② The national park area should be classified into three zones; 1) zone for conservation of natural environment, mainly protection of wild life and vegetation, 2) zone mainly for recreational activity by general public, and 3) historic zone, to establish an improvement plan required for accomplishing the purposes and to aim for intensive use of the national park.
For reference, 'Forest Management in Natural Parks' in Japan is attached.

③ It is desirable to take necessary actions for prompt reforestation of areas in the park where trees have been artificially eliminated, e.g., abandoned agricultural or pasture land and fire-ravaged area, except for areas required for recreational use.

4-3 Lima Model Area

The model area is located in a mountaineous area which includes an urban area of the City of Lima, a central point of the northeast region, in the Department of San Pedro, and also located at southeastern end of the planning area. The area contains a built-up area of the city, agricultural and livestock farming land along national road route 3, forest area made up of deep natural forest, and marsh land formed by Aguary –Guazú river in an entire northern part of the city.

In the area, the forests are conserved in relatively good condition because of its location and land condition, with balanced arrangement of city (settlement), agricultural land and forest. On the basis of this background, the model area was selected in the plan to focus on agricultural area including settlements and forest area.

4-3-1 General description of the area

(1) Geographical location and land area

The area is located in the Department of San Pedro, southwestern part of the planning area, and bounded by 23°45' and 23°52'30" South Latitude and 56°22'30" and 56°30' West Longitude. The area has a land area of 15,676 ha.

(2) Topographical/geological condition

The area is located on flat land including marsh land formed by Aguary – Guazú, river with an elevation ranging between 120 – 200 m to have a little relative height difference. The area constitutes a mid-stream area of Aguary – Guazú, river and its southern part is wholly occupied by large marsh land in the vicinity of a junction with Mboreui river which has the source from Laguna Blanca.

Geological formation of surface layers are of sand stone, conglomerate and basalt, and soils are generally of loam type or sandy soil.

(3) Forest condition

The forests in the area consist of medium forest, 73% of the total forest area, and high forest of only 12%, with relatively poor forest composition as a whole. In addition, mixed forest, 15% of the total forest area, is distributed around marsh land.

(4) Land use distribution

Land use distribution in the model area is as presented in the table below; urban land including built-up area of Lima constitutes 1% of the total area, agricultural land 13%, livestock farming land 6%, and forest land 46%, to show larger share of agricultural land than other areas.

Also, an entire southern part of the area is occupied by marsh land formed by Aguary – Guazú, river constituting 37% of the total area.

Table 1-4-9 Land use distribution

Land use classification		Symbol	Area		Remarks
Urban land		P	80ha	1%	
Agricultural land		A	2,043	13	
Livestock farming land		G	979	6	
Forest land	High forest	$A_1 \sim A_3$	858	(12)	( ) – % in total forest land
	Mixed forest	M	1,113	(15)	
	Medium forest	M_2, M_3	5,241	(73)	
	Sub-total		7,212	46	
Cut-over land		C	123	1	
Swamp and others		H	5,236	33	
Total			15,676	100	

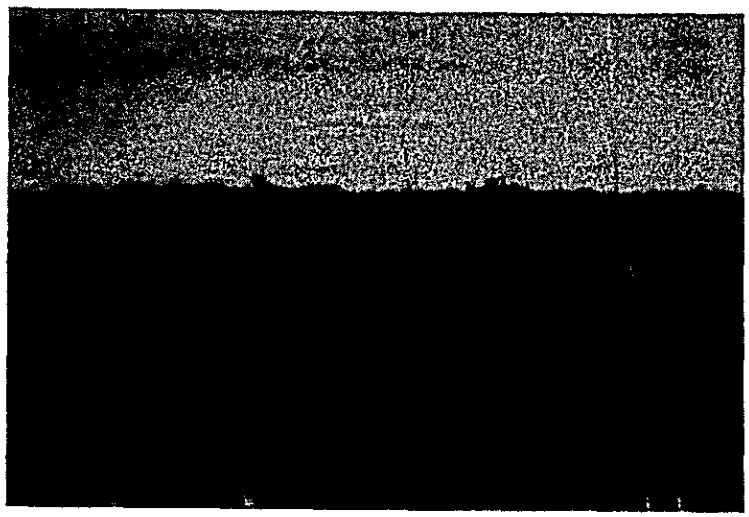


Photo 1-4-4 Lima model area

4-3-2 Forest classification

The forests in the model area were classified as presented in the table below; productive forest constitutes 92% of the total area. As 83% of the productive forest is medium forest, an improvement of the forest will be an important task to increase forest production. In addition to productive forest, protective forest of mixed forest type, 8% of the total area, is found along Aguary – Guazú river.

Table 1-4-10 Area by forest classification

Forest classification \ Land use classification		Forest zone	Mixed zone	Conservative zone	Total	
		ha	ha	ha	ha	%
Productive forest	A_1~A_3	599	250		849	16
	M_2, M_3	2,933	1,285		4,218	76
	Sub-total	3,532	1,535		5,067	92
Protective forest	M	275	187		462	8
Total		3,807	1,722		5,529	100

4-3-3 Standard for management plan method

(A) Management standard

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

Table 1-4-11 Managenent standard

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	849 ha 4,218	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)
Protective Forest	M	462 ha	Existing species	Postponent of cutting Light selective cutting for high/mixed forest with consideration to conservation	Natural regeneration	DBH 40 cm ~

(B) Productive forest

Forest type $A_1 - A_3, M_2, M_3$ group

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

(C) Protective forest

Forest type M group

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

4-3-4 Cutting plan

A. Selective cutting work

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

B. Light selective cutting work

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

C. Shelterwood cutting work

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

D. Clear cutting work

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

4-3-5 Reforestation plan

(A) Productive forest

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

(B) Protective forest

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

4-3-6 Forest road plan

(1) Existing condition and future policy

Main road system in the model area is national road route 3 which passes through the west end of the area, with no junction roads in the rest of the area since the southern and eastern part is occupied by a large marsh land formed by Aguary – Guazú river and its branch streams, and the northern part is made up of forest area.

Settlements and agricultural land are developing in linear pattern along the national road route 3, and mainly depend on route 3 and agricultural/livestock farming roads to connect route 3 and settlements.

In this plan, it is proposed that an agricultural/livestock farming road which branches out from route 3 and passes almost the center of the area in east-west direction (accessible to automobile traffic in a part) will be expanded and improved to make a main forest road, and from which branch forest roads will be constructed in north-south direction.

(2) Type and width of forest road

In accordance with P. J. C. model area

(3) Proposed length

Main forest road	12,000 m	Length per ha	0.8 m
Branch forest road	13,400 m		0.8 m
Total	25,400 m		1.6 m

4-3-7 Agroforestry

(1) Concept of agroforestry

This model area consists of agricultural zone and forest zone and the major themes for the project are advanced land use by compound management of agriculture and forestry and promotion of reforestation and forest management.

In order to develop reforestation in this area while producing food, a system of combined agriculture and forestry is essential.

The "agroforestry" is defined as being "a land management system employed to increase the total production of land and harvesting of agricultural products, plantation and live stock farming are concurrently and continuously combined in it" as the concept of land use to organically combine agriculture and forestry.

Accordingly, there are several types in the agroforestry; combination of agriculture and reforestation, reforestation and live stock farming, agriculture and reforestation and live stock farming, and multi-purpose forest tree cultivation. The light, nutrients and space (including underground) can be utilized to the fullest extent by combining cultivars and trees, eventually increasing the land production.

(2) Combination examples of agroforestry

1) Plantation of trees in a farming field or pasture (Fig. 1-4-5)

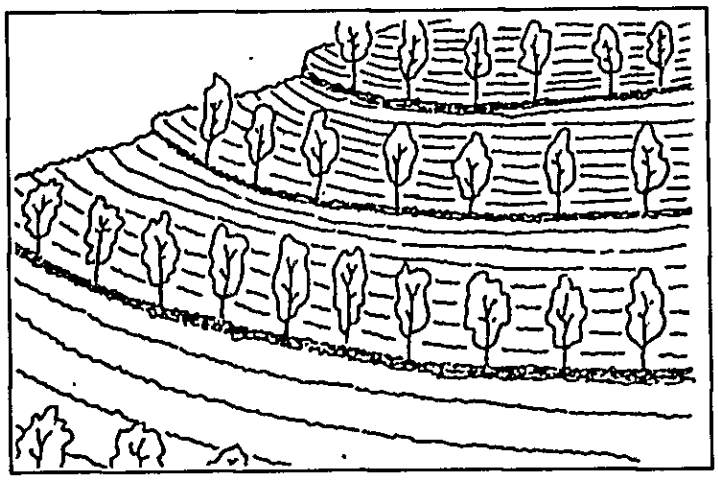


Fig. 1-4-5

2) Band form farming in a forest (Fig. 1-4-6)

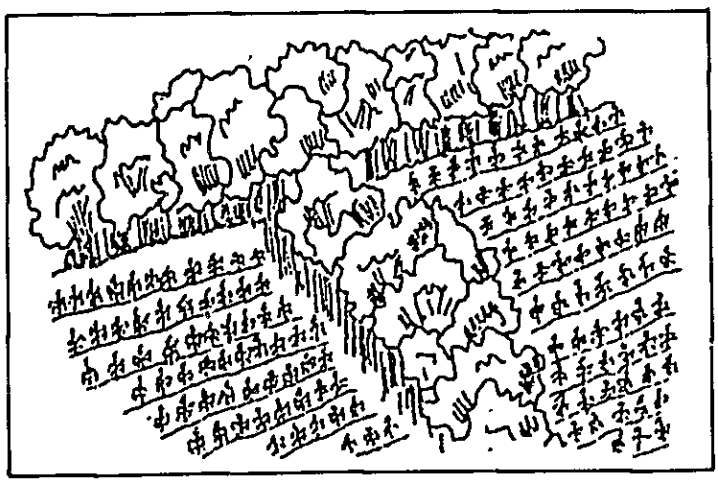


Fig. 1-4-6

3) Agriculture utilizing tree shades of a natural forest, for example, banana, coffee, palmito. (Fig. 1-4-7)

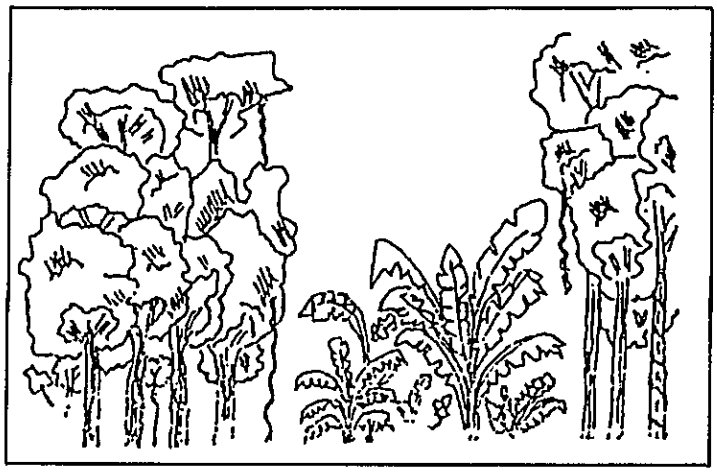


Fig. 1-4-7

(3) Agroforest examples practical in this area

1) Mate and one-year crop

Plantation of mate in intervals of 4m x 4m along the contour and plantation of one-year crop, such as, soy bean, wheat, mandioca, corn, cotton, between the mate trees (Fig. 1-4-8)

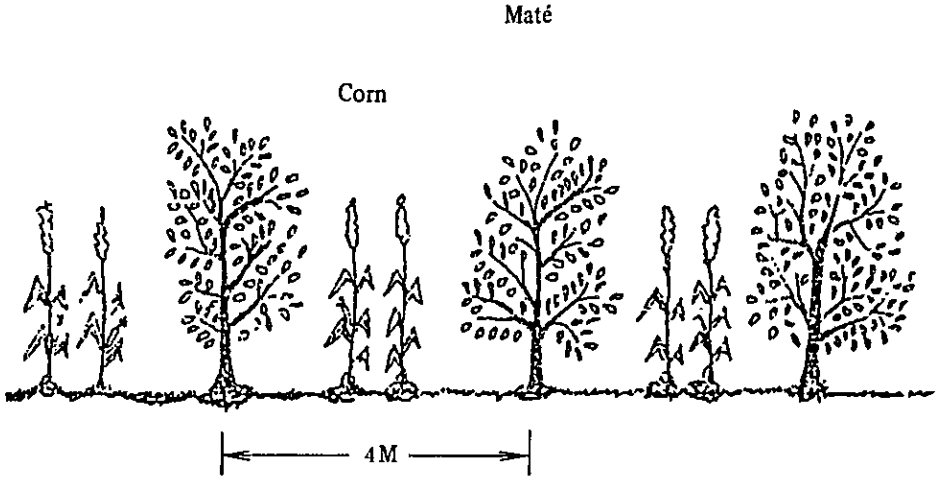


Fig. 1-4-8

2) One-year crop and cocotero

Cocotero trees are not cut and left at the time of forest cutting or making a farm land. Since cocotero creates not much shade, this arrangement is suitable for cotton, mandioca, corn and vegetable. (Fig. 1-4-9)

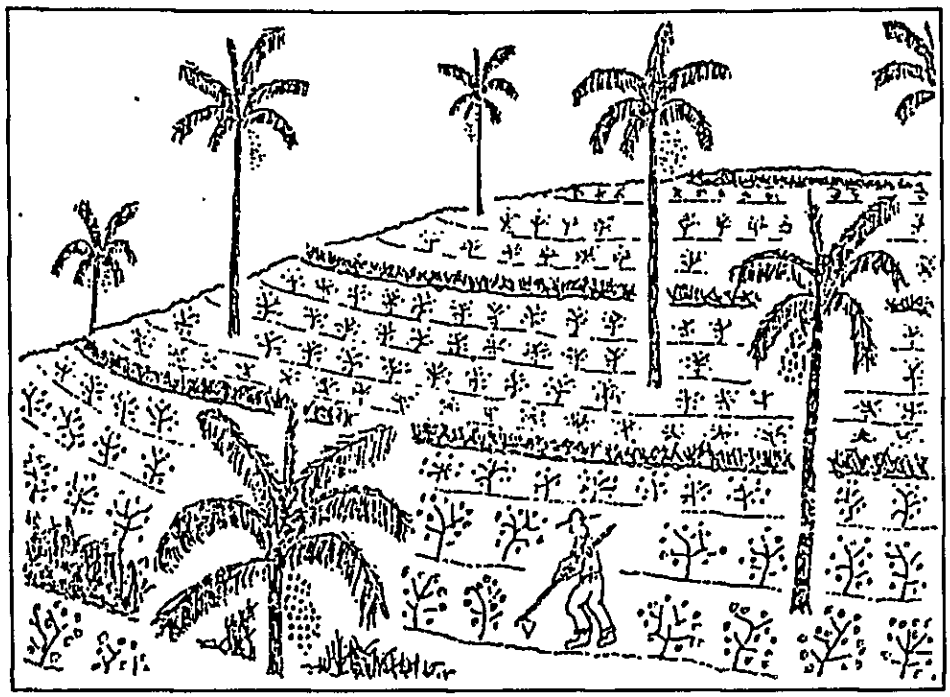


Fig. 1-4-9

3) Tung oil trees and intermediate culture

Plantation of tung oil trees in a straight line or along contours in about 10m ridge spacing and about 5m stump spacing, and farming is conducted between the trees.

Farming is possible for five to eight years until the tung oil trees grow to form much shadow. (Fig. 1-4-10)

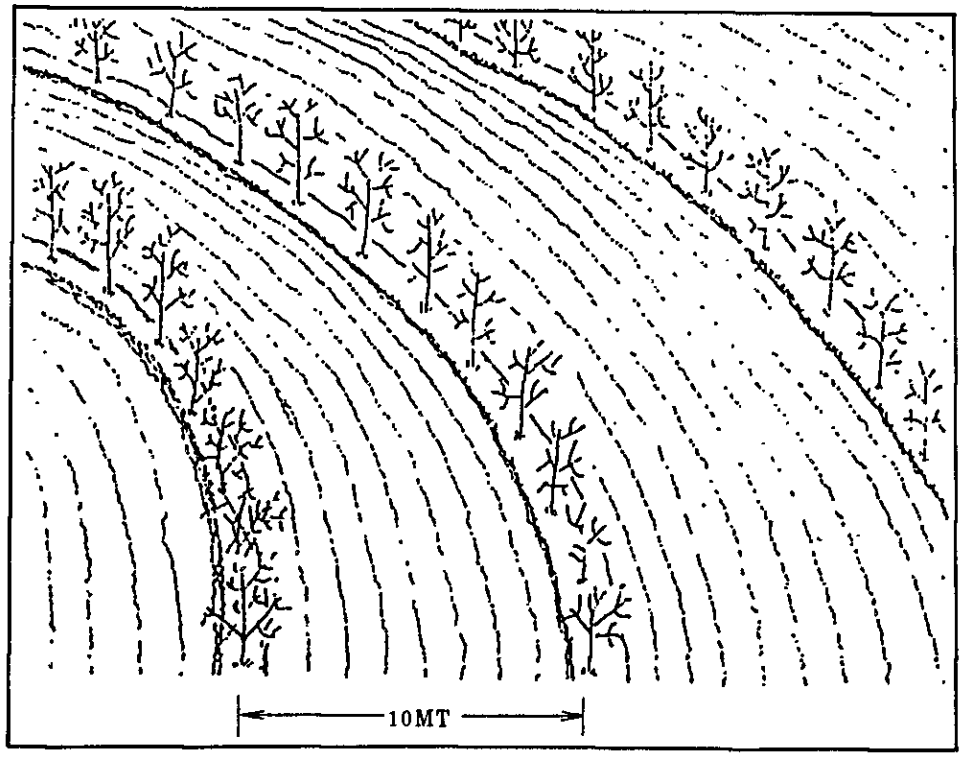


Fig. 1-4-10

4) Fruit trees and other farming crops

Plantation of fruit trees (Guayaba, tangerine, lemon, mango aguacate (avocado), peach, pear, pecán) in about 10 m ridge spacing and about 5 m stump spacing, and farming is conducted between the trees.

Bee-culture is also possible utilizing the fruit tree nectar.

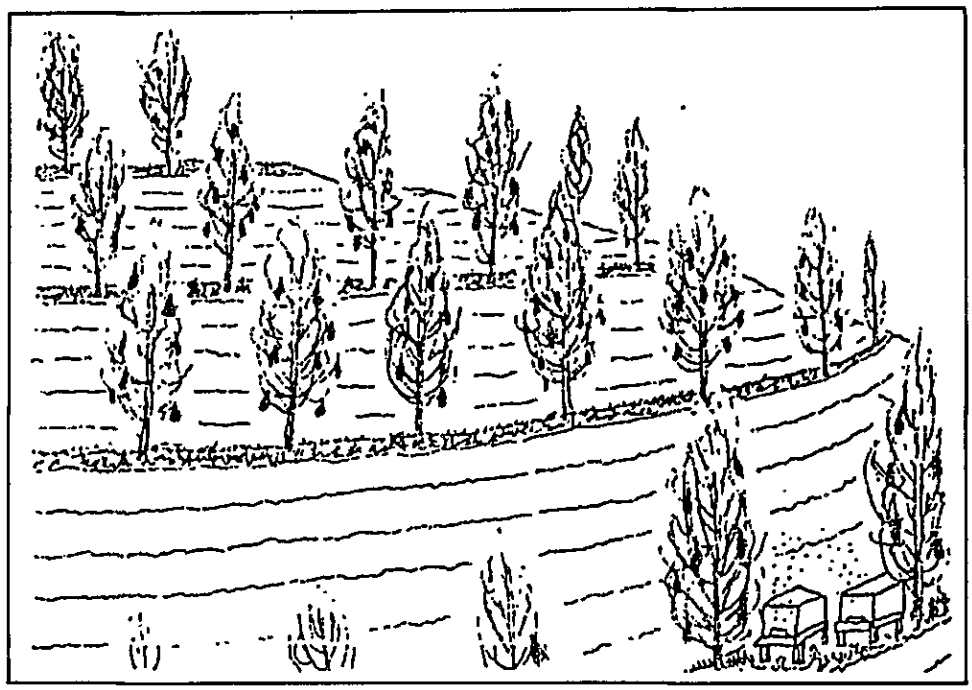


Fig. 1-4-11

5) Palmito, banana or mamon (papaya) in a forest

Plantation of these trees in a space of 25 to 400m² within a forest. The forest effectively protects these trees from frosting. (Fig. 1-4-12)

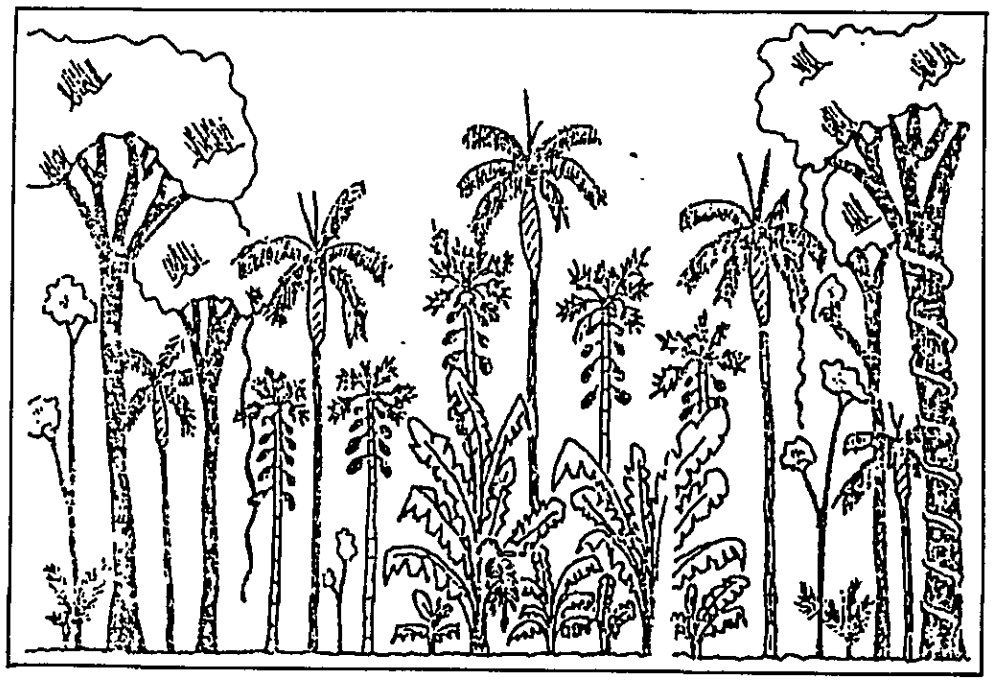


Fig. 1-4-12

6) Paraiso Gigante, Peterevý and farming

These trees provide high class materials for wood work. They are planted in intervals of 2.5m x2.5m, with Paraiso Gigante and Peterevý planted alternately, and farming is conducted between the trees.

Pruning is essential for both of them in the first three years.

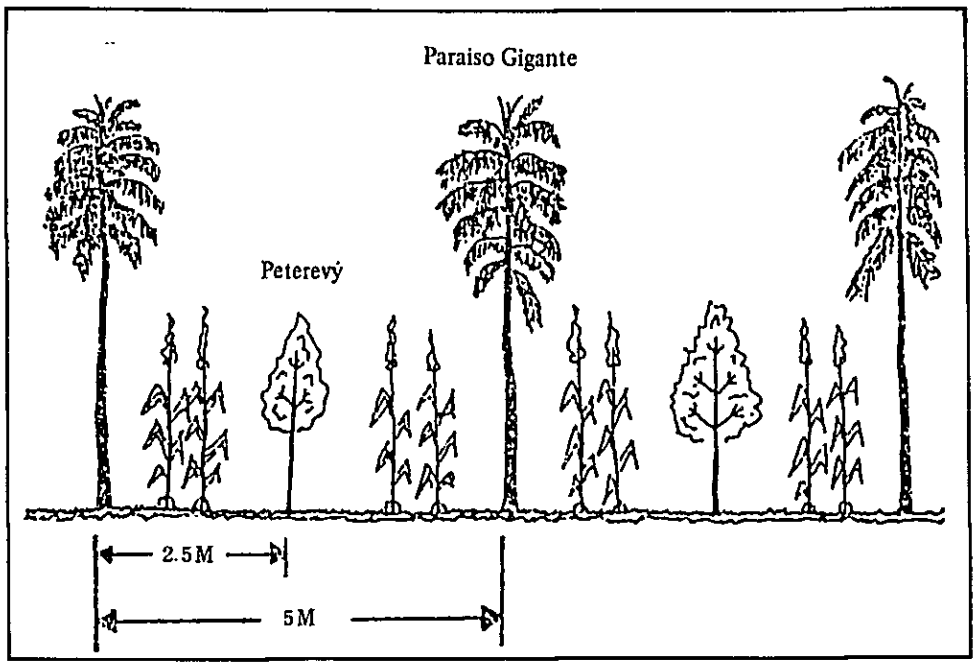


Fig. 1-4-13

Photo 1-4-5 Paraiso Gigante, Peterevý (1 year and 2 months) and corn

7) Alternate plantation of Paraiso Gigante and Maté

These two species are planted alternately in intervals of 2m x 2m. Paraiso Gigante trees are cut in 6 to 12 years, leaving normal intervals for Maté (4m x 4m). (Fig. 1-4-14)

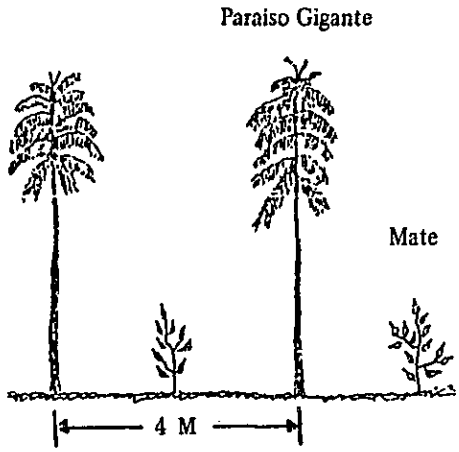


Fig. 1-4-14

8) Reforestation and live stock farming

Plantation of eucalyptus, Paraiso Gigante or pine trees in a band or group form within a grazing land for multiple purposes of providing shadows to live stocks, helping growth of grass and production of lumber.

Another method is to divide a grazing land into two types of wood production and live-stock farming and these operations are conducted alternately in a cycle of 10 to 15 years, thereby maintaining the land fertility.

(4) Trees and fruit trees applicable to agroforestry

The following trees and fruit trees are generally applicable to agroforestry.

Original species

Yerba Maté	Timbó
Parana pine	Lapacho
Peterevý	Guatambú
Loro Blanco	Incienso
Yvyrá Jú	Yvyrá ró
Yvyrá Pytá	

Adopted species

Paulownia	Caliandra
Leucaena	Eucaliptus spp
Paraiso Gigante	Ciprés
Sesbania	Grevillea
Hovenia	Pines

Fruit trees

Palmito	Guayaba	Pecán
Tung oil tree	Lemon	Tangerine
Coffee	Orange	Mulberry
Pear	Aguacate (avocado)	Loquat
Banana	Mamón	Grapefruit
Peach	Persimmon	Damson plum
Mango	Pineapple	

Note) Reference: Alto Parana Forestry Center; Agroforest System (1982)

5. FUTURE OUTLOOK OF FOREST RESOURCE AND CUTTING VOLUME

5-1 Forest Area

(1) Total forest area

From a result of the present survey it has become evident that the forests in the area have been cut and converted to other uses at rapid rate, particularly at accelerating rate in a recent few years. Under this circumstance, it is an important task for forestry policy to effectively control the decrease of the forests. In this plan, the future forest coverage was estimated under the following assumptions:

① Present forest area will be principally maintained in forest zone, mixed zone and conservative zone of the previous land use classification.

② 25% of the present forest area will be retained in other zones (except for swamp and others).

As a result, a future outlook of the forest coverage in the area was estimated as follows:

Table 1-5-1 Future outlook of forest area

Land use classification	Area classified	Estimated forest area	Forest ratio
	ha	ha	%
Urban zone	15,700		
Agricultural zone	32,800	89,700	25
Livestock farming zone	310,200		
Forest zone	938,700		
Mixed zone	223,300	880,400	74
Conservative zone	35,000		
Swamp and others	13,100	–	
Total	1,568,800	970,100	62

(2) Area by forest class

On the basis of the estimated forest area, the area by forest class was estimated by using area composition of the forest classes (refer 3-1), as follows:

Table 1-5-2 Future outlook of area by forest class

Forest classification	Areal composition	Estimated area by forest class
Productive forest	75 %	727,600 ha
Protective forest	22	213,400
Special forest	3	29,100
Total	100	970,100

Henceforth, the forest area in the future is estimated at 970,000 ha, with productive forest to be around 730,000 ha.

5-2 Stock and Increment

5-2-1 Stock

(A) Stock in productive forest

(1) Targeted volume natural forest (Standard volume in forest to be targeted for the future)

14 plots of dense crown forests, a subject of the forest resource survey, were arranged in the order of volume per ha, and among which 9 plots or upper 2/3 in terms of value were selected and divided by the number of plots to calculate the average volume. Then, the average volume of useful species group (A + B species group) was calculated, as separately from the above total volume, by using same calculation procedure. The results are as follows:

Table 1-5-3 Average volume of dense crown forest (averaged upper 2/3 plots)

Species group	Number of plots	Total volume	Average volume per ha	Remarks
All species	9	1,161.29m^3	129.03m^3	Total volume within the plots
Useful species	9	757.36	84.15	Volume of A + B species group included in above volume

On the basis of the above calculation results, the targeted volume of natural forest in the area was determined as follows:

Targeted volume of natural forest (per ha)

All species 130 m^3

Useful species 85 m^3

This targeted volume indicates a standard volume of natural forest when an appropriate management is done in accordance with the plan; natural forest with targeted volume of 130 m^3 in total and 85 m^3 for useful species or 65% of the total volume.

As a piece of reference information, we calculated the average volume of the current selective treatment forests. It is about 69 m^3 per ha, and the details are shown in the table below.

Table 1-5-4 Average volume of selective treatment forests

Forest classification	Forest type group	Area	Average volume/ha	Total volume	Remarks
Productive forest	$A_1 \sim A_3$	316,000 ha	73.12 m^3/ha	23,104,763 m^3	Includes Type D (22,200 ha.)
	M_2, M_3	324,500	65.02	21,098,225	The volume is the value obtained by calculation of each type.
	Total	640,500	69.01	44,202,988	

(2) Targeted volume of planted forest

Targeted volume of planted forest was determined for Parana pine and Ellitottii pine as index species.

According to a result of the survey (2.3), stand volumes of Parana pine and Elliottii pine at an age of 20 years, including final thinning volumes, are estimated at around 300 $m^3 \sim 400$ m^3 per ha or 350 m^3 per ha on the average.

Then, as this estimate is assumed to be of stem volume, the estimate was converted to usable volumes by multiplying usable rate of 70%, to be added to the volume of natural forest. As a result, targeted volume of palnted forest in the area was determined as follows:

Targeted volume of planted forest (per ha)

Parana pine
Elliottii pine 245 m^3

(3) Composition of natural and planted forest

Composition of natural and planted forest in productive forest was determined in accordance with '3.1 Forest Classification' and standards for management systems, to be as follows:

Natural forest	90%	655,000 ha
Planted forest	10%	73,000 ha

(4) Estimate of total stock

Aforementioned targeted volumes correspond to usable volumes of natural forest immediately before selective cutting and of planted forest expressed by total stand volume in a cutting period; when normal treatment of forests is carried out, productive forest (working-section) as a whole will have a distribution of stands immediately after cutting and before cutting in roughly equal area. (Normal stand distribution)

① Accordingly, change in normal stock of a forest which is subject to selective cutting and is under normal condition could be illustrated in the following diagram.

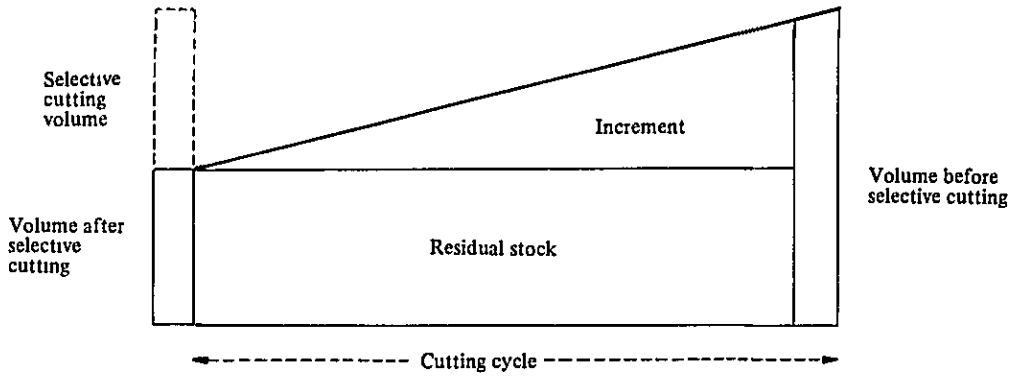


Fig. 1-5-1 Change in stock of forest subject to selective cutting

This change could also be expressed by the following formula:

$$V = A[v(1 - p) + \frac{1}{2}v \cdot p]$$

Whereas,

V: Total stock of a forest subject to selective cutting

A: Area of the forest

v: Targeted stock

p: Selective cutting rate

② By the same token, change in stock of a planted forest subject to clear cutting could be illustrated in the following diagram:

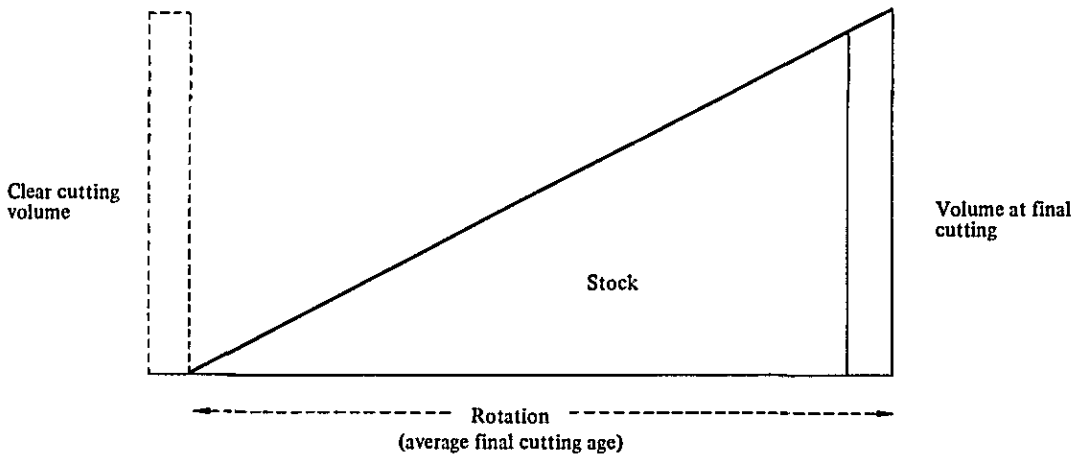


Fig. 1-5-2 Change in stock of forest subject to clear cutting

Total stock in this case could be calculated by

$$V = A\left(\frac{1}{2}v\right).$$

③ From the above results, total stock of the productive forest was estimated as follows:

Table 1-5-5 Total stock of productive forest

Type of forest	Area	Stock	Stock per ha	Remarks
	,000ha	,000m³	m³/ha	
Natural forest	655	63,863	97.5	Including stock of useful species of 41,756,000 m³
Planted forest	73	8,943	122.5	
Total	728	72,806	100.0	

(Calculation process)

Natural forest:

$$V = 655{,}000\ \text{ha} \times \left(130\ \text{m}^3 \times (1-0.5) + \frac{1}{2} \times 130 \times 0.5\right)$$
$$= 63{,}862{,}500\ \text{m}^3$$

(Selective cutting rate of 50% assumed)

Planted forest:

$$V = 73{,}000\ \text{ha} \times \frac{1}{2} \times 245\ \text{m}^3 = 8{,}942{,}500\ \text{m}^3$$

(B) Stock of other forest classes

① As protective forest and special forest are assumed to maintain the existing condition, a weighted average of the existing stock of mixed forest (M) and low forest (B_1, B_2) was calculated to determine the stock per ha of 50 m³.

② Then, the stock per ha was multiplied by the total area of two forest classes, 242,500 ha, or the area of productive forest in (2) of 213,400 ha and the area of special forest of 29,100 ha, to estimate the stock of these forests as follows.

Table 1-5-6 Total stock of other forest classes

Forest classification	Area	Stock	Stock per ha
	,000ha	,000m³	m³
Protective forest	213	10,650	
Special forest	29	1,450	
Total	242	12,100	50.0

C. Estimate of total stock

On the basis of the above results, the total stock in the area was calculated to obtain the estimate of around 84,906,000 m^3.

Table 1-5-7 Estimate of total stock

Forest classification	Area	Stock	Stock per ha
	,000ha	,000m^3	m^3
Productive forest	728	72,806	100.0
Other forest classes	242	12,100	50.0
Total	970	84,906	87.5

5-2-2 Increment

(A) Increment of productive forest

(1) Increment of natural forest

Under the assumption that the forest management such as adequate selective cutting and natural regeneration will be done in the future, increment of trees with diameter breast height of less than 40 cm, which is based on a result of an increment survey in natural forests, was divided by the stem volume per ha of same diameter class to calculate an increment rate of 4.8% as follows:

Increment rate

$P_{40}(\%) = 1.5768/32.72 \times 100 = 4.8\%$

In addition, other types of management were taken into consideration to determine the increment rate of the natural forests at 5%, and then which was multiplied by the stock of the natural forests which was previously determined to estimate the increment as follows:

Increment of natural forest

63,863,000 m^3 x 0.05 = 3,193,000 m^3

(2) Increment of planted forest

From a result of the present survey the annual increment of Parana pine and Elliottii pine at an age of 20 years is estimated between 20 m^3 ~ 30 m^3 per ha. In this plan, a value of 25 m^3 per ha was multiplied by a use rate of 70% to obtain the estimate of the increment as follows:

Increment of planted forest

73,000 ha x 25 m^3 x 0.7 = 1,277,500 m^3

(3) From the above results, the increment of productive forest was estimated at 4,471,000 m^3, as presented in the following table:

Table 1-5-8 Increment of productive forest

Type of forest	Stock	Increment	Increment rate	Remarks
	,000m³	,000m³	%	
Natural forest	63,863	3,193	5.0	Including increment of useful species of 2,088,000m³
Planted forest	8,943	1,278	14.3	
Total	72,806	4,471	6.1	

(B) Increment of other forest classes

Under the assumption that protective forest and special forest are assumed to maintain the existing condition, the increment of these forests was estimated from an increment rate of 3.5% (3.3% at present), as follows:

Increment of other forest classes:

$12,100,000\ m^3 \times 0.035 = 424,000\ m^3$

(C) Estimate of total increment

On the basis of the above results, the total increment in the area was estimated at around $4,895,000\ m^3$, as presented in the following table:

Table 1-5-9 Estimate of total increment

Forest classification	Area	Stock	Increment	Increment per ha	Increment rate
	,000ha	,000m³	,000m³	m³	%
Productive forest	728	72,806	4,471	6.1	6.1
Other forest classes	242	12,100	424	2.5	3.5
Total	970	84,906	4,895	5.0	5.8

5-3 Cutting Volume

When a normal forest composition is maintained by an adequate management, the cutting volume becomes equal to the increment. Thus, in this plan an annual increment of a forest is determined as the standard cutting volume in the future.

However, protective forest and special forest are designed to conserve and form forest functions in accordance with purposes of establishing each forest, rather than of producing woods. Thus, 1/3 of the increment of these forests is assumed to be cut and used for the time being, for these forests will require the management suitable to their actual conditions to maintain their functions as an actual management of these has been previously mentioned.

In consequence, the total cutting volume for this area in the future was estimated at around $3,190,000\ m^3$ for natural forest, around $1,280,000\ m^3$ for planted forest and around $140,000\ m^3$, to be totaled to $4,610,000\ m^3$, as presented in the following table:

Table 1-5-10 Estimate of cutting volume

Forest classification	Type of forest	Increment	Cutting volume	Remarks
		,000m³	,000m³	
Productive forest	Natural forest	3,193	3,193	Including useful species of 2,088,000m³
	Planted forest	1,278	1,278	
	Sub-total	4,471	4,471	
Other forest classes		424	140	The cutting volume is determined as 1/3 of increment
Total		4,895	4,611	

5-4 Summary on Future Outlook of Forest Resources and Cutting Volume

To this point, estimates were made on forest area, stock, increment and cutting volume in the area, on the basis of actual information from the field survey to a possible extent. These results are summarized as in the following table.

Table 1-5-11 Summary on future outlook of forest resources and cutting volume

Forest classification		Type of forest	Area	Stock	Increment	Cutting volume	Remarks
			1,000ha	1,000m³	1,000m³	1,000m³	
Estimate	Productive forest	Natural forest	655	(41,756) 63,863	(2,088) 3,193	(2,088) 3,193	( ) – useful species
		Planted forest	73	8,943	1,278	1,278	
		Sub-total	728	72,806	4,471	4,471	
	Protective forest		213	10,650	373	123	
	Special forest		29	1,450	51	17	
	Total		970	(41,756) 84,906	(2,088) 4,895	(2,088) 4,611	
Present (a)			970	(20,460) 46,166	(1,023) 3,051	(1,023) 2,912	
Existing forest (b)			955	(14,964) 27,845	(494) 919	(496) 924	Increment – estimate Cutting volume – standard cutting volume
Ratio	(a)/(b)x100		102	(137) 166	(207) 332	(206) 315	

For reference, we compared the planned result with the current forest situation. As shown in the above table, the stock will increase to about 1.7 times as much as the current state by the time the improvement period (60 years) terminates, and both of the increment rate and cutting rate will be about three times as much.

5-5 Present Cutting Volume and Future Outlook

Up to the previous section, the estimate of the forest resources and cutting volume has been done when an adequate forest management is carried out in accordance with the plan. In this section, on the basis of the present cutting volume (Part 2.3.2) which was estimated from the basic survey for the preparation of this plan, the exploitable years were estimated from the allowable cut such as stock and increment of the forest at present, to serve as a reference on implementing the government policy on forestry for the time being.

5-5-1 Present allowable cut of forest and actual cutting volume

(1) As previously stated, the standard cutting volume in the planning area was determined at 924,000 m^3, which includes 496,000 m^3 for useful species. The cutting volume should be construed as a maximum volume which is allowed to cut in a year.

(2) On the other hand, from the present basic survey, the actual cutting/logging volume in recent years was estimated at around 697,000 m^3, which is only logging volume for saw-logs. The cutting volume is thought to be corresponding to cutting volume of useful species in terms of standard cutting volume. Also, 523,000 m^3, which is equivalent to 75% of the cutting/logging volume, appear to be of Peroba.

(3) By using the above results, the allowable cut (standard cutting volume) and the actual cutting volume of the forests were compared as in the table below, to indicate that the actual cutting volume exceeds the allowable cut by 1.4 times for useful species and by three times for Peroba.

Table 1-5-12 Allowable cut and actual cutting volume

Species	Allowable cut ⓐ	Actual cutting volume ⓑ	ⓑ / ⓐ x 100
	1,000m^3	1,000m^3	
Useful species (A+B)	496	697	141
Peroba	174	523	301

5-5-2 Exploitable years under present cutting volume

(1) Exploitable years (ℓ) when a given cutting volume (Ew) is maintained could be obtained by transforming the formula to estimate the previous standard cutting volume to the following formula:

$$\ell = \frac{Vw}{Ew - \frac{1}{2} Zw}$$

(2) By using the actual stock (Vw) and the increment (Zw) for the standard cutting volume, the exploitable years for all species and Peroba were calculated on the basis of the above actual cutting volume as presented in the table below; which indicates that useful species could be cut for next 33 years and Peroba for only 12 years.

Table 1-5-13 Exploitable years under present cutting volume

Species	Actual stock Vw	Increment Zw	Actual cutting Ew	Exploitable years ℓ
All species	14, 963,651 m^3	493,800 m^3	697,000	33.2 years
Peroba	5,236,867	172,817	523,000	12.0

(Calculation process)

ℓ (Useful process)

$$= \frac{14{,}963{,}651}{697{,}000 - \frac{1}{2} \times 493{,}800} = \frac{14{,}963{,}651}{450{,}100} = 33.2 \text{ years}$$

ℓ (Peroba)

$$= \frac{5{,}236{,}867}{523{,}000 - \frac{1}{2} \times 172{,}817} = \frac{5{,}236{,}869}{436{,}592} = 12.0 \text{ years}$$

(3) Naturally, as the forest resources becomes closer to exhaustion to deteriorate the quality of forest products and to move the cutting work to remote areas, the cutting volume gradually decreases. Thus, it is not conceivable that all the forests are disappeared in the exploitable years. Nevertheless, it is obvious that the situation will go toward exhaustion of the forest resources, deterioration of the quality of wood products and increase of production cost at accelerated rate, so far as the present cutting practice continues. Since an ominous sign of such situation is clearly observed, prompt actions should be taken.

6. PROPOSAL FOR THE IMPLEMENTATION OF GUIDELINE FOR FORESTRY DEVELOPMENT PLAN

Guideline for Forestry Development Plan has been formulated for the purpose of improving the regional economy and advancing the welfare of the people in the northeastern part of Paraguay through cultivating and maintaining forestry resources, securing the continuous and stable supply of forestry products, expanding job opportunities, as well as conservation of soil, water sources conservation, and maintaining and strengthening the functions of forests for the public interests including maintenance and formation of natural environments, etc.

In order that these purposes may be achieved, it is necessary that the existing forests will be properly managed and the development of forestry resources be aggressively undertaken according to the provisions of the Guideline.

Since the details have specifically been provided in each item of the Guideline, we would like to discuss herein some of the matters that are essentially important with respect to the implementation of the Guideline, and wish to make comprehensive proposals in the following.

But, we will not go into details as to the method of implementation or adoption of these proposals considering the nature of the Guideline, because we hope that further experiments by experts will be made of these proposals.

(1) Expansion of measures for the development of nation's forestry and forest

a. Introduction of a forestry plan system

Forestry and forest has been a long-standing industry, that has supported the nation's economy for ten or more years, as well as it provides various benefits such as conservation of the soil stability, water-sources conservation, etc., conservation and formation of natural environments aside from its economic merits deriving from wood industry. Therefore, the measures for the development of forestry and forest, should be systematically carried out on a long-range and wide horizon.

For this purpose, it is necessary to formulate a systematic and integrated forestry plan which incorporates state and regional forest developments. It is desired that an equitable forestry plan system be studied and developed as early as possible.

We are submitting "the system of forest planning organizations" adopted in Japan for reference.

b. Designation of protective forest and clarification of management plan method

We have shown on the forestry plan map an area of approximately 191,000 ha classified as protection forests in accordance with the forestry law of Paraguay (Law No. 422).

It is expected that these protection forests be clearly distinguished in each area, and the forestry management standards be clearly established and other efective measures be provided in order to achieve the objectives.

We are submitting for reference the "Standards for Determination of Specified treatment conditions" of Protection Forests in Japan.

c. Cutting rules and accurate control of cut volume

As we have discussed the productive capacity of the forests in the region, the allowable cut, the current situation and future outlook of timber cutting, etc. in respection section, if the cutting should proceed at the current rate, the

forestry resources will be exhausted, and a great damage will be brought onto the regional economy and people's livelihood as well as on the conservation of national land.

Log shipments are presently checked at inspection stations established at the key points of main roads. From the observation we have made, the rate of seizure does not seen high enough.

In view of the situation, it may be necessary to provide such measures as follows as early as possible in order to effectively control the cutting and to have accurate knowledge of the cut volume.

① To have prior knowledge of the cut volume through a lisence system or an application system so that the forestry explitation may be done in an orderly manner and the cut volume may be controlled.

② To strengthen the current checking stations and the full-time watch system with respect to log shipments, as well as to carry out mobile checkings whenever necessary at loading pints or on roadways to improve the rate of seizure.

In addition, the forestry district office could be given the role of checking and completeness.

③ To provide measures to control the cut volume from the aspect of the log consumption side such as setting a goal of consumption per production facility of a sawmill, or controlling the Guia issuance.

(2) To put in order basic information necessary for the forestry management

a. To prepare the stand volume table

There is no timber stock table available in Paraguay, today. In our research work we had to calculate the usable stand valume by applying a calculation formula to individual timber stands. This is not only inefficient, but also makes it difficult to obtain an accurate result from the investigation.

To establish the standards of measurement is a prerequisite in trying to establish a proper forestry management. It is therefore necessary to prepare a stand volume table as early as possible.

It is possible for us to indicate the method for preparing a stand volume table separately.

b. To expand experiments and researches on forestry management

In this survey we have conducted researches on the increment of natural forest, natural regeneration, etc. These data will become more accurate and reliable through the accumulations of more data that would be gathered through a long-term and systematic observation.

Right now, there are several experimental natural forests. But, the size and condition of the forests, and the method of observation should be further studied.

It is necessary that experimental areas be established and observation be started as early as possible to collect necessary basic data to obtain the knowledge of the increment, harvest, and regeneration of natural forest.

In addition, we could separately indicate the methods of experimentation and investigation.

c. To put other basic data in order

In order to expand the forestry resources in this region, the promotion of reforestation is important. For this, putting basic data in order including systematic investigation of forest soils, preparation of a timber stock table, etc. are essential.

But, in view of the present forestry technique, we only emphasize the importance of this activity.

We could suggest some specific methods separately, whenever it is necessary to do so.

(3) To promote aggressive measures for the development of reforestation

a. Protective and supportive measures for reforestation by private sector

It is necessary to positively expand and strengthen the tax preference measures that are now partially enforced under the forestry law, as well as to extend assistance to private sector such as low interest loan, reforestation subsidies, etc.

b. Promotion of a profit-sharing forestation by national or public organizations

Generally, a long-term investment that extends over several decades is necessary for the development of forests. Under the existing situation in this region much cannot be expected of the private sector in this regard.

It is therefore necessary for national or public organizations to take initiatives for the development of forests and thus motivate the private sector toward that objective. In this case, since a majority of the areas in this region is owned by the private it seems proper that reforestation will be undertaken by foresters and land owners under contracts in which the sharing of profits from the cutting or thinning operation will be made by the parties under a predetermined ratio (profit-sharing contract).

A profit-sharing system should be studied as a part of measures for the promotion of reforestation.

(4) To promote and propagate the research and development of reforestation techniques

In the development of reforestation by private people there is a strong desire for adequate technical guidance along with the aforesaid financial assistance.

In the extension of technical guidance, the guiding institute should first study to develop the forestry techniques which would suit the conditions of the region. It is necessary to positively promote the research and development of forestry techniques according to the provisions of this plan, as well as to try to provide technical training to people who wish to engage in reforestation.

It is further necessary to provide necessary facilities and foster technical personnel for that purpose as quickly as possible.

(5) To promote measures for the development of wood-related industries

One of the essential elements in the promotion of reforestation is to secure the marketing channels of wood.

To increase the added value of wood industry through higher utilization of natural wood and untapped wood resources will be extremely important in the development of regional economy and the expansion of job opportunities.

Since this region is situated in an inland area there is a disadvantage in transporting or exporting large and heavy material like wood. It is therefore more advantageous to raise the level of processing and produce goods with higher added values, which will have better effects on national economy and people's welfare.

For that reason, it is necessary to aggressively induce and promote wood-consuming industries such as wood chips industry, pulp industry, plywood industry, furniture and wood work industry, paper industry, etc.

(6) To promote the development of new wood technologies including the use of untapped wood resources

As earlier discussed in this paper, the wood species utilized in this region are limited

to a few including Perab. But, in some of the advanced enterprises, a greater number of species are tried for furniture production, etc.

Particularly at the Forestry Development Center (CEDEFO) endeavors are made for the development of various uses of domestic wood species.

It is necessary to aggressively develop wood technologies including untapped wood resources in the region in close cooperation with CEDEFO, which will awaken the creativeness of private enterprises.

It is, further, necessary to provide necessary facilities and foster technical personnel for that purpose.

(7) To aggressively promote the education and propagation of the effects of forestry

Dunudation of tropical and subtropical forests is now occurring on the global magnitude. The advancing desert and changing climate are the matters of great concern to us.

This region is no exception. The decline in soil productive capacity and soil erosion are already observed in various areas. Some people are concerned of signs of climatic change. But, since this region has been favored with relatively rich forests, people in general seem to be less concerned of the indirect effects of forests.

It is therefore essential that national or public organizations will initiate to aggressively promote the educational and propagative activities on the importance of "green resources", so as to heighten the enthusiasm of people for reforestation.

(8) To promote more intensive and integrated use of land

As discussed in the land-use classification under this plan, a majority of land in this region is carelessly used except in cities, agricultural areas, and cattle raising land. Particularly noted is the careless land-use in which the process of logging – burning – cattle raising – wilderness has been repeated.

As discussed in the section of Forest Development Plan in the model area, it is necessary to restore the soil productive capacity and promote intensive land use through the establishment of reserved forests, and reforestation under the land classification system as well as to promote an integrated land use including compound management of cattle-raising and forestry, or agriculture and forestry. This will be an important problem for the development of this region toward the 21st century.

PART II

BASIC SURVEY

1. FOREST SURVEY

Pointed to controlled forest development, forestry promotion and development of regional economy in northeast region of Paraguay, forestry resource survey, including preparation of aerial photograph map, forest resources survey and soil investigation, was carried out in past three years starting from 1980, and clarified the existing condition of forest resources and characteristics of the forest. In this section, an outline of previous surveys including their progress and result was summarized, to reveal a whole part of forestry resource in the region.

1-1 Progress and Result of Previous Surveys

1-1-1 Progress of the surveys

The progress of the surveys are as follows:

Table 2-1-1 Progress of the surveys

<table>
<tr><th>Item of survey \ year</th><th>1980</th><th>1981</th><th>1982</th></tr>
<tr><td>General survey</td><td>Landsat data analysis</td><td></td><td rowspan="6"></td></tr>
<tr><td rowspan="5">Forestry resources survey</td><td colspan="2">Aerial photographing
(northern part) : (southern part)</td></tr>
<tr><td>Forest preliminary survey</td><td></td></tr>
<tr><td rowspan="4"></td><td>Air photo interpretation</td></tr>
<tr><td colspan="2">Forest regular survey
(northern part) : (whole area) 1st 2nd</td></tr>
<tr><td></td><td>Dense crown forest survey</td></tr>
<tr><td></td><td>Soil investigation</td></tr>
</table>

(1980)

① Landsat data analysis ..... Landsat data analysis was done for general survey area of 5 million ha.

② Preparation of forest and land use map ..... Land use map including forest was prepared on the basis of Landsat data analysis. Chronological change of forest area was identified.

③ Aerial photographing ..... Aerial photograph (scale: 1/20,000) was taken for about 800,000 ha in the northern part of the forestry resource survey area. (1.5 million ha)

④ Preparation of mozaic photo ..... 56 sets of mozaic photo were produced from the above air photos.

⑤ Forest preliminary survey ..... Preliminary survey for implementation of final survey was carried out for an area of 52,500 ha.

⑥ Designing of final survey method ..... Final survey method was designed on the basis of a result of the preliminary survey.

(1981)

① Aerial photographing ..... Aerial photograph was taken for about 700,000 ha in the southern part of the survey area.

② Preparation of mozaic photo ..... 53 sets of mozaic photo were produced from the above air photos.

③ Air photo interpretation and stratification ..... Stratification of each forest type was made for a whole part of the resource volume survey area of 1,500 ha. At the same time, the other land uses were read out and delineated.

④ Forest final survey ..... The sampling survey was carried out for 800,000 ha in the northern part of the survey area, at 32 points.

⑤ Analysis ..... Sampling survey results was compiled and analyzed by estimating the mean volume per ha of each story and its standard deviation, to ascertain the characteristics of the forests.

⑥ Estimate of resource volume ..... Land use area and resource volume for the northern part were estimated.

(1982)

① Designing of survey ..... On the basis of a result of analysis in 1981, sampling survey of a whole part of the area was designed. Sampling survey in 1981 constituted a part of the survey.

② Forest final survey ..... The sampling survey was done for 1,500 ha at 63 points. Together with 1981 survey the number of samplings is totalled to 95 points.

③ Analysis ..... A result of the survey at those sampling points was compiled and analyzed by estimating the mean volume per ha of each story and its standard deviation, to ascertain the characteristics of the forests, along with the various other analysis.

④ Estimate of resource volume ..... Land use area and resource volume for the whole survey area were estimated.

⑤ Dense crown forest survey ..... The area with high crown density on air photos was interpreted and delineated as dense crown forest, and field survey was carried out at major 14 points by same method as the resource sampling survey.

⑥ Soil investigation ..... Soil investigation was carried out for major sampling points of the resource survey and dense crown forest survey, to analyze forest soil and forest composition.

⑦ Preparation of read-out information card ..... Read-out information cards were prepared for 62 sampling points of major forest types.

⑧ Preparation of forest type map ..... Read-out results of the air photos were copied onto the mozaic photos, which then were used as a base map for polyester base forest type maps (109 sheets).

⑨ Preparation of forest survey ledger ..... The forest survey ledger, made up of forest composition factor, area and volume, was prepared for each read-out division.

1-1-2 Survey report

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

March, 1981 Report on The Landsat Analysis, The Forest Resources Inventory in The Northeastern Region, The Republic of Paraguay

March, 1982 Report on The Forest Inventory in The Northeastern Region, The Republic of Paraguay in 1981

March, 1983 Inventario Forestal Zona Noreste de la Region Oriental Republica del Paraguay

1982 report (March, 1983) was prepared as a final report on results of forestry resource survey carried out for three year period between 1980-1982; 1980 and 1981 survey results were included therein.

1-2 Landset Data Analysis

1-2-1 Preparation of forest type and land use map

From the results of Landsat data analysis, the forest type and land use map (scale: 1/500,000) was prepared.

1-2-2 Analysis of chronological change of forest

① Using Landsat data, analysis of chronological change of forest was done for a whole part of the area. As a result, it was estimated that the forests have disappeared at annual average rate of about 1.3% for five year plus period between September, 1972 and October, 1977, as presented in Table 2-1-2.

Table 2-1-2 Forest and cutting area by Landsat image interpretation

	Period	Forest area	Cutting area	Cutting area ratio	Annual cutting area ration
Western part (Main image sphere)	2 years 8 months (Mar. 1973 ~ Dec. 1975)	ha 771,200	ha 29,600	% 3.70	% 1.39
Eastern part (Supplemental image sphere)	5 years 1 month (Sep. 1972 ~ Oct. 1977)	209,800	14,300	6.38	1.26
Whole area	–	981,000	43,900	–	–

② According to the survey results on a specific area (52,500 ha) in combination of Landsat data analysis, aerial photographing in 1968 (scale: 1/60,000) and read-out value from 1980 photos (scale: 1/20,000), the rate of forest disappearance for 12

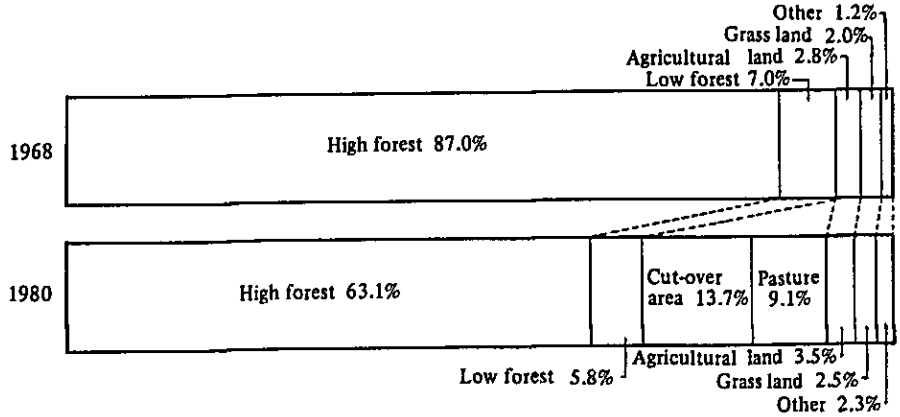


Fig. 2-1-1 Comparison of land use between 1968 and 1980

year period between 1968 and 1980 is 27.5% for high forest, 17.2% for low forest, with annual average rate of 2.3% and 1.4% respectively.

③ When the phenomenon was analyzed by yearly breakdown as in Fig. 2-1-2, rapid declining trend was observed in recent five years between 1975 and 1980; this trend is quite important on planning a treatment of forests in this area.

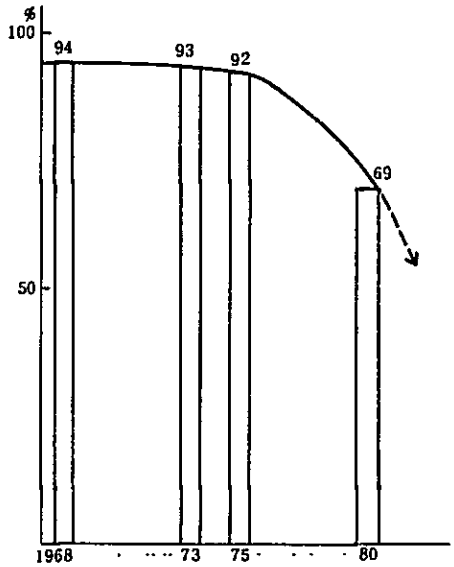


Fig. 2-1-2 Yearly change in share of forest

1-3 Forest Resources

The volume of forests in this area was estimated on a survey which used stratified sampling method.

The number of sampling is 95 points, with each area of 1 ha (500 m x 20 m).

1-3-1 Surveyed forest and stratification

Using criteria for stratification in Table 2-1-3, surveyed forests were stratified to obtain their area for each stratum and land use, as presented in Table 2-1-4, Fig. 2-1-3 and Fig. 2-1-4.

Table 2-1-3 Criteria for stratification

Stratum category	Symbol	Description
High forest	A1	Upper tree height of more than 15 m, crown density of less than 20%.
High forest	A2	Upper tree height of more than 15 m, crown density of less than 21 ~ 49%.
High forest	A3	Upper tree height of more than 15 m, crown density of more than 50%.
Mixed forest	M	High and low trees are mixed in upper trees.
Medium forest	M2	Same as A2, but crown size of single tree is smaller than A2.
Medium forest	M3	Same as A2, but crown size of single tree is smaller than A3.
Low forest	B1	Upper tree height of less than 15 m, with uniformly small crown size.
Low forest	B2	Upper tree height of less than 15 m, variation in crown size, with high tree found in some size.
Forest under cutting	E	Upper tree height of more than 15 m, with many service road to evidence cutting of useful trees in recent years.

Table 2-1-4 Area by stratum and land use

Stratum and land use	Symbol	Area (ha)	Share in total area (%)	Share in forest·non-forest (%)
High forest	A 1	68,908.56	4.39	7.21
High forest	A 2	247,706 11	15.79	25 93
High forest	A 3	20,244.00	1.29	2.12
Mixed forest	M	118,385 02	7.55	12.39
Medium forest	M 2	336,838 09	21.47	35. 25
Medium forest	M 3	32,188. 59	2.05	3 37
Low forest	B 1	30,829.04	1.97	3.23
Low forest	B 2	70,688. 78	4.51	7.40
Forest under cutting	E	29,615 92	1 89	3 10
Forest total	—	955,404 11	60 90	100 00
Agricultural land	A	78,927. 73	5.03	12 87
Swamp	H	50,225 87	3 20	8 19
Pasture	G	338,167 34	21.55	55 12
Cut-over area	C	143,704 89	9 16	23.43
Built-up area	P	2,373 20	0.15	0 39
Non-forest total	—	613,399.03	39 10	100 00
Total	—	1,568,803 14	100.00	—

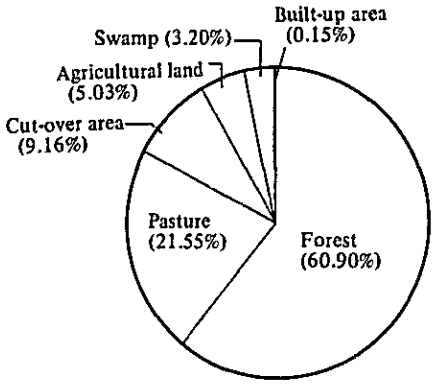


Fig. 2-1-3 Composition of area by land use

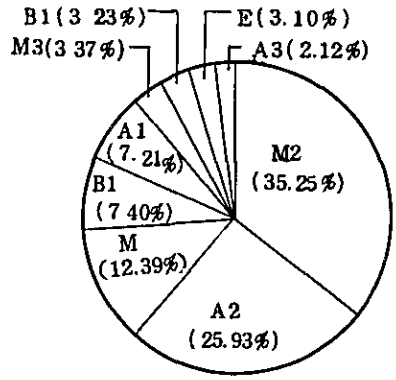


Fig. 2-1-4 Composition of area by stratum

1-3-2 Species identified

① 135 species with breast height diameter of more than 41 cm were identified in the sampling survey area, as seen in Table 2-1-5. Among stratum categories, many species were identified in high forest, medium forest and mixed forest.

Table 2-1-5 Number of identified species by stratum and class

Species class / Stratum	A		B		C		D		E		Total		Number of sampling
	Identified species	%	Identified species	%	Identified species	%	Identified species	%	Identified species	%	Identified species	%	
A 1	9	90	8	80	18	75	30	77	25	48	90	67	6
A 2	10	100	8	80	18	75	33	85	35	67	104	77	32
A 3	9	90	7	70	16	67	29	74	24	46	85	63	6
M	7	70	8	80	17	71	32	82	29	56	93	69	10
M 2	10	100	9	90	19	79	34	87	34	65	106	79	26
M 3	9	90	7	70	16	67	27	69	29	56	88	65	4
B 1	4	40	2	20	6	3	6	15	8	15	26	19	2
B 2	8	80	6	60	17	71	21	54	25	48	77	57	5
E	8	80	5	50	13	54	27	69	23	44	76	56	4
Total	10	7	10	7	24	18	39	29	52	39	135	100	95

② 10 species with largest volume were selected for typical diameter classes and listed in Table 2-1-6. According to this, Peroba constitutes 14.2% of the total volume for diameter class of more than 10 cm and 22.3% for diameter class of more than 41 cm, to show the highest share among species, particularly large diameter class. In addition, share of these species by their number was listed for reference.

Table 2-1-6 10 identified species with largest volume

Diameter brest height (DBH) of more than 10 cm						
Ranking	Local name	Branch	Genus	Class	Share by volume	Share by number
1	Peroba	*Apocynaceae*	*Aspidosperma*	B	14.2 %	6.1 %
2	Yvyrá pytá	*Leguminosae*	*Peltophorum*	B	5 5	—
3	Kupa ý	*Leguminosae*	*Copaifera*	C	4.5	—
4	Yvá poroitý	*Myrtaceae*	*Myrciaria*	D	4.1	11.6
5	Laurel	*Lauraceae*	*Nectandra*	C	3 5	5.0
6	Kurupay	*Leguminosae*	*Piptadenia*	A	3.4	—
7	Guatambú	*Rutaceae*	*Balfourodendron*	A	3 3	—
8	Yvyrá piú	*Sapindaceae*	*Diatenopteryx*	D	3 2	3.8
9	Kutupay rá	*Leguminosae*	*Piptadenia rigida*	B	2 8	—
10	Guajayví	*Boraginaceae*	*Patagonula*	C	2.7	—
Total					47 2	

Diameter brest height (DBH) of more than 41 cm						
Ranking	Local name	Branch	Genus	Class	Share by volume	Share by number
1	Peroba	*Apocynaceae*	*Aspidosperma*	B	22 3 %	14.0 %
2	Yvyrá pytá	*Leguminosae*	*Peltophorum*	B	10.0	6 8
3	Kupa ý	*Leguminosae*	*Copaifera*	C	7 1	6 4
4	Kurupay	*Leguminosae*	*Piptadenia*	A	5 5	4.3
5	Kurupay rá	*Leguminosae*	*Piptadenia rigida*	B	4.6	4.1
6	Guajayví	*Boraginaceae*	*Patagonula*	C	4 0	5.7
7	Guatambú	*Rutaceae*	*Balfourodendron*	A	3.3	3 8
8	Lapacho	*Bignoniaceae*	*Tabebuia*	A	3 1	—
9	Kurñai			E	2 8	2.9
10	Urunde y pará	*Anacardiaceae*	*Astonium*	C	2.8	—
Total					65 6	

1-3-3 Estimate of stock

(1) Total stock

Total stock (diameter breast height of more than 41 cm, without bark, defective trees excluded) in the survey area was estimated at 27,845,025 m^3 ± 2,314,944 m^3. Accuracy of this estimate is within an error of 8.31% at confidence level of 90%.

Likewise, total stock of A + B class was estimated at 14,963,651 m^3 ± 1,731,470 m^3 and Peroba at 5,236,869 m^3 ± 1,462,447 m^3, to constitute 53.7% and 18.8% of total stock in the survey area.

Stock by stratum is as follows:

Table 2-1-7 Stock by stratum

Stratum	Symbol	Stock	Composition
High forest	A1	1,528,737	5.5
	A2	9,163,655	32.9
	A3	1,236,369	4.4
Mixed forest	M	3,288,617	11.8
Medium forest	M2	9,859,121	35.4
	M3	1,196,691	4.3
Low forest	B1	12,640	0.1
	B2	781,111	2.8
Forest under cutting	E	778,084	2.8
Total	–	27,845,025	100.0

(2) Stock by species and state

① Stock of each species is as presented in Table 2-1-8, including Cedro of 457,000 m^3, Lapacho of 876,000 m^3 and Peroba of 5,237,000 m^3.

Table 2-1-8 Stock by species

Species class	Name of Species	Stock (1,000 m³)	Stock per ha (m³/ha)
Class A	Cedro	457	0.48
	Guatambú	971	1.02
	Incienso	72	0.08
	Kurupay	1,582	1.66
	Lapacho	876	0.92
	Peterevý	171	0.18
	Taperva guasú	267	0.28
	Urunde y mi	45	0.05
	Yvyrá ró	185	0 19
	Taperva hú	29	0.03
Class B	Cancharana	635	0.66
	Kirandy	87	0.09
	Kurupay rá	1,318	1.38
	Tatajy vá	104	0.11
	Timbó	135	0.14
	Yvyrá pytá	2,781	2 91
	Peroba	5,237	5.48
	Kurupay curú	7	0.01

② Stock by department is as follows:

Table 2-1-9 Stock by department

Department	Area (ha)	Stock (1,000 m³)		
		Total stock	A + B	Peroba
AMAMBAY	477,445	14,148	7,615	2,782
CONCEPCIÓN	105,503	3,121	1,682	581
SAN PEDRO	231,221	6,642	3,589	1,205
CANENDIYU	141,235	3,934	2 078	669
Total	955,404	27,845	14,964	5,237

1-3-4 Other elements of forest composition

(1) Average tree height and diameter

Average tree height and diameter for each stratum and diameter class are as presented in Table 2-1-10.

Table 2-1-10 Average tree height and diameter by stratum and diameter class (unit: diameter – cm, height – m)

Stratum	Diameter (DBH) of more than 10 cm					Diameter (DBH) of more than 41 cm				
	Average DBH	Diameter of average 5 m portion	Diameter of average usable portion	Average tree height	Height of average usable portion	Average DBH	Diameter of average 5 m portion	Diameter of average usable portion	Average tree height	Height of average usable portion
A 1	22 49	19 30	18.91	11 65	3.85	53.40	44 60	42.96	18 28	5.59
A 2	23.12	19 76	18 94	12.70	4 71	55.78	47.80	44.64	19 23	7.05
A 3	24 08	20 65	19 67	13.09	4 96	60.06	51.26	47.64	19.17	7.34
M	21 52	18.40	17.77	12.14	4 36	54.21	47.21	44.17	20.80	7.28
M 2	22 11	18 96	18 37	12.45	4.28	54 63	47.39	44.79	18.77	6.50
M 3	23 07	19 74	19 12	11.70	4 27	55.42	48 71	46 25	16 88	6.18
B 1	15.28	13 93	13 84	8 06	3.11	45.25	36 75	36.75	12.75	2.38
B 2	19 33	16.59	16.29	11.11	3.87	50.53	43 77	41.87	18.47	6.18
E	21.53	18.30	17.41	12 32	4 75	53.99	46.12	41 52	19.43	7.33
Mean	22 19	19 02	18.35	12 27	4 41	55 35	47.64	44 71	19 05	6.80

(2) Number of matured tree

The number of matured trees per ha by stratum and diameter class is as presented in Table 2-1-11, Fig. 2-1-5. Summarily, the number of matured trees in the natural forest of this area is 324 trees per ha, with over 41 cm diameter class of 25 trees per ha, or the share of approximately 8%.

Table 2-1-11 Number of matured trees per ha by stratum (unit: trees)

DBH \ Stratum	A 1	A 2	A 3	M	M 2	M 3	B 1	B 2	E	Mean
10 ~ 40 cm	252.7	276.6	340.1	311.6	305.9	274.8	427.0	342.0	316 4	299.0
More than 41 cm	23 5	27.8	37.4	22.5	25.3	31.2	2.0	12 0	22 1	25.4
Total	276.2	304.4	377.5	334 1	331.2	306.0	429.0	354 0	338 5	324.4
Share by class of more than 41 cm (%)	8.5	9 1	9.9	6.7	7.6	10.2	0.5	3.4	6 5	7.8

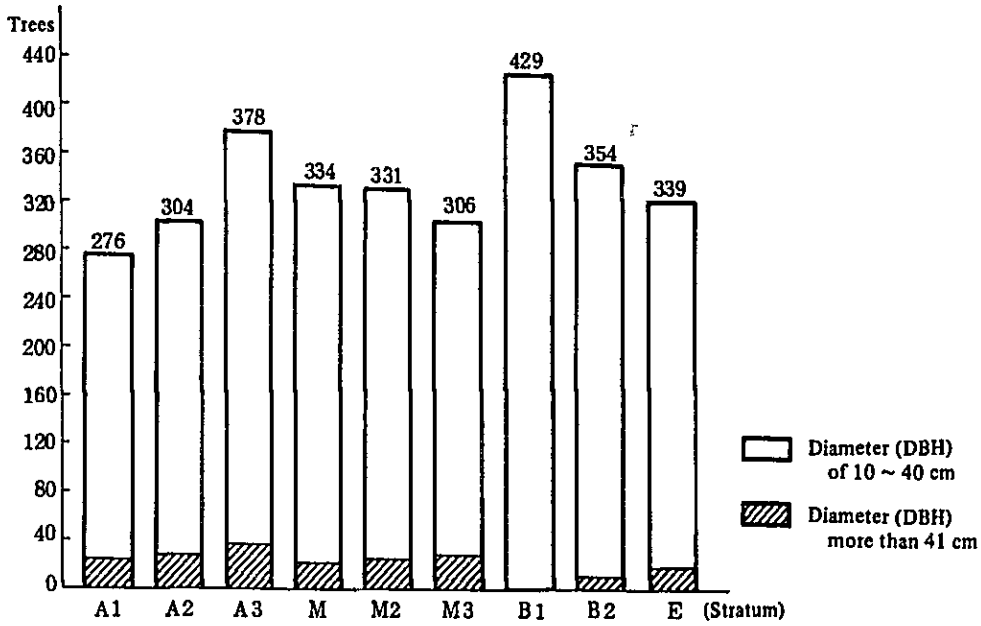


Fig. 2-1-5 Distribution of matured trees by stratum (trees per ha)

(3) Volume per ha by diameter class

① Volume per ha by species class and diameter class is as presented in Table 2-1-12.

Table 2-1-12 Volume per ha by species class and diameter class (unit: m^3)

Species class \ Diameter class (cm)	10~20	21~30	31~40	41~50	51~60	61~70	71~80	81~90	91~100	101~	Total
A	0.48	1.10	1 71	1.87	1.17	0.95	0.50	0.36	0.29	0.09	8.52
B	0.77	1 35	1.90	2 00	2 55	1 95	2 10	1.31	0 94	2 11	16.98
C	1.45	2 71	2 99	2.22	1 89	1 32	1 09	0 31	0.11	0.11	14 20
D	3 79	4 14	3 09	1 43	0.63	0.38	0 18	0 16			13.80
E	2.70	2 45	2 09	1.37	0 91	0 49	0.54	0.16	0.34	0 05	11.10
Defective tree	0.14	0 25	0 30	0.25	0.17	0 20	0 09	0.21	0.16	0 04	1.81
Total	9.33	12 00	12.08	9.14	7.32	5 29	4.50	2 51	1.84	2 40	66.41

② Among the above volume, the volume per ha of Peroba by diameter class is as follows:

Table 2-1-13 Volume per ha of Peroba by diameter class

Species \ Diameter class (cm)	10~20	21~30	31~40	41~50	51~60	61~70	71~80	81~90	91~100	101~	Total
Peroba (m^3)	0.45	0.71	1.01	0.97	1.31	1.16	1.14	0.56	0.56	1.42	9.29
(%)	4.9	7.6	10.9	10.4	14.1	12.5	12.3	6.0	6.0	15.3	100
	23.4			24.5		24.8		27.3			100

1-4 Forest Soil

60 soil profiles, mainly plots of forest resources survey, were established in the area, and field survey was carried out.

1-4-1 Major soil group

According to world soil map, one of major soil groups in the area is Ferralsols which is distributed over the west side of ridges of Amambay Mountain Range along the border with Brazil, in northeast part. Type of Ferralsols in this area is Acric Farralsols and Rhodic Ferralsols.

In adjacent to the west side of Ferralsols, Acrisols is widely distributed from northern part to southern part, running through a central part of the area. The type of Acrisols in the area is standard Orthic Acrisols.

Other soil groups are sporadically distributed in various places; Planosols in northeast end of the area along Apa river, Luvisols around the department boundary of Concepcion and San Pedro, and Gleysols around Lima in southwest part.

1-4-2 Distribution and characteristics of soil

Within the above general distribution pattern, at local level the various types of soil on Ferralsols base divide a relatively large area, while being affected by large undulating landscape and original components. In between, a long strip of Gleysols penetrates into low swamp land.

General characteristics of soil in the area are as follows:

① Very deep soil layer
② Strong reddish color such as dark red brown, red brown and dark red
③ Unclear boundary of stratums in most part
④ Stones and gravels not contained in soil layer
Probable presence of conglomerate in the depth between a few meters and several tens of meter.
⑤ Moderately moist soil mostly found, with rare dry soil

1-4-3 Classification of soil type

Mainly on the basis of soil structure, the forest soil in the area was classified to the following types·

(1) Sand type soil (Type S)

This is a deep sandy soil containing a variety of sand size from very fine grain to relatively

large grain. Fine sandy soil is largely contained, without stones and gravels.
Thickness of A layer is as many as 26 cm on average, with dark red brown – red brown color in general. pH in A layer is 5.6 on average and in B layer 5.4 on average.
The forest on this type of soil has a stand volume of about 63 m^3, with stand condition of a number of small diameter trees. Natural regeneration on the soil is generally good, but productivity of the forest is not high. Reforestation is feasible with a certain degree of increment to be expected. However, as this type of soil is subject to rapid wash-out after forest cutting and to resultant reduction of fertility, care will be required on forest development.

(2) Sand/Loam type soil (Type S·L)

This is an intermediate type between sand type soil and loam type soil, and widely distributed in flat land of the area. Much of this is of fine sand or very fine sand. This either contains less cohesive clay in its layers or has a relatively cohesive layer in the bottom part of B layer.
Thickness of A layer is as many as 28 cm on average, with dark red brown – red brown color in general but occasionally dark red – red color. pH in A layer is 5.7 on average and in B layer 5.3 on average.
The forest on this type of soil has a stand volume of about 73 m^3. The productivity of this soil is higher than the preceding type, to be sufficiently feasible for development of planted forest. Care should be taken for this type of soil because of a large impact by wash-out, fertility reduction and top soil erosion when becoming open land.

(3) Loam type soil (Type L)

This is largely distributed in high land forest area of undulating landscape with slope, similar to indicator Ferralisols of dark red color.
Thickness of A layer is as many as 28 cm on average, with dark red brown – red brown color or dark red color. pH in A layer is 5.4 on average and in B layer 5.1 on average.
Growth of saplings on this soil is satisfactory, with abundant vegetation. Indicator plants are Kai Arroz, Helecho Amambay and Tacua Pi in general.
The forest on this type of soil has a volume of about 82 m^3 per ha, with relative large single tree volume. This has the highest productivity among all the types in the area, to be feasible in developing highly growing planted forest if properly managed.

(4) Clay-loam type soil (Type CL)

This contains many clay in the layers; clay/loam soil or relatively cohesive loam soil in A layer and hard clay/loam soil in B layer. pH in A layer around 7.3 and in B layer around 6.9, to be roughly neutral.
Management of the forest on this type of soil is generally in accordance with that for loam type soil.

(5) Clay type soil (Type C)

This is heavy cohesive soil found in upper plateau of undulating landscape. A layer is of clay quality with dark red – dark red brown color, having remarkably developed nutty structure.
As the productivity of the forest on this type of soil is low, developing of planted forest should be avoided.

(6) Gleysols (Type G)

This is found at gentle slopes in lower part of slope and at swamp. B layer is gley layer with red – red brown color tinged with gray. Underground water table is high. pH in A layer is around 4.8 and in B layer around 4.9.

Vegetation on this type of soil includes wet grass land, shrub, and low forest. Because of low productivity of the forest on this soil, this could not be an object of forestry production.

2. FOREST MANAGEMENT SURVEY

2-1 Increment of Natural Forest

2-1-1 Trees surveyed

To estimate the increment of the natural forest, stumps of cutting trees were surveyed at local cutting locations. At the same time annual rings of log's stem part were surveyed as supplemental to the stump survey. The total number of 102 trees were surveyed.
The number of surveyed trees by species is as follows:

Table 2-2-1 The number of surveyed trees by species

Species	Class	Number	Species	Class	Number
		trees			trees
Peroba	B	53	Urundey mí	A	2
Cedro	A	16	Yvyra ró	A	4
Guatmbú	A	2	Timbó	B	5
Kurupay	A	1	Yvyra pyta	B	4
Lapacho	A	7	Kai Kai gua	C	2
Peterevy	A	2	Others		4
Total					102 trees

2-1-2 Survey method

(1) Annual ring survey

Annual ring survey was done by means of measuring the number and width of annual rings on cross section of stumps, felling trees and bottom end of logs, to record them on field book for growth volume survey. The survey was proceeded as follows:

① To draw straight line, on cross section of cut end of stumps or bottom end of log, in average diameter direction to pass through the center, and to make two radiuses.

② To count the number of annual rings on the cross section and to record them on age column of the field book as the age of the tree.

③ To mark the annual rings at every 10 years from the center on two radiuses, with care to make two marks on same annual ring.

④ To place a scale along the marked radiuses with "0" at the center, and to read the scale in order of outer surface of bark – inner surface of bark – marked annual ring for recording on the field book (unit of measurement is cm, with one point after decimal to be recorded).

⑤ To sum up the reading values for two radiuses on the field book, to be determined as diameter of the cross section (Table 2-2-2).

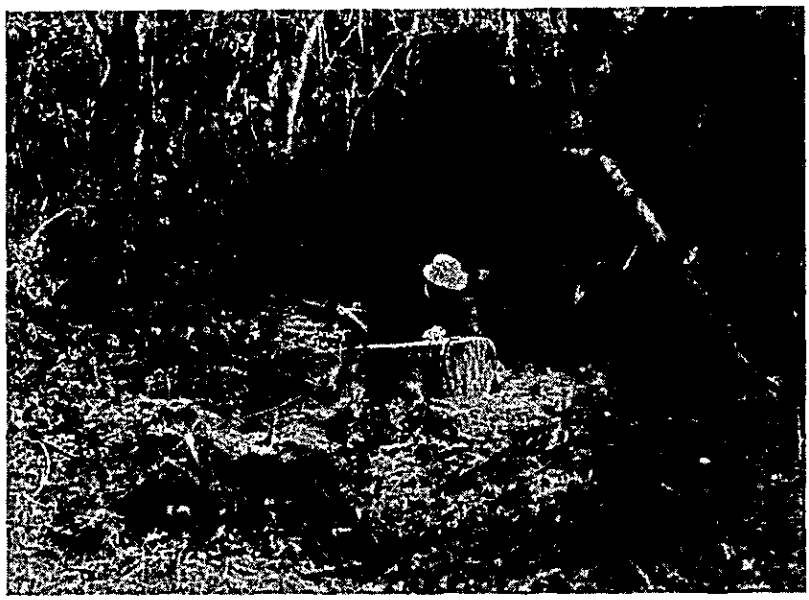


Table 2-2-2 Field book for increment survey

No. Spacies Date

Age Surveyed by

Age grade	Radius cm		Diameter (cm)	Tree height (m)	Stem volume (m^3)	Increment (m^3)	
	I	II				Per year	Average
Outer surface of bark							Bark ratio ( )

(2) Calculation of diameter breast height

① Using the data obtained in the resource survey, corelation basal diameter (ds) and diameter breast height (dB) was calculated.

$dB = k \cdot ds$ ..... ⓐ

② Using formula ⓐ, diameter height breast by age grade was calculated from basal diameter measured in ①.

(3) Calculation of stem volume

① Corelation between diameter breast height (dB) and stem volume (V) calculated.

$V = k \cdot dB^m$ ..... ⓑ

② Using formula ⓑ, stem volume by age grade was calculated.

(4) Calculation of average increment by diameter class

① Passing year (n) by diameter class was calculated.

② Using stem volume by diameter class calculated in (3) −②, increment by diameter class was calculated.

③ Annual average increment was obtained by dividing the above increment for diameter class by passing year. This calculation procedure could be expressed in the following formula:

$$Zd = \frac{Vd_2 - Vd_1}{n} \quad \cdots\cdots\cdots\cdots \text{ⓒ}$$

Whereas,

Vd_1 : Stem volume for a given diameter class

Vd_2 : Stem volume for a diameter class higher than Vd_1 by one class

n : The number of years required for passing from Vd_1 to Vd_2

(5) Calculation of stand increment

Increment per ha by diameter class was calculated by multiplying the number of stand per ha by diameter class, calculated from the result of resource survey, by the stem increment by diameter class in (5) −② and was totalled to obtain stem increment per ha.

2-1-3 Survey result

(1) Relation between age and basal diameter

Average basal diameter of all species (102 trees), A + B class (96 trees) and Peroba (53 trees) was obtained and compiled for each age grade, as presented in Table 2-2-3 and Fig. 2-2-1.

All species include A + B class and Peroba, and A + B class includes Peroba.

When increment process of all species, A + B class and Peroba was compared, while all species and A + B class show a similar value, Peroba show the different increment process in respect of initial increment stage which is slower than the other two, until becoming same increment process as others after a lapse of around 100 years.

Table 2-2-3 Relation between age and basal diameter

Species \ Age	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	Year
All species	4 78	9 15	13 70	18 32	22.06	26 17	30 73	33 21	39 57	43 93	49 15	52 77	58.23	62.08	66 56	71 71	73 38	76 89	80 92	84 20	cm
A + B	4 68	9 01	13 57	18 19	21.84	25.83	30 01	38.33	38 75	43.55	48 27	52.56	57 16	60 71	64.82	69 33	73 10	76 89	80.92	84 20	cm
Peroba	2.91	5 93	9 07	12 68	16 50	20 95	25 72	31 75	35 97	41 98	47 27	51 70	56.56	61 37	65 18	69 66	74 08	77 74	81 72	85 20	cm

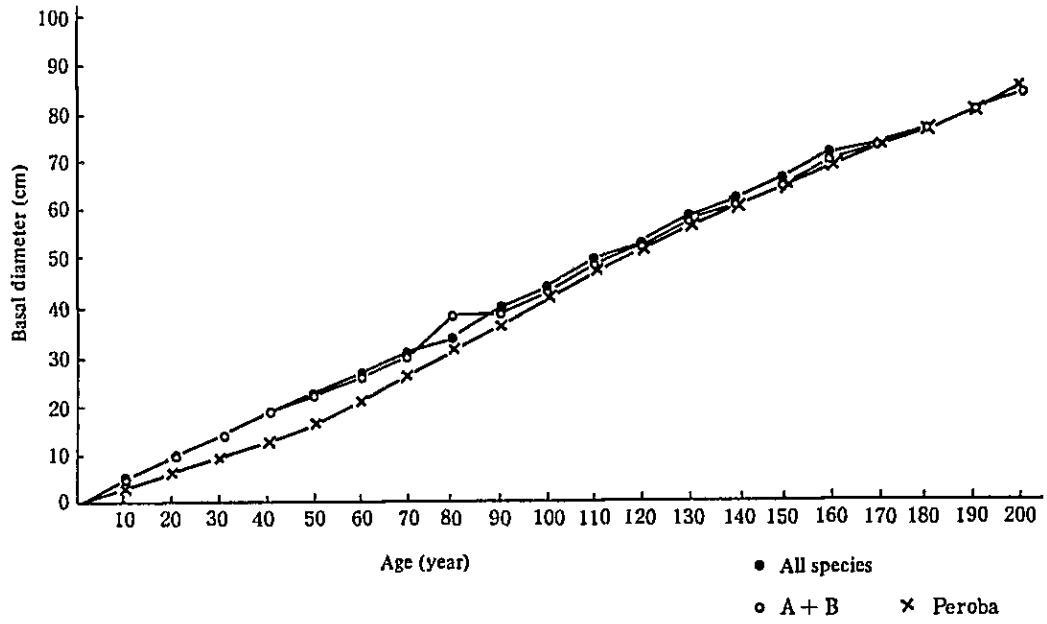


Fig. 2-2-1 Relation between age and basal diameter

(2) Relation between basal diameter and diameter breast height

On the basis of a result of the resource survey in 1982, the relation between basal diameter and diameter breast height was obtained for major species.

The number of species measured was 249 trees for Peroba, 361 trees for A + B class and 361 trees for all species; A + B class and all species include Peroba.

Regression models and their corelation coefficient for these species are presented below, and all of them show high degree of corelation.

All species : A + B : $D_{1.3} = 0.945637 \cdot D_0 - 1.217449$ ..... ⓓ
($\gamma = 0.99594$)

Peroba: $D_{1.3} = 0.944622 \cdot D_0 - 0.924199$ ..... ⓔ
($\gamma = 0.99623$)

(3) Relation between age and diameter breast height

Stem diameter was converted to diameter breast height by formula ⓓ and ⓔ, and thereby to convert relation between age and basal diameter in Table 2-2-3 to relationship between age and diameter breast height.

The result is presented in Table 2-2-4.

Table 2-2-4 Relation between age and diameter breast height

Species \ DBH	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	Year
All species	3 30	7 44	11 74	16 11	19 64	23.53	27 84	30 19	36 20	40 32	45 26	48 68	53.85	57 49	61 72	66 62	68 17	71 49	75 30	78.41	cm
A + B	3 21	7 10	11 61	15 98	19 44	23.21	27 16	35 03	35 13	39 97	44 43	48 49	52 84	56 19	60 08	64.34	67 91	71 19	75 30	78 41	cm
Peroba	1 82	4 68	7 64	11 05	14 66	18.87	23.37	29 07	33 05	38 73	43 73	47 91	52.50	57 05	60 65	64.88	69 05	72 51	76 27	79 56	cm

(4) Determination of increment curve formula

From the relation between age and diameter breast height obtained in (3), theoretical increment curve formula was determined to be the following formula which is most fitting (this is called molecule reaction formula).

$$dr = D(1 - e^{a-\lambda Y}) \quad \cdots\cdots\cdots\cdots \text{(f)}$$

Whereas D is a limiting value of diameter breast height d, Y is a given year and a diameter breast height in year.

Y + 1, a coefficient of a constant difference equation for dY and dY + 1, $dY + 1 = b_0 + b_1 dY$.

Using constant b_1 obtained, a constant for the increment curve formula was determined from the following formula:

$$D = b_0/(1 - b_1)$$
$$-\lambda = \ell n\,(b_1)$$
$$a = \ell n\,(1 - d_1/D) + \lambda$$

On the basis of the above formula, diameter increment curve formulas for three groups of species were determined as follows:

All species: $d = 205.7698\,(1-e^{\{0.0081-0.0024\,(Y-5)\}})$ ..... (g)

A + B : $d = 402.6069\,(1-e^{\{0.0030-0.0011\,(Y-5)\}})$ ..... (h)

Peroba : $d = 1192.9529\,(1-e^{\{-0.0011+0.0002\,(Y-5)\}})$ ..... (i)

Age by group of species and diameter class was calculated from formula (g), (h) and (i), as presented in Table 2-2-5.

Table 2-2-5 Relation between diameter class and age

Species \ DBH	10	20	30	40	50	60	70	80	90	100	110	cm
All species	29	50	74	98	123	150	180	212	246	283	325	year
A + B	30	54	78	103	129	155	182	210	238	268	299	year
Peroba	36	60	85	109	134	158	182	206	230	254	278	year

(5) Preparation of single variable volume table

To estimate volume from diameter breast height, relations between diameter breast height and volume of all species, A + B class and Peroba were determined from 96 plots surveyed in 1981 and 1982, to obtain regression models and to prepare single variable volume tables.

The relations between diameter breast height and volume of three group of species for said 96 plots were as follows:

(Note: The total number of species at 96 plots were 33,001 trees for all species and A + B class and 1,888 trees for Peroba, including Cedro, Lapacho, Yvyrá-ró, Tímbó, Yvyrá-pytá and Peroba.)

All species : $\log V = 2.649281 \log D + 0.801004$ ..... (j)

($\gamma = 0.977492$)

A + B :

Peroba: $\log V = 2.756332 \log D + 0.864132$ ..... (k)

($\gamma = 0.980388$)

On the basis of the formula (j) and (k), the volume by species and diameter class was obtained and presented in Table 2-2-6 and Fig. 2-2-2. (The volume obtained is the one without bark.)

Table 2-2-6 Relation between diameter breast height and volume

Species \ DBH	10	20	30	40	50	60	70	80	90	100	cm
All species A + B	0.014	0 089	0.260	0 558	1 008	1.634	2 458	3 502	4.784	6 324	m^3
Peroba	0 013	0 087	0 265	0 585	1 082	1 789	2.736	3 954	5 470	7.314	m^3
Species \ DBH	110	120	130	140	150	160	170	180	190	200	cm
All species A + B	8 141	10 251	12 673	15 422	18 515	21 967	25 795	30 012	34 634	39 675	m^3
Peroba	9 511	12 089	15 073	18 489	22 361	26 715	31 574	36 961	42 900	49.416	m^3

When the volume of all species, A + B class and Peroba was compared, there observed a trend that three groups show an almost same volume up to the diameter breast height of 30 cm and Peroba show a larger volume than others thereafter.
The reason for this is that the tree height of Peroba is higher and has larger form ratio compared to others.

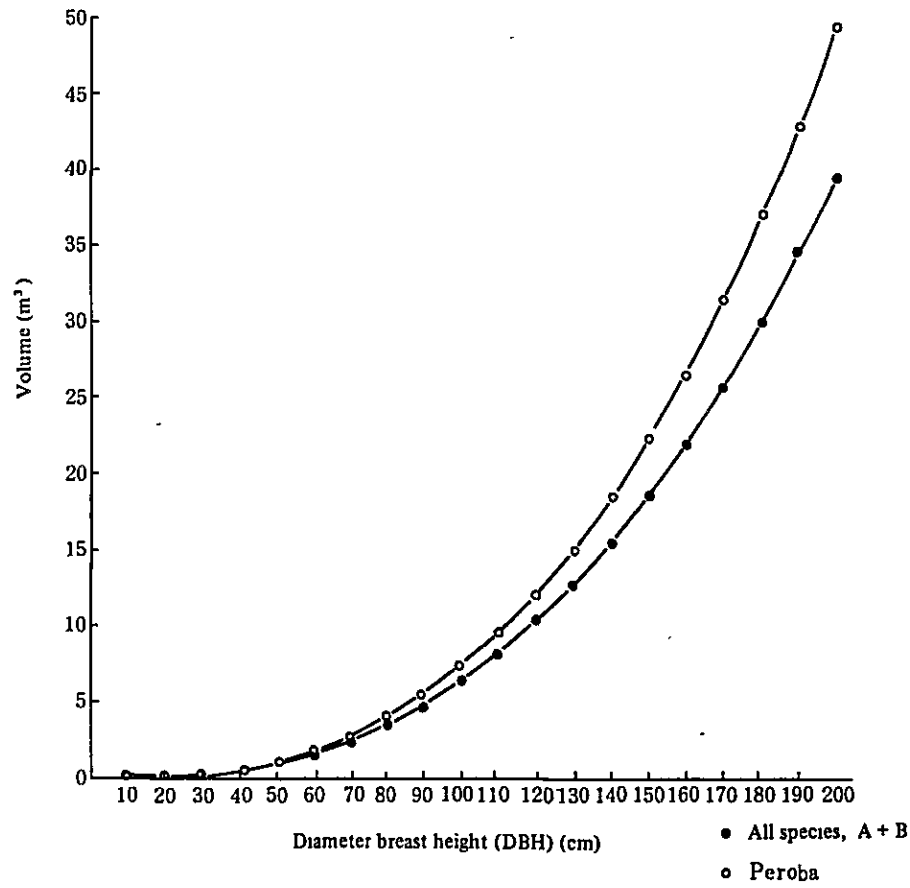


Fig. 2-2-2 Relation between diameter breast height and volume

(6) Calculation of average increment of each diameter class

① Using the age corresponding to the diameter breast height obtained in (4), the number of years (n) to required for passing to one higher class (one diameter class has 10 cm range) was obtained.

② Then using stem volume by diameter class obtained in (5) (Table 2-2-6), average stem increment (Zd) was calculated from formula ⓒ.

The result was presented in the following table.

Table 2-2-7 Average increment by diameter class

Species	Category \ Diameter class	10	20	30	40	50	60	70	80	90	100	110
All species	Age (year)	29	50	74	98	123	150	180	212	246	283	325
	Stem volume (m^3)	0 014	0 089	0 260	0 558	1 008	1 634	2 458	3 502	4 784	6 324	
	Passing year n (year)	21	24	24	25	27	30	32	34	37	42	
	Increment of stem volume (m^3)	0 075	0 171	0 298	0 450	0 626	0 824	1. 044	1 282	1 540		
	Average increment of stem volume Zd	0 0036	0 0071	0 0124	0 0180	0 0232	0 0275	0 0326	0 0377	0 0416		
A + B	Age (year)	30	54	78	103	129	155	182	210	238	268	299
	Stem volume (m^3)	0 014	0 089	0 260	0 558	1 008	1 634	2 458	3 502	4 784	6 324	
	Passing year n (year)	24	24	25	26	26	27	28	28	30	31	
	Increment of stem volume (m^3)	0 075	0 171	0 298	0 450	0 626	0 824	1 044	1 282	1 540		
	Average increment of stem volume Zd	0. 0031	0 0071	0 0119	0 0173	0 0241	0 0305	0 0373	0 0458	0 0513		
Peroba	Age (year)	36	60	85	109	134	158	182	206	230	254	278
	Stem volume (m^3)	0 013	0 087	0 265	0 585	1 082	1 789	2 736	3 954	5 470	7 314	
	Passing year n (year)	24	25	24	25	24	24	24	24	24	24	
	Increment of stem volume (m^3)	0 074	0 178	0 320	0 497	0 707	0 947	1 218	1 516	1 844		
	Average increment of stem volume Zd	0. 0031	0 0071	0. 0133	0 0199	0 0295	0 0395	0 0508	0 0632	0 0768		

(7) Calculation of stand increment

The increment per ha of each diameter class was calculated by multiplying the number of stand per ha of each diameter class, obtained from a result of resource survey, by stem increment of each diameter class previously obtained, to be totaled to obtain stem increment per ha.

The stand increment of all species in the planning area (total volume per ha in sum of each species) was estimated at 2.13 m^3 per ha, as presented in Table 2-2-8.

On the other hand, the stand increment A + B group and Peroba was estimated at 0.55 m^3 and 0.21 m^3 per ha.

Increment rate of stem volume was calculated by dividing stand increment of all species by stand stem volume per ha, to be estimated at approximately 3.3% in the area.

Table 2-2-8 Stand increment

Species	Type \ Diameter class (cm)	10~20	21~30	31~40	41~50	51~60	61~70	71~80	81~90	91~100	101~	Total
All species	Trees/ha	190.1	74.0	29.6	12.3	5.9	2.9	1.8	0.7	0.4	0.3	318.0
	Annual average increment m³/trees	0.0036	0.0071	0.0124	0 0180	0.0232	0.0275	0.0326	0.0377	0.0416	0 0461	
	Increment m³/ha	0.6844	0.5254	0 3670	0.2214	0.1369	0.0798	0.0587	0.0264	0.0166	0 0138	2.1304
A + B	Trees/ha	24.2	12.5	8.0	4.8	2.8	1.6	1.0	0.5	0.3	0.3	56.0
	Annual average increment m³/trees	0.0031	0.0071	0.0119	0.0173	0.0241	0.0305	0.0373	0.0458	0.0513	0.0568	
	Increment m³/ha	0.0750	0.0888	0 0952	0 0830	0.0675	0.0488	0.0373	0.0229	0.0154	0 0170	0.5509
Peroba	Trees/ha	10.2	3.7	2.1	1.1	1.0	0.6	0.4	0.1	0.1	0.2	19.5
	Annual average increment m³/trees	0.0031	0.0071	0.0133	0.0199	0.0295	0.0395	0.0508	0 0632	0.0768	0.0896	
	Increment m³/ha	0.0316	0.0263	0.0279	0.0219	0.0295	0.0237	0.0203	0.0063	0.0077	0.0179	0.2131

- Increment rate P (%) = Z/V × 100 = 2 1304/64.60 × 100 = 3.3
  - Whereas, stem volume per ha (V) = 64.60 m³

2-1-4 Summary

To determine increment in the existing natural forest, annual ring survey on stumps and others was carried out for 102 trees of useful species including Peroba, and stand increment was calculated The calculation results are as follows·

① From the relation between age and stem diameter, initial increment of Peroba is slower than that of all species and A + B group, becoming similar to other two after 100 years.

② On the basis of a result of the resource survey and from the relation between basal diameter and diameter breast height, the relation between age and basal diameter was substituted for by the relation between age and diameter breast height, to be used for estimate of increment curve formula and calculation of age for each species and diameter class.

③ From the relation between diameter breast height and volume of all species, A + B group and Peroba, the following regression model was obtained, and was used for preparation of single variable volume table,

All species. } $\log V = 2.649281 \log D + 0.801004$ ..... ⓙ
A + B } ($\gamma = 0.977492$)

Peroba . $\log V = 2.756332 \log D + 0.864132$ ..... ⓚ
($\gamma = 0.980388$)

Analysis of the tables indicates that the volume of Peroba increase at almost same rate as that of all species and A + B group up to diameter breast height and become larger than others thereafter.

④ From the age for each species and diameter class, the number of years required for passing to one higher diameter class was obtained. From the passing years and the stem volume of each diameter class obtained in (3), average increment of each diameter class was calculated. The result indicates that the volume per ha of all species, A + B group and Peroba increases at similar rate up to diameter breast height of around 30 cm, becoming in order of Peroba, A + B group and all species thereafter.

⑤ From the result of the resource survey and ④, stand increment was calculated; 2.13 m^3 per ha for all species, 0.55 m^3 per ha for A + B group and 0.21 m^3 per ha for Peroba. At the same time, increment rate of stem volume for all species was estimated at around 3.3%.

2-2 Natural Regeneration

2-2-1 Survey method

(1) Items of survey

The survey was done for the forests in the planning area, mainly in respect of: ① Relation between forest type and number of sapling. ② Increment of sapling and change in the number of living trees. ③ Relation between upper tree and sapling.

(2) Number and location of survey point

Survey points were selected from the resource survey plots with consideration that they were distributed to cover a maximum extent of area.

45 survey plots in total were established to take into account forest classification; 15 plots of type A, 17 plots of type M and 13 plots of type D. Type B and E were excluded from the survey.

A list of the survey plots and their geographical distribution were as presented in Table 2-2-9 and Fig. 2-2-3.

Table 2-2-9 List of regeneration survey plot by numbering

Forest type classification		Plot No.	Forest type classification		Plot No.
Type A	A1	70	Type M	M2	61
		80			69
		103			71
		104			79
		106			90
		107			97
	A2	53			98
		58			102
		60	Type D	DA2	19
		64			39
		89			52
		96			63
		100			64
		105			90
		108			93
Type M	M	44			107
		47			143
		49		DA3	24
		99			41
		101			55
	M2	51			61
		52			
		57	Total		45
		59			

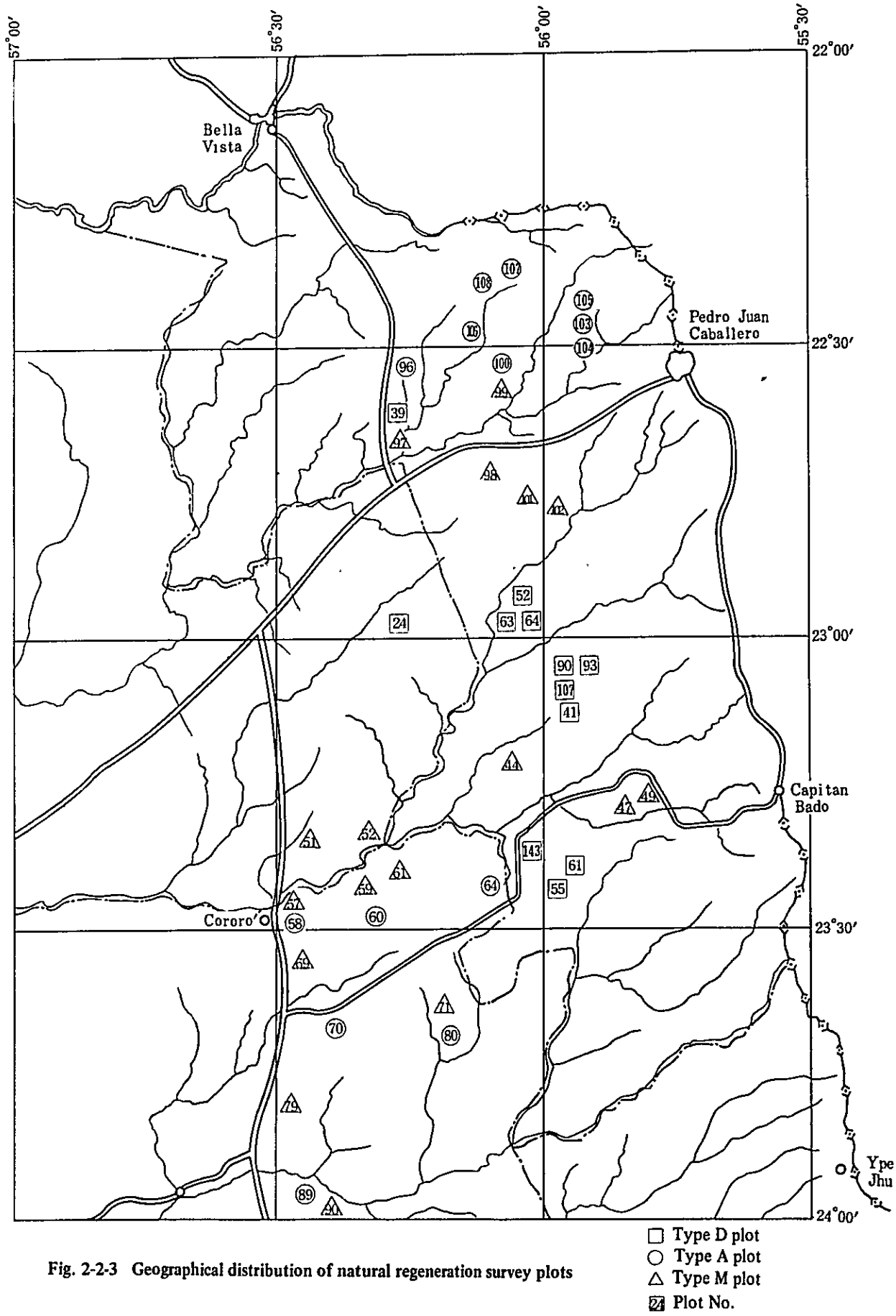


Fig. 2-2-3 Geographical distribution of natural regeneration survey plots

(3) Survey plot

As shown in Fig. 2-2-4, each survey plot is made up of three small plots with each size of 1 m x 20 m established at subplot 1, 5 and 10 in a resource survey plot, to be 60 m^2 in total.

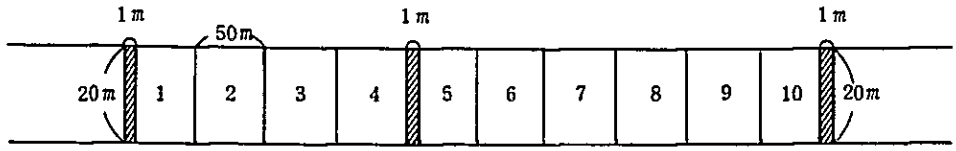


Fig. 2-2-4 Typical layout of survey plot

(4) Surveyed species and size

A class and B class species, classified in the resource survey, were a subject of the survey; observation was made separately for Peroba, A class and B class (excluding Peroba).

On surveying those species, the saplings were classified into three size classes, tree height of 0.3 – 1.3 m, tree height of more than 1.3 m and diameter breast height of less than 4 cm, and diameter breast height of 5 – 9 cm, and recorded in the field book (Table 2-2-10) accordingly.

Table 2-2-10 Regeneration survey field book

No. _____

No. of plot		Date		Forest type	
Sub-No of plot		Recorder			
Species		Tree height 0.3 ~ 1.3 m	Tree height, more than 1.3 m		
			Diameter less than 4 cm	Diameter 5 ~ 10 cm	
	Peroba				
	A class				
	B class				
	Memo				

2-2-2 Survey result

(1) Number of saplings for each forest type

a) Saplings with tree height of 0.3 m – 1.3 m

Saplings of tree height of 0.3 m – 1.3 m were divided into Peroba and A + B group, and tabulated according to each forest type determined in the resource survey, as presented in Fig. 2-2-5.

According to this, saplings of Peroba are 2,000 in type DA_3 and 1,556 in type DA_2, which dominate the rest of types, and followed by 1,083 in type A_1, 333 in type A_2, and 125 in type M_2.

On the other hand, saplings of A + B group are 944 for type A_2, followed by 750 in type A_1, 611 in type DA_2, 542 in type M_2, 375 in DA_3 and 200 in type M.

The above results indicate that saplings of Peroba is dominated by type D, or dense crown forest, whereas such dominant type is not identified for A + B group.

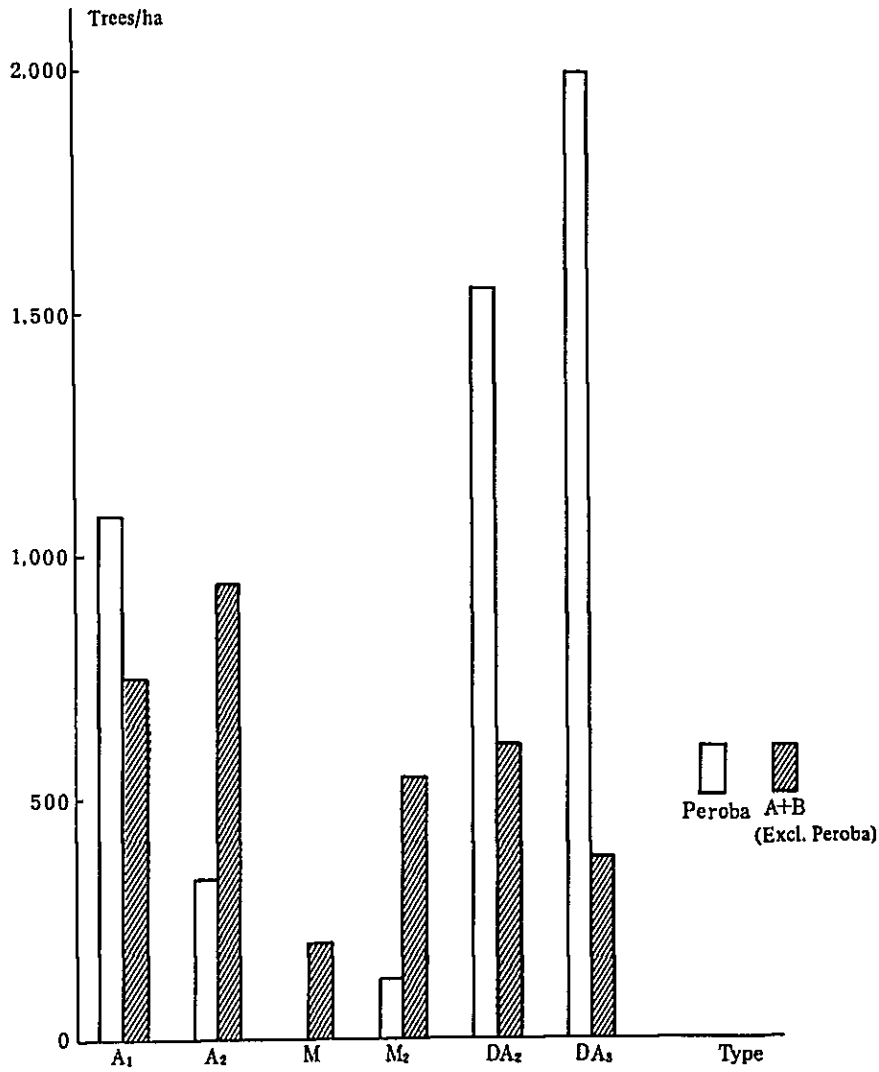


Fig. 2-2-5 Number of sapling by stratum (1)
(Tree height of less than 1.3 m)

b) Saplings with tree height of more than 1.3 m and diameter breast height of less than 4 cm

The saplings of diameter breast height of less than 4 cm were divided into Peroba and A + B group, and tabulated according to each forest type, as presented in Fig. 2-2-6.

Saplings of Peroba are 625 in type DA_3, 444 in type DA_2, 125 in type M_2, 111 in type A_2, 100 in type M and 83 in type A_1. As in the case of tree height of 0.3 – 1.3 m, saplings in dense crown forest dominates over the rest of forest types.

On the other hand, saplings of A + B group are 250 in type DA_3, 250 in type A_1, 167 in type DA_2, 167 in type A_2 and 42 in type M_2, to indicate the dominance of type D and A over type M.

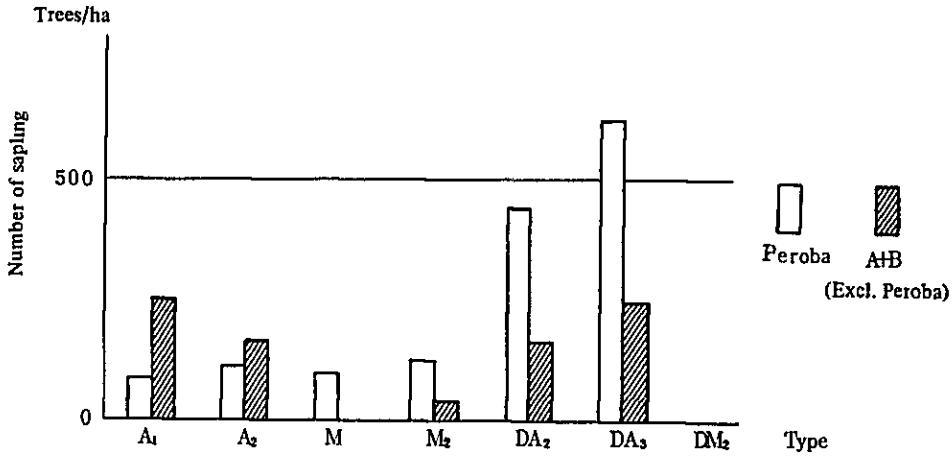


Fig. 2-2-6 Number of sapling by stratum (2) (DBH, less than 4 cm)

c) Saplings with diameter breast height of 5 – 9 cm

Number of saplings with diameter breast height of 5 – 9 cm for each forest type is as shown in Fig. 2-2-7.

Saplings of Peroba are 250 in type DA_3, 56 in type DA_2 and 56 in type A_2, while those of A + B group are 125 in type DA_3 and 56 in type DA_2, to indicate the dominance of type DA_3 for both species.

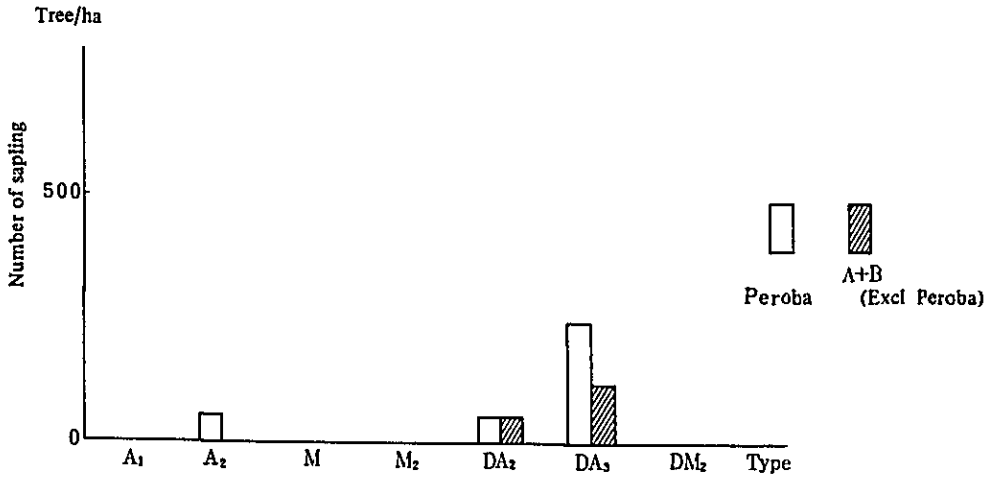


Fig. 2-2-7 Number of saplings by stratum (3)
(DBH, 5 ~ 10 cm)

(2) Number of saplings for diameter class

Change in regenerated saplings of Peroba and A + B group for each forest type was analyzed on the basis of the number of the saplings for each diameter class.

a) Peroba

The number of saplings of Peroba was examined as presented in Fig. 2-2-8.

According to this, the number of the saplings decreases with diameter class; 2,000 at tree height of less than 1.3 m, 625 at diameter breast height of less than 4 cm and then 250 at diameter breast height of 5 – 9 cm. When this change was translated to decrease rate, the saplings decreased at the rate of 70% before reaching diameter breast height of less than 4 cm and 87% before reaching diameter breast height of 5 – 9 cm.

For type DA_2; 1,556 at tree height of less than 1.3 m, 444 at diameter breast height of less than 4 cm and 56 diameter breast height of 5 – 9 cm, with the decrease rate of 71% and 96% respectively.

For type A_2; 333 at tree height of less than 1.3 m, 111 at diameter breast height of less than 4 cm and 56 at diameter breast height of 5 – 9 cm, with the decrease rate of 67% and 83% respectively.

For type A_1; 1,083 at tree height of less than 1.3 m, 83 at diameter breast height of less than 4 cm and 0 at diameter breast height of 5 – 9 cm, with the decrease rate of 92% and 100% respectively.

For type M; 0 at tree height of less than 1.3 m, 100 at diameter breast height of less than 4 cm and 0 at diameter breast height of 5 – 9 cm, without recognizable trend.

For type M_2; 125 at tree height of less than 1.3 m, 125 at diameter breast height of less than 4 cm and 0 at diameter breast height of 5 – 9 cm, to be difficult to find definite trend.

Together, change in the number of saplings of Peroba shows the decrease rate of 67 – 92% before diameter breast height of less than 4 cm in all forest types except for type M and M_2, to indicate that a significant number of the generated saplings disappears before reaching diameter breast height of 4 cm. Furthermore the decrease rate of 83 – 100% before diameter breast height of 5 – 9 cm in is

observed in same forest types, to indicate that a most of the generated saplings disappears at this stage of increment.

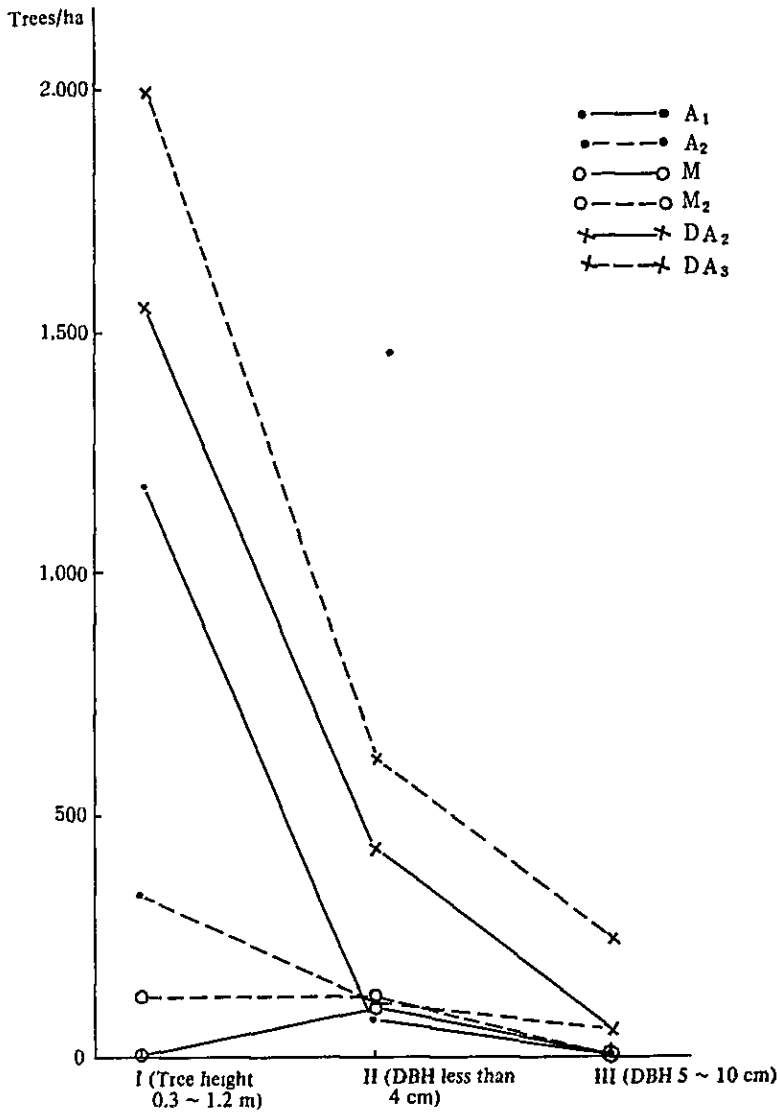


Fig. 2-2-8 Number of saplings of Peroba by diameter class

b) A + B group

Change in the number of saplings of A + B group for forest type is as presented in Fig. 2-2-9.

For type DA_3; 375 at tree height of 1.3 m, 250 at diameter breast height of less than 4 cm and 125 at diameter breast height of 5 – 9 cm, with the decrease rate of 30% and 60% respectively.

For type DA_2, 611 at tree height of less than 1.3 m, 167 at diameter breast height of 4 cm and 56 at diameter breast height of 5 – 9 cm, with the decrease rate of 73% and 96% respectively.

For type A_2; 944 at tree height of less than 1.3 m, 167 at diameter breast height

of less than 4 cm and 0 at diameter breast height of 5 – 9 cm, with the decrease rate of 82% and 100% respectively.

For type A_1; 750 at tree height of less than 1.3 m, 250 at diameter breast height of less than 4 cm and 0 at diameter breast height of 5 – 9 cm, with the decrease rate of 67% and 100% respectively.

For type M_2; 542 at tree height of less than 1.3 m, 42 at diameter breast height of less than 4 cm and 0 at diameter breast height of 5 – 9 cm, with the decrease rate of 92% and 100% respectively.

For type M; 200 at tree height of less than 1.3 m, 0 at diameter breast height of less than 4 cm and 0 at diameter breast height of 5 – 9 cm, to show complete disappearance before diameter breast height of 4 cm.

Together, change in the number of saplings of A + B group shows the decrease rate of 67 – 100% before breast height of 4 cm and 91 – 100% before diameter breast height of 5 – 9 cm, to indicate that a most of the saplings disappears at the stage of growth with diameter breast height of less than 4 cm, as in the case of Peroba.

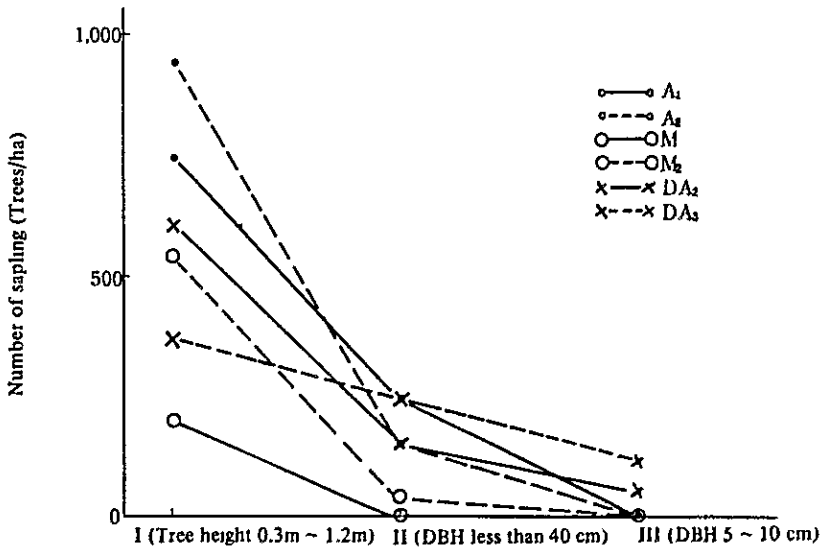


Fig. 2-2-9 Number of saplings of A + B group by diameter class

(3) Relation between upper trees and saplings

a) Relation between upper trees and saplings for forest type

Relation between upper trees with diameter breast height of more than 41 cm and the number of saplings with tree height of less than 1.3 m for forest type is as presented in Fig. 2-2-10.

In the relation between upper trees and saplings of Peroba, many saplings are observed in forest type DA_2 and DA_3 which have many upper trees while a small number of saplings is observed in forest type A_2 and M_2 with a small number of upper trees; this trend is similar to that in (1) 1) By the same token, in the relation between upper trees and saplings of A + B group may saplings are observed in forest type A_1 and A_2 which have many upper trees while a small number of saplings is observed in forest type M and DA_3 with a small number of upper trees.

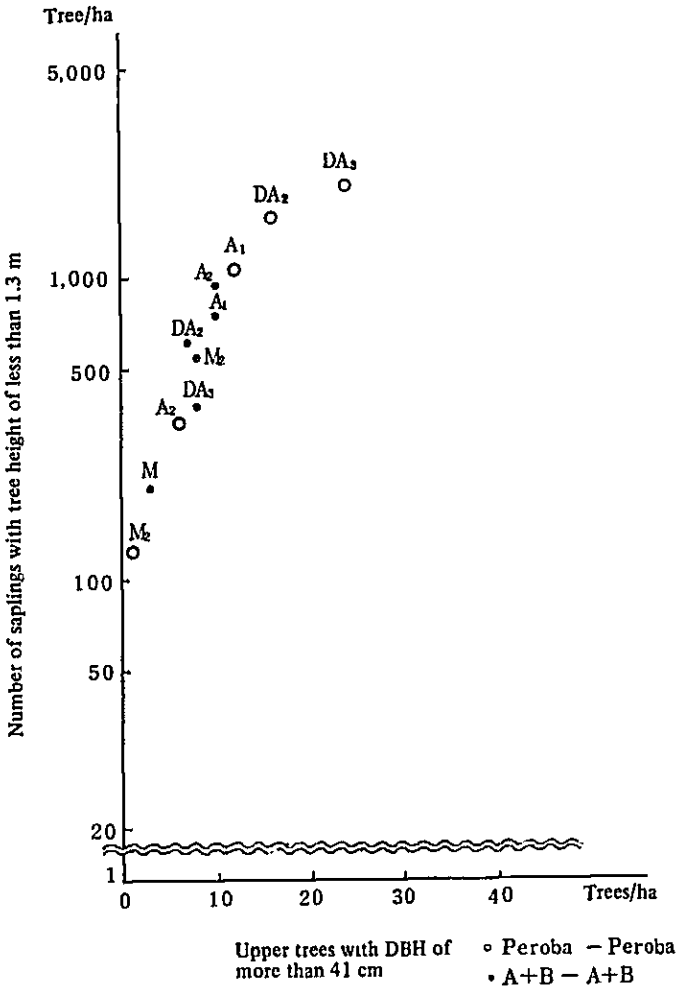


Fig. 2-2-10 Relation between upper trees and saplings by forest type

b) Relation between upper trees and saplings in dense crown forest

For forest type DA_2 and DA_3, the relation between upper trees and saplings was examined in respective combination of Peroba – Peroba and Peroba – all species; for Peroba – Peroba the relation between the mother trees and the saplings was studied, while for Peroba – all species the relation between spatial distribution of the saplings in the forest and upper trees was studied.

① Mother trees and saplings of Peroba

Assuming that Peroba with diameter breast height of more than 41 cm is the mother tree and Peroba with the tree height of less than 1.3 m is the sapling, the relation between the saplings and the mother trees was analyzed to obtain the result shown in Fig. 2-2-11.

500 – 2,000 saplings were observed in a plot with 20 – 30 mother trees, while 2,000 – 3,000 saplings in a plot with 1 – 10 mother trees, to indicate a trend that the number of saplings decreases with an increase of mother trees.

Consequently, this data do not show a trend that many saplings are found in a plot with many mother trees of Peroba. The reason for this is attributable to a strong influence of the relation between the saplings and the upper forest

crown density rather than the relation between the saplings and the number of mother trees.

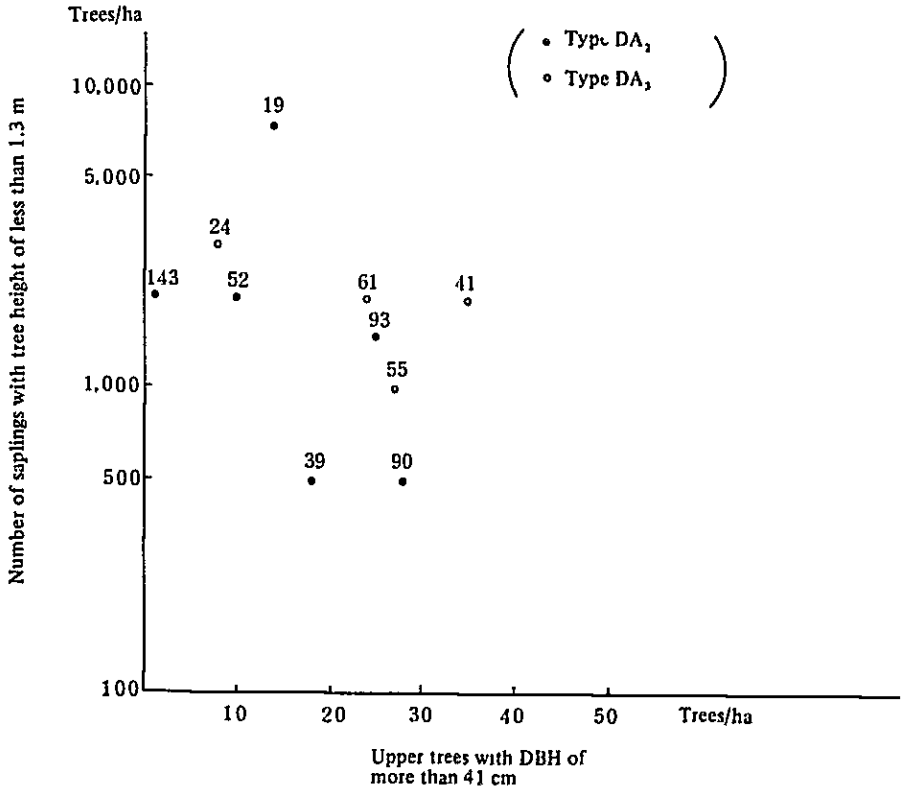


Fig. 2-2-11 Relation between mother trees and saplings of Peroba

② Peroba – all species

The relation between all species with diameter breast height of more than 41 cm, which are assumed to constitute upper forest crowns, and the saplings was as presented in Fig. 2-2-12.

300 – 2,000 saplings were observed in the forest with 30 – 40 upper trees, while 2,000 – 3,000 saplings in a forest with 10 – 20 upper trees, to indicate a trend that the number of saplings growing in lower story decreases with an increase of the number of upper trees. From this result, it is identified that many number of living sapling tend to be observed in a forest with sparse upper forest crowns, to suggest that a certain degree of luminous intensity in the forest is required for generation and growth of saplings.

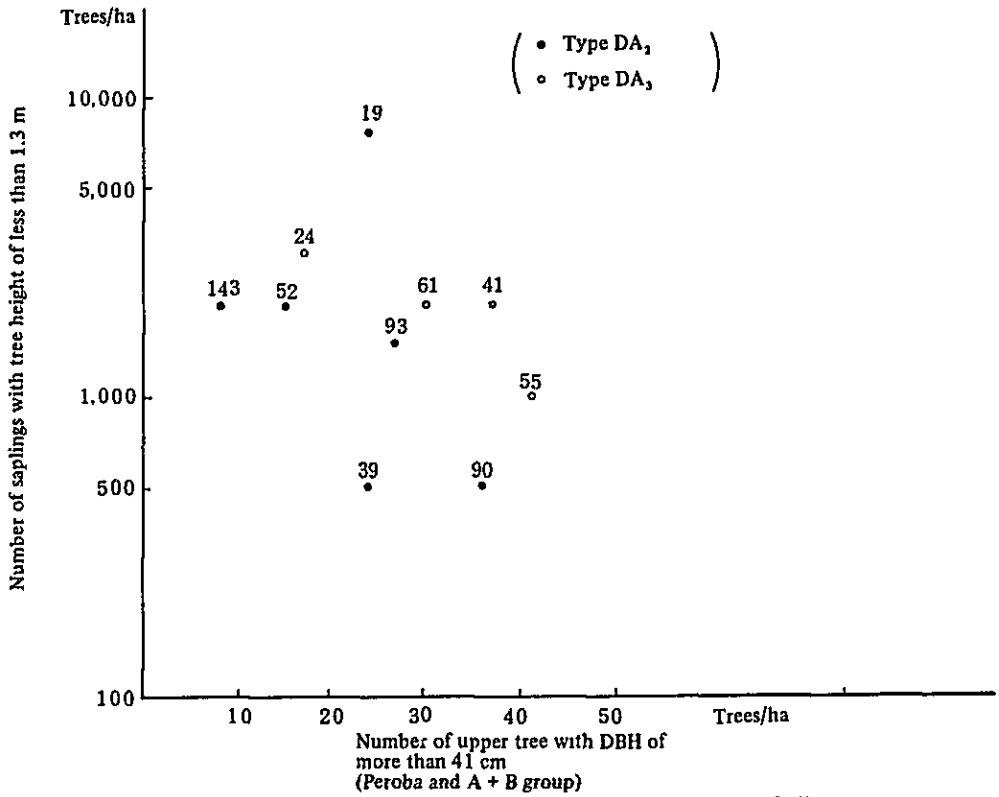


Fig. 2-2-12 Relation between upper trees and saplings of all species

2-2-3 Summary

① The number of saplings of Peroba is found more in type D than other types. On the other hand, A + B group shows similar trend in type A and D up to diameter breast height of less than 4 cm, and more in type D at diameter breast height of 5 – 9 cm. The number of saplings by forest type is as follows:

Table 2-2-11 Number of saplings by forest type

Forest type	Tree height 0.3 m ~ 1.3 m		DBH ~ 4 cm		DBH 5 cm ~ 9 cm	
	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	623	250	250	125

② Examining a change in the number of saplings for their size class, Peroba at diameter breast height of less than 4 cm decreases at the rate of 67 – 92% in all forest types except for type M and M_2, and at diameter breast height of 5 – 9 cm decreases below 82% in same forest types. On the other hand, A + B group at diameter breast height of 4 cm decreases at the rate of 67 – 100% in all forest types except for type DA_3 and at diameter breast height of 5 – 9 cm decreases at the rate of 91 – 100% in same forest types. Together it is believed that a most of generated saplings disappears before reaching diameter breast height of 4 cm.

③ In the relation between the number of upper tree and saplings, more saplings are found in forest type with many upper trees to show same trend as ①.

④ In the relation between mother trees and saplings of Peroba, the number of the saplings tends to decrease with an increase of mother trees. This appears to come from a dominance of the relation between crown density and saplings as mentioned in the next.

⑤ In the relation between upper tree density and saplings, the number of saplings in a forest trends to decrease with an increase of upper trees. It is believed that the degree of luminous intensity in the forest, which is dependent upon crown density of upper trees, affects generation and growth of saplings.

⑥ We conducted a regeneration research in a thin stand of Peroba (100 to 200 trees per ha, burned first and then seeds were laid for use as a pasturage) around Estrella, in the north suburb of P.J. Caballero. The investigation results are that, although there are no sapling that is more than 1.3 m, the number of saplings that are lower than 1.3 m is 6,300 per ha, or much more than the number of saplings in dense crown forests, and we consider that growth of a fairly good number of saplings can be expected, depending on how properly the light control is given.

2-3 Seedling and Planted Forest

2-3-1 Seedling and reforestation

The actual condition of nursery is difficult to study in Paraguay which has a little experience in reforestation.

Instead, on the basis of the various reports[1),2),3),4)], nursery practise and planting method were surveyed for three species, or Parana pine (Araucaria Angustifolia), Elliottii pine (Pinus Elliottii) and Eucalyptus (Eucalyptus spp) which are considered to be highly potential in use as planting species in the country.

(1) Parana pine (Araucaria Angustifolia)[2)]

This species is originated from the State of Parana in southern part of Brazil, with long history of planting in the country.

As its germination rate declines to 40% of the original rate in 3rd month, the seeds should be collected in an optimal time between April and May and sowed in July at the latest.

Sowing is done by direct sowing on the forest or planting the seedling after sowing on nursery.

In case of direct sowing, 60 – 90 kg per ha, or 7,800 – 11,700 seeds are sowed with spacing of 1.5 m x 1.5 m, 1.5 m x 2.0 m and 2.0 m x 2.0 m at the rate of 2 – 3 seeds per hole. The germination occurs in about 60 days, and a strong seedling is selected and retained at each hole in 1st and 2nd year after the germination, to form a forest.

In case of nursery sowing, pots are used. The germination occurs in about 60 days, and out-planting is done four months after the germination. 2,500 – 3,000 seedlings are planted in one ha.

(2) Elliottii pine (Pinus Elliottii, Slash pine)

This species is originated in southeast part of U.S.A., and grows very rapidly.

Its germination rate is 85 – 90%, with approximately 31,000 seeds per kg which require low temperature treatment before sowing.

Sowing is done directly in woodbox or pot, with one seed per pot. Target number of seedling is 20,000 per kg, to have survival percentage of seedling at 64%.

Planting is generally spaced by 3 m x 2 m, to be 1,700 seedlings per ha.

Rainy season is a suitable planting time for this species. Site levelling is not required unlike Eucalyptus, but care should be taken to prevent a fire.

(3) Eucalyptus (Eucalyptus spp)

This species is originated in Australia, and has a great variety, and each of which is planted to suit a particular use and climate.

Sowing is done between July and October, and the seedlings can be used for out-planting four months after sowing.

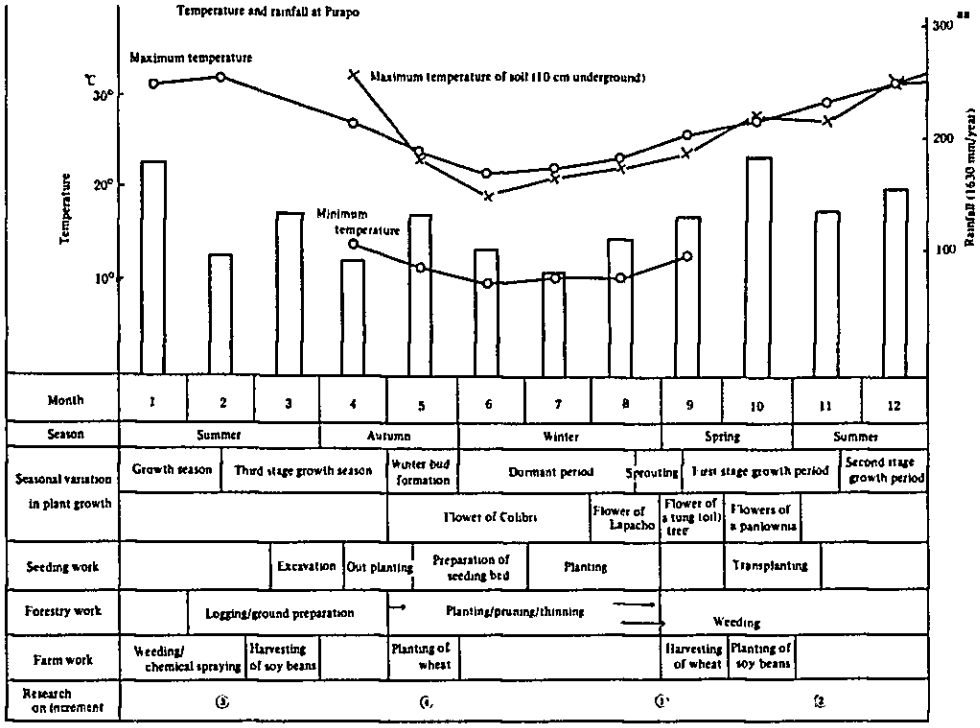
Its germination rate is low, and 25,000 – 30,000 seedlings per kg are usable. 50 g of seed are sowed on every 1 m^2 of a nursery, to produce as many as 1,200 survived seedlings.

Planting is generally spaced by 2 m x 2 m, to be 2,200 – 2,500 seedlings per ha.

In addition, site levelling is required before planting. And a special care should be taken to exterminate ants.

Finally, according to optimal planting work schedule (Table 2-2-12) in Cedeho district prepared by Mr. Komiya on the basis of his study results, suitable planting time on nursery is during the winter season between July and August when ground temperature becomes lower than air temperature[8)].

Table 2-2-12 Optimal planting work schedule



2-3-2 Increment of planted forest

The actual condition of planted forest in Paraguay is difficult to obtain as in the case of nursery. Particularly, in the northeast region the record is rarely found except for Eucalyptus planted area in some part.

Instead, increment condition of planted species was surveyed from the reports available.

Annual increment of 9 year old Taeda pine, Elliottii pine, Parana pine and Japanese cedar in Alto Parana forestry center[5] is as presented in Table 2-2-13; 26.2 m^3 for Taeda pine, 22.6 m^3 for Elliottii pine, 14.5 m^3 for Parana pine and 9.2 m^3 for Japanese cedar, to indicate high increment of the pines.

Table 2-2-13 Increment of planted forest (9 year old)

Species	Annual increment (m^3/ha/year)
Taeda pine	26.8
Elliottii pine	22.6
Parana pine	14.5
Japanese cedar	9.2

According to the data obtained in preliminary survey of increment[6] as shown in Table 2-2-14, annual increment of local species, or 26 year old Cedro, Peterevy and Lapacho is 1.71 m^3, 2.43 m^3 and 0.59 m^3 respectively, whereas among planted species annual increment of Elliottii pine (10 year old) and Parana pine (33 year old) – both are coniferous – is 8.73 m^3 and 8.94 m^3 respectively and annual increment of Eucalyptus (28 year old) – broad leaved tree – 13.07 m^3.
Together, the planted species show a considerable increment, especially Eucalyptus.

Table 2-2-14 Annual increment by species

Species	Age (years)	Tree height (m)	DBH (cm)	Increment (m^3/ha)	Annual increment (m^3/ha/year)
Cedro*	25 ~ 27	6	22	44.70	1.71
Peterevý*	25 ~ 27	12	4	63.26	2.43
Lapacho*	25 ~ 27	12	–	15.36	0.59
Elliottii pine**	10	9.25	11	87.27	8.73
Parana pine*	33	18.8	33	295.00	8.94
Eucalyptus	78	22.2	16	366.40	13.09
* South region ** Central region					

Stand yield table of Parana pine in the State of Misiones, Argentina, is as shown in Table 2-2-15.
Change in the increment of Parana pine in this table is relatively high; for 10 year old ones, total increment of 143 m^3 and annual average increment of 14.3 m^3, and for 20 year old ones, total increment of 370 m^3 and annual average increment of 18.5 m^3.

Table 2-2-15 Stand yield table of Parana pine (State of Misiones, Argentina)
(Site: High)

Age	Number of trees	Average DBH	Annual increment	Stand volume		
				Dominent tree	Secondary tree	
year	trees/ha	cm	m³	m³	m³	m³
4	2.2 5 0	6 6	1 1 4	2 7 0 0	–	2 7 0 0
5	2.0 0 0	8 4	2 6 7	3 8 4 0	–	3 8 4 0
6	1.7 5 0	1 0 0	1 8 2 4	6 5 1 0	–	6 5 1 0
7	8 0 0	1 1 7	1 8 0 1	4 8 0 0	3 5 3 4	8 3 3 4
8	7 1 5	1 3 4	2 0.4 8	6 0 9 1	5 1 0	1 0 1 3 5
9	6 1 2	1 5 2	2 1 0 1	7 4 3 3	7 0 7	1 2 1 8 4
1 0	5 6 5	1 6 9	2 1 8 2	8 7 4 6	7 8 8	1 4 2 8 5
1 1	5 0 5	1 8 6	2 4.1 4	9 9 9 8	9.2 9	1 6 4 6 6
1 2	4 4 7	2 0 5	2 6 2 7	1 1 2 6 4	1 1 4 8	1 8 8 8 1
1 3	3 9 8	2 2 1	2 7 0 4	1 2 6 5 6	1 2 3 5	2 1 5 0 8
1 4	3 5 2	2 3 8	2 3 7 8	1 3 8 9 7	1 4 6 3	2 4 2.1 1
1 5	3 1 3	2 5 6	2 2 8 4	1 4 7 2 4	1 5 4 0	2 6 5.9 0
1 6	2 8 0	2 7 3	2 2 0 3	1 5 4 5 6	1 5 5 2	2 8 8.7 3
1 7	2 5 5	2 9 1	2 0 6 8	1 6 2 7 9	1 3 8 0	3 1 0 7 6
1 8	2 3 6	3 0 8	1 9 2 6	1 7 1 3 4	1 2.1 3	3 2 0 6 4
1 9	2 2 3	3 2 6	1 8 8 4	1 8 1 1 6	9 4 3	3 5 0 7 0
2 0	2 1 5	3 4 5		1 9 3 5 0	6 5 0	3 6 9.5 4

On the other hand, annual average increment of Elliottii pine was examined in its stand yield table as shown in Table 2-2-16.

As in case of Parana pine, its increment is relatively high; for 10 year old, total increment of 281 m^3 and annual average increment of 28.1 m^3, and for 20 year old, total increment of 627 m^3 and annual average increment of 31.4 m^3.

Table 2-2-16 Stand yield table of Elliottii pine

Age	Average diameter	Average tree height	Single tree volume	Number of trees	Stand volume	Main thinning volume
year 1	cm	m	m³	trees	m³	m³
2						
3	3 0	2.0		2,7 5 0		
4	5 4	4 0	0.0 0 6 4	2.7 0 0	1 7	
5	7 6	6 0	0 0 1 6 5	2.6 5 0	4 3	
6	9 8	8 0	0 0 3 3 4	2,6 0 0	8 7	
7	1 2.0	9.8	0 0 5 8 1	1.2 0 0	7 0	8 1
8	1 3 8	1 1 5	0 0 8 7 2	1.1 7 0	1 0 2	
9	1 6 0	1 2 9	0 1 2 8 9	1,1 4 0	1 4 7	
1 0	1 8 2	1 4 1	0 1 7 9 8	1,1 2 0	2 0 1	
1 1	2 0 4	1 5.2	0 2 4 1 3	8 0 0	1 9 3	7 7
1 2	2 2 4	1 6.1	0 3 0 4 4	7 8 0	2 3 7	
1 3	2 3 8	1 6 9	0.3 5 7 5	7 6 0	2 7 2	
1 4	2 5 8	1 7.6	0 4 3 2 4	7 4 0	3 2 0	
1 5	2 7.2	1 8 1	0 4 9 5 6	5 0 0	2 4 8	1 0 9
1 6	2 8 6	1 8 6	0.5 6 1 6	4 9 0	2 7 5	
1 7	2 9 8	1 9.0	0 6 2 0 1	4 8 0	2 9 8	
1 8	3 0.8	1 9 5	0 6 7 7 7	4 7 0	3 1 9	
1 9	3 1 8	1 9.8	0 7 3 1 4	3 0 0	3 4 4	1 2 4
2 0	3 2 8	2 0 0	0 7 8 5 3	3 0 0	2 3 6	
2 1	3 3 6	2 0 3	0 8 3 4 8	3 0 0	2 5 0	
2 2	3 4 6	2 0.3	0 8 9 7 1	3 0 0	2 6 9	
2 3	3 5.2	2 0.8	0.9 3 5 5	3 0 0	2 8 1	
2 4	3 5 8	2 1.0	0 9 7 6 2	3 0 0	2 9 3	
2 5	3 6 2	2 1 2	1.0 0 6 7	3 0 0	3 0 2	3 0 2
Total						6 9 3

(Number of planting, 3,000 trees/ha)

2-3-3 Silviculture system

Silviculture system of Parana pine and Elliottii pine, which was prepared by Komiya on the basis of his survey in the State of Misiones, Argentina, is presented in Fig. 2-2-13 and 2-2-14.

Form these diagrams, tree height, diameter breast height and volume of the species for forest ages are tabulated as follows:

Table 2-2-17 Stand yield table base on silviculture system

Species	Forest age	Tree height	DBH	Volume		
				Dominant tree	Secondary tree	Total
	year	m	cm	m^3	m^3	m^3
Parana pine	12	14	21	150	100	250
	18	19	31	250	150	400
	25	21	35	320		320
	35					
Elliottii pine	12	14	20	200	100	300
	18	18	30	280	150	430
	25	21	36	100	300	400
	35	22	40			

Planting number of Elliottii pine is 1,600 per ha, with cutting period of 25 years* to reach tree height of 21 m, diameter breast height of 35 cm and volume of 300 m^3.
Planting number of Elliottii pine is 1,600 per ha, with cutting period of 25 years** to reach tree height of 21 m, diameter breast height of 36 cm and volume of 400 m^3.
Total increment and annual average increment of these species at forest age of 12, 18 and 25 years old are tabulated as follows:

Table 2-2-18 Total increment and annual average increment by forest age

Species	Forest age	Total increment	Annual average increment
	years	m^3	m^3
Parana pine	12	250	20.8
	18	500	27.8
	25	570	22.8
Elliottii pine	12	300	25.0
	18	530	29.4
	25	650	26.0

As seen in the above table, the increment of Elliottii pine is larger than that of Parana pine at all the ages.
Furthermore, according to the silviculture system brush cutting will be done for both species at three times annually up to the forest age of 4 years old.
Pruning will be done for both species at four times up to the forest age of 18 years old, with latter two times to be done along with thinning.
Thinning will be done for both species at three times up to their cutting period.

* The cutting period is determined at 25 years old, as 35 years old mentioned in the silviculture system is the one for seed trees.

** Similar to the above, the cutting period is determined at 25 years old as the volume at 35 years old mentioned in the silviculture system is not known.

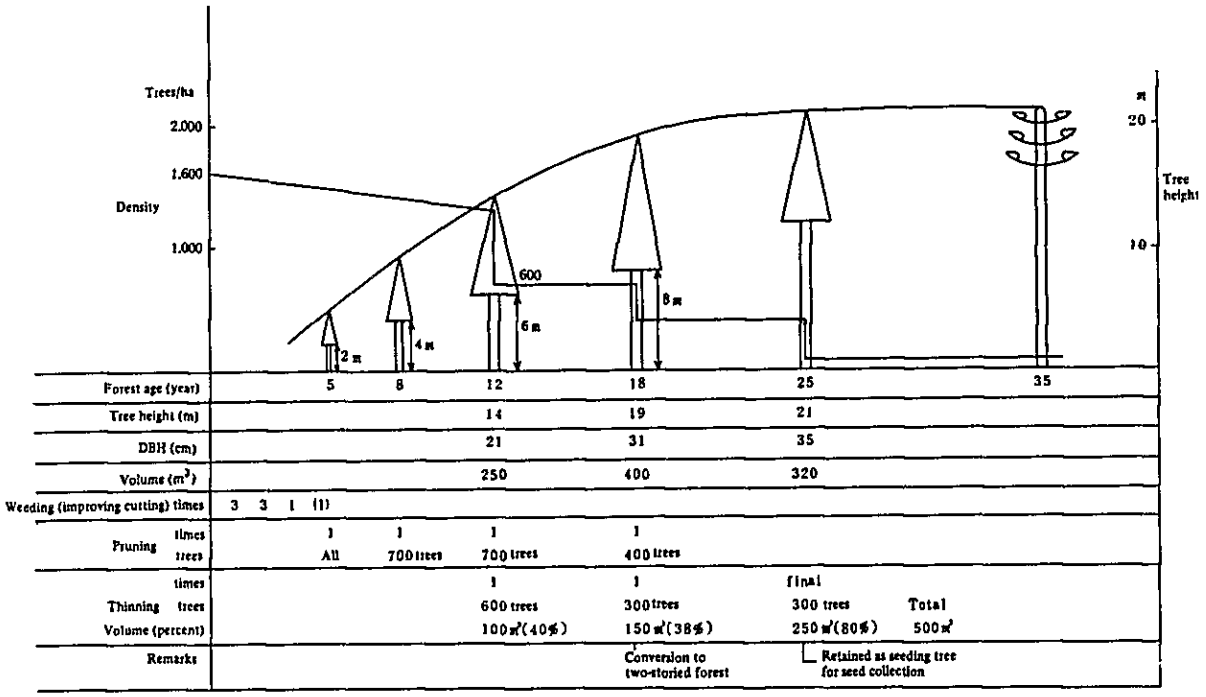


Fig. 2-2-13 Silvicultural system for Parana pine

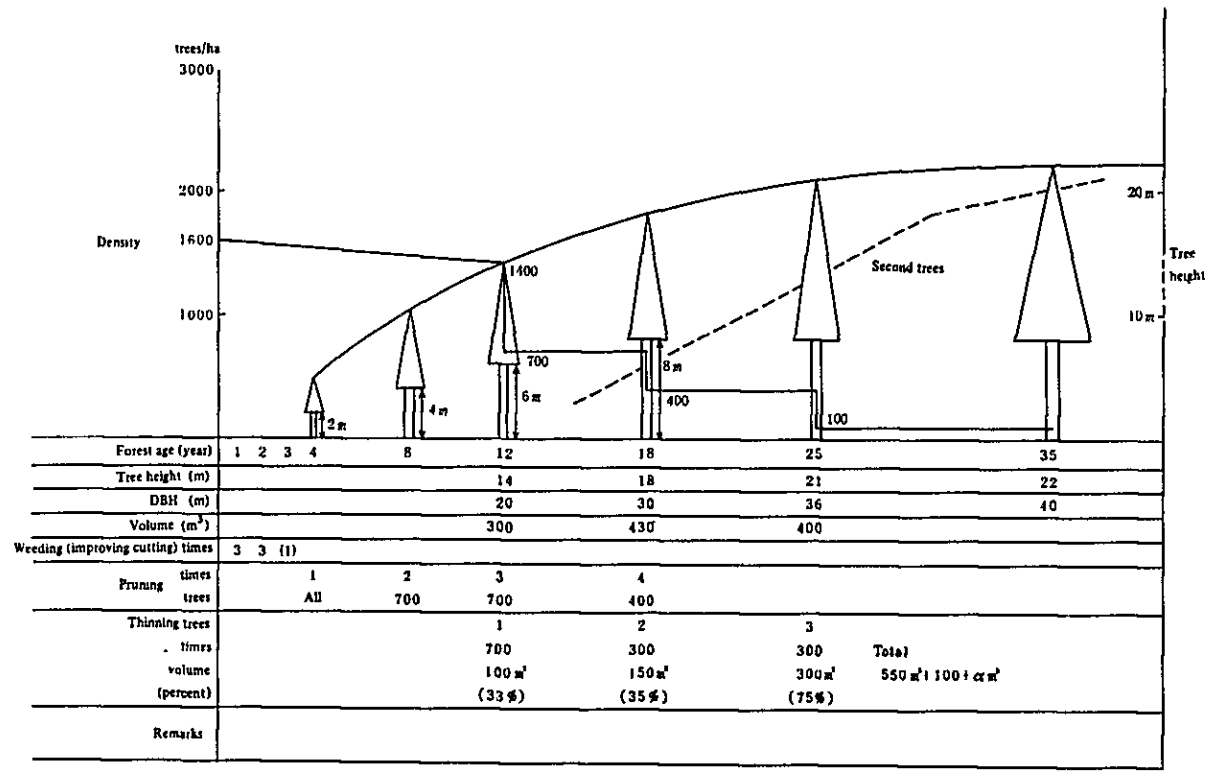


Fig. 2-2-14 Silvicultural system for Elliottii pine

Finally, additional reports on Eucalyptus (Eucalyptus spp), Caribbean pine (Pinus Caribaea) and Paraiso (Melia Azedarach) are summarized as follows:

Eucalyptus is planted in Brazil and Argentina; in the State of São Paulo, Brazil: yield of 250 m^3 at 7 years of forest age and annual increment of 35.7 m^3 per ha, and annual increment of 25 – 30 m^3 per ha at cutting period of 10 years; in the State of Misiones, Argentina: annual increment of about 33 m^3 at cutting period of 20 years, to show higher annual increment than Parana pine and Elliottii pine at same age. The number of planting is 2,500 per ha in both countries[7].

Stand yield table of Caribbean pine planted in São Paul is presented in Table 2-2-19.[8]

As Mr. Komiya suggests that the medium standing in the table is suitable for Paraguay, annual increment for the standing was obtained.

Table 2-2-19 Stand yield table of Caribbean pine

Site quality	Forest age	Average tree height	Number of planting	Volume	Main thinning volume
	years	m	trees	m^3	m^3
High	1	–	2.500	–	–
	7	1329	1.500	350	70
	10–12	1700	900	480	114
	14–17	2100	540	595	118
	18–26	2300	324	652	140
	35–40	2800	–	670	–
Medium	1	–	4.444	–	–
	6	950	2.222	226	63
	10–12	1300	1.333	300	99
	14–18	1700	800	379	102
	18–25	2100	480	428	105
	35–37	2700	–	519	–
Low	1	–	2.500	–	–
	7	900	1.500	158	35
	10–12	1150	900	195	47
	14–17	1480	540	342	59
	18–26	1750	324	271	67
	35–40	2300	–	338	–

As a result, at 10 – 12 years of forest age, its total volume is 300 m^3 and annual increment 27.2 m^3, whereas at 18 – 25 years of forest age 428 m^3 and 19.5 m^3 respectively, to indicate that the initial increment of Caribbean pine is faster than that of Parana pine and Elliottii pine reported by Mr. Komiya.

As to Paraiso, the case of the State of Misiones, Argentina is reported.

According to this, the increment of Paraiso is as shown in Table 2-2-20; at 2 years of forest age the diameter breast height of 11 cm and tree height of 8 m, at 6 years of forest age the diameter breast height of 30 cm and tree height of 15 m, and at 10 years of forest

age the diameter breast height of 50 cm and tree height of 18.5 m, to show remarkable increment[9].

Table 2-2-20 Increment of Paraiso

Forest age (year)	Number of trees (trees)	Thinning (trees)	Average DBH (cm)	Average tree height (m)
1	730			
2	360	370	11	8
4	250	110	20	12.5
6	170	80	30	15
8	120	50	40	17
10	120		50	18.5

2-3-4 Summary

(1) Seedling and reforestation

Amount of seeding, germination rate, planting time and seed spacing were surveyed for Parana pine, Elliottii pine and Eucalyptus.

① Amount of seeding is 60 – 90 kg (direct seeding) per ha with 7,800 – 11,700 grains for Parana pine, and 500 kg per ha for Eucalyptus.

② Parana pine is planted between April and May be direct seeding or in pot, Elliottii pine is planted between June and August in wood box or pot, and Eucalyptus is planted between July and October in seedbed. An optimal seeding time is in a fall through winter.

③ The number of plantings per ha by species is tabulated as follows:

Table 2-2-21 The number of plantings per ha

Species	Yamazoe report[2),3),4)]	Forest service report[1)]	Komiya report[8)]	Remarks
	trees/ha	trees/ha	trees/ha	Forest age
Parana pine	2,500 ~ 3,000	2,250*	1,600	–*
Elliottii pine	1,700	3,000	1,600	
Eucalyptus	2,200 ~ 2,500	2,500		

The number of plantings is varied with the reports; in Yamazoe report, 2,500 ~ 3,000/ha for Parana pine and 1,700/ha for Elliottii pine, in Forest Service report, 2,250/ha for Parana pine and 3,000/ha for Elliottii pine, and in Komiya report, 1,600/ha for Parana pine and 1,600/ha for Elliottii pine.

For Eucalyptus, the number is within the range between 2,200 – 2,500/ha in three reports.

④ Land preparation and ant extermination are required for Eucalyptus planting, and fire prevention for Elliottii pine planting.

⑤ From optimal planting work schedule by Komiya, adequate time of planting in

nursery is between July and August, and adequate time of planting in woodland is between May and August as well as in winter season.

(2) Increment of planted forest

Characteristics of species and increment in planted forest were surveyed mainly on the basis of the various reports.

① Cutting period appears to be appropriate to be around 20 – 25 years for Parana pine and Elliottii pine, and 10 years for Eucalyptus.

② Annual increment of planted forest by species and forest age are tabulated as follows:

Table 2-2-22 Annual increment by species, forest age

Species	Forest age	Alto Paraná forestry center report	Forest service report	Komiya report	CEDEFO forestry center report	Remarks
	year	m^3	m^3	m^3	m^3	
Parana pine	10	14.5 (9 years)	14.3	20.8 (12 years)		
	20		18.5	27.8 (18 years)		
	25			22.8		
Elliottii pine	10	22.6 (9 years)	28.1	25.0 (12 years)		
	20		31.4	29.4 (18 years)		
	25			26.0		
Caribbean pine	10		27.2			
	20					
	25		19.5			
Eucalyptus	10		25 ~ 30			
	20		33			
	25					
Cedro	25 ~ 27				1.71	
Peterevý	25 ~ 27				2.43	
Lapacho	25 ~ 27				0.59	
Paraiso	10					Average DBH 50 cm, tree height 18.5 m

Annual increment of Parana pine in 10 year old forest is 14.5 m^3 in Alto Parana report, 14.3 m^3 in Forest Service report and 20.8 m^3 in Komiya report; in 20 year old forest, 18.48 m^3 in Forest Service report and 27.8 m^3 in Komiya report; in 25 year old forest, 22.8 m^3 in Komiya report. This indicates that the annual increment increases until forest age reaches 20 years, and decreases thereafter.

Annual increment of Elliottii pine in 10 year old forest is 22.6 m^3 in Alto Parana report, 28.1 m^3 in Forest Service report and 25.0 m^3 in Komiya report; in 20 year old forest, 31.4 m^3 in Forest Service report and 29.4 m^3 in Komiya report; in 25 year old forest, 26.0 m^3 in Komiya report. Thus Elliottii pine shows larger annual

increment than Parana pine.

Caribbean pine, Eucalyptus and Paraiso show relatively large annual increment, and particularly Eucalyptus and Paraiso show larger annual increment than coniferous trees such as Caribbean pine.

③ Comparing increment between local and introduced species, introduced species such as Parana pine and Eucalyptus show much larger increment than local spacies such as Cedro, Peterevý and Lapacho, as seen in the table 2-2-22.

(3) Silviculture system

The detail of silviculture system is illustrated in the diagrams. According to this, brush cutting will be done for Parana pine and Elliottii pine, three times annually up to forest age of 4 years.

Pruning will be done for all trees at forest age of 5 years, for 700 trees at 8 years and 12 years, and for 400 trees at 18 years.

Thinning will be done for 600 trees and 100 m^3 at forest age of 12 years, and for 300 trees and 150 m^3 at 18 years.

Note

1) Forest Service: Survey Report on Forest and Forestry Condition in South America (1973)
2) Yamazoe, Genji: Characteristics of Parana Pine and Planting Method, Sao Paulo State Forestry Experimental Station (1973)
3) Ibid.: Capinous in Replacement of Parana Pine, Sao Paulo State Forestry Experimental Station (1973)
4) Ibid.: Planting of Eucalyptus, Sao Paulo State Forestry Experimental Station (1973)
5) Alto Parana Forestry Center: Research Center (1978)
6) CEDEFO Forestry Center: Preliminary Survey of Increment in Paraguay
7) Forest Service: Survey Report on Forest and Forestry Condition in South America (1973)
8) Komiya, Tadayoshi: Reforestation Technology, CEDEFO Forestry Center (1983)
9) Pariso in the State of Misiones: Advertisement on newspaper in Paraguay

3. FOREST CHARACTERISTIC SURVEY

3.1 Trend of Land Use and Forest Development

3-1-1 Trend of land use

The most significant feature of land use in Paraguay is that 39% of the land is used for live stock farming. Since the live stock farming is not managed carefully, its productivity is very low and there is a trend of converting forests into pastures as the result of seeking broader land spaces. The ratio of forestation is about 40% as a total of 37% for forestry and 3% reserve forests in national parks, but most of these forests are located in the western district. The forestation ratio in the eastern district is only 23%.

The forestry resource investigation conducted up to the preceding year discloses that the forestation ratio in the northeastern district is 60.9%, and this shows that the district is a very important forest area in Paraguay.

However, there is an obvious trend of the forest area being reduced at a high pace due to uncontrollable cutting of forest trees and subsequent change of land use state, that is, conversion of forest lands to farming or pastural lands.

According to the Landsat analysis conducted in 1980, the project area lost the forest at a rate of average about 1.3% per year during the five years of 1972 to 1977. Also, according to the detailed survey of a part of this project area by combining the Landsat data and aerophotographs, the area lost the forests at an average rate of 2.3% a year in the case of high tree forests and 1.3% in the case of low tree forests during the 12 years of 1968 to 1980.

Table 2-3-1 Present land use pattern (1979)

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	1882
Livestock farming	10,000,000	4050	5,662,300	3543	15,662,300	3851
Forestry	11,290,000	4572	3,710,000	2321	15,000,000	3688
National park · reserved forest	1,283,000	520	20,900	0.13	1,303,900	3.20
Other	400,500	162	653,500	4.09	1,054,000	259
Country total	24,692,500	100.00	15,982,700	100.00	40,675,200	10000

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

3-1-2 Analysis of forest change by Landsat data

(1) Direction of analysis

The following describes the results of analysis by the Landsat data on the chronological changes after 1981 in consideration of the land use trend as described in the foregoing. The aerophotographs used for the resources research were taken in October 1980 and June 1981, and the land area by the use types, area by the forests and forest stock contained in the research report of 1983 are the state as of the time the photographs were taken. It is extremely important that how the forests have changed since then up to today is determined, as well as making a forecast for the future trend, to establish a plan for this project. However, it is almost impossible to survey such a vast land, extending as wide as 1.5 million ha, in a short period of time. Use of the Landsat data is the optimum method to grasp the chronological changes in a vast land at a small amount of expenses and in a short period of time.

Accordingly, we try to observe the chronological changes of forests in recent years and determine the trend by running a comparative analysis on Landsat data of the same area and in successive years.

(2) Landsat data used

We used the following Landsat data for this analysis.

March 18, 1981	Landsat-III MSS images
March 25, 1983	Landsat-IV MSS images

The following caution was paid in selecting the data.

1) The data for 1981 was selected to be as close as possible to the date of aerophotograph taking.
2) The data for 1983 was selected from the latest ones.
3) On both of Items 1) and 2), the data was selected among those having as less cloud as possible.

(3) Analysis range

Landsat III and Landsat IV take different orbits and they do not cover the same area. Also, one picture of MSS image does not cover the whole of objective area of this project. Therefore, we determined to analyze the area where the images from the two Landsats completely overlap and prepared drawings of the chronological changes. The calculation of area size of chronological changes is applied to the objective research area only. The total objective area for this project is 1,568,803 ha, among which the analysis range by the Landsat data is 1,164,178 ha.

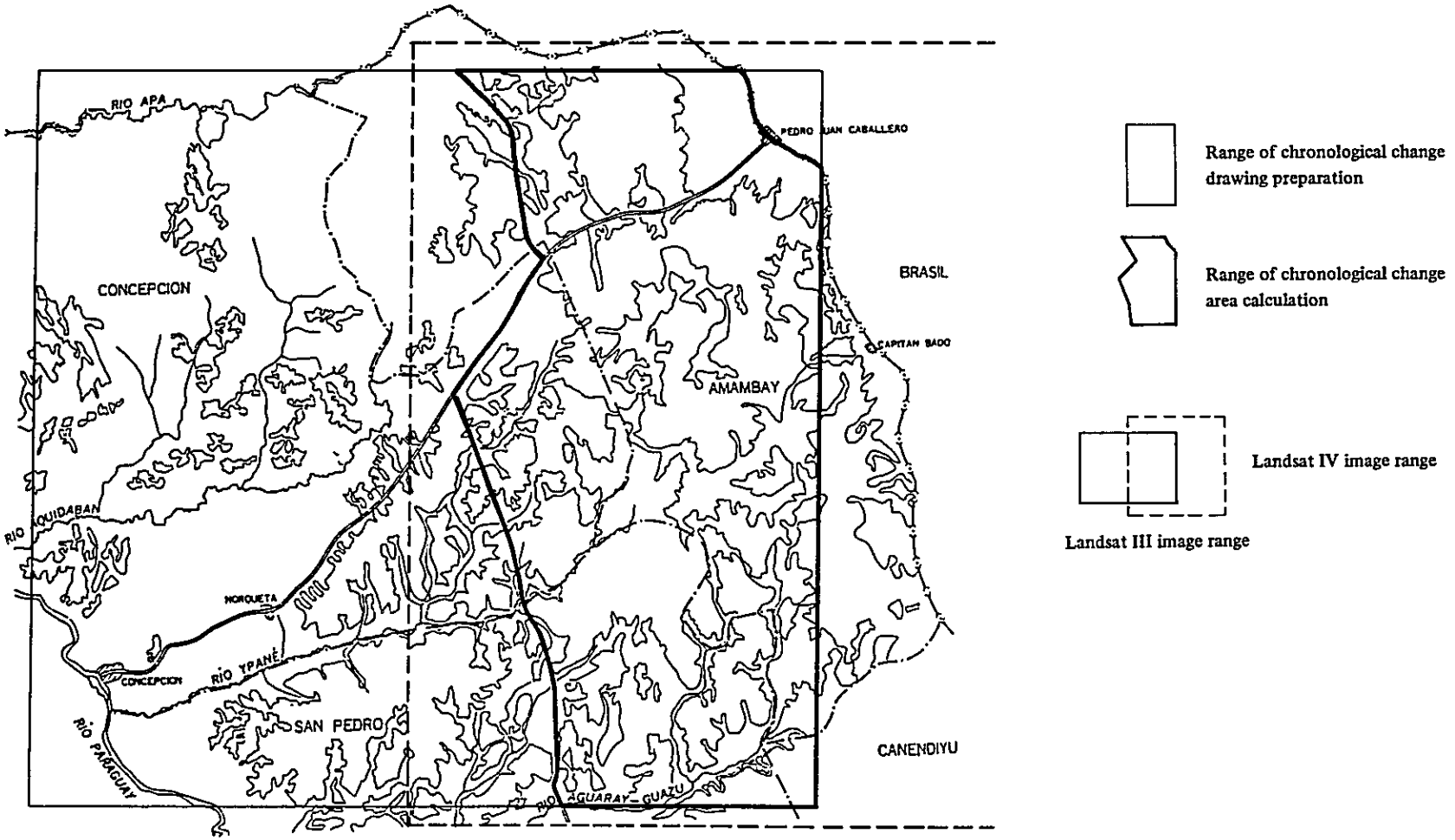


Fig. 2-3-1 Objective range of analysis

(4) Steps of analysis

Rough breakdown of the whole analysis work is as shown below.

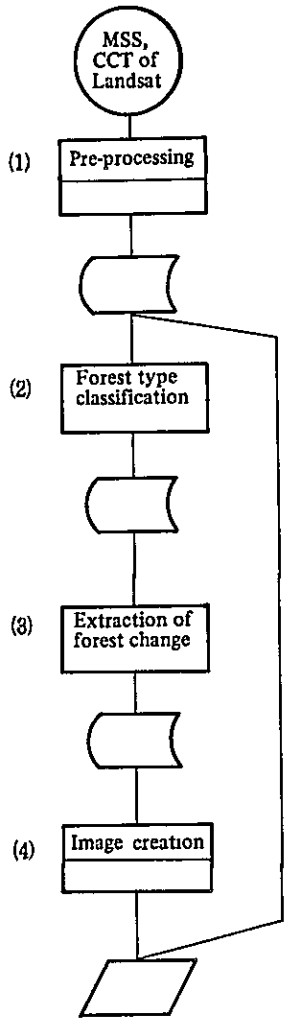


Fig. 2-3-2 Steps of analysis

1) Pre-processing

The pre-processing consists of work in two types; removal of scan noise that is unique to Landsat MSS (multi Spectral Scanner) and geometrical compensation to overlap the images of two different timings at the proper position.

2) Forest type classification

The standards of classification items were determined based on the aerophotographs taken in 1980 and 1981, and the classification was made for the both periods. The determined classification items are as shwon below.

High forest	A_1
"	A_2
"	A_3
Mixed forest	M
Medium forest	M_2
"	M_3
Low forest	B_1
"	B_2
Forest under cutting	E
Agricultural land	A
Swamp	H
Linestock farming land	G
Cut-over area	C

3) Extraction of forest type change

The data of two periods were overlapped and the changes were determined. The results were arranged in the image form, and at the same time, the quantitative values were calculated.

4) Image creation (Refer to the front picture and appendix drawing.)

The original images were processed for level intensification first, output as infrared colored photographs and colored photographs were prepared in the scale of 1/500,000. To obtain the annual change drawing, the image of 1983 was used as the base, to which the 1981 image was overlapped. The clear cutting area and partial cutting area were determined out of the overlaped images, an appropriate color is allotted to each part, and the results were output in a form of colored image. The final result is shown in colored photographs of 1/250,000 scale. The classification items used at the time of output are as shown below.

High forest
Mixed forest
Medium forest
Low forest
Forest under cutting
Non-forest
Clear cutting area
Partial cutting area

3-1-3 Trend of forest development as viewed from Landsat data

The decrease of forest area and change of forest type resulting from cutting in two years from March 1981 to March 1983 are shown in the chronological change table (Table 2-2-2) by the Landsat data. The information in Table 2-3-3 can be summarized as follows.

Table 2-3-2 Changes of area of forest and land use

(1981 →1983) (Unit: ha)

Type / Area	High forest				Mixed forest	Medium forest		Low forest		Forest under cutting	Non-high forest	Forest
	A_1	A_2	A_3	Total	M	M_2	M_3	B_1	B_2	E	Total	Total
Area in 1981	74,768	79,048	68,827	(19.1%) 222643	98,539	131,046	63,555	81,553	108,636	61,113	(46.8%) 544,492	(65.9%) 767,135
Area in 1983	56,641	55,722	57,986	(14.6%) 170,349	74,843	142,887	67,763	89,668	102,662	57,305	(46.0%) 535,128	(60.6%) 705,477
Decrease	18,127	23,326	10,841	(4.5%) 52,294	23696	−11,841	−4,208	−8,115	6024	3808	(0.8%) 9,364	(5.3%) 61658

Type / Area	Agricultural land A	Swamp H	Livestock farming land G	Cut-over area C	Built-up area P	Non forest Total	Grand Total
Area in 1981	9941	67,180	174,384	122198	23,339	(34.1%) 397,043	1164,178
Area in 1983	56,667	74198	217,805	78386	31,645	(39.4%) 458701	1164178
Decrease	−46,726	−7,018	−43421	43812	−8,306	(−5.3%) −61,658	0

The ratio of forest among the total land decreased from 65.9% to 60.6%, or by 5.3%. This is a decrease of annual 2.6% (4% if calculated against the forest area), or about 30,000 ha forest has disappeared in the two years. Based on this investigation result, it is assumed that about 40,000 ha forest has disappeared in the entire project area. The contents of wood in the remained forests are becoming poorer because of partial cutting of good quality and bulky trees.

For example, the size of high forests has decreased by 50,000 ha or more in the two years, and the size of non-high forests has slightly decreased but its ratio against the total forest area relatively increased.

Table 2-3-3 Chronological change table by Landsat data

Upper column: Area (ha)
Lower column: Change ratio (%) in 1983 against the classification of 1981. However, the ratios of total against grand total.

1981 classification / 1983 classification		High forest A_1	High forest A_2	High forest A_3	Mixed forest M	Medium forest M_2	Medium forest M_3	Low forest B_1	Low forest B_2	Forest under cutting E	Agricultural land A	Swamp H	Livestock farming land G	Cut-over area C	Built-up area p	Total of 1981
High forest	A_1	18,757 2.51	6,366 8.5	2,574 3.4	1,133 1.5	3,389 4.5	2,736 3.7	4,782 6.4	2,268 3.0	10,118 13.5	1,029 1.4	496 0.7	7,036 9.4	8,201 11.0	5,881 7.9	74,768ha 6.4%
"	A_2	10,792 13.7	13,591 17.2	6,637 8.4	1,475 1.9	5,635 7.1	6,923 8.8	7,978 10.1	2,342 3.0	14,694 18.6	348 04	429 0.5	2,567 3.2	3,434 4.3	2,202 28	79,048 6.8
"	A_3	3,968 5.8	9,412 13.7	10,028 14.6	2,343 3.4	11,156 16.2	10,600 15.4	6,974 10.1	3,183 4.6	6,505 9.5	154 0.2	315 0.5	1,241 1.8	1,745 2.5	1,203 1.7	68,827 5.9
Mixed forest	M	1,472 1.5	1,596 1.6	3,904 4.0	15,445 15.7	21,612 21.9	4,957 5.0	6,605 6.7	20,893 212	1,655 1.7	973 1.0	6,750 6.9	7,626 7.7	3,594 3.6	1,456 1.5	98,539 8.5
Medium forest	M_2	3,480 2.7	5,535 4.2	12,880 9.8	14,373 11.0	37,642 28.7	14,439 11.0	9,459 7.2	17,665 13.5	4,146 3.2	409 0.3	1,920 1.5	3,372 2.6	3,733 2.8	1,995 1.5	131,046 11.3
"	M_3	2,302 3.6	4,608 7.3	7,513 11.8	4,620 7.3	14,960 23.5	8,781 13.8	6,620 10.4	4,851 76	3,298 5.2	231 0.4	817 1.3	1,879 3.0	2,062 3.2	1,012 1.6	63,555 5.5
Low forest	B_1	2,348 2.9	2,318 2.8	2,181 2.7	7,696 9.4	9,609 11.8	3,801 4.7	11,775 14.4	5,819 7.1	3,129 3.8	2,114 2.6	7,266 8.9	15,465 190	6,749 8.3	1,283 1.6	81,553 7.0
"	B_2	2,268 2.1	2,120 2.0	4,122 3.8	15,970 14.7	21,811 20.1	4,675 4.3	5,230 4.8	34,918 32.1	2,132 2.0	590 0.5	4,399 4.0	4,464 4.1	3,318 3.1	2,669 2.5	108,686 93
Forest under cutting	E	3,835 6.3	7,647 12.5	6,567 10.7	2,547 4.2	8,416 13.8	7,917 13.0	7,708 12.6	2,851 4.7	6,513 10.7	329 0.5	785 1.3	2,325 3.8	2,477 4.1	1,197 2.0	61,113 5.2
Agricultural land	A	45 0.5	18 0.2	10 0.1	55 05	60 0.6	15 0.1	167 1.7	43 0.4	32 0.3	4,116 41.4	408 4.1	3,957 39.8	428 4.3	589 5.9	9,941 0.9
Swamp	H	906 1.3	351 0.5	276 0.4	2,320 3.5	1,839 2.7	530 08	3,372 5.0	2,815 4.2	635 0.9	5,085 7.6	17,510 26.1	23,857 35.5	5,740 85	1,945 2.9	67,180 53
Livestock farming land	G	899 05	457 0.3	305 0.2	3,349 19	2,550 1.5	723 0.4	7,667 4.4	1,925 1.1	838 0.5	28,787 16.5	24,147 13.8	87,645 50.3	11,546 6.6	3,546 2.0	174,384 15.0
Cut-over area	C	3,983 3.3	1,298 1.1	731 0.6	3,227 2.6	3,611 3.0	1,378 1.1	10,522 86	2,245 1.8	2,922 2.4	10,163 8.3	8,514 7.0	47,874 392	22,220 18.2	3,510 2.9	122,198 10.5
Built-up area	P	1,586 6.8	407 17	258 11	290 1.2	597 2.6	287 1.2	810 3.5	843 3.6	688 2.9	2,340 10.0	441 1.9	8,498 36.4	3,139 134	3,156 13.5	23,339 2.0
Total of 1983		56,641 4.9	55,722 9.8	57,986 5.0	74,843 6.4	142,887 123	67,763 5.8	89,668 7.7	102,662 88	57,305 4.9	56,667 4.9	74,198 6.4	217,805 187	78,386 6.7	31,645 2.7	1,164,178 100.0

We have also estimated stock of forests that have decreased because of the decrease of forest area and degrading of the contents. The following calculation method was employed for this estimation.

[Calculation example]

1) The area of high forest A_1 has decreased by 18,127 ha in the two years.
2) The average stock (more than 41 cm diameter) in high forest A_1 is estimated to be 22.19 m^3/ha based on the investigation result.
3) Accordingly, the difference on the stock between 1981 and 1983 is:

   18,127 ha x 22.19 m^3 = 402,238 m^3

   The decrease of forest stock was calculated on each classification item in the same way as shown in the calculation example and the results are shown in the table below. The total decrease of forest stock amounts to about 2.25 million m^3, and when the reserves that have decreased per year in the whole project area is calculated as follows:

$$\frac{\text{Total area of project area } 1{,}568{,}803 \text{ ha}}{\text{Area of Landsat analysis } 1{,}164{,}178 \text{ ha}} \times \frac{2{,}245{,}637 \text{ m}^3}{2 \text{ years}} = 1{,}500{,}000 \text{ m}^3$$

   The decrease of forest stock per year amounts to about 1.5 million m^3. Assuming that about 50% of 1.5 million m^3 were burnt down or thrown away, the wood that is utilized each year is estimated as 0.75 million m^3.

Table 2-3-4 Calculation table of decreasing stock

Forest type		Decreasing area	Average stock	Decreasing stock
		ha	m^3/ha	m^3
High forest	A_1	18,127	22.19	402,238
"	A_2	23,326	36.99	862,829
"	A_3	10,841	61.07	662,060
Mixed forest	M	23,696	27.78	658,275
Medium forest	M_2	−11,841	29.27	−346,586
"	M_3	−4,208	37.18	−156,453
Low forest	B_1	−8,115	0.41	−3,327
"	B_2	6,024	11.05	66,565
Forest under cutting	E	3,808	26.27	100,036
Total				2,245,637

3-2 Cutting Volume and Disposition

3-2-1 Survey Method

It is very important to know cutting species and cutting volume for each species in the study area. As it is not possible to survey all cutting areas widely distributed throughout the survey area, alternative survey method was employed by means of surveying the number of log carrying trucks from the cutting areas and measuring species, diameter and length of loaded logs so as to know cutting disposition.

In addition, two surveys, 1st survey in 1982 and 2nd survey in 1983, was carried out to know change of cutting volume and disposition over time. Unfortunately, in 1983 longest rain in past 80 years badly affected road condition to suspend cutting and transportation work for long period. 2nd survey was carried out in middle of July under unusual condition immediately after roads were opened and log transportation work was resumed, to make difficult an optimal comparison with 1st survey result.

Table 2-3-5 Location and time of cutting disposition survey

Location of survey	Date of survey	Time of survey	Period of survey
P.J. Caballero	20th October, 1982	10 am – 8 pm	10 hours
Estrella	〃	10 am – 5 pm	9 〃
P.J. Caballero	13th July, 1983	9 am – 4 pm	9 〃
Capitan Bado	15th July, 1983	9 am – 5 pm	10 〃

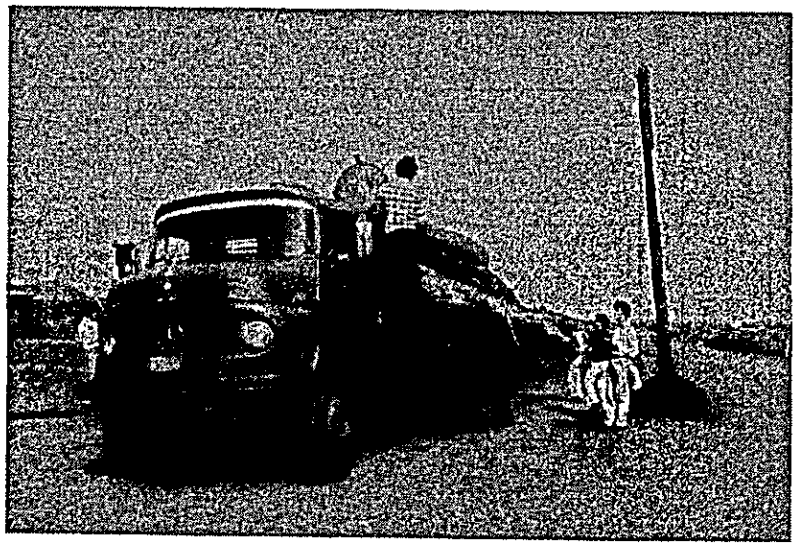


Table 2-3-6 Species, Number and Volume of Carried Logs 1st survey (1982)

Survey point		Total				P. J. C.				Estrella			
Number of trucks		70 trucks				59 trucks				11 trucks			
		Quantity		Share		Quantity		Share		Quantity		Share	
Tree species	class	Number	Volume	Number	Volume	Number	Volume	Number	Volume	Number	Volume	Number	Volume
Peroba	B	508 trees	905.71m³	94.6%	95.2%	418 trees	757.89m³	95.7%	96.2%	90 trees	147.82m³	90.0%	90.4%
Cedro	A	2	3.62	0.4	0.4	2	3.62	0.4	0.5	—	—	—	—
Kurupay	A	6	9.63	1.1	1.0	6	9.63	1.4	1.2	—	—	—	—
Lapacho	A	3	5.86	06	0.6	1	3.05	0.2	0.4	2	2.81	2.0	1.7
Yvyra ró	A	8	11.63	1.4	1.2	3	4.35	0.7	0.5	5	7.28	5.0	4.5
	Sub-total	(19)	(30.74)	(3.5)	(3.2)	(12)	(20.65)	(2.7)	(2.6)	(7)	(10.09)	(7.0)	(6.2)
Kurupay rá	B	1	2.18	0.2	0.2	1	2.18	0.2	0.3	—	—	—	—
Yvyra pyta	B	3	2.76	0.5	0.3	3	2.76	0.7	0.3	—	—	—	—
	Sub-total	(4)	(4.94)	(0.7)	(0.5)	(4)	(4.94)	(0.9)	(0.6)	(—)	(—)	(—)	(—)
Yvyra piú	C	1	3.22	0.2	0.4	—	—	—	—	1	3.22	1.0	2.0
Tata jyva	C	2	2.28	0.4	0.2	—	—	—	—	2	2.28	2.0	1.4
	Sub-total	(3)	(5.50)	(0.6)	(0.6)	(—)	(—)	(—)	(—)	(3)	(5.50)	(3.0)	(3.4)
Palo blanbo	D	3	4.75	0.6	0.5	3	4.75	0.7	0.6				
Total		537 trees	951.64m³	100.0%	100.0%	437 trees	288.23m³	100.0%	100.0%	100 trees	16341 m³	100.0%	100.0%

Table 2-3-6 Species, number and volume of carried logs 2nd survey (1983)

Survey point		Total				P. J. C.				Capitan Bado			
Number of trucks		44 trucks				32 trucks				12 trucks			
		Quantity		Share		Quantity		Share		Quantity		Share	
Tree species	class	Number	Volume	Number	Volume	Number	Volume	Number	Volume	Number	Volume	Number	Volume
Peroba	B	270 trees	397.81m³	71.8%	75.5%	212 trees	332.05m³	88.0%	89.6%	58 trees	65.76m³	43.0%	42.0%
Cedro	A	4	2.16	1.1	0.4					4	2.16	3.0	1.4
Guatambú	A	1	1.06	0.3	0.2					1	1.06	0.7	0.7
Kurupay	A	12	14.77	3.2	2.8					12	14.77	8.9	9.4
Lapacho	A	5	5.48	1.3	1.0	4	3.90	1.6	1.0	1	1.58	0.7	1.0
Yvyra ró	A	2	3.10	0.5	0.6					2	3.10	1.5	2.0
	Sub-total	(24)	(26.57)	(6.4)	(5.0)	(4)	(3.90)	(1.6)	(1.0)	(20)	(22.67)	(14.8)	(14.5)
Cancharana	B	1	0.75	0.3	0.1					1	0.75	0.7	0.5
Yvyra pytá	B	16	21.99	4.2	4.2	10	14.35	4.2	3.9	6	7.64	4.5	4.9
	Sub-total	(17)	(22.74)	(4.5)	(4.3)	(10)	(14.35)	(4.2)	(3.9)	(7)	(8.39)	(5.2)	(5.4)
Guajavi	C	1	0.83	0.3	0.2					1	0.83	0.7	0.5
Jata yva	C	5	5.91	1.3	1.1	5	5.91	2.1	1.6				
Kupa y	C	51	65.91	13.5	12.5	6	9.53	2.5	2.6	45	56.38	33.5	36.1
Laurel canela	C	1	0.33	0.3	0.1					1	0.33	0.7	0.2
Tata i yva	C	3	3.66	0.8	0.7	3	3.66	1.2	1.0				
Urunde y para	C	1	0.63	0.3	0.1					1	0.63	0.7	0.4
	Sub-total	(62)	(77.27)	(16.5)	(14.7)	(14)	(19.10)	(5.8)	(5.2)	(45)	(58.17)	(35.6)	(37.2)
Marinero	D	1	0.99	0.3	0.2					1	0.99	0.7	0.6
Kuruguay	E	2	1.69	0.5	0.5	1	1.22	0.4	0.3	1	0.47	0.7	0.3
Total		376 trees	527.07m³	100.0%	100.0%	241 trees	370.62m³	100.0%	100.0%	135 trees	156.45m³	100.0%	100.0%

3-2-2 Survey result

Survey result of number of trucks, tree species, number of logs and their volume is presented in Table 2.3.6.

(1) Cutting species

Peroba constitutes 88% of the total volume, to clearily indicate its dominant share in cutting, leaving a small share of 12% to the rest of species. In other words, the market is monopolized by Peroba, rather than dominated. At the same time, it is clearily recognizable that the share of Peroba is in declining trend in a past year; when the share of Peroba in the total volume surveyed is compared between two years, considerable rate of the decrease, from 95% in 1982 to 76% in 1983, is observed. From data at P.J.C., which is in same survey point, slight decrease of the share of Peroba, from 96% in 1982 to 90% in 1983, is observed.

Accordingly, the cutting volume of the other species has increased; particularly, at Capitan Bado the species other than Peroba has a dominant share of 58% in 1983.

Composition of the volume of species other than Peroba for each class is as follows:

Class	Volume (m^3)	Share %
A	57.31	33
B	27.68	16
C	82.77	47
D	5.74	3
E	1.69	1
Total	175.19	100

Surprisingly enough, class C has the highest share of 47%, especially Kupay with relatively high share among the class.

Among class A, which has a share of 33%, Kurupay and Yvyrá-ró have a large share while Cedro and Lapacho have a small share.

(2) Volume of logs per truck

	1st survey	2nd survey
Average loaded volume per truck	13.59 m^3	11.98 m^3
Average number of logs per truck	7.67 trees	8.55 trees
Average volume per log	1.77 m^3	1.40 m^3
Average diameter per log	588 cm	52.6 cm

When average diameter of log loaded is compared for 1st survey in 1982 and 2nd survey, decreasing trend is observed, from 58.8 cm to 52.6 cm.

Accordingly average volume of log per truck has decreased, although the number of log loaded was increased.

This indicates that large diameter trees have become less available and relatively small diameter trees, which were not used previously, have become an object of cutting.

3-2-3 Estimate of cutting volume

As previously mentioned, data obtained from 2nd survey is not suitable for estimate of cutting volume since the survey was done under unusual condition on resuming log transportation after long period of torrential rain. Thus, only the data obtained from 1st survey was used for estimation purpose.

(1) Estimate of number of passing trucks

At PJC, 59 trucks passed during 10 hour period between 10 am and 8 pm, averaging 6 trucks per hour. According to the interview with nearby residents, peak time of the traffic is between 8 pm and 0 pm, and midnight traffic continues until 3 am. On the basis of this information, the traffic rate between 8 pm and 0 am was estimated at 10 trucks per hour, and between 0 am and 3 am as well as 7 am and 10 am at 3 trucks per hour, to estimate daily traffic at P.J.C. at 117 trucks.

7 am – 10 am	9 trucks (Estimate)
10 am – 8 pm	59 " (Actual)
8 pm – 0 pm	40 " (Estimate)
0 pm – 3 am	9 " (Estimate)
Total	117 trucks

On the other hand, the traffic count at Estrella was 11 trucks during 7 hour period between 10 am and 5 pm. Together with estimate for the rest of hour on thebasis of the interview with nearby residents, the daily traffic at Estrella was estimated at 31 trucks.

Both estimates were added up to 148 trucks/day, and normal traffic volume at two points was determined at 150 trucks/day.

(2) *Estimation of cutting quantity*

We have set several suppositions to estimate the cutting volume in the survey area. The items where the suppositions are set are ratio of cutting and carrying out volume per day at the above two survey points against the total cutting volume of whole area (1.5 million ha) and the total number of days per year for carrying-out work.

1) Precondition:

The cutting and carrying out volume of logs in P.J.C. and Estrella (per day) is set to 2,011 m^3 (13.59 m^3 x 148 trucks)

2) Suppositions

Supposition	Ratio of cutting volume against whole area	Working days for carrying out per year
1	2 times	216 days (18 days x 12 months)
2	2 times	180 days (15 days x 12 months)
3	1.5 times	216 days
4	1.5 times	180 days

3) Estimation

Supposition 1	868,752m^3	= 2,011m^3	x	2 (times)	x 216 (days)
Supposition 2	723,960	= 2,011	x	2	x 180
Supposition 3	651,564	= 2,011	x	1.5	x 216
Supposition 4	542,970	= 2,011	x	1.5	x 180

The estimation results based on these suppositions are roughly in the range of 869,000 m^3 to 543,000 m^3.

The supposition values used in the estimation were arrived at by summarizing the opinions of related parties and by converging the empirical forecast values obtained from investigators who had covered the whole survey area for research in the past four years, and we consider that they are appropriate ones.

For these reasons, we determine that the estimated cutting quantity per year in the survey area is 697,000 m^3, which is the average value of the four estimations.

4) Estimation of Peroba cutting volume

As mentioned in the above, the result of first stage survey indicated that Peroba occupied 95% of the cutting and carried out volume. However, since there is a fairly apparent trend of changing to other tree species, which probably is caused by the Peroba resource area moving into the interior part, as found through the second stage survey and from the recent situation in the country, we determined to set the share of Peroba to 75% when calculating the estimate. At this share ratio, the annual cutting volume of Peroba is estimated to be about 523,000 m^3.

(3) Trends of cut

Since it is difficult to obtain systematic statistics of cutting volumes in the whole surveyed areas we will show in Table 2-3-7 the number of Guia (cutting license) issuances granted during the 5 years from 1978 to 1982 by Amambay forestry office (having jurisdiction in Dept Amambay). According to the table, an increasing tendency is seen after the year 1979 except in 1981. It can be said that this nearly corresponds with the analysis of the Landsat data.

Further, one issuance of Guia is converted to one log, or almost 2 m^3.

The number of sawmills shows a declining trend since 1979. According to local people, the major reason for that is the sawmills are being moved to other areas.

Table 2-3-7 Number of Guia from 1978 to 1982

(Dept Amambay) (unit: piece)

Month \ Year	1978	1979	1980	1981	1982
January			8180	6750	7281
February			10610	8000	7.200
March			9.370	6.240	4330
April			10000	4.000	8150
May			6150	6750	8100
June			7.650	5.080	7.000
July			9.686	5.950	10.800
August			9400	7.500	11.900
September			7.540	6400	10600
October			9947	5300	6775
November			7760	5.434	7.525
December			8753	3000	5.150
Total	69800	91200	105.046	70.404	94811
Average	5.817	7.600	8754	5867	7.901

Table 2-3-8 Trends of Sawmills (Dept. Amambay)

Items \ Year	1975~1979	1980	1981	1982(83)
Number of sawmills	45	40	35	28
Sawing capacity				144,000m³
Number of workers				460

3-3 Wood Processing and Marketing

Products of Paraguay forestry sector are divided to fuel wood, and 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 Argentina. However, because of incessant 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 1975 and 1982, with large flactuation 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 seems to operate in recent years.

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

Table 2-3-9 Trends of wood products exports

(unit: metric ton, FOB $1,000.)

Items \ Year	1975		1980		1981		1982	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1. Lumber	107,012	22,184	186,879	47,487	75,349	23,046	70,602	20,172
2. Process goods	9,736	5,688	75,455	18,964	42,392	13,903	40,199	24,017
(1) Veneer	5,041	1,329	47,220	9,481	24,932	7,207	17,769	5,072
(2) Flooring	2,713	1,613	2,844	1,752	1,655	1,304	5,365	9,850
(3) Doors	866	2,058	543	1,415	403	1,028	71	196
(4) Plywoods	778	540	2,065	2,378	1,755	1,646	744	770
(5) Wood for furniture	3	5	—	—	56	20	—	—
(6) Pole	—	—	—	—	5	2	8	2
(7) Wall material	38	42	25	57	9	28	—	—
(8) Others	297	101	21,958	3,881	13,577	2,668	16,242	8,127
3. Palm wood	1,556	133	—	—	606	30	—	—
Total	118,304	28,005	262,334	66,451	118,347	36,979	110,881	44,189

Source: Paraguay Central Bank

Table 2-3-10 Trends of paper & paper products imports

Items \ Year	1975	1980	1981	1982
	Quantity	Value	Quantity	Value
Wrapping paper	698	3,137	1,028	2,048
Paper for newspaper	3,059	8,027	4,883	10,643
Paper for tobaco	20	69	120	82
Paper for note books	1,364	3,828	2,629	3,744
Cardboard paper	—	—	—	—
Processed paste board	36	2	7	3
Processed paper	59	114	14	54
Books, booklets	91	159	156	186
Others	2,287	1,030	1,441	2,027
Total	7,614	16,366	13,308	18,787

4. QUESTIONNAIRE

4-1 Survey Method

On preparing a guideline for the forest development plan, to know opinions of forest owners, local residents, sawmill operators and public administrative bodies in the departments municipalities on forest is required for forest plan closely related to the area. For this purpose, the questionnaire was done by means of personal interview with the above four groups by using four different types of questionnaires suit their particular interests and situations.

Category of surveyed groups and the number of surveyed samples are as follows:

Category of surveyed group	Number of surveyed samples
Forest owner	11
Local resident	9
Sawmill operator	25
Key person in the departments and municipalities	3
Total	48

4-2 Survey Result

4-2-1 Questionnaire to forest owners

11 forest owners in the survey area were picked out for the questionnaire; 7 residing in Pedro Juan Caballero, 1 residing in Capitan Bado, 1 residing in Lima and 2 residing in Asunción.

Question 1 : Name
Answer : (Not specified in this report)
Question 2 : Nationality
Answer : 5 Paraguayans, 3 Brazilians, 2 Japanese and 1 American; relatively many Brazilians partly due to a proximity to the border.
Question 3 : Profession
Answer : Farm or pasture management constitutes a half of them, followed by other self-employment business and government employee.
Question 4 : Size of property
Answer : Size of their property is very large; ranged between 220 – 15,000 ha, with average size of 4,000 ha, since large landowners were selected for the survey. Percentage of forest coverage in the properties is high; more than 50% in most of them and 90 – 100% in some of them.
Question 5 : Share of their income from forestry in total income.
Answer : Very large variation from 0% to 100%, with 20% on average; 5 persons, nearly a half of them, answered '0%', 2 persons answered '100%'.
Question 6 : Annual cutting volume (average of 5 years period).
Answer : 5 owners (45%) have not done cutting in past five years. Cutting volume by the rest of owners were ranged from 1,700 – 20,000 m^3, with 10,000 m^3 on average. Share of Peroba in total volume is 80%.
Question 7 : Use of forest land after cutting

Answer : 10 owners (91%) have converted their forests to a farm or pasture after cutting useful trees. Only one owner thinks about the management of natural forest on permanent basis.

Question 8 : Manpower for cutting

Answer : Employed labors ..... 5 owners (56%);
Contract ..... 3 owners (33%);
Selling on stumpage ..... 1 owner (11%);
Self labor ..... 0 owner (0%);
It is evident that the cutting work on vast property of 4,000 ha on average could not be handled by self labor.

Question 9 : Buyer

Answer : Sawmill ..... 5 owners (83%); One owner has his own mill. Only one owner (17%) sells his logs to a middleman.

Question 10 : Sales price

Answer : Delivery on roadside ..... 8,000 Gs/m^3 on average
Delivery at sawmill ..... 12,000 Gs/m^3 on average

Question 11 : Loss by illegal cutting and prevention measures

Answer : 2 out of 11 owners have been a victim of illegal cutting. Some owners have a prevention measure, such as fencing, watchman and help from neighbors.

Question 12 : Trade of forest land in past five years

Answer : Sold ..... 2 owners (18%); 220 ha on average
Purchases ..... 4 owners (36%); 470 ha on average

Question 13 : Intended use of purchased forest land

Answer : To cut useful trees in the forest and then to convert it to a farm or pasture.

Question 14 : Future use of owned forest

Answer : Forest ..... 3 owners; Pasture ..... 10 owners; Farm ..... 3 owners. Most of them intend to convert their forest to a pasture, only three owners intend to manage their forest on permanent basis.

Question 15-1 : Interest in reforestation

Answer : Not interested ..... 2 owners (18%)
Interested ..... 4 owners (36%)
Do not know ..... 5 owners (46%)
All the owners, who expressed an interest, attached conditions such as financing on reforestation project, strong guidance by government and establishing of paper mills.
Also 2 out of 4 owners have already carried out a small scale reforestation for windbreak and other purposes.

Question 15-2 : Species selected for reforestation

Answer : Fast growing species ..... Pine, Eucalyptus, Paraiso and paulownia. Species sold as construction material at high price.

Question 16 : Usefulness of forest on their living

Answer : A) Source of fuel 3
B) Material for housing construction 4
C) Source of income 7
D) For agriculture and livestock farming 5
E) Other (recreational use) 1

Source of income is the most frequent answers, from 7 owners. Use for agriculture and livestock farming is mostly on fencing.

Question 17 : Opinon on rapid decrease of forest in recent years

Answer : A majority of the opinions could be summarized as follows: Although rapid decrease of forest should be concerned about, cutting of forest is inevitable to support people who make a living on forest and related industries.

They have an intention to cut their own forest as required. However, unlimited cutting is not desirable, and protective forest should be retained for prevention of erosion, securing of water resource, and flood prevention.

Question 18 : Usefulness of forest is general

Answer :

A) Production of log and firewood	6
B) For agriculture and livestock farming	6
C) Weather alleviation	10
D) Securing of water resource	7
E) Prevention of soil erosion	8
F) Recreational activity	3
G) Protection of sild life	4
Total	44

Except for one answer 'do not know', high interest in public functions of forest is evident, partly because the survey was done immediately after torrential rain in 85 years. An effect of forest on weather alleviation and prevention of soil erosion is highly valued, while valuation on recreational activity and protection of wild life is still low.

Question 19 : Knowledge on Forest Law

Answer :

A) Do not know	2 (18%)
B) Know about its existence	4 (36%)
C) Know about its content	5 (46%)

Because of large forest owners, relatively many of them know about the act. Yet a majority of them do not know about its existence or content by ratio of 6 : 5.

Question 20 : Problems on forest management

Answer : A most of the owners answered 'Not particularily'. This could be interpreted that they are not seriously involved in forest management.

Question 21 : Requests to central and department government

Answer : Three owners answered 'Non', and the requests by 8 owners are listed as follows:

- o Need for land use control
- o Concerning uncontrolled cutting
  - Strict enforcement of Forest Law
  - Need for supervision on forest management
  - Prevention of smuggling
  - Public education and information service
- o Need for government financing on reforestation project on long term and low interest rate

- o Avoiding to coerce reforestation without assistance
- o Developing the use of unused species
- o Maintaining adequate lumber price

4-2-2 Questionnaire to local residents

9 local residents in the survey area were picked out for the questionnaire; 5 residing in Pedro Juan Caballero, 3 residing in Capitan Bado and 1 residing in Lima.

Question 1 : Name
Answer : (Not specified in this report)
Question 2 : Nationality
Answer : 6 Paraguayans, 1 Brazilian, and 2 Japanese
Question 3-1 : Profession
Answer : Farmer . . . . . 4; Trader 2;
Bank employee . . . 1; Teologist 1;
Driver 1
Question 3-2 : Income
Answer : 200,000 – 1,500,000 Gs/year, with 500,000 Gs/year, on average (cash income of interviewee).
In some familities, all the members are working to supplement the income from the head of the family.
Question 4 : Years of Residency
Answer : 2–57 years, with 20 years on average.
Except for transference, long term residents constitute a majority.
Question 5 : Forest ownership
Answer : Do not own 5 (56%)
Own small forest 4 (44%)
Size of 4–100 ha; used for firewood collection and water source protection.
Question 6-1 : Work experience in forest or sawmill
Answer : Yes 5 (56%)
No 4 (44%)
Question 6-2 : Type of work
Answer : Management of sawmill (small scale) 2
Labor or machinery worker at sawmill 2
Middleman
Two of them were laid off from sawmill at the time of interviewing due to no supply of logs caused by torrential rain in 1983.
Question 7 : Interest in forest work
Answer : Not interested 6 (67%)
Interested 3 (33%)
Those who answered 'Interested' are not particularly interested in forest work, but as one of employment opportunities.
Question 8-1 : Experience of recreational activity in forest
Answer : No 5 (56%)
Yes 4 (44%)
Major activities are stralling and camping, but no gathering of edible wild plants.

Question 8-2 : Need for forest park

Answer : Not needed 2 (22%)

Needed 7 (78%)

There are a few opinions to suggest that parks in cities be provided before ones in suburb.

Question 9 : Opinion on rapid decrease of forest in recent years

Answer : Favorable for its decrease (conversion to agricultural use) .. 1 (11%)

Do not know 3 (33%)

Realize its decrease 5 (56%)

Selected opinions of those who realize its decrease are summarized as follows:

- o There are fewer jobs related to forest than the past.
- o The decrease of forest will not affect their generation.
- o The decrease of forest is inevitable, but essential part should be retained, with reforestation if possible.

Question 10 : Change caused by decrease of forest

Answer : A Weather (air temperature) has become warmer (colder) 5

B Rain has become more frequent (less frequent) 2

C Flood occurs more frequently 2

D Water level of rivers has lowered 4

E Soil has been washed out by erosion 7

F Wild life has become less 5

G Others 3

Most frequent answer is soil wash-out by erosion, followed by change in air temperature and decrease of wild life.

In 'Others', difficulty to obtain firewoods and less frequent frost are mentioned.

Question 11 : Usefulness of forest on their living

Answer : Not particularly 2 (22%)

Useful 7 (78%)

'Useful' is specified as production of firewood (5), source of income/ employment opportunity (3), and windbreak and erosion prevention forest (1).

Question 12 : Knowledge on Forest Law

Answer : Do not know 5 (56%)

Know about its existence 2 (22%)

Know about some of its content 2 (22%)

most of them do not have no knowledge on the Law, except two person.

Question 13 : Request to government concerning forest and forestry

Answer : Not particularly 2 (22%)

Have some request 7 (78%)

These requests include:

- o Promotion of reforestation by government's subsidiary (financing and distribution of seedling)
- o Reforestation on slope area
- o Employment opportunity on forest work
- o Guidance and supervision on forest cutting
- o Upgrading of district forest office

Question 14-1 : Amount of tax paid
Answer : 2,000 – 50,000 Gs; 20,000 Gs on average
Question 14-2 : Public facilities required
Answer : Road improvement and expansion 3
Establishment agricultural school 3
Improvement of medical facilities 2
Complaint about high cost of public service share 2

4-2-3 Questionnaire to sawmill operators

Owners or managers of 25 sawmills, 21 in Pedro Juan Caballero and 4 in Capitan Bado, were interviewed for the questionnaire.

Question 1 : Name of sawmill
Answer : (Not specified in the report)
Question 2 : Nationality of owners
Answer : Brazilian 17 (68%)
Japanese 6 (24%)
Paraguayan 2 (8%)
Most of owner are Brazilian, and the number of Paraguayans is very small.
Question 3 : Number of employees and type of work
Answer : 5 – 250 employees, with 40 employees on average; mainly engaged in sawing and wood work; Sawmill/forest owners employ loggers and drivers. Ratio of Paraguayan and Brazilian in total employees appear to be almost same.
Question 4 : Sawing volume
Answer : 5 – 125 m^3/day, with 30 m^3/day on average
Question 5 : Sawing yield percentage
Answer : 40% – 85%, with 53% on average
Question 6 : Owned machineries
Answer : Band saw ..... 1.3 per sawmill
Disc saw 3.1
Planer 2.6
Large sawmills have the above three machineries, and a most of small ones without planer.
Question 7 : Species used
Answer : Peroba 82%
Yvyrá pyta 8%
Others 10%
Peroba is overwhelming, but recently use of other species are increasing.
Question 8 : Standard size of lumbers
Answer : As a most of lumbers are exported to Sao Paulo, sawing is done to meet the standard of export; 6 cm x 1.5 cm, 6 cm x 5 cm, 6 cm x 12 cm and 6 cm x 16 cm, along with ceiling board (1 cm x 10 cm), flooring board (2 cm x 10 cm) and door frame (14 cm x 4 cm).
Question 9 : Production cost of lumber
Answer : Varied with type of product and sawmill in relatively wide range; around 15,000 Gs/m^3 on average.

Question 10 : Sales price of lumber

Answer : Also having a wide range of variation; around 23,000 Gs/m^3 on average.

Question 11 : Source of log supply

Answer : Sawmill/forest owners obtain log supply from their own forest, and other sawmill owners make a purchase from middleman. In case of purchasing, source of supply seems to have become further away from the sawmills every year; near ceroguas in recent year.

Question 12 : Market of lumber

Answer : Mostly Sao Paulo

Question 13 : Forest ownership

Answer : About a half of the sawmill operators, or 13 out of 25, own forests.

Question 14 : Starting year of sawmill operation

Answer : 1965 – 1970 ..... 3 (12%)
1972 – 1979 ..... 22 (88%)
1980 – 0
A most of them started an operation between 1972 and 1979, and non in 1980's.

Question 15 : Knowledge on Forest Law

Answer : Do not know 8 (32%)
Know about it 17 (68%)
A third of them do not know about the Law; relatively a large percentage for the forest related establishments.

Question 16 : Benefit and welfare facilities for their employees

Answer : o Housings are provided to the employees, except for ones who live out.
o Mandatory minimum wage is guaranteed.
o Employees are covered under required insurances.
Almost all of the sawmills carry the above insurances. However, there are some opinions than those insurances are difficult to obtain indemnification.

4.2.4 Questionnaire to key persons in department and municipality

Although the questionnaire was originally designed to survey local governments' land use planning, forest and forestry development planning and other policies on the subject, self govering power of local governments in Paraguay is considerably weak in comparison to ones in Japan; departmental governments are practically a local agency of the central government, and jurisdiction of municipal governments is limited to a built-up city street area. Thus, the questionnaire was done by asking opinions of three key persons in the area, namely a municipal government's employee, an university professor and a member of the political ruling party.

Question I : Plan on future land use

Answer : There is no official plan on this. The following composition of land use was stated as personal opinion:
Urban zone 2%
Agricultural zone 12%
Livestock farming zone 25%
Forest zone 60%
Environmental conservative zone 1%

Question 2 : Amount of wood required for the area in future

Answer : The amount in future was not given. Instead, there is an opinion on a composition of wood consumption:

Export 80%
Public consumption 5%
Self consumption by local population 10%
Others 5%

A most of consumption is considered to be for export, mainly to Sao Paulo.

Question 3 : Need for retaining forest for environment conservation and its required size

Answer : 20,000 – 30,000 ha will be required to retain in the Department of Amambay.

Question 4 : Opinion on administrative action against decrease of forest

Answer : Programmes such as education, securing of seedbed and sales of seedlings are carried out, yet not satisfactory.

Question 5 : Environmental change caused by decrease of forest

Answer : Wash-out of soil by erosion is conspicuous.

Question 6 : Need for promotion of reforestation to increase employment opportunity and for guidance and assistance on forest management

Answer : Although considered to be highly necessary, but there is no particular plan.

Question 7 : Opinion on relation between forestry and other industries such as agriculture and livestock farming

Answer : As there is a close relation between them, the coordination should be attempted.

Question 8 : Administrative action implemented or will be implemented by departmental (municipal) governments

Answer : No particular action
Compliance with laws and governmental guidance

4-3 Summary of Questionnaire Result

(1) Opinions of forest owners, local residents, sawmill operators and key persons in department or municipality could be summarized as follows:

① Future land use

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

② Effectiveness of forest

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.

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

There are many complaints about difficulty to obtain firewoods.

③ Forest as economic resources

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

④ Reforestation

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

⑤ Situation on progress of forest cutting

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 resources appear to be rather optimistic. Many sawmill operators are Brazilian, and have an intention to relocate the sawmill when the resource is exhausted.

⑥ Manpower

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.

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

① As an absence of recognition on rapid decrease of forest resource 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 project.

5. ECONOMIC AND SOCIAL SURVEY

5-1 General Backgound

Paraguay has lost 1/3 of her territory as a result of the Triple War (2865–69) against Brazil, Argentina and Uruguay, to result in considerable exhaustion of the national strength. Furthermore, her political and economic strength was adversely affected by Teyaco War (1932) against Bolivia arising out of conflict in a possession of the western part. Aftermath of the war was continued until a first half of 1950's, and during which no significant development was witnessed.

In 1960's, her social foundation was improved to enable an active production activity to start. Politically, the president Stroessner has been taking the office since 1954, to indicate that a long term and stable administration is maintained as an exceptional case in unstable Latin American countries. This stable political condition is believed to for a foundation of the improvement of her social institution and the development of the national economy after 1960.

5-2 Population

5-2-1 Population trend

According to 1982 census, Paraguay has approximately 3.03 million population, with density of 7.4 persons/km^2. The population density is extremely below that of the world, or 32 persons/km^2* as well as that of developing countries in total, or 48 persons/km^2*. The population density in the eastern region is 18.6 persons/km^2, since the western region (Chaco region) which constitutes 60% of the total land area has only 2% of the total population.

Historically, as the country suffered a devastating damage from the Triple War (1865–69), her population was only about 200,000 in 1887. Since then, the population grew at annual rate of above 2%, and reached 1.33 million in 1950 and then 2.36 million in 1972. After then annual population growth rate of 2.5% was recorded during 10 year period between 1972–1982, to be way above the world average growth rate of 1.8%.

Although accurate data is not available, the population in the survey area of 1.5 million ha was estimated from the population in the Department of Amambay of 68,534 to be around 100,000, with the density of 6–7 persons/km^2. The population in the Department of Amambay increased by only 3,423 in past 10 years, with annual growth rate of 0.5%.

5-2-2 Population distribution by employment nent

Employment in primary industry, including agriculture, livestock farming and forestry, constitutes a dominant share of 41.3%, to indicate that Paraguay is an agriculture base country. At the same time, the share decreased by 10% in recent ten years, being replaced by other sectors, particularly commerce sector.

The employment in the Department of Amambay is 33,900 in 1980, and that in the survey area is estimated to be 40,000–50,000. According to the forecast of the Economic Planning Agency, the employment in the Department of Amambay is 70,000 in 2,000, with relatively high growth rate in the country as a whole.

* Source: United Nation Annual Statistics 1979/1980

Table 2-5-1 Change of population and density by department
(source: Census of population)

Department	Land area	1982		1972		1962		1950	
		Population	Density	Population	Density	Population	Density	Population	Density
	K㎡	Persons	Persons /km²	Persons	Persons /km²	Persons	Persons /km²	Persons	Persons /km²
AMAMBAY	12933	68534	5.3	65111	5.0	34505	2.7	18160	1.4
CONCEPCIÓN	18051	135204	7.5	108130	6.0	85,690	4.7	62326	3.5
SANPEDRO	20002	191,812	9.6	138018	6.9	91,804	4.6	64,534	3.2
CANENDIYU	14,667	66296	4.5	27825	1.9				
Total (4 Departments)	(65,653)	(461,846)	(7.0)	(339,084)	(5.2)				
Total of PARAGUAY	406752	3026165	7.4	2357,955	5.8	1,819,103	4.5	1,328452	3.3

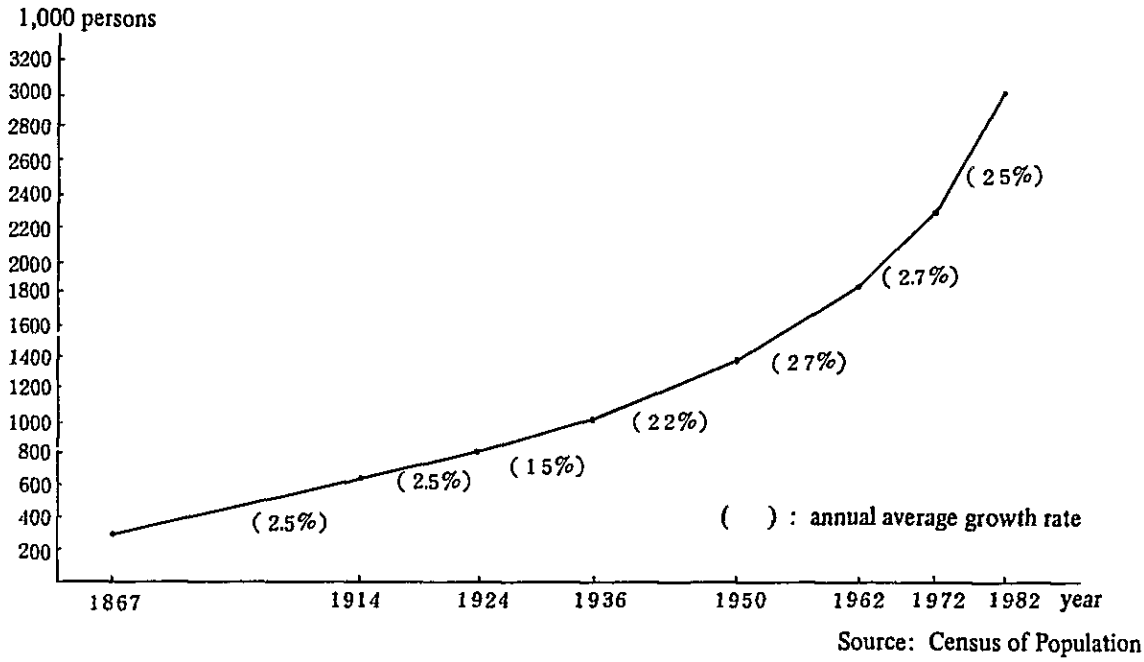


Fig. 2-5-1 Change of population

Table 2-5-2 Employment structure by industrial sector

Sector	1983	1977	1973
Agricultural, livestock farming forest and mineral industry	41.3%	43.5%	51.3%
Manufacturing	17.7	17.7	14.2
Construction	6 2	5.6	4.2
Electricity, water supply and transportation	4.3	3.7	3.2
Commerce	14.4	13.2	9.3
Service	161	16.3	178
Total	100.0	1000	100.0

Table 2-5-3 Forecast of employment growth by department

Department	Employment			2000/1980
	1980	1990	2000	
	1,000 persons	1,000 persons	1,000 persons	
AMAMBAY	33.9	49.5	70.0	2.1
CONCEPTIÓN	40.3	519	64.7	1.6
SANPEDRO	54.3	73.0	98.6	1.8
CANENDIYU	18.4	30.4	47.2	2.6
Total (4 Departments)	(146.9)	(204.8)	(2805)	(1.9)
	1,077.4	1,497.9	2,027.8	1.9

Source: Economic Planning Agency

5-3 Gross National Product

As shown in Table 2-5-4 'Comparison of Gross National Product by Country', growth national product of Paraguay, as an indicator of scale of the economy, is US$4,110 million to be ranked 9th among 12 countries in South America, 1/60 of Brazil, 1/16 of Argentina and 1/280 of Japan. GNP per capita is US$1,300 to be ranked 8th in South America; slightly above that of Columbia and Equador, but around 60% of Brazil and Argentina and around 1/8 of Japan.

At the same time, growth of the economy appears to be stable. As shown in Table 2-5-5 'Change of Gross National Product', the growth rate was limited to 2.8% on annual average for ten years before 1965, and increased to 5.2% during ten year period between 1965 – 1975, and then reached above 10% between 1977 – 1980 due to a rapid increase of overseas demand and large projects such as Itaipú dam. After 1981, the economy grew at relatively stable rate, albeit lower rate, in comparison to neighboring countries which suffer serious depression and inflation.

Table 2-5-4 Comparison of Gross National Product by country

	Country or region	Land area 1,000 km²	Population (million)	Gross National Product (GNP) (million US dollars)	GNP per capita (US dollars)	Monetary Unit	Exchange rate (per one US dollar)
	Japan	378	117.65	1,152,910	9,890	Yen	220.54
	U.S.A.	9,363	229.81	2,582,460	11,360	Dollar	—
State of South America (12 Nations)	Argentine Republic	2,767	28.09	66,430	2,390	Peso	4,4027
	Republic of Bolivia	1,099	5.76	3,190	570	Peso	24.510
	Federative Republic of Brazil	8,512	121.55	243,240	2,050	Cruzeiro	93125
	Republic of Chile	757	11.29	23,980	2,150	Peso	39.000
	Republic of Colombia	1,139	(27.30)	31,570	1,180	Peso	54491
	Republic of Ecuador	284	864	10,230	1,270	Sucre	(25.000)
	The Cooperative Republic of Guyana	215	0.90	550	*690	Guianas'dollar	2.8125
	Republic of Paraguay	407	3.27	4,110	1,300	Guarani	(126.00)
	Republic of Peru	1,285	18.28	16,470	930	Sol	422.85
	Republic of Suriname	163	0.40	1,000	2,840	Suruname guilder	(1.7850)
	Oriental Republic of Uruguay	176	2.93	8,240	2,810	New Peso	10.871
	Republic of Venezuela	912	14.31	54,220	3,630	Bolivar	4.2925

Source Table of World Countries 1983 (compiled by the Department of Information and Culture, the Ministry of Foreign Affairs, Japan)

Note 1) Land area – United Nations Annual Statistics 1978

2) Population –United Nations Monthly Statistics September, 1982 (1981 estimated)

3) Gross National Product – World Bank, 1981 Atlas (1980 estimated)

4) GNP per capita – World Bank, World Development Report 1982 (1980 caiculated)

5) Foreign Exchange Rate – IMS, IFS November 1982 (1981 average)

Tabe Table 2-5-5 Change of Gross National Product

Year	Amount (million US$)	1977 Value (million US$)	Growth rate (%)
1962	3607	890.5	
1963	3839	925.0	3.9
1964	4084	961.0	3.9
1965	443.6	1,012 5	5.4
1966	465.9	1,024.3	1.2
1967	492.7	1,111.5	8 5
1968	517.7	1,146.5	3.1
1969	5563	1,1937	4.1
1970	5946	1,2521	4.8
1971	664.6	1,320.2	5.4
1972	769.0	1,405.2	6.4
1973	995.5	1,5063	7.2
1974	1,3335	1,630.4	8 2
1975	1,511.4	1,7334	6 3
1976	1,6990	1,855.1	7.0
1977	2.092.1	2.0922	1 2.8
1978	2,560.0	2.3193	1 0.9
1979	3,417.0	2,567.5	1 0 7
1980	4,4481	2,860.2	1 1.4
1981	5,624.5	3,1019	8 5

Source; Paraguay Central Bank

Looking at the gross national product in terms of sectoral composition, production sector constitutes 54.1% to be above 45.9% of service sector.

Withun the production sector, agricultural sector with beans and bottom as main products constitutes a large share of 20.5%, followed by industrial sector of 16.6%. A share of forestry sector is 3.2%. A share of agriculture, livestock farming and forester sector is 30.3% to be an important industry of the country, but in declining trend compared to a share of 35.7% in 1975, particularly livestock farming sector. In terms of production index in 1981 (1977 value = 100), while that of a whole production sector is 148, agriculture sector records 135, livestock farming sector 116 and forestry sector 145. Construction sector showed a highest growth (production index – 252) due to large projects such as Itaipú and Yacyretá dams, and thus it is questionable to expect such growth in future.

Service sector shows a growth throughout subsectors. Particularly, electricity sector is expected to grow considerably after the start of power supply in quantity from Itaipú dam. Within service sector, commerce and finance sector shows a largest share of 26% in 1981, while government project a small share of 4.1%.

5.4 External Trade

5.4.1 Balance of trade

Having kept balance between 1960 – 1977 with some degree of flactuation, the balance of trade turned into deficit thereafter due to an increase of imports in areas of capital, producer's goods and consumer's goods which were triggered by rise of oil price, and reached a deficit of US$2,100 million in 1981. (Table 2-5-7 Balance of trade)

5.4.2 Item of export and import

Characteristic of the external trade is a typical structure of primary product export and industrial product import.

Almost all of export items are made up of agricultural, livestock farming and forestry products. According to export record in 1981, cotton and textile constitute a predominant share of 43% in total export value of US$296 million to earn a foreign currency of about US$1,300 million, followed by grains such as beans (17.8%) and wood products (12.5%).

The share of wood products has rapidly increase from 8.0% in 1978 to 13.8% in 1979, and then to 21.4% in 1980 until cut by half in 1981. Forest byproducts, mainly vegetable oil and Quebracho extract, constitutes a share of 7.6% and 1.9% respectively (Table 2-5-8 Major export commodities).

Among import items, the items essential to the economic development, such as machineries and fuel, constitute a large share; 21.3% by machineries and tools as well as motors, 18.7% by fuel oils and lubricants, and 12.9% by vehicles and accessories. Fuel oils and lubricants, or petroleum products, reached a share of 25% in total import value in 1980, and decreased to 18.7% in 1981 due to the oversupply. Petroleum import will further decline in area of industrial energy when electricity will have been abundantly supplied from Itaipú and Yacyretá dams.

Import value of paper, paper board and wood processed products are amounted to about US$10 million in 1981, to constitute 1.9% of the total import value (Table 2-5-9 Major import items).

5-4-3 Trade partners

Looking at regional breakdown of trade partners, the trade with the countries in LAFTA (Latin American Free Trade Association) has a highest share; especially dominated by

Table 2-5-6 Gross national production by sector & structure Ratio & growth index (based on '77)standard)

Sector	Gross National Product by Year (million US$)					181 Structural Ratio	181 index with '77 as 100
	'77	'78	'79	'80	'81		
Manufacturing Sectors							
Agriculture & Forestry							
Agriculture	470.7	499.9	5323	588.8	6371	205	135
Livestock	172.8	1794	186.5	194.0	2002	65	116
Forestry	68.2	73.6	83.9	94.2	987	32	145
Fishery	2.0	2.7	36	3.9	40	01	200
(Subtotal)	(7137)	(755.6)	(8063)	(8809)	(9400)	(303)	(132)
Industrial mining, & construction							
Mining	5.4	63	10.0	11.3	13.0	04	241
Industrial	3569	395.9	422.0	4752	5132	166	144
Construction	839	1106	143.8	181.2	211.5	68	252
(Subtotal)	(446.2)	(512.8)	(575.8)	(667.7)	(737.7)	(238)	(165)
[Manufacturing Total]	[1,159.9]	[1,2684]	[1,382.1]	[1,548.6]	[1,677.7]	[541]	[145]
Service Sector							
Basic Service Sector							
Electric Power	314	36.4	43.7	527	548	18	175
Water, Sanitation	5.2	64	7.2	79	89	03	171
Transportation & Communication	81.5	904	100.8	111.4	114.9	37	141
(Subtotal)	(118.1)	(133.2)	(151.7)	(1720)	(1786)	(58)	(151)
Service Sectors							
Trade & Finance	524.1	598.9	6739	744.7	807.1	260	154
Government Enterprises	816	88.1	96.8	1036	127.2	41	156
Housing	483	53.8	59.4	64.8	692	22	143
Other Service Business	160.4	181.1	204.5	226.5	2421	7.8	151
(Subtotal)	(814.4)	(921.9)	(1,034.6)	(1,1396)	(1,2456)	(401)	(153)
[Service Total]	[932.5]	[1,055.1]	[1,1863]	[1,311.6]	[1,4242]	[459]	[153]
[Total Production]	2,0922	2,3193	2,567.5	2,860.2	3,101.9	1000	148
GNP per capita	728 US$	781 US$	837 US$	903 US$	949 US$		130

Paraguay Central Bank '82

Argentina and Brazil to clearly indicate a significant invluence of these countries on the economy of Paraguay.

Export value and share in 1981 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., to be amounted to more than 60% of the total export value. Regional share has been shifted from European countries to Latin American countries in recent years in excess of 50%.

On the other hand, import value and share by major exporting country are US$131 million and 25.9% for Brazil and US$100 million and 19.8% for Argentina, two of which constitute a dominant share of 45.7%; followed by 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. The share of these countries exceeds 70% of the total import value.

5-5 Forestry Production

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

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.

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 from 2.12 million tons in 1974, and this is slightly declining rate of the growth. Log production showed two fold 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 Itaipú dam construction work. Production of railroad sleepers is very small due to small scale of railroad in the country. Major export market of the product is traditionally Argentina, and demand from Brazil has increased 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 are, is exported to U.S.A. and Uruguay.

Table 2-5-7 Balance of trade

(FOB price, million US dollars)

Year	Export	Import	Balance
1960	27.0	32.4	−5.4
1965	57.2	47.4	9.8
1970	64.1	63.8	0.3
1975	176.7	178.4	−1.7
1976	181.8	180.2	1.6
1977	278.9	255.4	23.5
1978	256.9	317.7	−60.8
1979	305.2	431.8	−126.6
1980	310.2	517.1	−206.9
1981	295.5	506.1	−210.6

(Source: Economic Planning Agency)

Table 2-5-8 Export value by major items

(million US dollars)

Item	1978	1979	1980	1981	Share in 1981
Cotton (Textile)	99.5	97.6	104.5	127.2	43.1 %
Wood products	20.5	42.2	66.5	36.9	12.5
Grains	41.6	81.3	45.3	52.5	17.8
Oil expression lees (compressed and extracted)	10.2	14.2	22.3	14.4	4.8
Vegetable oil	16.8	19.1	17.0	22.4	7.6
Tabacco	9.2	8.5	10.1	6.5	2.2
Essential oil	8.5	9.7	9.1	6.6	2.2
Quebracho extract	5.2	3.2	4.4	5.6	1.9
Cowhide (tanned)	7.8	6.2	3.1	6.5	2.2
Meat product	24.0	5.5	1.1	—	—
Others	13.6	17.7	26.9	16.9	5.7
Total	256.9	305.2	310.3	295.5	100.0 %

Table 2-5-9 Import value by major items

(million US dollars)

Item	1978	1979	1980	1981	Share in 1981
Food element	14,453	19,977	24,074	32,604	6.4 %
Bevarage and cigarette	28,979	41,567	39,664	37,222	7.3
Fuel and lubricant	59,644	87,520	129,518	94,588	18.7
Paper, paperboard and wood processed product	7,111	8,693	12,301	9,797	1.9
Chemical product	16,333	26,229	31,719	31,070	6.1
Vehicle and accessories	60,133	63,310	93,252	65,493	12.9
Textile and apparel	6,733	9,436	9,816	9,767	1.9
Farm machinery and accessories	10,478	11,083	9,483	13,196	2.6
Steel processed product	14,655	30,899	20,002	22,657	4.5
Non-ferros processed product	5,222	4,448	6,414	7,616	1.5
Machine and tool and motor	53,831	74,737	79,739	107,757	21.3
Others	40,166	48,859	61,159	74,344	14.7
Total	317,738	431,758	517,141	506,111	100.0 %

(Source: Economic Planning Agency)

Table 2-5-10 Export value by country (million US dollars)

Country	1978	1979	1980	1981	Share in 1981
AMERICA (EXCL. LATIN AMERICA)	(37,567)	(52,414)	(54,528)	(52,817)	(10.4) %
U.S. AMERICA	34,754	49,809	51,159	49,156	9.7
CANADA	233	524	261	538	0.1
PUERTO RICO	580	343	213	524	0.1
OTHERS	2,000	1,738	2,895	2,599	0.5
LAFTA	(129,429)	(189,467)	(267,454)	(252,566)	(49.9)
ARGENTINA	48,767	74,040	106,442	100,090	19.8
BRAZIL	62,711	96,371	140,504	131,257	25.9
URUGUAY	13,428	14,275	14,952	15,475	3.1
CHILE	3,325	2,935	4,297	4,037	0.8
MEXICO	687	499	496	549	0.1
OTHERS	511	1,347	763	1,158	0.2
REST OF AMERICA	2,348	2,362	3,292	5,466	1.1
EC	(70,093)	(75,528)	(83,281)	(87,565)	(17.3)
WEST GERMANY	26,190	31,665	33,533	41,038	8.1
UNITED KINGDOM	30,499	24,192	28,843	24,898	4.9
NETHERLANDS	1,341	2,672	2,154	3,331	0.7
LUXENBOURG	1,925	1,820	1,640	2,392	0.5
FRANCE	6,423	8,776	12,030	9,098	1.8
OTHERS	3,715	6,403	5,081	6,808	1.4
EFTA	(7,771)	(8,658)	(8,975)	(9,886)	(2.0)
SWITZERLAND	1,534	2,297	2,904	3,078	0.6
AUSTRIA	1,462	2,029	2,129	2,287	0.5
SWEDEN	4,586	4,138	3,564	4,283	0.8
OTHERS	189	194	378	238	0.1
REST OF EUROPE	(5,355)	(8,124)	(8,285)	(9,106)	(1.8)
SPAIN	3,752	5,361	5,502	6,014	1.2
OTHERS	1,603	2,763	2,783	3,092	0.6
ARGERIA	34,637	50,069	37,082	27,458	5.4
ASIA	(30,088)	(41,982)	(52,183)	(60,681)	(12.0)
JAPAN	25,193	36,085	42,031	41,990	8.3
OTHERS	4,895	5,897	10,152	18,691	3.7
REST OF WORLD	450	3,154	2,061	566	0.1
TOTAL	317,738	431,758	517,141	506,111	1000%

(Source: Economic Planning Agency)

Table 2-5-11 Import value by country (million US dollars)

Country	1978	1979	1980	1981	Share in 1984
AMERICA (EXCL. LATIN-AMERICA)	(23,122)	(17,947)	(17,136)	(16,582)	(5.6)%
U.S. AMERICA	22,212	17,628	16,679	15,308	5.2
CANADA	462	42	37	7	0.0
PUERTO RICO	448	277	420	1,267	0.4
LAFTA	(66,808)	(104,017)	(140,668)	(147,487)	(49.9)
ARGENTINA	24,154	51,009	74,181	68,542	23.2
BRAZIL	29,103	40,240	54,146	40,240	13.6
URUGUAY	7,013	13,611	10,158	9,124	3.1
CHILE	13,487	7,154	11,307	11,040	3.7
MEXICO	1,172	2,452	4,017	2,394	0.8
OTHERS	569	678	765	2,241	0.8
REST OF AMERICA	469	1,025	1,323	1,235	0.4
EC	(102,823)	(121,998)	(78,636)	(60,000)	(20.3)
WEST GERMANY	38,807	46,407	38,454	32,902	11.1
UNITED KINGDOM	14,976	625	1,802	2,894	1.0
NETHERLANDS	26,497	45,344	19,746	13,257	4.5
LUXENBOURG	1,469	1,811	5,741	3,027	1.0
FRANCE	3,530	5,907	5,028	4,603	1.6
OTHERS	17,544	21,904	7,865	3,317	1.1
EFTA	(20,456)	(29,691)	(44,093)	(27,571)	(9.3)
SWIZERLAND	15,978	21,789	31,614	14,651	5.0
OTHERS	4,478	7,902	12,479	12,920	4.4
REST OF EUROPE	(7,444)	(10,721)	(5,949)	(6,203)	(2.1)
SPAIN	6,782	5,569	4,796	3,791	1.3
OTHERS	662	5,152	1,153	2,412	0.8
ASIA	(32,961)	(17,909)	(17,960)	(31,004)	(10.5)
JAPAN	32,310	16,407	11,296	24,940	8.4
OTHERS	651	1,502	6,664	6,064	2.1
REST OF WORLD	2,900	1,868	4,465	5,459	1.9
TOTAL	256,983	305,176	310,230	295,541	100.0%

(Source: Economic Planning Agency)

Table 2-5-12 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

Attachments

1. Table of Number of Saplings by Forest Types

Table 1 Number of saplings by forest type

Type M

(Unit Number of saplings)

Plot No.	Tree height 0.3m~1.2m		Tree height 1.3m ~ D. B. H ~ 4 cm		D. B. H 5 cm~ 9 cm		D. B. H 10cm~ 40cm			D. B. H 41 cm ~		
	Peroba	A+B	Peroba	A+B	Peroba	A+B	Peroba	A+B	All species	Peroba	A+B	All species
44	0	0	0	0	0	0	0	13	231	1	4	36
47	0	0	500	0	0	0	4	25	280	1	4	49
49	0	0	0	0	0	0	0	18	314	0	3	12
99	0	500	0	0	0	0	0	80	388	0	3	43
101	0	500	0	0	0	0	13	25	235	3	3	40
Total	0	1,000	500	0	0	0	17	161	1,448	5	17	180
Aver-age	0	200	100	0	0	0	3	32	290	1	3	36

Type M_2

(Unit Number of saplings)

Plot No.	Tree height 0.3m~1.2m		Tree height 1.3m ~ D. B. H ~ 4 cm		D. B. H 5 cm~ 9 cm		D. B. H 10cm~ 40cm			D. B. H 41 cm ~		
	Peroba	A+B	Peroba	A+B	Peroba	A+B	Peroba	A+B	All species	Peroba	A+B	All species
51	0	0	0	0	0	0	0	18	329	0	1	17
57	500	500	0	0	0	0	5	53	320	1	9	28
59	0	500	0	0	0	0	1	36	269	0	15	27
61	0	500	0	0	0	0	1	37	274	0	10	17
69	0	0	0	0	0	0	0	25	267	0	8	16
71	500	0	0	0	0	0	10	29	220	5	4	15
52	0	500	1,000	500	0	0	23	27	247	1	11	37
79	0	2,500	0	0	0	0	1	16	329	0	6	25
97	500	500	500	0	0	0	18	18	333	0	8	28
98	0	0	0	0	0	0	19	23	348	1	5	28
102	0	1,000	0	0	0	0	25	43	410	0	10	38
90	0	500	0	0	0	0	0	80	287	0	4	12
Total	1,500	6,500	1,500	500	0	0	103	405	3,633	8	91	288
Aver-age	125	542	125	42	0	0	9	34	303	1	8	24

Table 1 Number of saplings by forest type

Type A_1 (Unit: Number of saplings)

Plot No	Tree height 0.3m~1.2m		Tree height 1.3m ~									
			D. B. H ~ 4 cm		D. B. H 5 cm~ 9 cm		D. B. H 10cm~ 40cm			D. B. H 41 cm ~		
	Peroba	A+B	Peroba	A+B	Peroba	A+B	Peroba	A+B	All species	Peroba	A+B	All species
70	0	0	0	500	0	0	1	13	268	0	6	24
80	0	500	500	500	0	0	1	57	248	0	11	24
103	0	3,000	0	0	0	0	0	53	328	5	18	75
104	2,500	500	0	0	0	0	10	28	290	0	13	70
106	500	500	0	500	0	0	175	30	560	48	3	55
107	3,500	0	0	0	0	0	13	48	235	18	10	35
Total	6,500	4,500	500	1,500	0	0	200	229	1,929	71	61	283
Aver-age	1,083	750	83	250	0	0	33	38	322	12	10	47

Type A_2 (Unit Number of saplings)

Plot No	Tree height 0.3m~1.2m		Tree height 1.3m ~									
			D. B. H ~ 4 cm		D. B. H 5 cm~ 9 cm		D. B. H 10cm~ 40cm			D. B. H 41 cm ~		
	Peroba	A+B	Peroba	A+B	Peroba	A+B	Peroba	A+B	All species	Peroba	A+B	All species
64	1,000	1,500	0	500	0	0	20	39	221	6	9	22
53	500	0	500	0	0	0	18	25	269	1	17	27
58	0	500	0	0	0	0	1	31	188	0	12	23
60	0	500	0	0	0	0	0	30	296	0	4	12
89	0	2,500	0	1,000	0	0	0	78	245	0	12	26
96	500	2,500	0	0	0	0	18	15	298	15	8	40
100	0	0	0	0	500	0	230	28	370	20	3	28
105	0	1,000	0	0	0	0	3	33	383	3	18	38
108	1,000	0	500	0	0	0	18	13	240	5	10	68
Total	3,000	8,500	1,000	1,500	500	0	308	292	2,510	50	93	284
Aver-age	333	944	111	167	56	0	34	32	279	6	10	32

Table 1 Number of saplings by forest type

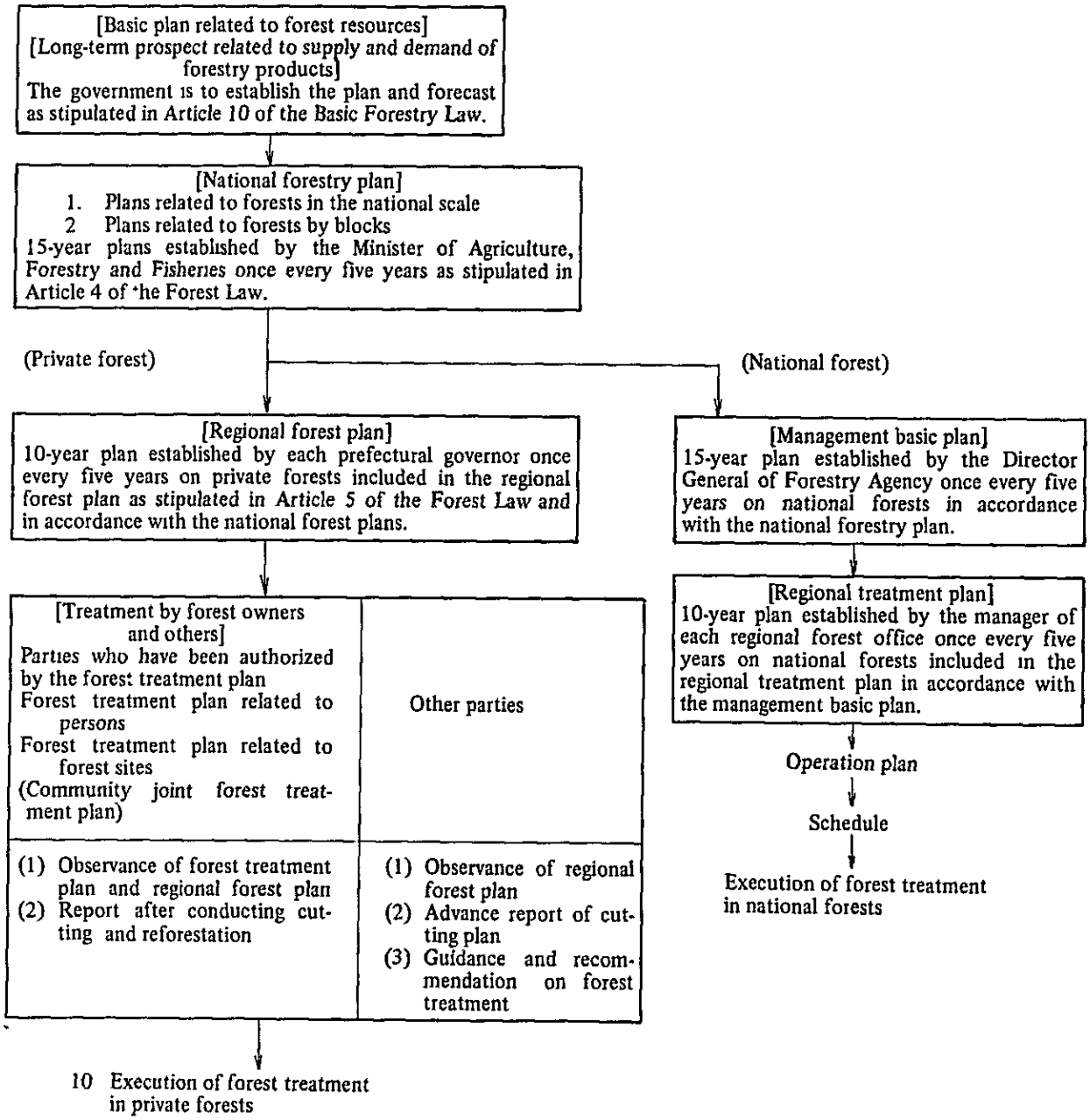
Type DA_2 (Unit: Number of saplings)

Plot No.	Tree height 0.3m~1.2m		Tree height 1.3m ~									
			D. B. H ~ 4 cm		D. B. H 5cm~ 9cm		D. B. H 10cm~ 40cm			D. B. H 41 cm ~		
	Peroba	A+B	Peroba	A+B	Peroba	A+B	Peroba	A+B	All species	Peroba	A+B	All species
39	500	500	1,000	0	0	0	13	16	197	18	6	36
52	2,000	500	500	0	0	0	38	18	235	10	5	26
63	0	1,000	0	1,000	0	0	45	17	300	21	9	45
64	0	1,000	0	500	0	0	26	11	182	22	5	36
90	500	0	0	0	0	0	21	7	168	28	8	44
93	1,500	500	1,000	0	500	0	58	11	218	25	2	40
107	0	0	0	0	0	0	6	19	135	1	11	47
143	2,000	0	500	0	0	0	44	14	202	1	7	20
19	7,500	2,000	1,000	0	0	500	13	19	164	14	10	41
Total	14,000	5,500	4,000	1,500	500	500	264	132	1,801	140	63	335
Aver-age	1,556	611	444	167	56	56	29	15	200	16	7	37

Type DA_3 (Unit Number of saplings)

Plot No.	Tree height 0 3m~1.2m		Tree height 1.3m ~									
			D. B. H ~ 4 cm		D. B. H 5cm~ 9cm		D. B. H 10cm~ 40cm			D. B. H 41 cm ~		
	Peroba	A+B	Peroba	A+B	Peroba	A+B	Peroba	A+B	All species	Peroba	A+B	All species
24	3,000	0	1,500		500	500	19	13	207	8	9	35
41	2,000	500	500	500	500	0	20	10	160	35	2	58
55	1,000	500	0	0	0	0	65	17	346	27	14	56
61	2,000	500	500	500	0	0	40	10	226	24	6	38
Total	8,000	1,500	2,500	1,000	1,000	500	144	50	939	94	31	187
Aver-age	2,000	375	625	250	250	125	36	13	235	24	8	47

2. System of Forest Planning Organizations



3. Standards for Determination of Specified Treatment Conditions

(Government Ordinance No. 276, 1951)
[Final revision: Government Ordinance No.227, 1968]

Item 2 of Article 4: The standards to be determined by the government ordinance as stipulated in Item 5 of Article 33 of the law shall be as listed in the table below.

Item	Standards
1. Cutting methods	(1) Methods related to Final cutting a. As a rule, no cutting method shall be specified for a protection forest established for such purposes as headwaters conservation or for protection from wind damage, drought damage or fog damage. b. As a rule, selection cutting shall be applied to a protection forest established for such purposes as for protection from soil flow, protection from soil slide, protection from shifting sand, protection from flood damage, tide water damage or snow damage, fish shelter, conservation of a navigation target, or conservation of public health or the beauty of a place of scenic or historic interest. c. As a rule, cutting is completely forbidden in a protection forest established for such purposes as prevention of avalanche or rock falling or protection from a fire, or in a forest that is located in a protection facility area. d. Standing trees that may be cut in a forest where cutting is not forbidden shall be, as a rule, trees in the standard cutting age or older as stipulated in Item 2-1 of Article 5 of the law. (2) Methods related to thinning a. In a forest where final cutting is not prohibited, cutting is permitted, as a rule, in places where the crown density, as calculated in accordance with the ministry ordinance (Note 1), is not smaller than eight tenths. b. As a rule, cutting is prohibited in a forest where final cutting is prohibited.
2. Limit of cutting	(1) Limitation related to final cutting a. The total area where clear cutting may be applied in each cutting year in protection forests that are regarded as one forest unit, as a rule, shall not exceed the area size that is equivalent to the quotient from division of a number that is equivalent to the total area size of forests that are regarded as one forest unit and in which selection cutting is specified as the cutting method and the area size of other than forests where final cutting is prohibited, by a number that is equivalent to the cutting age determined by the party who determines the relevant specified treatment conditions on tree species, cutting of which can be regarded as appropriate to achieve the purpose of the specification, based on the standard cutting age as stipulated in Item 2-1 of Article 5 of the law, in accordance with the ministry ordinance (Note 2). b. In a forest where the protection function must be maintained or strengthened depending on such conditions of topography, weather or soil, the limit of area size per place where clear cutting may be conducted each cutting year shall be the size specified by the party who determines the relevant specified treatment conditions, matching the degree of necessity to maintain or strengthen the protection function as stipulated by the ministry

	ordinance (Note 3). c. As a rule, clear cutting in a protection forest established for the purpose of protection from wind damage or fog damage, shall be permitted on condition that a part where the whole or major portion of the standing trees in the protection forest are not younger than the standard cutting age as stipulated in Item 2-1 of Article 5 of the law is left in a band form of not narrower than 20 m in the width. d. The volume of standing trees of which selection cutting is permitted each cutting year, as a rule, shall not exceed the volume that is equivalent to a product of multiplying a number that is equivalent to the volume of standing trees of the relevant forest as of the first day of the relevant cutting year by the selection cutting rate as calculated in accordance with the ministry ordinance (Note 4). (2) Limitation related to thinning As a rule, the volume of standing trees that are cut in each cutting year shall not exceed two tenths of the volume of standing trees of the relevant forest as of the first day of the relevant cutting year, and shall not exceed the volume within the range with which recovery of the relevant crown density to the state of eight tenths or denser within five years starting from the first day of the relevant cutting year can be regarded as being certain in the event that the crown density of the forest, as referred to in (2)-a. of 1. Cutting methods of this table, becomes smaller than eight tenths as the result of such cutting.
3. Plantation	(1) Plantation method Nursery stocks of one-full year or older shall be uniformly planted at a rate of 3,000 trees or more per ha. (2) Plantation period Plantation shall be conducted within the period of two years from the first day of the cutting year following the cutting year in which the cutting was completed. (3) Species to be planted The species that the party who determines the specified treatment conditions specifies as the species that would maintain or strengthen the protection function, as well as contributing to the economical use, shall be planted. The provision of Item (3) shall apply to a cut-over area where sure regeneration is considered to be difficult by other than plantation.

(Note 1) Article 22 (Crown density) of Enforcement Regulations of the Forest Law (Ministry ordinance No. 54, 1951)

Article 22 The crown density referred to in (2)-a. of 1. Cutting methods in the table shall be calculated by dividing the crown projection area in a forest of about 20 square meter by the size of the relevant area.

(Note 2) Item 2 of Article 22 of Enforcement Regulations of the Forest Law.

Article 22, Item 2

The cutting age referred to in (1)-a. of 2. Limit of cutting in the table shall be determined in consideration of the purpose of specification of the relevant protection forest or protection facilities and growth state of standing trees in the relevant forest, and within the range of standard cutting age as stipulated in Item 2-1 of Article 5 of the law.

(Note 3) Item 3 of Article 22 of Enforcement Regulations (Area size per place where clear cutting is permitted.)

Article 22, Item 3

The specification of area size referred to in (1)-b. of 2. Limit of cutting in the table, shall be made in consideration of the topography, weather and soil conditions of the relevant forest and within a range of not exceeding 20 ha.

(Note 4) Item 4 of Article 22 of Enforcement Regulations (Selection cutting ratio)

Article 22, Item 4

The selection cutting ratio referred to in (1)–d. of 2. Limit of cutting in the table shall be calculated by multiplying the annual growth rate of the relevant forest by the number of cutting years between the cutting year of the day on which the last selection cutting was completed and the year immediately before the next cutting is planned. If the ratio resulting from the calculation is greater than three tenths, three tenths shall be applied.

Regardless of the stipulation in the preceding paragraph, the selection cutting ratio to be applied to selection cutting that is conducted for the first time after specification of the protection forest or protection facilities shall be calculated by multiplying three tenths by a coefficient that is determined by the party who determines the specified treatment conditions on the relevant forest in consideration of the volume trees or other state of the standing trees in the relevant forest.