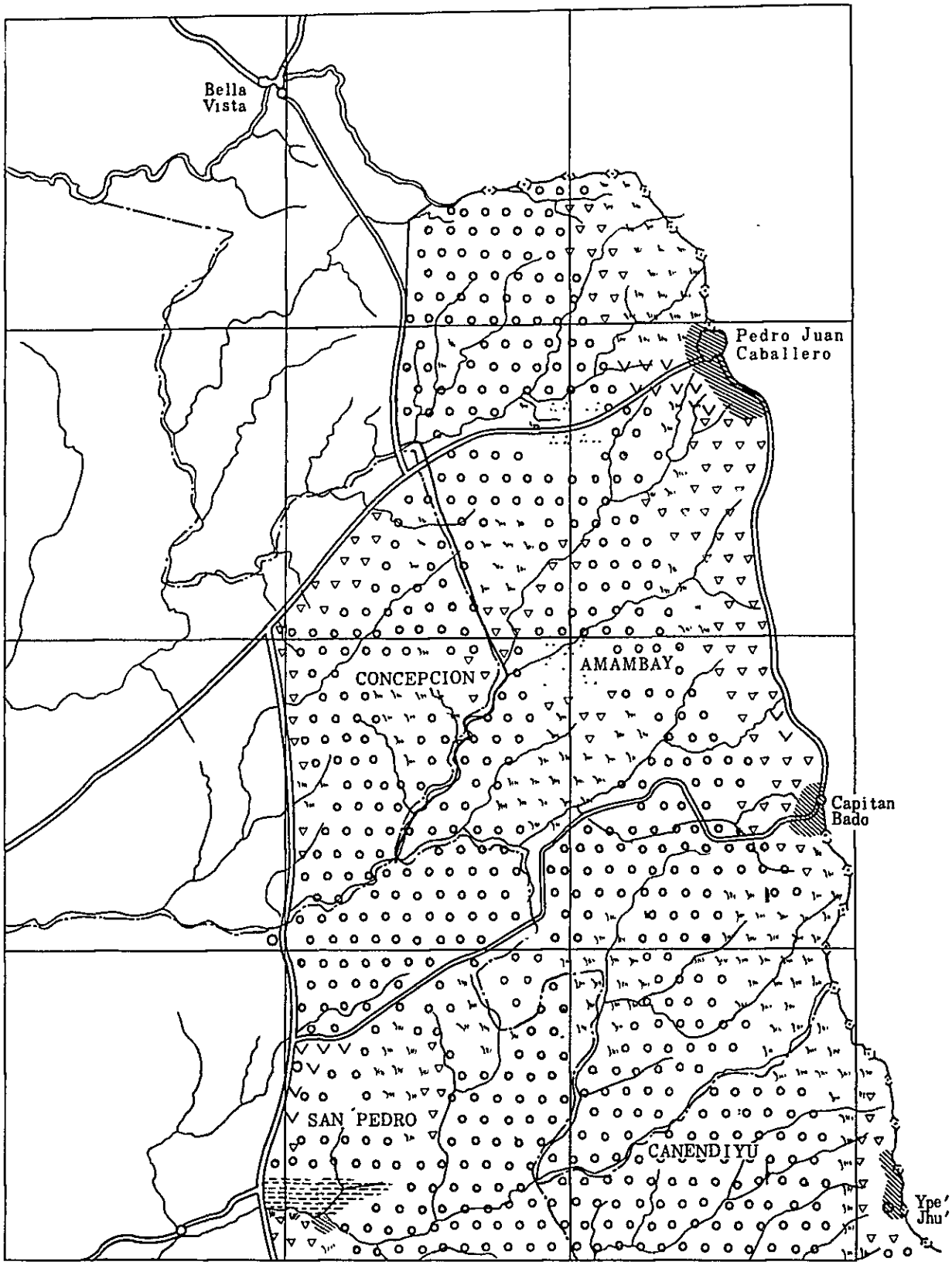
However, it is noted that direct comparison between two figures are not very meaningful, since they are different in purpose of classification as well as definition of land uses and thus are included in the items of each classification in overlapping fashion. For instance, urban zone includes agricultural or forest land which surround the present builtup area and are thought to be suitable for integrated and overall development, improvement and conservation; mixed zone is an area which is intended to use in multiple purpose of agriculture, livestock farming and forestry, and currently contains the three

types of land use in a mixed way; conserved zone is currently forests in large part; existing cut-over area will be included in livestock farming zone and/or forest zone, depending on situation in future.

Thus, instead of direct comparison, when two data are looked at as general trend of land use, this land use classification is thought to be appropriate for the purpose.

Table 1.-2-5 Comparison between land use classification and present land use pattern

Type of data / Land use classification	Land use classification		Present land use pattern		Remarks
	Area		Area		
	ha	%	ha	%	
Urban Zone	15,700	1	2,373	(0.2)	Built-up area
Agricultural Zone	32,800	2	78,928	5	Agricultural land
Livestock Farming Zone	310,200	20	338,167	22	Pasture
Forest Zone	938,700	60	955,404	61	Forest
Mixed Zone	223,300	14	—		
Conservative Zone	35,000	2	—		
Swamp and Others	13,100	1	50,226	3	Swamp
	—		143,705	9	Cut-over area
Total	1,568,800	100	1,568,803	100	



	Urban zone	▽	Mixed zone
V	Agricultural zone	∴	Conservative zone
	Livestock farming zone		Swamp
○	Forest zone		

Fig. 1-2-1 Geographical distribution of land use classification

2-5 Summary of Land Use of Classification

2-5-1 General distribution of zones

(1) Urban zone

The urban zone includes an area containing built-up area of P.J. Caballero and its surrounding settlements which are distributed along an international border with Brazil and national road route 5, built-up area of Capitan Bado and its surrounding area, Lima settlement and its surrounding area, and built-up area of Ypé Jhú and its surrounding area. The urban zone constitutes around 1% of the total area.

(2) Agricultural zone

The agricultural zone is generally located at margin of urban zones as well as areas along main roads, containing small settlements. In the Department of Amambay, the zone is widely distributed around P. J. Caballero, and in hill area of type L soil along national road route 5 which extends from P. J. Caballero to Cerro Cora. In the Department of San Pedro, the zone is located in Colonia Rio Verde.

The zone constitutes around 2% of the total area. Its share in the area is not very high, because significant portion of potential agricultural land is included in mixed zone.

(3) Livestock farming zone

There is no exaggeration that a most of forest land in the planning area after development has been converted into livestock farming land. Thus, the livestock farming zone includes the areas at margin of urban and agricultural zone and along main and branch roads, and which are widely distributed in the area. The zone constitutes around 20% of the total area, and are particularily distributed in the area in ajacent to an international border with Brazil extending from P. J. Caballero to Estrella in the north, the area along the border extending from Capitan Bado to Ypé Jhú, and the area along national road route 3, 5 and 11. These areas have concentration of relatively large scale of pasture, which is generally under extensive use.

(4) Forest zone

The forest zone constitutes around 60% of the total area; when conservative zone is included, the area mainly consisting of forest constitutes around 62%,

However, a part of the zone in vicinity of cities and along roads at accessible location has been rapidly developed in recent years, to be mainly converted into livestock farming land. As fully discussed in later section, this problem is one of main subjects on preparing the guideline.

(5) Mixed zone

The mixed zone is located in the entire eastern part from P. J. Caballero to Capitan Bado, in the areas along national road route 3 and 5, and transitional area between livestock farming zone and forest zone. The zone constitutes around 14% of the total area. Among the observed forms of land use mix, namely agriculture – livestock farming, livestock farming – forest and agriculture – livestock farming – forest, the form of live – stock farming – forest is most common at present.

(6) Conservative zone

The Conservative zone constitutes around 2% of the total area, mainly located in Cerro Cora and Cerro Guazú.

The zone in Cerro Cora includes designated national park area of about 5,500 ha and its future expansion under this plan of about 8,500 ha. The zone is Cerro Guazú is a proposed national park under this plan, covering about 21,000 ha.

(7) Swamp and others

The zone is located in low swamp land around Aguaray – Guazú river extending to the

east of Lima, and covers 13,100 ha to constitute about 1% of the total area.
Although the zone is not likely to be an object of ordinary land use for the time being, it will become important in future by using its peculiar characteristic for the purpose of the recreational use along with the forest zone, and academic research and conservation of natural environment such as protection of wild animal and vegetation.

2-5-2 Problem and future direction of land use

Change in forest area in a whole part of four states directly related to the planning area, including the Department of Amambay, for three year period between 1976 and 1979 was determined on the basis of data prepared by the Forestry Service of the Ministry of Agriculture and Livestock, and presented in Table 1-2-6.
According to this, more than 130,000 ha of the forest have disappeared in this period, to reduce forest ratio by around 2%. This equivalent to annual average rate of disappearance of 2% from the forest area in 1976. As mentioned in Item 1.1 "Characteristics of the Forest", disappearance of the forests has been accelerating in recent years, and this trend has been verified by Landsat data analysis.
If this trend continues in future, in due course not only a shortage of wood for domestic demand, including construction material and firewood, will be created but also serious deterioration of the forest will have an adverse effect on conservation of the land and its natural environment such as flood prevention and soil protection; to be anticipated as serious obstacles to economic and social development of Paraguay.
Henceforth, in the planning area effective programmes should be promoted for maintaining and securing of the forest under comprehensive land use plan.

Table 1-2-6 Area of forest in east region

Department	Total land area (ha)	Area of forest 1976 (ha)	Forest ratio (%)	Area of forest 1979 (ha)	Area of forest (%)
AMAMBAY	1,293,300	422500	3267	400,000	30.93
CONCEPCIÓN	1,805,100	244,400	13.54	220,000	12.19
SAN PEDRO	2,000,200	540,000	27.00	510,000	25.50
CANENDIYU	1,466,700	1,235,000	8420	1,180,000	80.45
TOTAL	6,565,300	2,441,900	37.19	2,310,000	3518

Source : Area, Annual Statistics of Paraguay 1978, Department of Statistics and Census, Area of forest; Technical information No. 8, Project FAO/SFN, PAR/76/005.

3. FOREST PLAN

3-1 Forest Classification

To clarify the object of forest management and to establish a standard for appropriate and planned treatment of forest, the forest classification was done in accordance with the following forest types:

3-1-1 Classification of forest type

High Forest Type A_1:

The forest is interpreted as upper tree height of more than 15 m and crown density of 20%. There is an evidence of cutting in many places with stumps and logging roads. The forest is densely covered with low trees of 2–3 m high and numbers of climbers and roots, particularly on abandoned service roads.

High Forest Type A_2:

This is a forest with upper tree height of more than 15 m and crown density of 21–49%. Compared to type A_1, stand density of upper trees is high. An evidence of cutting is extensively seen. Dense cover of low trees are found.

This type of forest constitutes around 25% of the total forest area.

High Forest Type A_3:

This is a forest with upper tree height of more than 15 m and crown density of more than 51%. This has a largest stock among other types of forest. And a part of the forest includes virgin forest, a most of which has been cut. The forest with high crown density has a little undergrowth.

This type of stand is frequently dominated by Peroba. The share of this type of forest is relatively small, or 2% of the total forest area.

Mixed Forest Type M:

This is a forest type with upper tree height of more than 15 m and mixed growth of low trees. The part dominated by high trees is similar to type M_2, and the part with a major share of low trees is similar to type B_2.

This type of forest is frequently distributed at the riversides. This type of forest constitutes about 12% of the total forest area.

Medium Forest Type M_2:

Crown size of this forest is relatively small in comparison to type A_2, with high crown density of 21–50%. Considerable growth of low trees, climbers and roots is observed in the forest.

This constitutes about 35% of the total forest area, most widely distributed. An evidence of cutting is throughly observed.

Medium Forest Type M_3:

Crown size of this forest is relatively small compared to type A_3. A number of species with relatively small crown diameter are found.

Growth of low trees is very intensive, and cutting has been done in the part with useful species.

Low Forest Type B_1:

Small crowns in uniform size with upper tree height of less than 15 m are found in this type of forest, with considerable growth of low trees, climbers and roots.

This type of forest is generally distributed on sand type soil under dry condition.

Low Forest Type B_2:

This is low forest with trees higher than type B_1, with uniform crowns of upper trees, and largely distributed in swamps.

A part of this type of forest has become similar to type M_2 as a result of partial cutting of high forest, mainly at the margin of the forest. Area of such forest is relatively small.

Forest Under Cutting Type E:

This is a forest with upper tree height of more than 15 m, and in which liberation cutting is progressed or has been recently done.

This type of forest is thought to be changed to type A_1 in a few years after liberation cutting

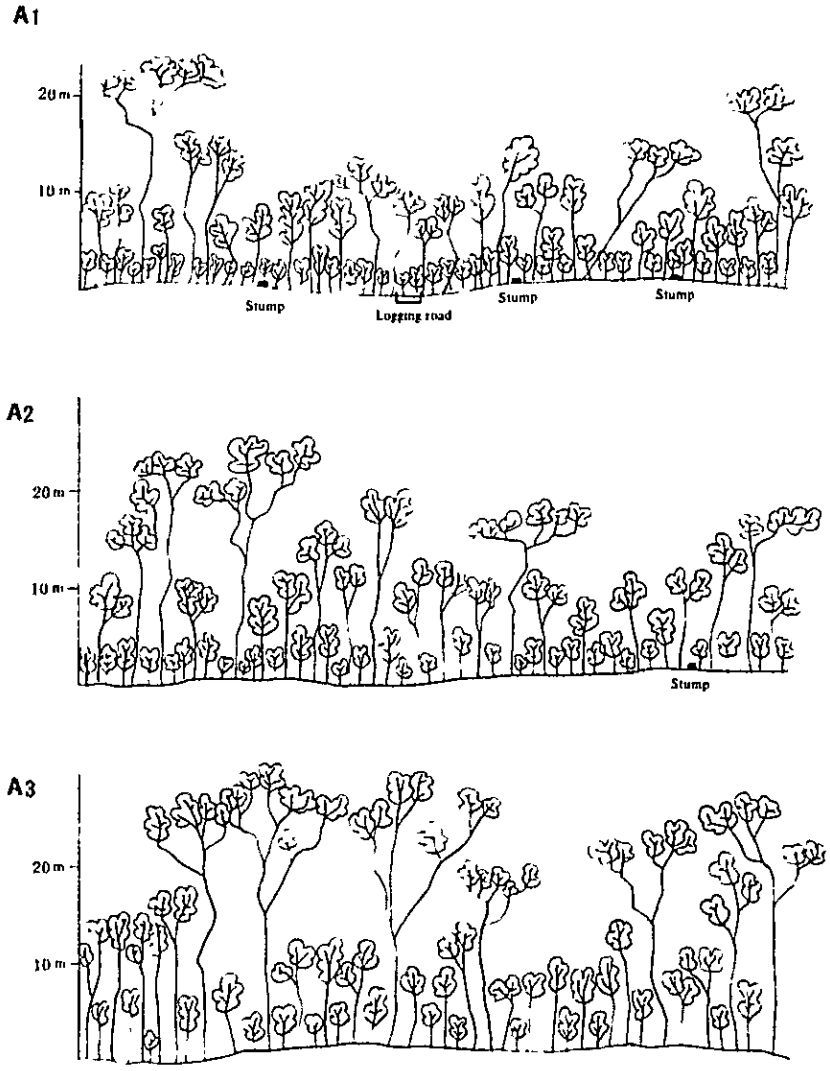


Fig. 1-3-1 Sectional sketch by forest type

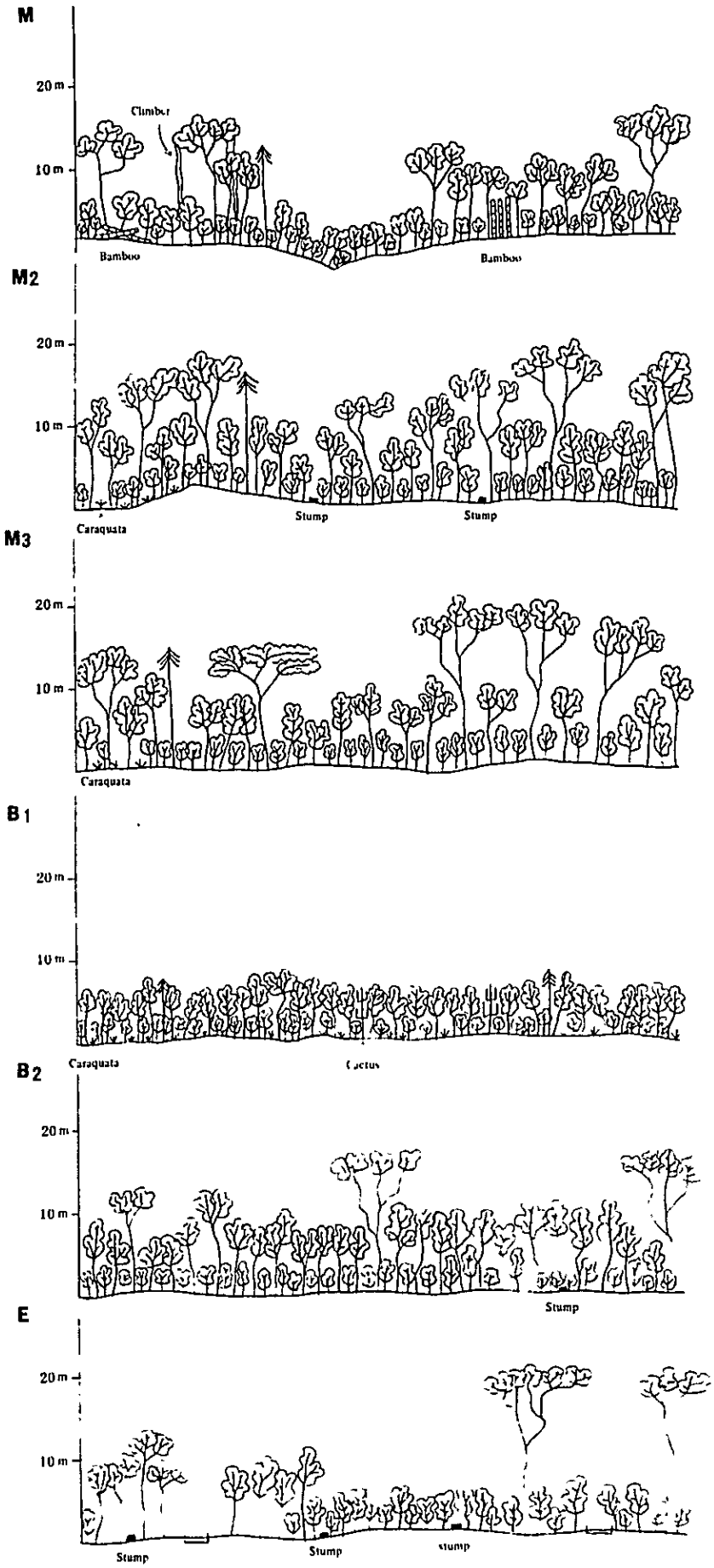


Fig. 1-3-1 Sectional sketch by forest type

3-1-2 Classification and definition of forest

Upon overall examination of present condition of the forest, present situation of forest development and its future trend, it is considered to be most appropriate to do classification of forest and woodland in the area in accordance with Paraguay Forest Law (Law No. 422).

The forest and woodland in the area are classified into the following three classes, as in Article 4 of the Law.

a. Productive forest
b Protective forest
c Special forest

(1) Productive forest

Productive forest is defined as forest and woodland which are expected to generate annual or regular earnings through a certain degree of work. (Article 5 of the Act)

(2) Protective forest

Protective forest is defined as forest and woodland which are established to serve the following purposes (Article 6 of the Law):

a) Control of water resource (water system)
b) Protection of soil, agricultural activity, livestock farming activity, roads, rivers and streams, lakes and marshlands, water channels, and reservoirss.
c) Prevention of soil erosion, flood, wind damage and drought.
d) Protection of wild animal and vegetation
e) Securing of public health
f) Securing of other public purpose

(3) Special forest

Special forest is defined as forest and woodland which are required for protection on account of their high academic, educational, historical, aesthetic, environmental or recreational values. (Article 7 of the Law)

3-1-3 Method of forest classification

Forest classification was made for forest zone, mixed zone, and conservative zone in accordance with the aforementioned land use classification, taking into account integration with present condition and future image of land use in a whole part of the area. Each forest and woodland was classified, on the basis of forest type classification, through analysis of its natural and socio-economic condition in present and future, to be as follows.

(1) Productive forest

① Productive forest is defined as forest and woodland, other than protective forest and special forest, including high forest (forest type A_1, A_2, A_3), medium forest (forest type M_2, M_3), forest under cutting (forest type E), mixed forest (forest type M), and a part of low forest (forest type B_2).

② The forest includes cut-over area and other land which are expected to be an object of forestry management in future.

(2) Protective forest

① Protective forest is defined as forest and woodland which are required for serving the purposes described 3-1-2 (2).

② The forest includes forest and woodland which are expected to serve the same purposes in future.

③ The forest includes forest and woodland which are not appropriate for productive forest due to natural condition. (most of mixed forest type M, low forest type B_1 and B_2)

(3) Special forest

① Special forest is defined as forest and woodland which are required of conservation for the benefit of the effects described in 3-1-2 (3).

② The forest includes forest and woodland which are expected to generate the above effects in future.

③ The forest includes forest and woodland which are required of conservation for special purposes.

(4) Forest type and classification

Management of forest should be established on the basis of natural condition pertaining to each forest, including climate, topography, geology and soil condition, along with overall and long term viewpoint related to economic and social condition (objective) as described in 3-1-1.

On preparing this plan, as discussed to this point, adequate classification was made on the basis of forest type which is mainly representation of the natural condition, by means of analyzing each forest for its natural, economic and social condition in present and future. To establish criteria for forest classification by arranging above interrelations, a general relation between forest types and forest classifications was made into the following table:

Table 1-3-1 Forest type and forest classification

Forest type / Forest classification	High forest	Mixed forest	Medium forest	Low forest	Forest under cutting
	A_1 A_2 A_3	M	M_2 M_3	B_1 B_2	E
Productive forest	———	- - - -	———	- - -	———
Protective forest	- - - - -	———	- - - - -	———	- - - -
Special forest	- - - - -	- - - -	- - - - -	- - - - -	- - - - -

Note: —— mostly associated
- - - Partly or specially associated

3-1-4. Result of forest classification

In accordance with the above principles, forest classification was made for forest zone, mixed zone and conservative zone in land use classification, and forest plan map (accompanied) was prepared.

As a result of the classification, the area of each forest classification is assessed as follows:

Table 1-3-2 Area of forest by classification and department (ha)

Department / Forest classification	AMAMBAY		CONCEPCIÓN		SAN PEDRO		CANENDIYU		TOTAL	
	Area ha	%	Area ha	%	Area ha	%	Area ha	%	Area ha	%
Productive forest	306,800	71	76,600	77	183,200	85	98,200	73	664,800	75
Protective forest	98,900	23	23,200	23	32,800	15	35,900	27	190,800	22
Special forest	24,800	6							24,800	3
Total	430,500	49	99,800	11	216,000	25	134,100	15	880,400	100

In addition, area of forest by forest classification and forest type is shown in the following table:

Table 1-3-3 Area of forest by forest class and forest type

Forest classification / Forest type	Productive forest ha	Protective forest ha	Special forest ha	Total ha	Total %
A_1	63,400	4,500	3,600	71,500	8
A_2	215,300	2,300	5,500	223,100	25
A_3	15,100	800	700	16,600	2
M		84,800	4,000	88,800	10
M_2	294,700	6,800	4,100	305,600	34
M_3	29,800	4,600	1,300	35,700	4
B_1		23,500	300	23,800	3
B_2		63,500	2,700	66,200	8
E	24,300		300	24,600	3
D	22,200		2,300	24,500	3
Total	664,800	190,800	24,800	880,400	
%	75	22	3		100

3-2 Standard of Management Method

3-2-1 Management standard

Forest management in the planning area was studied for each unit of forest on the basis of forest classification and type, and thereby to establish the appropriate standard of management method, as presented in the following table.

Table 1-3-4 Management standard table

Forest classification	Forest type group	Area	Tree species	Cutting system	Regeneration	Final cutting age
Productive Forest	$A_1 \sim A_3$ M_2, M_3	316,000 ha 324,500 (640,500)	Broad leaved tree Parana pine Elliottii pine	Selective cutting Shelter wood cutting Clear cutting	Natural seeding A_1, A_2, M_2 –Supporting work. Clear cutting–Planting	DBH 40 cm ~ (90 years)
	E	'24,300	Parana pine Elliottii pine Eucalyptus Broad leaved tree	Clear cutting	Artificial planting	Pine 20 years Eucalyptus 15 years
Protective Forest	$A_1 \sim A_3$ M_2, M_3	7,600 11,400 (19,000)	Existing species	Light selective cutting	Natural regeneration Supporting work as required	DBH 40 cm ~
	M	84,800	Existing species	Postponent of cutting Light selective cutting for high/mixed forest with consideration to conservation	Natural regeneration	DBH 40 cm ~
	B_1, B_2	87,000	Existing species	Postponent of cutting Light selective cutting or clear cutting for similar to M_2 forest for protection purpose	Natural regeneration Clear cutting–Planting	
Special Forest	All forest type	24,800	Existing species	Prohibition of cutting Scenery improvement cutting	Natural regeneration Scenery improvement cutting	

3-2-2 Productive forest

(A) Forest type $A_1 - A_3, M_2, M_3$ group

(1) Tree species

In principle, natural forest with broad leaved trees will be fostered. The present composition of species has a great variety, including 135 species to be found in the present survey. In future, fostering of useful species should be attempted through such forest management as cutting, regeneration and tending, thereby aiming for gradual conversion to the forest with high mix ratio of useful species and high productivity.

(2) Cutting

Cutting will be done by selective cutting system. Particularly single tree selective cutting system will be principally used, as on-site collection by large type machines will be relatively easy on gentle landscape to be found in most of the planning area. Shelterwood or clear cutting system will be used in the location where succeeding types of broad leaved trees are abundant to promise stable regeneration or reforestation by planting.

(3) Regeneration

Regeneration will be principally done by natural seeding of useful broad leaved trees, except for the forest type A_1, A_2 and M_2 on which compensatory planting will be done as required by growing condition of saplings.

Species and planting method for clear cut-over area or newly reforested area will be in accordance with those of reforestation.

(4) Final cutting age

In principle, final cutting age is determined at an age when the diameter breast height (DBH) reaches 40 cm, taking into consideration the increment process of trees and use value of products. A result of the present survey indicates that the age is generally within the range of 90–100 years. The age is thought to be shortened by 20–30 years if the increment accelerating measures, such as cutting of upper trees and improvement of tending, will have been provided.

(B) Forest type E group

(1) Tree species

For this group, Elliottii pine, Parana pine, Eucalyptus and other broad leaved trees will be fostered.

(2) Cutting

Clear cutting system will be used, with due consideration to effective use of saplings of Peroba and other useful species.

(3) Regeneration

Regeneration will be done by planting of desired species, with maximum retaining and fostering of saplings of useful species, thereby to aim for development of healthy forest.

(4) Final cutting age

With consideration to trend of increment and use value products, final cutting age for Parana pine and Elliottii pine is determined at 20 years, and Eucalyptus at 15 years.

3-2-3 Protective forest

(A) Forest type $A_1 - A_3, M_2, M_3$ group

(1) Tree species

The existing species of the natural forest will be mainly fostered for the time

being. An attempt should be made to gradually improve it to species and forest composition suitable for the purpose of protective forest.

(2) Cutting

The forest is required of fully providing its important functions, namely water resource control, soil conservation, erosion and flood prevention, protection of wild animal and vegetation, and securing of public health. These functions should be maintained and improved by means of management suitable for each purpose. To do this, light selective cutting will be done in need for maintaining healthy forest, along with careful management to aim for conversion to a desired type of forest.

(3) Regeneration will be done by natural regeneration of the existing species, with saplings of useful species through regeneration and tending as well as replanting when required.

(4) Final cutting age

Target diameter for final cutting should be more than 40 cm.

(B) Forest type M group

(1) Tree species

In principle, the existing species of the natural forest will be fostered, with gradual conversion to the composition suitable for the purpose of protective forest.

(2) Cutting

The cutting will be postponed until the composition of the forest will have been improved. Light selective cutting should be permitted where conservation effect will not be obscured by cutting because of mixed growth of upper trees, or regeneration will be required for achieving conservation purpose.

(3) Regeneration

For selective cut area, regeneration will be made by natural regeneration of the desire species, as well as planting of the species suitable for conservation purpose.

(C) Forest type B_1, B_2 group

(1) Tree species

Natural regeneration of the existing species will be done for improvement of the composition of the forest.

(2) Cutting

Cutting will be postponed. Where required, cutting other than for the purpose of caring will be prohibited.

For the forest, which type is B_2 as a result of partial cutting but originally similar to M_2, light selective cutting will be done within the limit to require for regeneration or clear cutting will be done to improve forest type when required for conservation purpose.

(3) Regeneration

Regeneration will be done principally to improve the composition of the forest.

3-2-4 Special forest

(1) Tree species

In principle, the existing species will be fostered. At the same time conversion to the species suitable for conservation purpose should be done.

(2) Cutting

The forest with high academic or historical value will be strictly protected by prohibition of cutting.

Scenic management or scenery improvement cutting will be done in the forest for scenic

purpose or recreational use, taking into account the present condition.

(3) Regeneration

Regeneration will be done by natural reproduction of the existing species, with scenery improvement planting where required.

3-2-5 Standard forest composition by purpose

On establishing the standard of forest management method in the planning area, improvement of the functions of the forest together with coordination among the functions was intended for the purpose of maximizing such functions, irrespective of tangible or intangible, in total and sophisticated manner. At the same time maintenance and development of sound forest resources were intended through implementation of appropriate forest management.

The following are the standards of desired forest composition in need for maximizing the various functions under given condition of the forest within the planning area.

(1) Wood producing function

The forest with large increment, consisting of trees with good shape and quality while maintaining appropriate stand density.

(2) Water-source conservation function

The forest of fast increment, high crown closure rate, and sufficient development of roots, having soil with well developed crumbled structure and abundant macropore.

(3) Soil conserving function

The forest having deeply and widely developed roots, litter layers, and well developed undergrowth aided by appropriate sunlight.

(4) Public health/scenery conserving and recreational function

The forest having high scenic value in combination with lakes, marshlands and valleys, consisting of many species and stand types to have a variety of light and shade as well as color tone, having high environmental value peculiar to the area, and being suitable for recreational activity.

The forest in vicinity of urban areas, having stable stand type with local species as majority, and having high effect on living environment conservation such as weather alleviation and noise absorption.

3-3 Standard Cutting Volume

On the basis of forest stock obtained in resource survey, standard cutting volume was calculated by using a result of increment survey in the natural forest: Ammual standard cutting volume in the planning area was estimated at 924,000 m^3.

The estimation procedure is described hereinafter.

3-3-1 Base stock and increment

(1) Base stock

The stock obtained in the resource survey was used as a base stock for estimation of cutting volume, as presented in the table below:

Species	Stock
Total stock	27,845,025 m^3
A + B	14,963,651
Peroba	5,236,869

(2) Increment

The increment was calculated by multiplying the above stock by the increment rate of all species obtaned by increment survey in the natural forest.

It is noted that increment rate of A + B group and Peroba in the aforementioned increment survey is considerably low compared to that of all species, because a number of these species, in order of A + B group and Peroba, are of high age grade with large diameter. When an appropriate management will have done through cutting and regeneration, diameter class makeup in forest composition will be normalized, to increase their increment rate accordingly.

Thus, it is considered to be appropriated to use the increment rate of all the species as an estimate base of the allowable cutting volume for this plan. Under this concept, the increment was estimated as follows:

Tree species	Base stock	Increment rate	Increment
Total increment	27,845,025 m³	3.3 %	918,886 m³
A + B	14,963,651		493,800
Peroba	5,236,869		172,817

3-3-2 Estimation of standard cutting volume

(1) Formula for estimation of cutting volume

The following formula was used to estimate cutting volume for this plan:

$$Ew = \frac{Vw}{u} + \frac{Zw}{2}$$

Vw . . . . . .Actual volume in total

Zw . . . . . .Average increment in total

u . . . . . .Rotation

The formula is used as an estimation method established in an Imperial Forest Management Regulation of Japan (1910), and could be obtained under the following procedure: When Zw is an increment of an entire forest and Z is an increment on land area subject to cutting in a year, Zw will decrease by Z in each year. Thus, the total increment in a fall season of u the year (just before cutting) is

$$uZw - [0 + Z + 2Z + \ldots\ldots + (u-1)Z]$$

$$= uZw - \frac{n-1}{2} Zw$$

$$= \frac{u}{2} Zw + \frac{Zw}{2} \qquad \text{(whereas, } Zw = u \cdot Z\text{)}$$

By the same token, the increment in the spring season is $\frac{u}{2} Zw - \frac{Zw}{2}$ and in the summer season $\frac{u}{2} Zw$.

As total cutting volume in u years is actual stock (Vw) plus total increment $\frac{u}{2} Zw$ in u years, standard cutting volume (Ew) is calculated as follows:

$$Ew \approx \frac{Vw + \frac{u}{2} Zw}{u} \approx \frac{Vw}{u} + \frac{Zw}{2}$$

This formula suits to be used for improvement of forest type with many aged trees or degraded composition.

(2) Rotation

As indicated in a result of increment survey of the natural forest in the planning area, increment period of 90–100 years is generally required before the major species reach their expected diameter class of 40 cm. Accordingly in this plan the final cutting age of the natural forest was determined at 90 years. However, as most of the forests in the area

is aged, a conscious effort will be required to increase forest production by means of positive improvement of the natural forest along with reforestation to a possible extent. On implementation of such plan, indiscrete implementation will result in damage for deterioration of the forest rather than improvement, thereby to adversely affect securing and development of forest resources in future.

Thus in this plan it is considered to be reasonable to establish an improvement period, equivalent to around two third of the final cutting age, so as to promote improvement and replenishment of forest composition. The improvement period of 60 years was used for rotation (u) in the formula to estimate the standard cutting volume.

(3) Standard cutting volume

Using the above factors, standard cutting volume in this planning area was estimated as follows·

Standard cutting volume	924,000 m^3
Including A + B	496
Peroba	174

Summary of the estimation standard cutting volume is tabulated as follows:

Tree species	Actual stock (Vw)	Increment (Zw)	Improvement period (u)	Standard cutting volume (Ew)
All species	27,845,025m^3	918,886m^3	60 years	923,527m^3
A + B	14,963,651	493,800		496,294
Proba	5,236,869	172,817		173,690

Formula for estimation

$$\text{Ew (All species)} = \frac{Vw}{u} + \frac{Zw}{2} = \frac{27,845,025}{60} + \frac{918,886}{2}$$

$$= 464,084 + 459,443 = 923,527$$

$$\text{Ew (A + B)} = \frac{14,963,651}{60} + \frac{493,800}{2}$$

$$= 249,394 + 246,900 = 496,294$$

$$\text{Ew (Peroba)} = \frac{5,236,869}{60} + \frac{172,817}{2}$$

$$= 87,281 + 86,409 = 173,690$$

As clearly seen in the above table, estimated standard cutting volume mostly agrees with the increment in the area; same result as estimated by increment method. Thus the standard cutting volume is proven to be generally reasonable from testing result by increment method as well.

3-4 Cutting Plan

3-4-1 Cutting budget

On the basis of the standard cutting volume, annual cutting budget in the planning area was determined with overall consideration to actual cutting volume and living environment factors such as population and life style, and presented as follows:

	Lumber	Firewood & charcoal	Total
Cutting budget	800,000 m^3	100,000 m^3	900,000 m^3
(Useful species)	500,000 m^3		500,000 m^3

The above cutting budget will be controlled as of the total volume, and allowable cut of useful species in ( ) is listed for reference only.

The cutting budget for firewood was determined under the assumption that total population in the area is approximately 100,000 (see Part 2, 5-2) and consumption per person is 1 m^3.

This cutting budget includes lumbers, firewoods, self consumed materials in agricultural and livestock farming activity, consumer products, unused materials retained or disposed in the forest, the resource burnt for conversion to other uses, and all other forest resources extracted from a forest.

Allowable cut of useful species, which is equivalent to the standard cutting volume of A + B group, is specifically included in the cutting budget in order to demonstrate that allowable cut of lumbering logs of species and diameter class currently produced is limited to roughly 500,000 m^3, even when an object of cutting will have been expanded from Peroba to all species of A + B group.

In addition, it is particularly important to recognize that allowable cut of Peroba is limited to roughly 170,000 m^3, as mentioned in 'Standard Cutting Volume.'

3-4-2 Cutting method

(A) Selective cutting work

Selective cutting work will be applied to a most of productive forest. An such forest will serve as a base of forest production in the area, appropriate management should be designed for improvement of the forest composition to be converted into highly productive forest.

(1) Cutting method

a. The forest with high tree density

Single tree selective cutting will be done for this type of forest in light of growing condition of sapling in lower story and residial stand crop.

b. Ordinary forest

This is the forest other than one with high tree density and dispersed one. For this type of forest, group selective cutting will be mainly done in the woodland with high production rate and good environmental condition, while taking into account working condition such as shrubbery. On the other hand, light single tree selective cutting less favorable environment for the time being, so as to maintain the existing forest.

c. Dispersed forest

This is the forest with low density of high trees and crown dispersal. For this type of forest, efficient cutting, including surface treatment by large type machines, will be done in the woodland with good environmental condition. Light single tree selective cutting will be done in other woodland as required for fostering a healthy forest.

(2) Criteria for tree selection

Selection of tree for cutting work will be done by totally analyzing the forest composition, such its density, shape and quality of trees, diameter class, and quality of trees, diameter class, and condition of succeeding trees so as to maintain healthy residual stand crop and to increase production in future.

Criteria for tree selection are listed in the following table for reference.

Table 1-3-7 Criteria for the selection on group selective cutting

		Unhealthy tree group			Healthy tree group		
Upper story group / Lower story group		Tree group mainly consisting of decaying ones with little growth which are difficult to care untill the next cutting time.	Tree group mainly consisting of ones of large diameter which have reached the final cutting age and are not expected to further improve the quality.	Tree group mainly consisting of defective ones with inferior quality.	Tree group mainly consisting of numbers of ones with small/medium or medium/large diameter which have relatively inferior quality but are expected to increase the volume of future.	Tree group mainly consisting of numbers of ones with medium diameter which are expected to steadily grow by the next cutting time.	Tree group mainly consisting of numbers of ones with small/medium diameter which are expected to further increment in both quantity and quality.
Succeeding time	Present	X	X	X	△	○	○
	Non	X	△	△	○	○	○

Note 1: Small diameter is diameter breast heigh of less than 20 cm; medium diameter is diameter breast height of 22 ~ 38 cm; large diameter is diameter breast height of more than 40 cm.

Note 2: ○ to be retained; △ to be cut as required; X to be cut.

Table 1-3-8 Criteria for tree selection on single tree selective cutting

Category / Forest category	Unhealthy tree			Healthy tree			
	Damaged tree	Defective tree damaged by insect or fungus	Decaying tree Overmatured tree	*Inferior quality*		Good quality	
				Presence of succeeding tree on lower story	Non	Presence of succeeding tree on lower story	Non
Forest with high stand density	X	X	X	X	△	△	○
Ordinary forest	X	X	X	X	○	△	○
Dispersed forest	X	X	△	X	○	○	○

(3) Cutting rate

Cutting volume in a unit of continuous forest will be limited to 50% of the total volume.

Cutting volume on a unit of selective cutting area was calculated by the following formula:

$$Ew = \frac{2m}{n+1}$$

Whereas, EW. . . .Selective cutting volume

m. . . . .Total volume on a unit of selective cutting area

n . . . . .Multiple of rotation against cutting cycle, or u/l

This calculation method is to obtain normal cutting volume in selective cutting forest, and $\frac{2}{n+1}$ is selective cutting rate.

In this plan, as improvement period (u) = 60 years and cutting cycle (1) = 30 years are employed, $n = u/1 = 60/30 = 2$.

$$\frac{2}{n+1} = \frac{2}{2+1} = 0.667 \text{ then,}$$

Although maximum cutting rate is 66.7%, the selective cutting rate is set within 50% with consideration to forest composition in the planning area at present and treatment of the forest in future.

(B) Light selective cutting work

For forest type $A_1 - A_3$, M_2, M_3 in protective forest and protective tree zone in productive forest, light selective cutting will be done to foster healthy forest, to maintain and improve its protective functions, and to increase total production in the forest by means of producing usable woods at the same time.

Cutting method will be generally based on the following criteria:

(1) Protective forest and protective tree zone

a. To primarily cut damaged trees and large diameter trees highly susceptible to wind broken (overmature tree and decayed tree).

b. To retain trees for main roof materials and trees along rivers to a maximum extent

c. To mainly do single tree selective cutting, and to limit cutting rate to around 30% with variation in accordance with density, diameter and species.

d. To cut protective tree zone, which is mainly used for securing of natural scenery, with due consideration to local condition and purposes.

(2) Steep slope area, wet land, and stone and gravel land

a. To primarily cut damaged trees, overmatured trees, decaying trees, titled trees of large diameter which are likely to induce erosion of woodland.

b. To protect healthy trees of small or medium diameter to a maximum extent.

c. To mainly do single tree selective cutting, and thereby to avoid drastic change in forest composition.

(3) National park and other special forest

a. To do minimum cutting when required for securing and improving the functions of forest to achieve the purpose such as securing of natural scenery.

b. To primarily cut damaged trees, decaying trees and overmatured trees so as to prevent forest deterioration.

c. To mainly do light single tree selective cutting, and thereby to avoid drastic change of forest composition.

(C) Shelterwood cutting work

Shelterwood cutting work will be done for the forest which has high potential in being

developed as productive forest of good growing forest type, has mostly completed regeneration, and contains saplings and small diameter trees of useful species in undergrowth. Upper story group will be cut to stimulate increment of undergrowth group, and thereby to develop the forest with high productivity.

(1) The forest with confined undergrowth

For the forest where normal growth of lower trees is hampered by higher trees of medium or large diameter, two step cutting will be done to avoid drastic change of environment for benefit of protection and fostering of undergrowth group, and to foster healthy succeeding forest type.

The first cutting will be primarily done for damaged trees, diseased trees, and aged trees of large diameter, but healthy middle aged trees to be retained, while tending or growing condition of undergrowth group. Cutting rate will be between 40 – 60%.

The second step cutting will be done 10–20 years after the first cutting with consideration to growing condition of undergrowth group and residual stand crop. The cutting method will be in accordance with that for dispersed forest described in the next section.

(2) Dispersed forest

Most of higher trees will be cut to stimulate the increment of undergrowth group, retaining useful species of medium diameter to a possible extent.

(D) Clear cutting work

Clear cutting will be done for a part of forest type A_1–A_3, M_2, M_3 group of productive forest which are highly feasible in being developed as reforestation by planting, and for forest type E group, and thereby to aim for improving species and stand type

(1) Cutting method

On cutting and transporting of trees, the area where group of sapling of useful species is growing to become matured woodland will be carefully retained to make an effective use of natural ability and to allow the sound growth of new planted forest.

(2) Protective tree zone

Protective tree zone will be established for protection of planted forest, prevention of soil erosion, maintaining of soil fertility, conservation and creation of natural environment, under the following criteria:

a. The zone will be provided along ridges and rivers where required for wind protection, forest fire prevention, prevention of soil erosion and maintaining of soil fertility.

   Also, the zone will be provided in wide slope or flat land where one cutting area is large, at about 1,500–2,000 m interval with consideration to predominant wind direction and surrounding condition.

   Width of protective tree zone will be 100 m for each side of a ridge and river, or 200 m in total, and 200 m for flat land, with variation in accordance with local condition.

b. The zone will be provided for the recreational area along roads or an area along roads with heavy traffic, to be mainly required for conservation of natural environment. This width will be more than 100 m on each side, with variation in accordance with location condition to reflect surrounding landscape, scenery and intensity of land use.

c. Management of protective tree zone will be in accordance with that of protec-

tive forest and other applicable.

3-5 Regeneration and Seed/Seedling Plan

3-5-1 Natural regeneration

For a part of natural forest which received selective or shelterwood cutting, regeneration by natural seedings from upper story trees will be done.

At the same time, natural regeneration supporting works will be done, to a possible extent, for forest type with low tree density in productive forest (type A_1, A_2 and M_2.).

(1) Required number of saplings for regeneration

Dense crown forests (14 plots) of the forest resource survey were arranged in the order of the number of saplings for three species groups, all species, useful species (A + B) and Peroba, to pick out upper 2/3 of plots (9 plots), and which were divided by the number of plots to calculate average number of trees for each species group, as presented in the table below.

Table 1-3-9 Average number of saplings in dense crown forests by species group (average on upper 2/3)

Species group	Number of plots	Total number of sapling	Average number of sapling per ha
All species	9	2,951	328
Useful species	9	785	87
Peroba	9	586	65

Since this number of trees can be interpreted as the number of trees applicable to the cutting season, we determined to estimate a number of about three times as much as that as the number of trees available at the time of completing the regeneration. Therfore, the target number of trees at the time of regeneration completion is set to 1,000 covering all tree species, 300 for useful trees and 200 for Peroba.

On the other hand, a result of natural regeneration survey (Part 2, 2-2) reveals that generated natural saplings show high rate of decrease before growing to matured trees. However, this decrease rate is a result of leaving the forests in natural condition, and significant reduction of the decrease rate (increment rate) could be expected when planned management, such as an improvement of luminous intensity in the forest by cutting upper story trees, is carried out.

Therefore, the following formula was tentatively established, albeit rough approximation, to use as a base for calculating required number of saplings for regeneration in the forest management for the time being.

It is noted that this formula is a tentative solution on preparing the present plan, and it is hoped that the formula will be revised to suit the actual condition by continuing positive studies in the future.

whereas,

n_1 . . .The number of saplings with tree height of 0.3 – 1.3 m

n_2 . . .The number of saplings with tree height of more than 1.3 m and diameter breast height of less than 4 cm.

n_3 . . .The number of saplings with diameter breast height of 5 cm– 9 cm

k_1 . . .Decrease rate of saplings for 0.67

k_2 . . . for 0.30

k_3 . . . for 0.10

N . . . .The number of saplings required to complete regeneration

From this formula, the number of useful species required for natural regeneration was calculated for each size class, as presented in the table below; the number of useful saplings at a regeneration point could be calculated by summing up the number of useful species which correspond to observed number of saplings for each size class.

Table 1-3-10 Number of useful species for natural regeneration (per ha)

Observed No. of sapling	n_1 (1 - k_1)	n_2 (1 - k_2)	n_3 (1 - k_3)	
100	33	70	90	Saplings which grow within spacing of less than 2m should be counted as one sapling.
250	82	175	225	
500	165	350	450	
750	247	525	675	
1,000	330	700	900	
1,250	412	875	1,125	
1,500	495	1,050	1,350	
1,750	577	1,225	1,575	
2,000	600	1,400	1,800	
2,500	825	1,750	2,250	

(2) Natural regeneration supporting work

On implementing natural regeneration, when the number of generated saplings does not reach one required for completion of regeneration, natural regeneration supporting work will be proceeded as follows:

a. Planting

Planting will be done at points where a shortage of succeeding useful species or a lack of uniformity is observed.

1) Species

Parana pine, Elliottii pine, Eucalyptus, Paraiso and other naturally growing useful species

2) Number of plantings

The number of plantings will be as twice as required for completion of regeneration with consideration to the number of cucceeding saplings, their distribution and sizes.

3) Method of planting

Large saplings should be used on planting to a maximum extent, in row or group as required by condition of planting areas.

Also, efficient planting works should be proceeded by planting around stumps, etc.

b. Cutting

Ground floor plants will be weeded at points where growth of succeeding saplings generated in good condition is hampered by such ground floor plants, to stimulate the growth.

3-5-2 Reforestation

Reforestation will be actively promoted in the area where new forest could be developed, e.g., cut-over area of natural forest and the areas developed as protective tree zone, so as to aim at an improvement of forest resources and to serve the purpose of prevention of soil erosion and other environmental conservation as well as development of regional economy.

(A) Species for reforestation

With reference to cases of Brazil and Argentina which have abundant experiences in reforestation and similar natural condition, the following species are selected with due consideration, the following species are selected with due consideration to the criteria

(1) suitability to natural condition,
(2) fast increment rate and healthy condition, and
(3) high use value when produced;

1) Area mainly for wood production;
protective forest and a part of special forest

a. Coniferous trees
Parana pine
Elliottii pine
Caribbean pine, etc.

b. Broadleaved trees
Eucalyptus
Paraiso, etc.

c. Naturally growing species

On reforestation of useful trees that grow naturally like Peroba, we determined to run experimental reforestation for the time being, while concurrently and actively promoting the research and development of reforestation techniques, such as, abundancy of seeds, storage, nursery practice, reforestation, and tending or protection, in order to assure steady supply for the future.

(2) Area mainly for conservation function; protective forest where natural growing species are particularly suitable for the purpose, and a most of special forest

Yvyrá pytá
Trebol
Lapacho
Cedro
Peroba
Yvyrá ró
Other useful species

(B) Method of reforestation

(1) Planting (sowing) time

Planting on forests will be done in winter season between May–August. Generally, adequate planting time is said to be in the season when ground temperature is higher than air temperature, particularly between July–August as optimal time.

On the other hand, direct sowing of Parana pine on forest is done between April – May.

(2) Number of plantings

In general, the number of planting is determined in accordance with the following standard, with decrease/increase as required by local condition and purpose of reforestation.

Standard number of plantings (per ha)

Species	Number of plantings	Planting space
Parana pine	seedlings	
Elliotti pine	1,600 ~ 2,000	2m x 3m ~ 2.5m
Other pines		
Eucalyptus	2,000 ~ 2,500	2m x 2.5m ~ 2.0m
Paraiso		

(3) Tending

After planting, tending such as weeding, pruning and thinning will be done. Tending time and frequency will be principally based on the following silvicultural system, with adjustment as required by local condition such as growing condition.

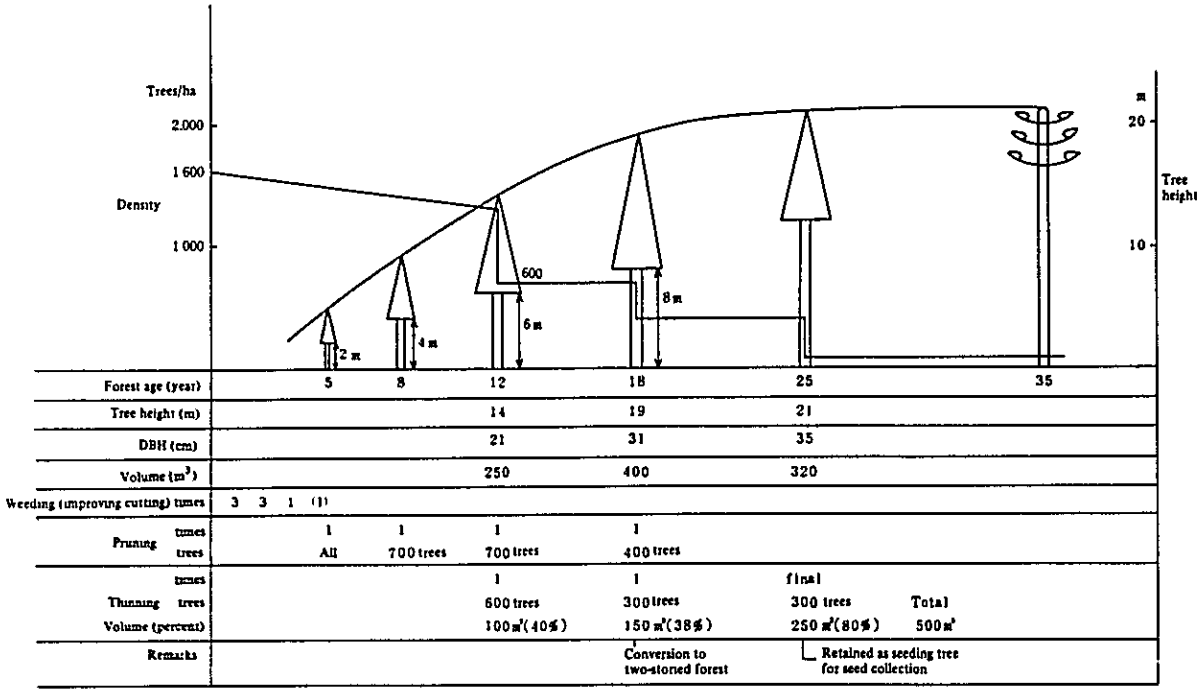


Fig. 1-3-2 Silvicultural system for Parana pine

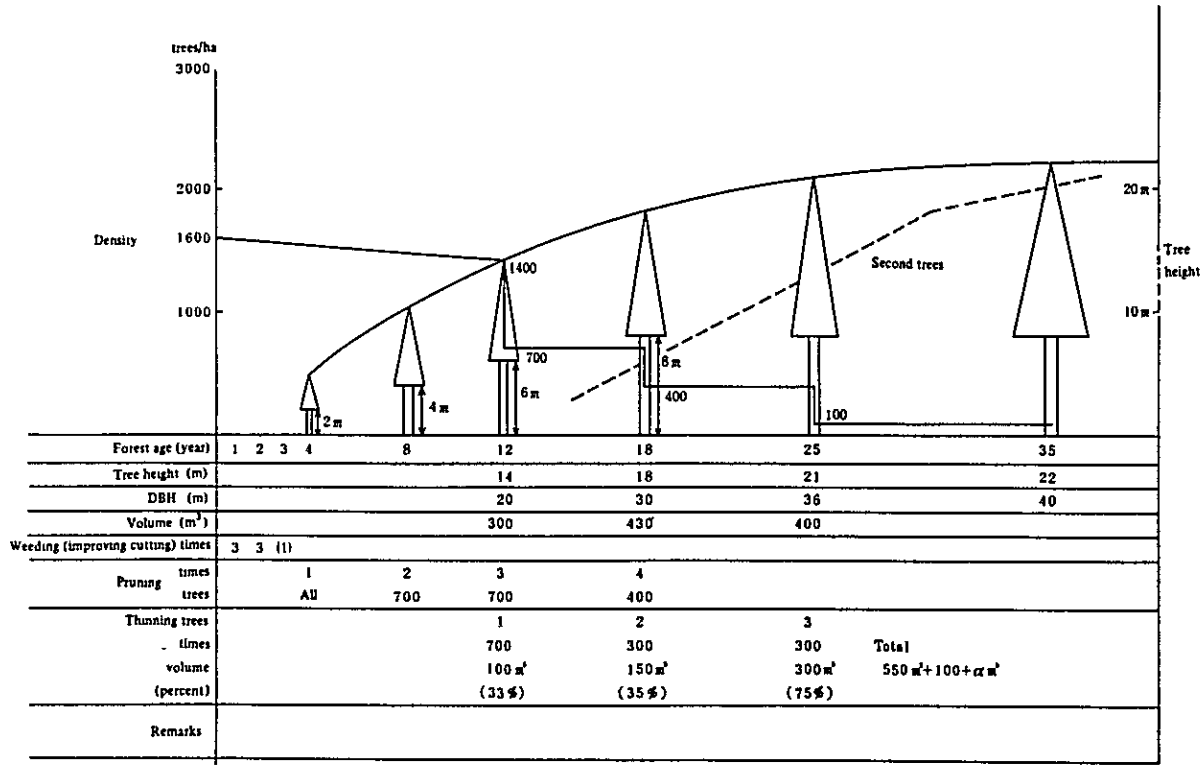


Fig. 1-3-3 Silvicultural system for Elliottii pine

(C) Protection

(1) Forest fire prevention

To prevent damages from forest fire which is caused by burning on surrounding pasture land, spread of fire by shifting cultivation and accidental fire, the various measures such as installation of fire lines and watching/patrol on dangerous season will be reinforced. At the same time, fore fighting system will be improved by building up fire extinguishing equipments and carrying out fire fighting drill.

(2) Prevention of ant damage

This area suffers damages by ant brosing; particularly, there are cases that a large area of Eucalyptus was seriously damaged by browsing over night. Also, pines are subject to ramified ends caused by browsing on their top ends Together, there are many damages to considerably reduce growth of forest and use value. To cope with this, patrol in reforestated areas should be intensified and early extermination by chemicals should be carried out. At the same time, effective extermination methods such as repellent should be studied and developed.

(3) Prevention of damage by disease and insect

As the various damage by disease and insect is expected with an increase of new reforestated areas, systems for detection at an early stage and prompt action should be provided, and study and development of damage prevention techniques should be promoted by close collaboration with research organizations.

3-5-3 Seed/Seedling and nursery

All forest in the area is privately owned, except for national park areas. It appears to be essential for promoting reforestation to produce and supply seeds and seedlings through public organizations. In addition, the various promotion programs such as profit sharing reforestation in which public organizations are directly involved should be considered. For the time being, seeds and seedlings for reforestation will be directly produced and used by public organizations or distributed to planters. At the same time, research, development and extension/guidance on nursery practice technology will be carried out by govern organizations.

(1) Nursery

The nursery (approximately 38 ha) managed by Amambay forest office, located in suburb of the city of P. J. Caballero, will be improved to be a central nursery in the northeast region.

In addition, temporary nursery in the forest will be provided in Cerro Cora National Park to mainly produce seeds and seedlings of natural growing species.

As maturing period of seedlings for forestry in this region is between 6 – 9 months, an improvement of nursery should be successively proceeded with progress of reforestation projects in accordance with yearly reforestation plan, by starting the leveling off nursery in the preceding year.

(2) Seed

Although seeds of superior grade species by breeding will be used in the long run, seeds collected from healthy mother trees of good shape/quality and fast growing will be used for the time being.

As supply of seeds will be dependent on import for the time being, care should be taken to use seeds which are acquired from reliable source through forestry institutions or organizations.

At the same time, in order to secure required quantity of seeds from domestic source to a maximum extent, seed orchard will be provided in nursery site for pines and euca-

lyptus of selected individuals with superior grade species or strain.

For natural growing species, healthy stand with good shape/quality and growing condition will be selected and designated as seed collecting stand, where cutting of mother trees will be restricted.

(3) Sowing and nursery practice

a Parana pine

This is originated from the State of Parana, Brazil, and has been used for reforestation in the country from old times.

As germination rate of the seeds decreases to around 40% in third month, seeds collected between April and May are preferably sowed in July at the latest. Parana pine is sometimes directly sowed in forest, but pot is used when sowed in nursery. Germination occurs in 60 days after sowing and out-planting is done in four months after germination.

b. Elliottu pine

This is originated from the southeast part of the United States, and known of remarkably fast growth.

Germination rate of the seeds is 85 – 90%, and low temperature treatment is required before sowing.

Sowing is done by using wood box or pot, with one grain per pot. Survival percentage of seedlings is generally aimed at 20,000 per 1 kg of seed.

c. Eucalyptus

This is originated from Australia, with great variety of species. The species suitable to purpose of the use and climate will be planted.

Sowing is done between July and October, and seedlings could be used for outplanting in around 4 months after sowing.

Survival percentage of the seedlings is 25,000 – 30,000 per 1 kg of seed.

d. Other species

For natural growing species, observation, experiment and research will be done on seeds' yield, collection, sowing and cultivation of seedlings to develop the nursery operational techniques.

(4) Nursery management and facility

a. Nursery administraion and organization

① The nurseries will be managed by a chief of Amambay forest office. For this purpose, assistants trained on nursery technology will be assigned to the nurseries on full time basis.

② The nursery administrator and his assistants will be responsible for guidance and extension of nursery technology to private advisor in forest owners and nursery operators.

③ Nursery workers will be educated to be a central work team as expert.

b. Nursery facility

Facilities in the central nursery required for seeds/seedlings production project will include the followings;

a) Buidlings

① Nursery administration office

② Warehouse for equipment and material

③ Manure and fertilizer house

④ Workshop

⑤ Resting room and lavatory for employees

⑥ Lodging house for administrative assistants

b) Water supply and irrigation facilities

Facilities will be constructed to intake water from neighboring rivers.

c. Temporary nursery in the forest

Cerro Cora temporary nursery in forest will be managed by utilizing organization and facility of national park office, except for water supply and irrigation facilities to be newly provided.

3-5-4 Establishment of experiment/research facility

The planning is thought to permanently form a central zone for forestry in this country. On the basis of this understanding, an experiment/research facility will be established by using a part of the existing nursery site to cover a whole part of the northeast region. This facility is to carry out research, development, extension and guidance on technology in the whole range of forestry and forest related industries, including seeds/seedlings, reforestation, compound management of agriculture/livestock farming/forestry, and use of forest and wood.

In addition, administration and management of the facility will be done by means of close collaboration with Forestry Development Center (CEDEFO).

3-6 Forest Road and Conservation Plan

3-6-1 Forest road plan

(1) Road transport condition

Road transport condition in the area is described as limited availability of serviceable public roads except for national roads, mentioned later, and a few branch roads. There are many private roads which are constructed and maintained directly by business owners or groups, and these roads are closed everwhere to prohibit the public use.

Furthermore, division of public road administration is not clearly difined except for national roads and other main roads, so that the responsible administrative bodies are not clarified.

Conditions of main roads.

① National road route 3 :	Paving work is under way
② National road route 5 :	Unpaved
③ Roads branched out at the south of Sun Luis from a road in Brazil along the border, and ; running to the north of Estrella :	Unpaved
④ Roads from Bella Vista to national road route 5 around the departmental border between Amambay and Conception:	Unpaved
⑤ Roads along the border between Capitan Bado and P. J. Caballero :	Unpaved
⑥ Roads running in southwest direction from Capitan Bado to national road route 3 :	Unpaved

(2) Forest road plan

Under the existing road transport condition, it is very difficult to formulate a comprehensive forest road plan in the planning area, and rather running a risk to become an unrealistic plan.

Therefore, when needs for preparation of areal forest road plan arise, such plan will be done in accordance with forest road plan in model areas which is discussed in separate

sections, instead of formulating a forest road plan to cover a whole part of the planning area.

3-6-2 Conservation plan

(1) Conservative area

Under the land use classification (Chapter 2) in this plan, areas of 35,000 ha were classified as preserved area; the one area in Cerro Cora containing the designated national park of around 5,500 ha and its expansion proposed in the plan, and the other area in Cerro Guazú which is new national park of around 21,000 ha proposed in this plan.

a. Cerro Cora national park and its expansion

Conservation will be implemented as mentioned in the sections of Cerro Cora model area (4-2).

b. Proposed Cerro Guazú national park

It is proposed in this plan that an area of around 21,000 ha will be designated as a national park.

This area is the largest mountain forest zone in the planning area, with a great variety of wild life and vegetation along with a great extent of untouched natural forest.

For this reason, this plan intends that the area will be designated as a national park principally aiming at conservation of natural environment including wild life and vegetation.

It is noted that uncontrolled forest development in recent years is approaching to this remotest area, and thus prompt procedure for designating of national park is expected so as to control such uncontrolled forest development in this area. And it is desirable to designate the area of around 20,000 ha which includes peripheral buffer (controlled) zone.

(2) Protective forest

In this plan, forest classification was done in accordance with applicable provisions of Paraguay Forest Law (Legistlation No. 422), to classify an area of around 191,000 ha, or 22% of total forest area, as protective forest to be plotted in the forest plan map. Actual substance of protective forest is fully discussed in the section on forest classification (3-1). It is expected that provision will be made to proceed the designation of protective forest by clearly delineating the subject areas, while functional classification and treatment standard for each forest will be clearly defined to accomplish the purposes of designation through appropriate treatment, and thereby to implement really effective management.

(3) Protective tree zone

Protective tree zones will be retained in forests including natural forest, by the method mentioned in each section of cutting method.

Protective tree zones will be developed in an area where forests have been disappeared to require new zone, by the method fully discussed in the section of forest plan in the model area (4-1). The plan was prepared to serve as a model to materialize a guideline for forest development plan and thus a conscious effort by parties concerned to materialize the plan is expected.

4. FOREST DEVELOPMENT PLAN IN MODEL AREAS

4-1 Pedro Juan Caballero Model Area

Pedro Juan Caballer Model Area (P. J. C. model Area) is located north of, and in adjacent to, the City of P. J. Caballero which is a capital of the Department of Amambay, a core of the planning area, and has the second largest population (approximately 40,000) in the country. The city is closely related to the City of Ponta Pora, Brazil, to form an urban area, with total population of 70,000.

The area has been used and developed as agricultural and livestock farming land from old times because of its location and land condition; at present, livestock farming land constitutes 69% of the total area, while forest land constitutes only 22%.

On the basis of this background, the model area was selected to focus on treatment of forests in livestock farming development zone and intensification of land use by compound management of livestock farming and forestry which is a major industry in the area and will increase in the future.

4-1-1 General description of the area

(1) Geographical location and land area

The model area is bounded by 22°22'30" and 22°30' South Latitude and 55°45' and 55°52'30" West Longitude.

The area has a land area of 17,502 ha.

(2) Topographical/geological condition

The model area is made up of a hill which is a part of wide plateau-like landscape in Amambay Mountain Range which forms a dividing ridge along an international border with Brazil, and extends along the ridge. The elevation of the area is mostly within the range between 400 m – 710 m, the highest in flat part of the country. The area contains an up-end part of Aquidabán River, to form the headstream of Aquidaban-mi river, San Luis River and Aguara River.

Geological formation of surface layers is of consolidated sediment formed at the end of the Tertiary, and which is widely distributed in the flat area. The soils are generally sandy or sandy gravel, with relatively low productivity.

(3) Forest condition

The model area has several concentration of high forest and mixed forest in the hilly area of the southern part, but scattered presence of small forest around rivers and streams in a plain of the central and northern part.

(4) Land use distribution

Land use distribution in the model area is, as presented in the next table, 2% by agricultural land, 69% by livestock farming land and 22%by forest land. Except for forests of relatively small area which are dispersely distributed in a part of the southern hilly area and alongside of streams, most of the area is used as livestock farming land. In addition, cut-over area constitutes 6%of the total area, most of which is already used as livestock farming land.

Table 1-4-1 Land use distribution

Classification	Symbol	Land area		Remarks
		ha	%	
Agricultural land	A	380	2	
Livestock farming land	G	12,037	69	
High forest	A_1~A_3	1,661	(44)	( )–% in total forest land
Mixed forest	M	1,635	(43)	
Medium forest	M_2, M_3	–		
Low forest	B_1, B_2	419	(11)	
Forest under cutting	E	95	(2)	
Sub-total		3,810	(100)	
			22	
Cut-over area	C	1,014	6	
Swamp and others	H	261	1	
Total		17,502	100	

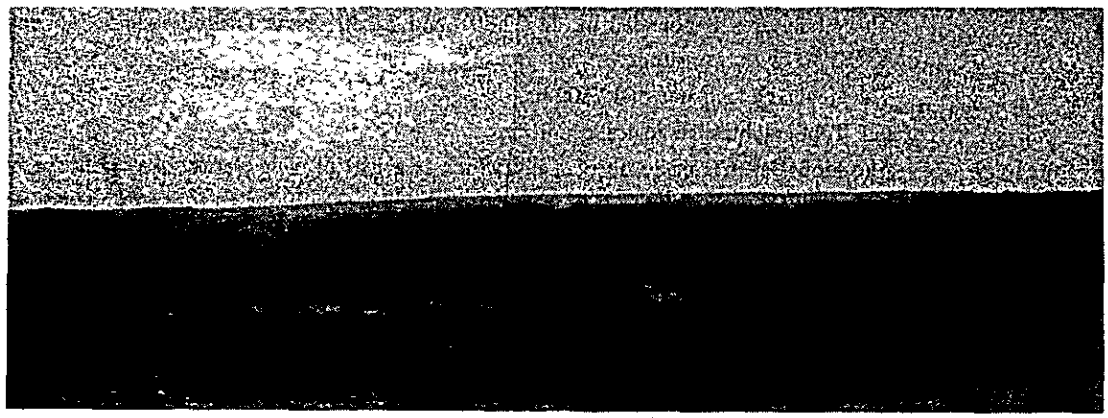


Photo 1-4-1 P. J. Caballero Model Area

4-1-2 Forest classification

The forests in the model area were classified on the basis of Article 4 – 7 of Paraguay Forest Law (Legislation No. 422). The result is presented in the table below.

As mentioned earlier, most of the forests are scattered, in the form of small forest, alongside of streams within the livestock farming land. An area to be subject to forest classification accounts for around 20% of the total forest land, and protective forest constitutes 84% of this forest classification

Table 1-4-2 Forest area by type of classification

Land use classification / Forest classification		Forest zone	Mixed zone	Conserved zone	Total	
		ha	ha	ha	ha	%
Productive forest	A_1~A_3	62			62	8
	E	62			62	8
	Sub-total	124			124	16
Protective forest	M	37	624		661	84
Special forest						
Total		161	624		785	100

4-1-3 Standard for management plan method

(A) Management standard

A standard for management plan method is established on the basis of the forest plan, as shown in the table below.

It is noted that although most of the forests in the model zone are protective forest as mentioned in the section on forest classification, a management standard for all forest classification except for special forest and for all forest type groups is specified here since small forest which requires different types of treatment is contained or will appear within mixed zone and livestock farming zone.

Table 1-4-3 *Management standard table*

Forest classification	Forest type group	Area	Tree species	Cutting system	Regeneration	Final cutting age
Productive Forest	$A_1 \sim A_3$ M_2, M_3	62 ha	Broad leaved tree Parana pine Elliottii pine	Selective cutting Shelter wood cutting Clear cutting	Natural seeding A_1, A_2, M_2 –Supporting work. Clear cutting–Planting	DBH 40 cm ~ (90 years)
	E	62 ha	Parana pine Elliottii pine Eucalyptus Broad leaved tree	Clear cutting	Artificial planting	Pine 20 years Eucalyptus 15 years
Protective Forest	$A_1 \sim A_3$ M_2, M_3		Existing species	Light selective cutting	Natural regeneration Supporting work as required	DBH 40 cm ~
	M	661 ha	Existing species	Postponent of cutting Light selective cutting for high/mixed forest with consideration to preservation	Natural regeneration	DBH 40 cm ~
	B_1, B_2		Existing species	Postponent of cutting Light selective cutting or clear cutting for similar to M_2 forest for protection purpose	Natural regeneration Clear cutting–Planting	

B. Productive forest

(1) Forest type $A_1 - A_3, M_2, M_3$ group

a. Species

In principle, natural forest with broadleaved trees will be fostered. As the existing natural forests consist of a great variety of species, fostering of useful species will be attempted through the future forest management such as cutting, regeneration and tending so as to gradually convert them to high forest with high mix ratio of useful species and high productivity.

b. Cutting

Selective cutting system will be employed, principally of single tree selective cutting system. Shelterwood cutting system will be considered for areas with a large amount of succeeding trees of useful broadleaved species where regeneration could be expected for certain.

Clear cutting system will be employed for an area where the development of planted forest by planting could be certainly expected.

c. Regeneration

Regeneration will be principally done by natural seeding of useful broadleaved trees. Replanting will be done for forest type A_1, A_2, M_2 as required by a generating condition of the saplings.

Species and planting method for cut-over area and development of planted forest will be in accordance with the section on reforestation.

d. Final cutting age

Final cutting age is principally set at an age when reaching diameter breast height (DBH) of more than 40 cm in consideration of progress of stand increment and use value of forest products. A period required to reach this age in the area is estimated around 90 – 100 years, which could be reduced by 20 – 30 years by providing increment acceralating measures such as cutting of upper story trees and improvement of tendering.

(2) Forest type E group

a. Species

Parana pine, Elliottii pine, Eucalyptus and other broadleaved trees will be fostered.

b. Cutting

Clear cutting will be done in consideration of an effective use of saplings of useful species including Peroba.

c. Regeneration

Regeneration will be done by planting of desirable species. At the same time, saplings of useful broadleaved trees will be retained and fostered to a possible extent, and thereby to aim for fostering healthy forests.

d. Final cutting age

Final cutting age is set at 20 years for Parana pine and Elliottii pine and 15 years for Eucalyptus with consideration change in increment and use value of forest products.

(C) Protective forest

(1) Forest type $A_1 - A_3, M_2, M_3$ group

a. Species

Existing species in natural forest will be mainly fostered, with an attempt to gradually improve them to species and stand composition with functions as protective forest.

b. Cutting

This forest class is highly expected to provide important functions including water resource control, soil conservation, erosion/flood prevention, protection of wild life and vegetation and conservation of public health. Thus, maintenance and improvement of such functions will be aimed by management method suitable for each purpose.

For this purpose, light selective cutting required for maintaining healthy forests will be done, to carry out careful management for the conversion to a desirable forest composition.

c. Regeneration

Regeneration will be done by natural regeneration of existing species to foster useful species through regeneration and tendering. Also, supporting work will be done where required.

d. Final cutting age

Diameter class of more than 40 cm will be a target for final cutting.

(2) Forest type M group

a. Species

Existing species in natural forest will be principally fostered, with gradual conversion to species composition suitable for purposes of protective forest.

b. Cutting

Cutting will be postponed for the time being to improve a quality of forest. Light selective cutting may be done where conservation effect will not be distributed by cutting because of mixed growth of high trees or regeneration will be required to accomplish conservation purposes.

c. Regeneration

Regeneration in selective cut-over area will be done by natural regeneration of desired species, along with planting of species suitable for protection purposes.

(3) Forest type B_1, B_2 group

a. Species

Existing species will be fostered by natural regeneration to improve a quality of forest.

b. Cutting

Cutting will be postponed, and where necessary cutting other than for the purpose of tending will be prohibited.

For the forests which were originally similar to type M_2 and became type B_2 as a result of partial cutting, light selective cutting will be done as far as required for regeneration, or where required for protection purposes clear cutting will be done to improve the stand type.

c. Regeneration

Regeneration will be done to principally focus on improvement of a quality of forest.

4-1-4 Cutting plan

(A) Selective cutting system

Selective cutting system will be applied to most of productive forest. As such forest is a base of forest production in the area, an appropriate management will be done to improve a quality of the forests and thereby to convert them to ones with high productivity.

(1) Cutting system

a. Forest with high stand density

Single tree selective cutting will be done in consideration of growing condition of saplings and residual stand crops.

b. Ordinary forest

This is the forest other than one with high stand density and dispersed one in the following section. For this type of forest, group selective cutting in consideration of working condition will be done mainly for the forests with high productivity and good environmental condition. On the other hand, single tree light selective cutting will be done for the forest with poor environmental condition so as to maintain the existing forests.

c. Dispersed forest

This is the forest with less densed high trees and dispersed crowns. For this type of forest, efficient cutting which considers ground surface treatment by large type machineries will be done for the forests with good environmental condition. Otherwise, single tree light selective cutting will be done as required for conditioning the forests.

(2) Standard of tree selection for selective cutting

Selection of trees to be cut will be done by surveying and totally evaluating the forest composition in terms of density of forest, shape/quality of lumbers and condition of diameter class and succeeding trees, so as to maintain healthy condition of residual stand crops and future increase of production.

(3) Selective cutting rate

Volume of selective cutting within a continuous forest will be maintained at less than 50% of the total volume in the forest.

(B) Light selective cutting

Light selective cutting will be done for forest type $A_1 - A_3, M_2, M_3$ of protective forest and protective tree zone in productive forest, to foster healthy forests, to maintain and improve thier protective functions as well as to increase total production from the forests by producing usable woods. Cutting system will be principally in accordance with the following criteria;

(1) Protective forest and protective tree zone

① Damaged trees and large diameter trees with high risk of windfall (overmatured trees and decaying trees) will be primarily cut.

② Trees on major ridges and alongside of rivers will be retained to a maximum extent.

③ Single tree selective cutting will be principally employed, and the cutting rate will be maintained below 30% with variation in accordance with density, diameter class and species.

④ The protective tree zones which are established mainly for maintaining natural scenery will be cut in accordance with location condition to meet the purposes.

(2) Steep slope area, wet land and stone/gravel land

① Damaged trees, overmatured trees, decaying trees and large diameter tilting

trees having a risk to induce forest land erosion will be primarily cut.

② Healthy small/medium diameter trees will be conserved to a maximum extent.

③ Single tree selective cutting will be mainly employed to avoid a drastic change in a quality of forest.

(3) National park and other special forest

① Minimum extent of cutting will be done only when required for maintaining and improving the functions of forest to meet the purposes such as maintaining of natural scenery.

② Damaged trees, decaying trees and overmatured trees will be primarily cut to prevent the forests from decaying.

③ Light selective cutting, mainly single tree selective cutting, will be done to avoid drastic deterioration of a quality of forest.

(C) Shelterwood cutting

Shelterwood cutting work will be applied to upper story group of the forests which contain a large amount of saplings and small diameter trees of useful species and has mostly completed regeneration to expect development of new stands with good condition as productive forest, so as to acceralate the increment of lower story and thereby to develop forests with high productivity.

a. Forest with suppressed lower story

For the forests in which normal growth of lower story trees is hampered by medium/large diameter trees in upper story, two step cutting will be done to avoid a drastic change in environment for protection and for fostering of lower story goups and to foster healthy succeeding stands.

The first cutting will be primarily done for damaged trees, unhealthy trees and aged/large diameter trees while caring about growing condition of lower story groups, retaining healthy thrifty trees. The cutting rate will be around 40 – 60 %.

The second cutting will be done 10 – 20 years after the first cutting by taking into consideration growing condition of lower story groups and residual stand crops. The cutting methos will be in accordance with that for dispersed forest in the next section.

b. Dispersed forest

A most of upper story trees will be cut to accelerate increment of lower story groups, while retaining healthy medium diameter trees of useful species to a possible extent.

(D) Clear cutting

Clear cutting will be done for forest type A_1-A_3, M_2, M_3 group of productive forest in which development of planted forest by planting could be certainly implemented and for forest type E group, to actively device an improvement of species and stand type.

(1) Cutting method

On cutting and logging, care will be taken to conserve an area where saplings of useful species, with high expectation to become matured forests in the future, are growing in group, so as to make an effective use of natural power and to make certain the maturing of new planted forest.

(2) Protecive tree zone

For protection of new planted forest, prevention of soil erosion, maintaining of soil fertility, and conservation and formation of natural environment, protective tree zones will be provided in the following locations;

① Protective tree zones required for windbreak, forest fire prevention, prevention of soil erosion and maintaining of soil fertility will be provided mainly on ridges and alongside of rivers.

Also, the zones will be provided on wide slope or flat areas where a cutting area will be large, at 1,500 m – 2,000 m interval in consideration of direction of predominant wind and surrounding conditions.

The zones will be provided on both side of ridges or rivers with 100 m wide on each side, and on flat areas with 200 m wide as standard being adjusted in accordance with local condition.

② The zones will be provided in wayside area of roads, used for health and recreational purpose, and public roads with heavy traffic to maintain natural environment, with 100 m wide on each side as standard being adjusted in accordance with local condition such as surrounding landscape/scenery and intensity of use.

③ Management of the zones will be in accordance with that of protective tree zone.

4-1-5 Reforestation plan

(A) Productive forest

Planted forest will be actively developed in cut-over area and newly planned forest so as to aim at improvement of forest resources, production of woods, conservation of water resource and prevention of soil erosion.

(1) Species for reforestation

Flat growing species to produce easily marketable and profitable woods will be selected. The following species will meet such requirements;

a. Coniferous tree — Parana pine, Elliottii pine, Caribbean pine, Etc.

b. Broadleaved tree — Eucalyptus, Paraiso, Etc.

c. Naturally growing species

On reforestation of useful trees that grow naturally like Peroba, we determined to run experimental reforestation for the time being, while condurrently and actively promoting the research and development of reforestation techniques, such as, abundancy of seeds, storage, nursery practice, reforestation, and tending or protection, in order to assure steady supply for the future.

(2) Method of reforestation

a. Planting time

Planting on forest will be done in winter season between May and August.

b. Number of plantings

The number of plantings will be determined in accordance with the following standard, with decrease/increase as required by local condition and purpose of reforestation;

Table I-4-4 Standard number of plantings by species (per ha)

Tree species	Number of planting	Planting space
	seedings/ha	
Parana pine Elliottii pine	1,600 ~ 2,000	2m x 3.0m ~ 2.5m
Eucalyptus	2,200 ~ 2,500	2m x 2.5m ~ 2.0m

(3) Tending and protection

Tending, such as weeding, pruning and thinning will be done after planting. Silviculture systems for Parana pine and Elliottii pine are presented in the following diagrams.

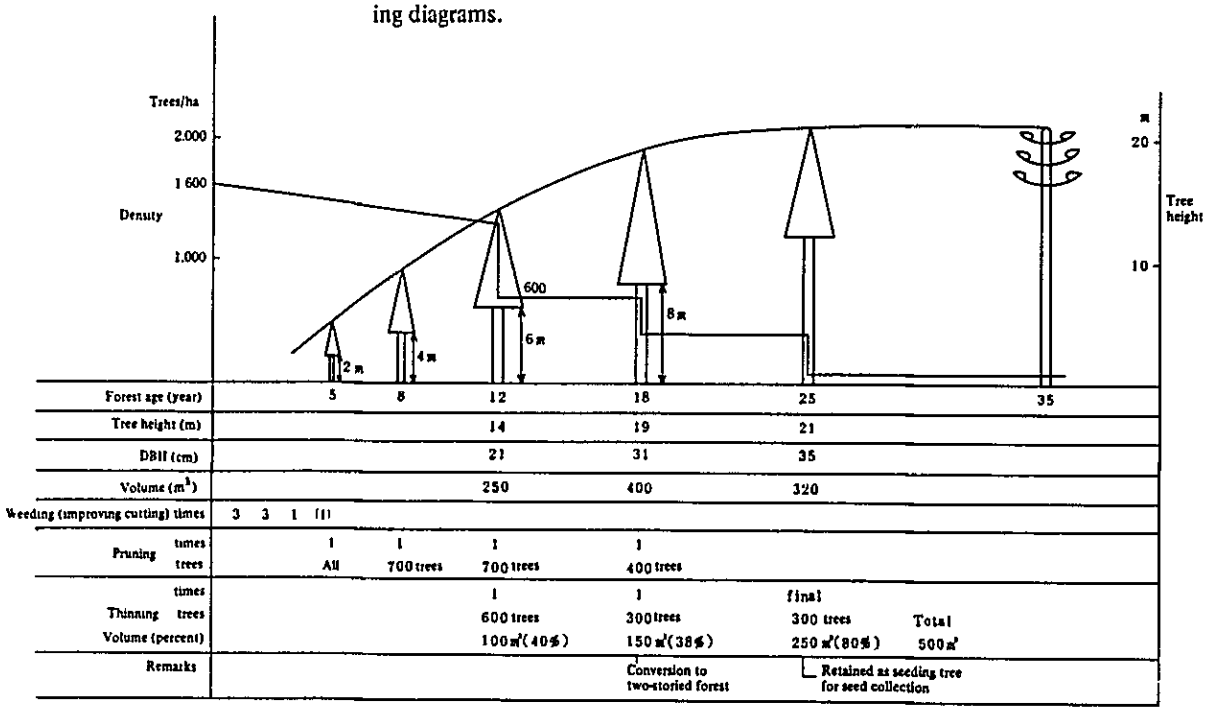


Fig. 1-4-1 Silvicultural system for Parana pine

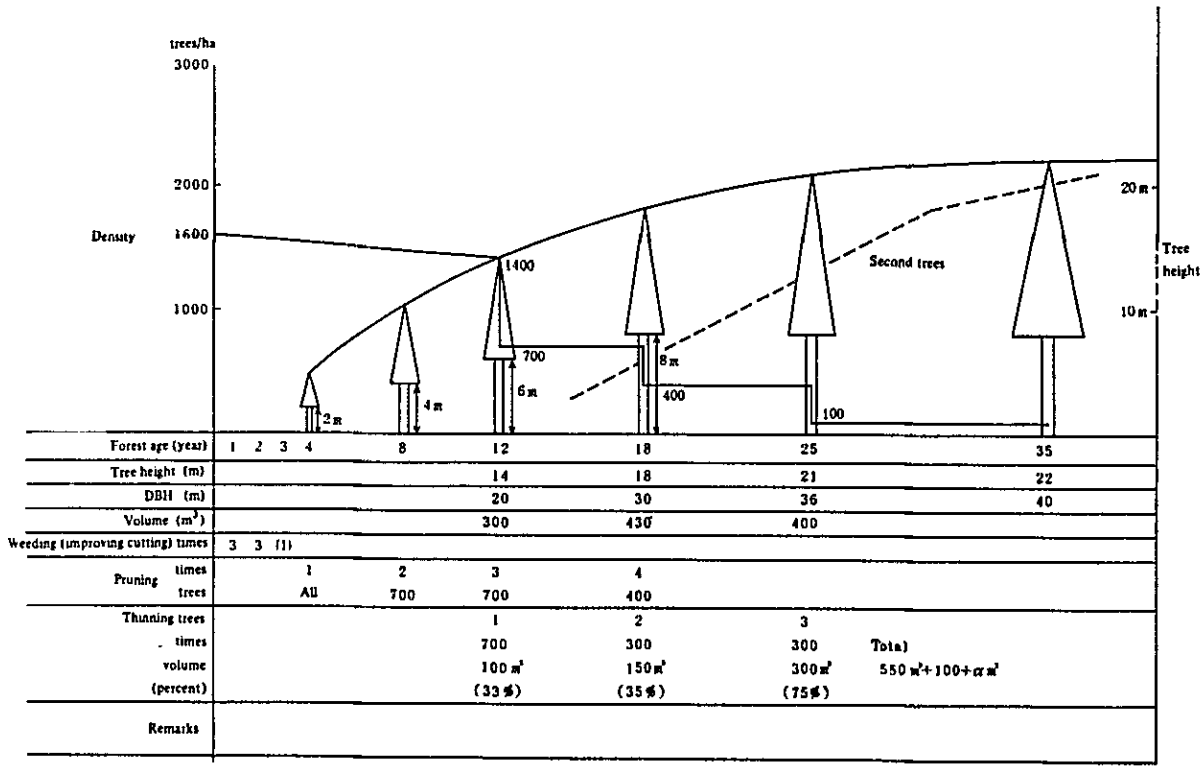


Fig. 1-4-2 Silvicultural system for Elliottii pine

(B) Protective forest

Natural forests which exist in alongside of major rivers and streams in the area will be conserved to a possible extent. In wayside of such rivers and stream with no natural forest, reforestation will be actively done to aim for conservation of water quality, prevention of soil erosion and conservation of riverside.

(1) Species for reforestation

① Fast increment species with high use value will be primarily considered; Parana pine, Elliottii pine and Eucalyptus.

② For areas with high risk of fire, e.g., in adjacent to pastures, fast increment species with great fire resistance will be selected; Eucalyptus Paraiso, etc.

③ For deteriorated areas to require prompt revegetation, fast growing species with high breeding potential, such as Yvyrá pytá, will be selected.

(2) Reforestation, tending and protection

Method of reforestation, tendering and protection for protective forest will be in accordance with that of productive forest.

(3) Target area for reforestation

Wayside area (100 m wide on each side) of rivers and streams with high risk of erosion, slopes around swamps, deteriorated areas and their surroundings which are susceptible to deterioration, catchment or flood storage areas and surrounding slopes.

C. Recommendations on promoting reforestation

The area was once a vast forest land having a sizeable stock of forest resources, and has been developed as livestock farming and agricultural land from old times because of its location and environment. As a result, forest area has decreased to 22% of the total area with decreasing quality.

On the other hand, the area is located in proximity to the City of P. J. Caballero, a center of wood consumption in the northeast region, and thus has a great locational advantage of wood production, marketing and use.

On the basis of this background, the following recommendations were made on promotion of reforestation in the area;

① To actively convert the existing natural forests, where suitable, to planted forests

② To actively implement reforestation in agricultural and livestock farming land with low intensity of use.

③ To implement reforestation in livestock farming land by establishing the zoning, and thereby to promote compound management with forestry though improving of grazing capacity and maintaining of soil fertility while securing forestry production.

④ To actively develop protective tree zones in accordance with the corresponding plan, and at the same time to aim for increasing forestry production.

⑤ To carry out public education on need and importance of reforestation as well as research, development and guidance on reforestation technology by means of utilizing planted forests in this area (refer to 3.5.4).

4-1-6 Protective tree zone

Within the survey area, large tracts of agricultural and livestock farming land, which were converted from forest after clear cutting, are observed everywhere.

In such a Land, there is a clear evidence of soil erosion by torrential rain.

A forest has multiple functions on conserving of water resource, flood prevention, prevention of soil erosion, climate alleviation such as windbreak, and fostring of land produc-

tivity. Thus, when forests are cut and converted to other uses, a part of them should be retained in band or group to avoid extensive clear cutting. And an area where such extensive clear cutting has been done should be developed of forest zone.

(1) Specific area to retain and develop forest

Protective tree zones will be established in the following types of landscape;

① Steep slope area

The forests will be retained or developed on slope areas with following grades which correspond to different soil types;

② Ridges and convexed part

③ Alongside of swamps and streams

Soil type		Grade	
S	type	more than	6°
S. L	"	"	9°
L	"	"	12°

(2) Size of forest to be retained or developed

A certain size of forest, preferably continuous, will be required to fully show the various functions. In this plan, it is proposed that strips of forest zone will be retained or developed in grid pattern, with the following dimension;

① Width of a forest zone	200 m
② Length of a forest zone	more than 200 m
③ Spacing between forest zones	around 2 km

(3) Management of retained or developed forest zone

a. Species

In consideration of values as economic forest and burning in agricultural and livestock farming land, the following types of species will be selected;

Useful species

Fire resistant species

When reforestated, as pines are easily combustible, care should be taken by priotizing Eucalyptus species or arranging broadleaved species such as Eucalyptus around pines to form fire break tree belt. At the same time, simultaneous reforestation by single species should be avoided.

b. Cutting and regeneration

Regeneration work will be required to fully use the role of economic forest as well as protective forest. In doing so, clear cutting on a large area should be avoided, and instead selective cutting system or alternate strip clear cutting system will be employed.

Example

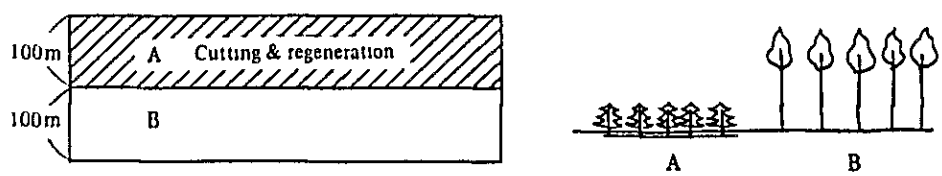


Fig. 1-4-3 Regeneration by alternate strip clear cutting

(4) Protective tree zone development plan

a. Specific area to be developed

Major ridges, wayside area of rivers and streams, and on lines connecting them. Details are as presented in Model Area Forest Plan Map.

b. Dimension

200 m wide strips

c. Size of development

Size of the development by type of area is as follows;

Major ridges	660 ha
Wayside of rivers and streams	655 ha
Others	847 ha
Total	2,162 ha

d. Development cost

Development cost for protective tree zone (Parana pine, as of 1981; Mr. Komiya) is estimated as in the following table.

According to this, development cost per ha is 120,000 Gs, to be totaled to approximately 259 million Gs, and approximately 158 million Gs for major ridges and wayside area of rivers and streams.

Table 1-4-5 Estimate of development cost for protective tree zones (as of 1981, Gs/ha)

Item	1st year	2nd year	3rd year ~Tending period	Total
Grand clearance	30,000	—		30000
Planting/compensatory planting	31,000	2,000		33000
	12,000	9,000	12,000	33,000
Ant extermination	8,000	4,000		12,000
Others	8,000	2,000	2,000	12,000
Total	89,000	17,000	14,000	120,000

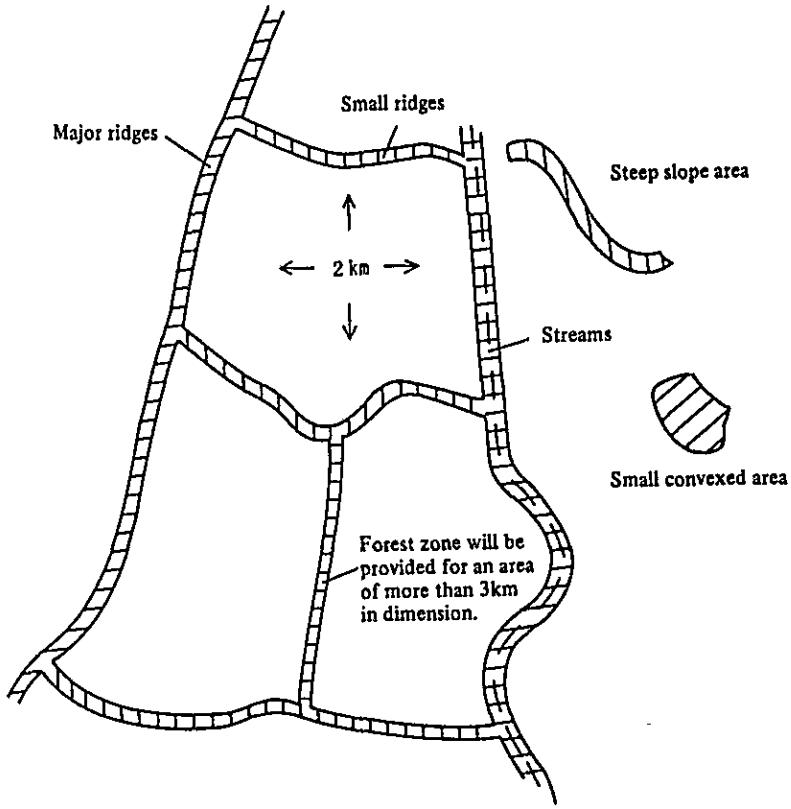


Fig. 1-4-4 Example of retained/developed forests in large clear cutting area

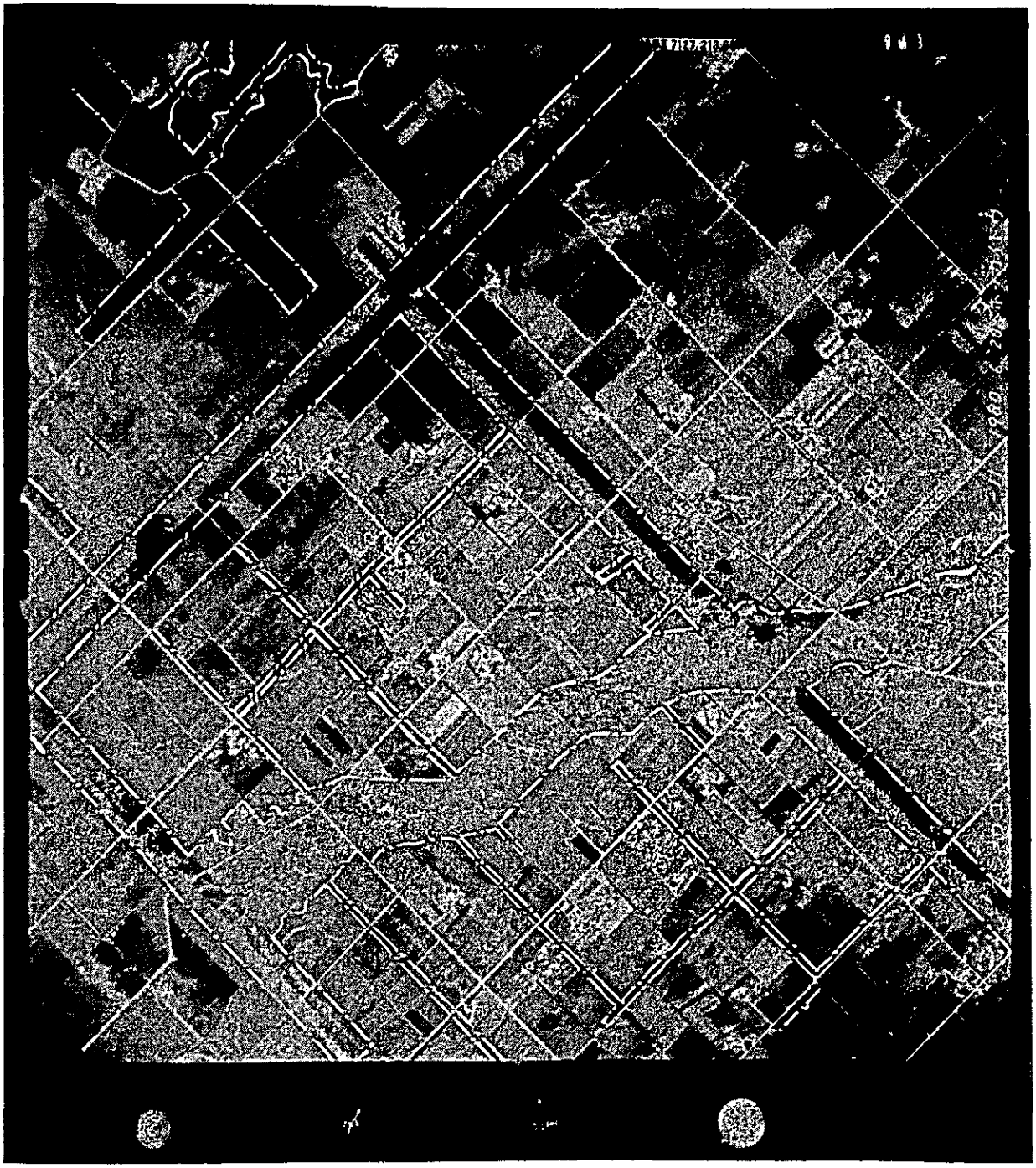


Photo 1-4-2 Protective tree zone (aerial photo)

4-1-7 Forest road plan

(1) Basic principle

Although there is no serviceable public road available in the model area, there are three major roads running in peripheral of the area; along the south end of the area; a road extending westward from Cerro Cora Ye, around the east end of the area; a main road in Brazil running along the border in north-south direction, and mostly along the northern margin of the area; a road running westward from San Luis.

Thus, in this plan, a forest road system consisting of main roads (4 m wide) and branch roads (3 m wide) are proposed as specified later on, in consideration of their connection to external main road systems of the above three roads which enclose three sides of the model area. The forest road system will serve as a multi-purpose road to establish/administer of protective tree zones and administer of other forests and livestock farming land.

The forest road system will be administered directly by the government, its representative or any other appointed organizations, and opened to general traffic within a specified range. Actual administration and management system will be separately discussed.

(2) Types and width of forest roads

Main forest road	width 4 m
Branch forest road	Width 3 m

(3) Proposed length

Main forest road	29,080 m	Length per ha	1.7 m
Branch forest road	26,400 m		1.5 m
Total	55,480 m		3.2 m

4-2 Cerro Cora Model Area

Cerro Cora model area is located around 35 km southeast of the City of Pedro Juan Caballero, or within one hour driving distance via national road route 5.

The area contains Cerro Cora National Park (total area of 5,538 ha) which is used for public recreation and other activities.

As an expansion of the national park is proposed in this plan, the area is selected as conservative zone in main part.

4-2-1 General description of the area

(1) Geographical location and land area

The model area is bounded by 22°37'30" and 22°45' South Latitude and 56°00' and 56°07'30" West Longitude, and has a land area of 17,522 ha.

(2) Topographical/geological condition

The model area is made up of a slope on west side of wide plateau landscape, an elevation of 500 – 600 m, in Amambay Mountain Range which forms a dividing ridge along an international border with Brazil. An elevation of the area is ranged between around 260 m and 550 m. The area constitutes an upper river system of Tacuara River, and generally forms flat or gentle sloped hilly landscape.

Also, as the name implies, the area contains a several Cerros of 100 m – 200 m high which stand out as if to surround the national park. Geographical formation is mainly of sand stone, and soils are generally of sand, namely sand type soil (type S) or sand/loam type soil (type S-L) with relatively low land productivity in general.

(3) Forest condition

The forests in the area consist of medium forest and mixed forest, 80% of the total forest area, low forest of 14%, forest under cutting of 6%, and little high forest, to indicate that cutting is under way in this area.

(4) Land use distribution

Land use distribution in the model area is as presented in the table below; agricultural land constitutes 8% of the total area, livestock farming land 22%, and forest 55%. In addition, cut-over area constitutes 14%, and appears to have been converted mainly to livestock farming land.

Table 1-4-6 Land use distribution (Cerro Cora model area)

Classification		Symbol	Area		Remarks
			ha	%	
Agricultural land		A	1,362	8	
Livestock farming land		G	3,882	22	
Forest land	High forest	A_1~A_3	7	–	( )– % in total forest land
	Mixed fores	M	2,116	(22)	
	Medium forest	M_2, M_3	5,632	(58)	
	Low forest	B_1, B_2	1,373	(14)	
	Forest under cutting	E	536	(6)	
	Sub-total		9,664	(100)	
				55	
Cut-over area		C	2,426	14	
Swamp and others		H	188	1	
Total			17,522	100	

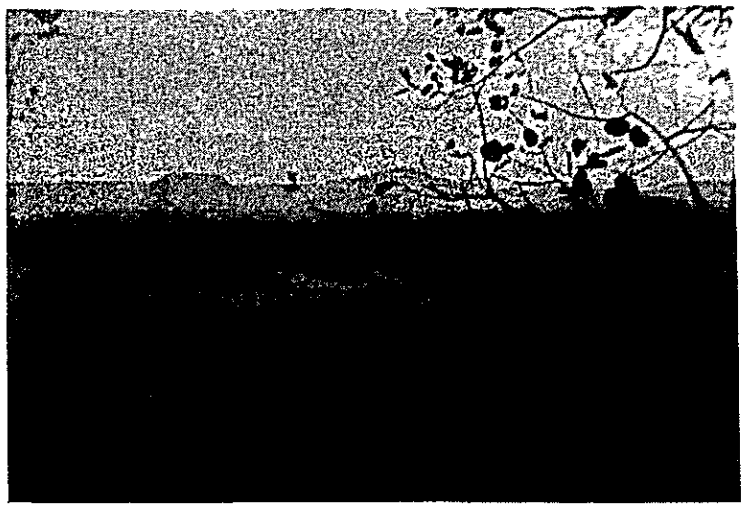


Photo 1-4-3 Cerro Cora National Park

4-2-2 Forest Classification

The forests in the model area were classified on the basis of Article 4 – 7 of Paraguay Forest Law (Legistlation No. 422). The result is presented in the table below.

It is noted that a special forest in the table means Cerro Cora National Park and its future expansion proposed in this plan.

Table 1-4-7 Forest area by type of classification

		Forest zone	Mixed zone	Conserva-tive zone	Total	
		ha	ha	ha	ha	%
Productive forest	M_2, M_3	3,793	187		3,980	38
	E	562			562	5
	Sub-total	4,355	187		4,542	43
Protective forest	M	1,048	87		1,135	11
	B_1, B_2	836	62		898	8
	Sub-total	1,884	149		2,033	19
Special forest				3,931	3,931	38
Total		6,239	336	3,931	10,506	100

4-2-3 Standard for management plan method

(A) Management standard

Standard for the management plan method is established on the basis of the forest plan, as shown in the table below.

Table 1-4-8 Management standard table

Forest classification	Forest type group	Area	Tree species	Cutting system	Regeneration	Final cutting age
Productive Forest	M_2, M_3	3,980 ha	Broad leaved tree Parana pine Elliottii pine	Selective cutting Shelter wood cutting Clear cutting	Natural seeding A_1, A_2, M_2 –Supporting work. Clear cutting–Planting	DBH 40 cm ~ (90 years)
	E	562 ha	Parana pine Elliottii pine Eucalyptus Broad leaved tree	Clear cutting	Artificial planting	Pine 20 years Eucalyptus 15 years
Protective Forest	M	1,135 ha	Existing species	Postponent of cutting Light selective cutting for high/mixed forest with consideration to conservation	Natural regeneration	DBH 40 cm ~
	B_1, B_2	898 ha	Existing species	Postponent of cutting Light selective cutting or clear cutting for similar to M_2 forest for protection purpose	Natural regeneration Clear cutting–Planting	
Special Forest	All forest type	3,931 ha	Existing species	Prohibition of cutting Scenery improvement cutting	Natural regeneration Scenery improvement cutting	

(B) Productive forest

(1) Forest type M_2, M_3 group

In accordance with P. J. C. model area

(2) Forest type E group

In accordance with P. J. C. model area.

(C) Protective forest

(1) Forest type M group

In accordance with P. J. C. model area.

(2) Forest type B_1, B_2 group

In accordance with P. J. C. model area.

(D) Special forest

a. Species

In principle, existing species will be fostered, with an effort to make conversion to species suitable for conservation purposes.

b. Cutting

Forests, which should be conserved for academic or historical value, will be strictly protected by prohibiting cutting. Forests, which are mainly for maintaining of scenic beauty or recreational use, will have scenic management such as scenery improvement cutting as required by local condition.

c. Regeneration

Regeneration will be done by natural regeneration of existing species, with scenery improvement planting as required.

4-2-4 Cutting plan

(A) Selective cutting

In accordance with P. J. C. model area.

(B) Light selective cutting

In accordance with P. J. C. model area.

(C) Shelterwood cutting work

In accordance with P. J. C. model area

(D) Clear cutting

In accordance with P. J. C. model area.

4-2-5 Reforestation plan

(A) Productive forest

Reforestated species, method of reforestation, tending and protection will be in accordance with that of P. J. C. model area.

(B) Protective forest

Reforestated species, method of reforestation, tendering, protection, and target area for reforestation will be in accordance with that of P. J. C. model area.

(C) Protective tree zone

Protective tree zones will be provided for the areas along rivers and streams which have no forest and thus high risk of soil erosion and outflow.

Approximately 516 ha should be reforestated for development of protective tree zones.

4-2-6 Forest plan for national park area

(A) Cutting plan

In principle, cutting will be prohibited to comply with a purpose of the national park to preserve the existing forests.

However, a minimum extent of cutting required for appropriate maintenance of the national park and scenery improvement cutting required for a use of the park, may be carried out.

(B) Reforestation plan

Regeneration of the forests in the national park will be, in principle, done by natural regeneration of existing species so as to maintain the ecological system.

(C) Forest road plan

(1) Construction of new forest road

No forest road will be constructed as a number of roads are available in the national park; national road route 5 which passes through a part of the park, loop roads which connect the national road and historic districts, and inforest foot paths, in addition to roads which connect the settlements in the proposed expansion of the park.

(2) Maintenance and repair

As roads other than national road route 5 are in poor maintenance condition to disturb traffic in rainy season, road surfaces will be repaired and improved. Also, in-forest foot paths will be repaired at appropriate time to secure safety and convenience of users.

(D) Facility and administration plan

(1) Administrative facility and organization

Management of the roads will be improved by effectively using the existing national park office.

(2) Seed/seedling production facility

An existing nursery in adjacent to the park office will be expanded and improved to produce seedlings for reforestation in the park area for the time being.

Irrigation facilities should be provided for this purpose.

(3) Forest fire prevention facility

Forest fire watch stations should be provided at appropriate locations in the park area or its vicinity, along with build-up of fire extinguishing equipments.

(4) Public facility

As users of the park are expected to increase in the future because of its location in the center of the northeast region as well as its abundant wilderness, public facilities such as rest houses and camping area should be improved.

(5) Education facility

In addition to historic districts, education facilities such as historic museum, botanical garden and camping school facility will be preferably studied to prepared for the future need.

(E) .Recommendations on treatment of forests in the national park area.

① Expansion plan for Cerro Cora National Park was prepared in the plan, with the following area;

Classification	Total area	Area within the model area
Present area	5,538ha	4,015ha
Area of proposed expansion	9,342	680
Total	14,880	4,695

For the above proposed expansion, it is desirable to take a necessary action for being designated as national park in earliest time.