No.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NATIONAL FORESTRY SERVICE (SFN) OF THE MINISTRY OF AGRICULTURE AND LIVESTOCK (MAG), THE REPUBLIC OF PARAGUAY

THE STUDY ON REFORESTATION PLAN IN THE EASTERN REGION, THE REPUBLIC OF PARAGUAY

FINAL REPORT

MARCH 2002

JAPAN FOREST TECHNOLOGY ASSOCIATION (JAFTA)

PASCO INTERNATIONAL INC.

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PREFACE

In response to the request from the Government of the Republic of Paraguay, the Government of Japan decided to conduct the Study on Reforestation Plan in the Eastern Region, the Republic of Paraguay and entrusted the study to Japan International Cooperation Agency (JICA).
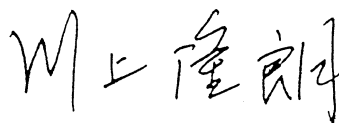
JICA sent to Paraguay a study team headed by Dr. Itsuhito Ohnuki of Japan Forest Technology Association, four (4) times between April 2000 and February 2002.

The team held discussions with the officials concerned of the Government of the Republic of Paraguay, and conducted field surveys in the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between the two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Paraguay for their close cooperation extended to the team.

March, 2002

Takao Kawakami
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

March 2002

Mr. Takao Kawakami
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Ser,

I am pleased to submit the Final Report for the Study on the Reforestation Plan in the Eastern Region, the Republic of Paraguay. The Report compiles the findings of the field surveys and analysis conducted between March 2000 and March 2002 and plans formulated by the Study Team.

In the course of the Study, a land cover map featuring the Eastern Region has been prepared and recommended reforestation areas have been selected. The Reforestation Plan (Master Plan) has also been formulated for the purposes of sustaining forest resources and creating local employment opportunities at the same time. This Master Plan is designed to create production forests mainly in the recommended reforestation areas in the Eastern Region. Furthermore, the Five Year Reforestation Programme has been formulated to materialise projects based on the Reforestation Plan for the Eastern Region.

It is my strongest hope that the Reforestation Plan will be precisely implemented through the efforts of the Government of Paraguay to enrich forest resources and to contribute to the future development of Paraguay.

I would like to express my gratitude to officials of the JICA, the Ministry of Foreign Affairs and the Ministry of Agriculture, Forestry and Fisheries for their understanding of and assistance for the Study. I would also like to commend the advice and assistance provided to the Study Team by members of the JICA's Paraguay Office, the Embassy of Japan in Paraguay and the Paraguayan Ministry of Agriculture and Livestock and other related organizations.

I sincerely hope that this Report will be actively used by the JICA to materialise and promote the Reforestation Plan concerned.

Very truly yours,

Itsuhito Ohnuki
Team Leader
The Study on Reforestation Plan in the Eastern
Region, the Republic of Paraguay

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ABBREVIATIONS

BID	Banco Interamericano de Desarrollo	Inter-American Development Bank
CAH	Credito Agricola de Habilitacion	Agricultural Development Credit Union
CETAPAR	Centro Technologico Agropecuario en Paraguay	Paraguay Agricultural Technology Centre
CRAN	Centro Regional Ambiental del Norte	Northern Regional Environment Centre
CRVSA	Cia de Reforestacion Yguazu S.A.	Yguazu Afforestation Co., Ltd.
DGP	Direccion General de Planificacion	Directorate General of Planning
DINCAP	Direccion Nacional de Coordinacion y Administracion de Proyectos	Natural Bureau of Project Coordination and Administration
DOA	Direccion de Ordenamiento Ambiental	Environmental Coordination Bureau
EDEP	Estudio Sobre el Desarrollo Economico en el Paraguay	Study on Economic Development in Paraguay
EMBRAPA	Empresa Brasilera de Pezquisa Agropecuaria	National Agricultural Experiment Station of Brazil
ENAPRENA	Proytecto Estrategia Nacional Para la Proteccion de Recursos Naturales	National Strategic Project for the Protection of Mineral Resources
FEPAMA	Federacion Paraguaya de Madereros	Federation of Lumber Industries in Paraguay
IAN	Instituto Agronomico Nacional	National Agricultural Institute
IBR	Instituto de Bienestar Rural	Rural Welfare Institute
IICA	Instituto Interamericano de Cooperacion Agricola	Inter-American Agricultural Cooperation Institute
INTA	Instituto Nacional de Tecnologia Agropecuaria	National Agropastoral Technology Institute (Argentina)
MAG	Ministerio de Agricultura y Ganaderia	Ministry of Agriculture and Livestock
MERCOSUR	Mercado Comun del Sur	South American Common Market
SARO	Sistema Ambiental de la Region Oriental	Environmental System Project in Eastern Region
SEAM	Secretaria del Ambiente	Environmental Agency
SFN	Servicio Forestal Nacional	National Forestry Office
SSERNMA	Sub Secretaria de Estado de Recursos Naturales y Medio Ambiente	State Office for Natural Resources and Environment
UGRNA	Undid de Gestion de los Recursos Naturales Renovables	Management Unit for Renewable Natural Resources
UNA	Unnersidad Nacional de Asuncion	Asuncion National University

The exchange rate used for the Report is US$1 = 3,787 Gs (April, 2001).

SUMMARY

SUMMARY

CHAPTER 1   OUTLINE OF THE STUDY

1.1 Background of the Study

There is grave concern in Paraguay in regard to the disappearance of natural forests and it is a pressing task for the country to secure a sufficient wood supply volume. While the Afforestation Promotion Law (Law No. 536) has created the legal framework for the promotion of afforestation, actual afforestation work based on this law has become stagnant, mainly due to a shortage of funds. In October, 1998, the Government of Paraguay made a request to the Government of Japan for the implementation of a development study for the formulation of an afforestation plan. In response to this request, the Preliminary Study Team (for discussions on the S/W) was dispatched to Paraguay in October, 1999 and the S/W was concluded and signed on 9th November, 1999.

1.2 Objectives of the Study

The Study has the following objectives.

(1) The Afforestation Plan (M/P) will be formulated for the Eastern Region of Paraguay (some 15.98 million ha) together with the preparation of a land cover map and the selection of recommended afforestation areas.

(2) The Five Year Afforestation Programme which will be required to implement the afforestation work (project) will be formulated.

(3) Technology transfer and guidance on the survey techniques for each survey item, planning process and basic concept, etc. will be made to engineers of the counterpart (C/P) organization.

1.3 Study Area

(1) Study Area

The Study Area is the Eastern Region (some 15.98 million ha) of Paraguay which accounts for approximately 39% of Paraguay's total land area of 40.68 million ha.

(2) Recommended Reforestation Areas

Certain municipal areas in the Eastern Region are selected as recommended afforestation areas with the potential for the creation of production forests based on the Phase 1 survey results.

1.4 Scope of the Study

The Study consists of Phase 1 and Phase 2 as shown in Table 1-1 and was conducted over two fiscal years.

1.5 Relationship Between the Study and the EDEP

1.5.1 Outline of the EDEP

Through joint work with the Government of Paraguay, the JICA formulated (i) development strategies to contribute to the strengthening of the international competitiveness of Paraguay and (ii) a draft project implementation plan and compiled the work results in the Final Report for the Study on Economic Development in Paraguay (EDEP) in November, 2000. The purpose of this study was the formulation of economic development strategies to facilitate the economic development of Paraguay by means of improvement of the agricultural productivity, departure from the dependence on agriculture, diversification of industries, industrialisation and promotion of exports so that Paraguay can properly prepare itself for changes of the economic environment following its participation in the MERCOSUR.

The finalised development strategies are (1) strategy to overcome the factors constraining the general competitiveness (inter-sectoral strategy), (2) sector-specific strategy and (3) cluster strategy.

1.5.2 Relationship Between Planned "Afforestation Plan for the Eastern Region" and "Timber Cluster"

In short, the afforestation project under the Five Year Afforestation Programme to be formulated by the Study means the actual implementation of the timber cluster initiative while the Afforestation Plan (M/P) offers the future prospect for the timber cluster initiative.

CHAPTER 2　PREPARATION OF LAND COVER MAP FOR THE EASTERN REGION

2.1 Preparation of Land Cover Map

2.1.1　Preliminary Analysis of Satellite Data

Using 14 scenes of satellite data (Landsat TM) covering the Study Area, satellite images (infrared colour images) were prepared for the field verification survey.

2.1.2　Field Verification Survey

Prior to the verification survey on the ground, an aircraft was used to conduct aerial investigation. The number of training areas, collected by the field verification survey, was 212 for the southern part and 237 for the northern part, totalling 449.

2.1.3　Examination of Classification Categories for Land Cover Map

The classification categories for the land cover map are shown in Table 1.

Table 1　　Classification Categories for Land Cover Map

Primary Category	Secondary Category	Tertiary Category	Description
Forest	Natural Forest	High Forest (Dense to Medium)	Forest with relatively little human impact with a dense to medium density of high trees
		High Forest (Sparse)	Forest with relatively high human impact due to cutting, etc. with a sparse density of tall trees
		Low Forest	Forest dominated by low trees because of natural constraining factors in terms of the soil and topography, etc. or low forest in the process of regeneration after cutting
		Bamboo Forest	Forest dominated by bamboo
		Shrub Land	Land dominated by shrubs due to natural constraining factors in terms of the soil and topography, etc. or shrub land in the process of forest regeneration or abandoned pasture land and others
	Artificial Forest		Artificially created forest
Cultivated Land	Dry Cultivated Land		In addition to general cultivated land, this category includes orchards, plantations
	Paddy Fields		Paddy rice fields
Grassland	Natural Grassland	Unflooded or Seasonally Flooded	Natural grassland not subject to flooding throughout the year or subject only to seasonal flooding; mainly used as pasture land
		Permanently Flooded	Natural grassland subject to permanent flooding and dominated by bog plants or aquatic plants; unused or hardly used in most cases
	Artificial Grassland		Artificial grassland seeded for intensive stock raising
Urban Area/ Settlement			In addition to urban areas, this category includes suburban residential areas/rural settlements/village areas
Water Body			Water bodies, including rivers and lakes
Others			Bare land and quarries, etc.

2.1.4 Analysis of Satellite Images and Preparation of Draft Land Cover Map

Based on the field verification survey results and the satellite image data, a catalogue of supervised data was prepared and the draft land cover map was prepared by means of the primary Landsat data classification.

2.1.5 Field Verification Survey for Draft Land Cover Map

Verification work was conducted during the second field survey period using the false (infrared) colour images and draft land cover map.

2.1.6 Field Verification Survey Results and Their Incorporation in Analysis Work

The problems of the classification results found by the field verification survey were listed for each scene and their causes were analysed. The results of this work are reflected on the final analysis work.

2.1.7 Finalisation of Land Cover Map

The accuracy achieved for the land cover map is 89.8%, showing a fairly high level of accuracy.

2.2 Forest Area: Comparison with Existing Study Results

The forest area extracted from the land cover map prepared under the Study is 2,619,142 ha using the same basic unit used by the Department of Forest Engineering, Faculty of Agricultural Science, National University of Asuncion to analyse the forest area using satellite images taken in 1991. The above figure shows a decrease of 722,816 ha from the 3,341,958 ha in 1991.

CHAPTER 3　SELECTION OF RECOMMENDED AFFORESTATION AREAS

3.1 Selection of Recommended Cities for Afforestation

106 cities were selected as the recommended cities for afforestation.

3.2 Selection of Recommended Afforestation Areas

A total area of 4,054,000 ha was selected as the recommended afforestation areas in the recommended cities for afforestation.

CHAPTER 4　ANALYSIS OF CURRENT CONDITIONS OF RECOMMENDED AFFORESTATION AREAS AND THEIR SURROUNDING AREAS

4.1 Current Conditions of Recommended Afforestation Areas and Their Surrounding Areas

4.1.1　Natural Conditions and Socioeconomic Conditions

The mean annual temperature in and around the recommended afforestation areas is approximately 21 – 24°C and the annual rainfall range is approximately 1,400 – 1,800 mm. The recommended afforestation areas are areas with an elevation of some 100 – 600 m sandwiched between Paraguay River to the west and Parana River to the east and south. According to the land cover map prepared under the Study, the category of non-flooded and seasonally flooded grassland covers the largest area of 1.9 million ha or 47% of the total area of the recommended afforestation areas, followed by dry farmland with 1.33 million ha (33%) and artificial grassland with 0.72 million ha (18%).

The estimated population of the recommended cities for afforestation in 2000 was 2,297,000, accounting for 41.8% of the total population of Paraguay and 42.9% of the population of the Eastern Region. The planted area by agricultural product in 1999 (1998 for wheat) for districts where the recommended afforestation areas are situated was 1,165,000 ha for soybeans, 343,000 ha for maize, 242,000 ha for cassava, 188,000 ha for wheat and 147,000 ha for cotton. There were 5,892,000 head of cattle in districts with recommended afforestation areas in 1999, accounting for 87.6% of the total head in the Eastern Region and 61.1% of the total head in the country. In Paraguay, the agricultural sector (including agriculture, livestock raising, forestry, hunting and fishery) still plays an important role in the national economy as

its share of the GDP is 27% (quick report for 2000) which is comparable with the GDP share of the industrial sector. While soybeans top the list of export products, timber has been among the top three products for the last few years, constituting a leading export product of Paraguay. Despite such importance, however, the export value of the main agricultural products, including timber, has been steadily declining since the late 1990's. The survey on afforestation intentions conducted under the Study found that the average annual income and expenditure per land owner in the recommended cities for afforestation were G157,558,000 and G90,624,000 respectively.

4.1.2　Current Conditions of Forestry

In order to deal with the deepening forest crisis, forest and forestry-related laws have been actively introduced and some of the main laws are outlined below.

① Law No. 422 (Forest Law, 1973) and Government Ordinance No. 11681 Regarding Forest Management (1975)

② Forest Law-Related Government Ordinances and Law

　i. Government Ordinance No. 18831 on Environmental Conservation (1986)

　ii. Government Ordinance No. 14047 on Regulation of Commercial Cutting of Natural Forests (1992)

　iii. Government Ordinance No. 24489 (1972) and Law No. 515 (1994) on Prohibition of Export of Logs, etc.

③ Law No. 536 (Afforestation Promotion Law, 1995) and Government Ordinance No. 9425 (Enforcement Regulations for Forestation Promotion Law, 1995)

There are other measures related to forestry as listed below.

① "Basic Measures and Actions Relating to Nature and Its Functions" (Ministry of Agriculture and Livestock: MAG, 1998)

② "Agroforestry Programme" (MAG, 1998)

Recent developments of forestry policies can be observed with the following.

① "National Plan (1999 – 2003)" (Technical Committee for Future Development of Paraguay, 1999)

② Direction for Forest and Forestry Policies in Paraguay (National Forestry Commission, March, 2000)

In view of the extremely weak fiscal base, the following problems must be solved to continue the subsidy under the Afforestation Promotion Law.

① As the Afforestation Promotion Law restricts its funding source to the general budget of the government, it is subject to tight fiscal measures adopted by the government. It will, therefore, be difficult to enlarge the budget to facilitate the effective implementation of the Afforestation Promotion Law in the foreseeable future.

② The Afforestation Promotion Law only stipulates the necessary procedure and fails to define its purpose and its superior laws.

③ The existing high level subsidy system does not reflect the reality as it can lead to speculative afforestation activities to obtain a subsidy and/or makeshift work to receive a cash subsidy. Because of the limited budget size, it is difficult to enlarge the total afforestation area.

The existing system involves time-consuming as well as expensive procedures for both afforesters and the SFN.

Under the present mechanism, it is impossible to restrict the application of the Law within the budgetary limit.

The forestry administration is under the jurisdiction of the SFN which was established in conjunction with the Forest Law enacted in 1973. Following the launch of the SEAM pursuant to Law No. 1561 in July, 2000, the SSERNMA together with its two subordinate offices, i.e. the DOA and the Directorate of National Parks and Wildlife, was transferred to the SEAM. At the same time, the SFN was placed under the direct control of the Minister of Agriculture and Livestock.

Forests in the Eastern Region of Paraguay covered some 8,311,000 ha or approximately 52% of the region's total land area in 1945. By 1991, the forest area had drastically decreased to some 3,342,000 ha or approximately 21% of the total land area (Land Use and Forest

Disappearance in the Eastern Region of Paraguay: Part I, Faculty of Agriculture, NUS, May, 1994).

Since the 1980's, a large number of landless farmers have moved into natural forest areas and settled there. The socioeconomic background for such settlement is the presence of many poor people in Paraguay (estimated to be some 1.7 million). Furthermore, large-scale land owners tend to cut natural forests because of their concern in regard to the intrusion of landless farmers to their land, further accelerating the decrease of natural forests. Meanwhile, stock farm owners designate existing pasture land as fallow land and develop new pasture land within the areas owned by them. Natural forests often become the targets of this development and, therefore, natural trees are cut to make way for pasture land.

According to the agricultural and livestock census in 1991, while afforestation activities were low in the Western Region, the afforested area in the Eastern Region doubled in the 10 years from 1981. The actual figure was a mere 15,000 ha, however, far below the forest area lost due to development. From 1995 to 2000, some 30,000 ha were affected.

The scale of each afforestation site is approximately 0.3 – 4.0 ha for land owners with up to 20 ha or as large as 200 – 300 ha for large-scale land owners. The main planted species are eucalyptus (mainly E. camaldulensis and E. grandis), pine (P. elliottee and P. taeda) and paraiso (Melia azedarach). There should be a real demand for plantation consisting of these species in both the domestic and international markets to replace the dwindling natural trees. Furniture and plywood made of paraiso in particular enjoy a high reputation even today.

In the case of paraiso, some 12 – 13 year old trees show yellowing of the leaves and a slowing down of the growth, leading to die-back from the top. At the present stage, no effective prevention method has yet been established. Substantial damage at afforestation sites is caused by particular types of leaf cutting ants (locally called ysau and akeke). The control of these ants is an important factor for successful afforestation and the work is recognised as being an essential component of forestry activities in most areas.

Actual cases of agroforestry are mainly associated with small-scale land owners. There are cases of agroforestry in the Central Region which were part of European assistance for sustainable agricultural production by settlers. Other cases assisted by the BID are observed in the Northern Region.

Most of the seedlings for afforestation work are produced by afforesters at home. Small-scale land owners often purchase seedlings from the SFN's nurseries. Nurseries belonging to the

SFN have been established in most districts under the national guidance and extension system for seedling production techniques. It is necessary for Paraguay to make serious efforts to secure excellent seeds and seedlings to establish advantageous trading terms in the international market for the timber to be produced from its artificial forests.

In its guidelines for agricultural and stock raising policies, the Government of Paraguay classifies those conducting farming and stock raising in three groups, i.e. industrial farming group (large-scale stock farm owners and owners of large-scale industrial farms), medium-scale commodity crop producers' group and small farmers' group. While expressing its continuous support for the first two groups, the government considers support for the small farmers' group and landless farmers who are inferior to the other two groups in terms of their financial and technical strength to be the highest priority task.

4.1.3   Current Conditions of Forest Products Industry

As far as the scale of forest cutting is concerned, 63% of cutting is conducted in accordance with a medium-scale forest management plan which is applicable to medium-scale forests of not larger than 500 ha as set forth in Article 26 of Law No. 422 (Forest Law, 1973). 22% of cutting is conducted under a land use plan to convert forests to farm land and pasture land, etc. while 8% of cutting is conducted under a large-scale forest management plan which is applicable to forests of larger than 500 ha. Finally, 7% of cutting is conducted under a small-scale forest management plan which is applicable to forests of up to 50 ha. One serious problem faced by forestry in Paraguay is that nearly one-quarter of timber production is associated with the development of farm land and is responsible for the disappearance of natural forests. A total of 384 sawmills and plywood plants were registered with the SFN in 1999. However, the actual number is believed to be more than 600 as many small, unregistered plants were also in operation.

According to data compiled by the Central Bank of Paraguay, the total production volume of wood in 2000 was 6,937,000 tons, consisting of 2,675,000 tons of log wood (39%), 3,828,000 tons of fuelwood (55%) and 434,000 tons of electric poles and others (6%), indicating the main use of wood as fuelwood. The relative ratios of log wood and fuelwood have remained almost unchanged in the last 10 years. At present, more than 90% of the timber produced in Paraguay comes from natural forests but it is anticipated that such production will experience a sharp decline in the future because of the decrease of the natural forest area due to the progressive conversion to farm land and the declining quality of the timber resources at the remaining forests. This situation definitely indicates the urgent need for the creation of artificial forests to ensure the continual domestic supply of timber in a sufficient quantity.

Paraguay imports wood products mainly from Argentina and Brazil, etc. As the wood import volume is less than 1% of the production volume of wood products, the total domestic demand for wood in Paraguay is considered here to be equivalent to the cutting volume at 6,937,323 tons. In Paraguay which does not have any fossil fuel resources, the demand for fuelwood by the manufacturing sector will not sharply decline for some time because of the high cost of other energy sources. The use of eucalyptus and other artificially planted trees to meet the demand for fuelwood to replace natural trees should prove highly effective not only for the conservation of natural forests but also for the steady supply of fuelwood.

With the progress of forest development, the main cutting sites are moving to the northeastern districts of San Pedro, Canindeyu and Concepcion, etc. which are far from the main consumption areas. Cut wood is mainly sawn locally or in nearby areas. Some is sold to local consumers in the form of such final products as flooring. Most logs are sawn to produce thick timber and are transported to sawmills in such areas as Caaguazu and Corenel Oviedo (furniture production areas), Asuncion (largest wood consumption area) and Ciudad del Este and Encarnacion (export bases for wood products) for processing to produce final products for consumers.

The total import volume is not large and almost exclusively consists of particleboard and fiberboard which are not produced in Paraguay. Neighbouring Argentina and Brazil are the predominant exporting countries of wood products to Paraguay. According to the interview survey results, imports of pine products from Argentina and Brazil are rapidly increasing. In view of the fact that there are not many pine afforestation sites which have reached the cutting age in Paraguay, the import volume of pine is expected to continually increase in the coming years.

The export value of wood products generally ranks third after oil seeds such as soybeans and cotton. As such, wood products comprise an important export industry in Paraguay. The export value steadily increased up to 1996 and has since levelled despite minor fluctuations.

The price of logs for sawing is US$ 50 – 60/m^3 for Class 1 species, such as cedro and guatambu, for natural trees with an end diameter class of 10 pulgada (25.4 cm). The price of Class 2 species, including kupay, is significantly lower at around US$ 30. The standing tree price for thinned pine wood is US$ 7.1/ton (the raw wood weight immediately after cutting is deemed to be 1 ton/m^3; hereinafter the same shall apply). The delivery price to the factor of final cutting wood is US$ 15/ton for logs with an end diameter of 20 cm or larger. No survey data is collected on eucalyptus as it is hardly traded in Paraguay. In the case of the price of eucalyptus in Argentina, the price of standing trees of 18 – 30 cm in diameter is US$ 18 – 20

ton in Corrientes Province. The price per ton for pine (US\$ 18 – 23 for pine trees of 18 – 30 cm in diameter) is higher than the price of eucalyptus in this province. The price of paraiso wood for timber is similar to that of araucaria but the price of paraiso wood (35 cm or larger) for timber of US\$ 85 – 90/ton is higher than that of araucaria (US\$ 60 – 90/ton) and is the highest priced wood from planted trees.

It appears reasonable to assume a cutting and hauling cost (including loading cost) of approximately US\$ $5.5/m^3$ for estimation of the profitability in the future. The total production cost of firewood, including the cutting cost and the transportation cost of ready-made firewood to the road side, is $G4,953/m^3$ (stacked) or US\$ $1.32/m^3$. The production cost of charcoal from initial cutting to transportation of the charcoal to the road side is G62,800/ton or US\$ 16.7/ton.

4.2 Survey on Afforestation Intentions

4.2.1 Purposes

The purposes of the survey on afforestation intentions were to establish a clear understanding of the intentions of land owners in the recommended afforestation areas regarding afforestation and to obtain basic information to determine the likely scale of the master plan for afforestation plans in the Eastern Region and to estimate the preferable work volume of the Five Year Afforestation Programme. Another purpose of this survey was to obtain basic data which would prove useful for the examination of possible measures to promote the active participation of land owners in afforestation work.

4.2.2 Survey Areas and Target Persons of the Survey

The recommended cities for afforestation and land owners in the survey areas were decided as the survey areas and target persons of the survey respectively.

4.2.3 Survey Method

The survey was conducted in the form of a questionnaire survey through interviews with the target land owners. The total number of samples was set at approximately 600. This survey was subcontracted to a local consultancy company.

4.2.4　Survey Results

Based on the findings of the survey on afforestation intentions and the land cover map prepared under the Study, it was possible to infer that some 380,000 ha could be afforested by those land owners in the recommended afforestation areas who are interested in conducting afforestation work on their land.

4.3 Prospects of Wood Distribution/Markets and Wood Demand

4.3.1　Prospects of Wood Distribution/Markets and Forest Products Industry

With the implementation of the planned afforestation plan, future wood production will increasingly be based on planted trees, particularly pine and eucalyptus, while the supply of wood from natural forests will substantially decrease in terms of both logs and fuelwood. The expected concentration of working sites resulting from the expansion of the afforestation area will facilitate the mechanisation of cutting and the introduction of an efficient operation system to reduce the production cost. The development of the road network with an increase of the total paved road length will enlarge the economical zone for wood collection. In turn, this will reduce the number of small-scale sawmills near the cutting sites which will be replaced by large-scale sawmills at several wood production sites.

It is expected that the raw materials for timber in the future will mainly be supplied from artificial forests in Paraguay. Accordingly, the present production system which is mainly based on wood from natural forests will be transformed to a production system relying on medium and small diameter wood from artificial forests as in the case of the more advanced Brazil and Argentina in this regard. Wood products using eucalyptus and pine will form the main trend of processed products. Various types of laminated wood using the finger joint technique and others will be produced together with the production of overlaid laminated wood as well as plywood using wood from artificial forests as the base and high quality sliced veneer from wood from natural forests for the surface. The creation of particleboard, MDF, paper and pulp industries will be considered to ensure the effective use of wood resources.

The absence of an ocean port given the fact that Paraguay is an inland country has proved to be a major obstacle for Paraguay's exports to effectively compete with those of neighbouring countries. The establishment of the MERCOSUR has, however, mitigated this problem and the slightly longer transportation distance does not necessarily pose a serious disadvantage for Paraguay compared to Argentina and Brazil. The lower labour and electricity costs and fertile land in Paraguay can prove to be an advantage for Paraguay. The important task for Paraguay

in the coming years will be to catch up with Brazil and Argentina in the fields of sawing and processing technologies and product design. The US which is a relatively short distance away from Paraguay will provide the largest market for wood products using planted trees. Such European countries as Italy and Spain, Taiwan and some other countries can also be considered promising export markets given their historical ties with Paraguay in terms of wood trade.

4.3.2　Prospects of Wood Demand

It is believed that the domestic demand for wood products will steadily increase in the coming years due to the population increase and progress of economic development, particularly improvement of the living and educational standards in rural areas. Moreover, there will be a strong consumer drive for good quality but inexpensive products. The domestic demand in 2020 is estimated to be 633,000 tons for industrial logs, 378,000 tons for agricultural logs, 434,000 tons for electric poles and 3,637,000 tons for fuelwood. The export demand in the same year is estimated to be 1,929,000 tons for industrial logs and 191,000 tons for fuelwood. Based on these figures, the total demand for wood in 2020 is estimated to be 7,202,000 tons.

4.4 Examination of Afforestation Assistance System and Fund Raising

4.4.1　Afforestation Assistance System

Based on the opinions expressed by several financial institutions in Paraguay, the likely loan scheme for afforestation work is outlined below, assuming the financial support of an overseas aid organization(s).

Loan amount	:	up to 75% of the required fund
Loan period	:	10 years (maximum of 12 years)
Grace period	:	2- 3 years
Annual interest rate	:	Guarani-based loan – 20 – 30%; US$-based loan – 4 – 8%
Collateral	:	registered real or movable property, including land and house
Guarantee	:	joint and several liability by guarantor with equal or higher creditability than the borrower if real property cannot be provided as collateral..

Based on the above consideration, the following financing scheme is deemed to be appropriate for the project to implement the Afforestation Programme.

Medium and large-scale land owners ⇔ advantageous loan scheme

Small-scale land owners ⇔ free supply of afforestation inputs

  ⇔ loan via saw millers

  ⇔ loan via agricultural cooperatives

For the development of a loan scheme for afforestation work, it is essential to confirm the presence of suitable intermediary financial institutions in Paraguay. Many government-affiliated financial institutions are willing to provide an afforestation loan, indicating the existence of reliable channels for the financing of afforestation work. In accordance with consultations with the IMF and other international organizations, the Government of Paraguay is to merge or abolish government-affiliated financial institutions. However, the future uncertainty regarding the possible merger or abolition of government-affiliated financial institutions is making everyone sit back to observe future developments.

4.4.2   Fund Raising by the Government

The relevant issues for the formation of a concrete afforestation project include (i) the annual borrowing limit for Paraguay, (ii) accumulated foreign debt, (iii) counterpart fund, (iv) planned afforestation area and (v) markets for products and their risks.

CHAPTER 5 AFFORESTATION PLAN (MASTER PLAN) FOR EASTERN REGION

5.1 Basic Concept of Master Plan

In view of the importance of wood production for the national economy, the supply of wood resources from afforestation sites is essential to meet the wood demand in the future when natural wood resources are on the decline. Here, the creation of production forests in the Eastern Region is planned to secure wood resources and to create local employment opportunities in the said region. This afforestation plan sets forth the basic matters as the Master Plan to promote afforestation work in the Eastern Region and acts as a guideline for the formulation of an actual afforestation plan (projects) for the recommended afforestation areas which have strong potential for the creation of production forests.

5.2 Target Work Volume for Afforestation

The target work volume for afforestation in the near future is set at 400,000 ha. The aim is to achieve planting over this area in 15 years, taking the necessary funding for planting work and the average cutting period (approximately 16 years) of eucalyptus, pine and paraiso into consideration. It is aimed at completing the work in three phases with each phase lasting for five years and the precise work volume planned is 50,000 ha for Phase 1, 150,000 ha for Phase 2 and 200,000 ha for Phase 3.

5.3 Management Framework

It has been decided not to specify the forest management method based on the type of land management and the scale of land ownership. Instead, several forest management methods are proposed for selection by each land owner who may adopt some of them at his afforestation sites.

Several forest management objectives are established for the Plan and a specific forest management method is determined for each objective as shown in Table 2. Individual land owners select the preferred method to conduct afforestation work.

Table 2 Objectives and Target Sites by Forest Management Type

Forest Management Type	Objectives	Target Sites	Remarks
Production Forest I-1	Production of timber wood	Farm land, pasture land and shrub land	
Production Forest I-2	Production of fuelwood and pulpwood	Farm land, pasture land and shrub land	Production of fuelwood near a fuelwood consumption area
Production Forest II	Agroforestry	Farm land	Mainly targeting small-scale land owners
Production Forest III	Production of timber wood and protection of livestock	Pasture land	
Production Forest IV-1	Production of timber wood and windbreak forest	Farm land and pasture land	Area with seasonally strong winds
Production Forest IV-2	Production of fuelwood and windbreak forest	Farm land and pasture land	
Production Forest V	Silvopasture	Farm land and pasture land	

5.4 Planting Species

Eucalyptus grandis, E. camaldulensis, Pinus taeda, P. elliottii and Melia azedarach (Paraiso gigante) are mainly selected for the Plan on the grounds of their reliable performance of past afforestation work. The selection of these species will facilitate understanding of the economic advantages of afforestation by potential afforesters, who will become actively engaged in afforestation work.

5.5 Management Method

The main processes of afforestation work are a survey on the planned afforestation site, selection of the species, ant control, ground clearance, planting, direct seeding, weeding, climber cutting, pruning and thinning.

5.6 Forest Protection

At present, the shrinkage and yellowing of the leaves are observed at some parts of afforestation sites of paraiso. There are no other diseases worthy of special mention. No significant insect damage to afforestation sites other than the damage by ants is observed. The creation of a large size mono-cultural afforestation site with a single exotic species should be avoided and the arrangement of different sites with different species should be considered in

order to prevent the outbreak or spread of damage by disease or insect pest and to preserve healthy afforestation sites.

A forest fire is often caused by human action. When there is a risk of forest fire because of the weather conditions, afforestation sites should be patrolled in view of the early detection and extinguishing of any fires.

5.7 Estimation of Yield

As good quality seedlings will be used for the planned afforestation work, the growth at the planned afforestation sites is expected to be better than the past performance. For the Plan, the expected growth at the new afforestation sites assumes a 10% increase on the growth at the existing afforestation sites.

5.8 Afforestation Cost

The actual afforestation cost varies depending on the natural and other conditions at each afforestation site and cannot be uniformly determined. Here, the afforestation cost by species and by forest management type at natural grassland (scale of afforestation: 50 – 300 ha) is estimated taking the fact-finding survey results by afforesters into consideration.

5.9 Production of Seedlings

The required number of seedlings to meet the average annual work volume is 13.8 million for Phase 1, 41.4 million for Phase 2 and 55.2 million for Phase 3 based on an approximate planting density of 1,200 seedlings/ha and a supplementary planting rate of 15%.

5.10 Estimation of Required Labour Volume

The required labour volume to conduct the planting of 400,000 ha and to produce the necessary seedlings is estimated from the viewpoint of the effect of the project on the creation of employment in local communities. The estimated employment volume is approximately 90,000 workers.

5.11 Implementation System

The state forestry authority must complete and strengthen its administrative structure and urgently develop the implementation system for the proposed afforestation plan by achieving the following necessary conditions.

(1) Clarification of the organizational status of the state forestry authority and strengthening of its own organization

(2) Collection and accumulation of technological information on afforestation and establishment of a research and experiment system regarding the forest tree breeding

(3) Establishment of a collaboration system for all related parties

(4) Accumulation of various records relating to the implementation of the afforestation plan

5.12 Environmental Impacts Assessment (EIA)

5.12.1 Administrative Bodies and Laws Concerning Environmental Impacts Assessment

Practical work relating to EIA is conducted by the Environmental Impacts Evaluation Bureau of the Directorate General for Quality Control of the Environment and Natural Resources. The laws and government ordinance related to EIA are Law No. 294 (1993), Law No. 345 (1994) and Government Ordinance No. 14281 (1996) which provides the detailed rules for Law No. 294.

5.12.2 Activities Requiring Environmental Impacts Assessment

Government Ordinance No. 14281 sets forth activities subject to EIA. Based on the above provisions, an EIA will be required for the implementation of the Five Year Afforestation Programme when afforestation work using a single species is planned for an area of 1,000 ha or more or when there is a large afforestation site in the area, when the existing land use is very important or when the planned site is very important from the environmental point of view for a planned afforestation area of less than 1,000 ha.

CHAPTER 6   FIVE YEAR AFFORESTATION PROGRAMME

6.1 Basic Concept of Five Year Afforestation Programme

The basic concept of the Five Year Afforestation Programme is explained below.

(1) The Five Year Afforestation Programme is purposes to transform the Afforestation Plan in Eastern Region (Master Plan) into a concrete project.

(2) The artificial forests to be created are production forests.

(3) The project sites are mainly located in the recommended afforestation areas. The total project area is determined in consideration of the results of the survey on afforestation intentions, the past afforestation results in Paraguay and the capacity to borrow overseas funds, etc. The specific locations of the project sites in the recommended afforestation areas are not determined.

(4) The planting species and forest management methods are those adopted by the Master Plan.

(5) While funding for those wanting to conduct afforestation work is made in the form of a loan, free assistance, etc. is considered for small-scale land owners.

(6) The conditions of a loan for those wanting to conduct afforestation work take the results of the survey on afforestation intentions into consideration.

(7) Financial and economic analyses of the project are conducted to examine the profitability and the financial as well as economic viability of the project.

6.2 Work Plan

6.2.1   Annual Work Volume

In the Five Year Afforestation Programme, the annual work volume, i.e. planting volume, is planned to gradually increase from 5,000 ha each in Year 1 and Year 2 to 10,000 ha in Year 3, 10,000 ha in Year 4 and 20,000 ha in Year 5 to ensure (i) the development of the project implementation system through the planting of 50,000 ha in Phase 1 and (ii) the smooth transition from Phase 1 to Phase 2.

6.2.2 Seedling Production Plan

Based on the above assumptions, the quantity of seedlings required for each type of forest management was estimated. The estimated total quantity of seedlings required for five years is approximately 61.9 million, including those for supplementary planting (15%). By year, 6.19 million each will be required for Year 1 and Year 2, 12.38 million each for Year 3 and Year 4 and 24.76 million for Year 5.

6.2.3 Annual Funding Plan

The estimated total cost necessary to conduct afforestation work over 50,000 ha in five years is approximately US$ 26.06 million (based on an exchange rate of G3,800 to US$ 1, June, 2001) while the total project cost is estimated to be US$ 33.0 million.

6.2.4 Estimation of Required Labour Volume

When examining the required labour volume for the afforestation of 50,000 ha and the production of the necessary quantity of seedlings in Phase 1, the employment of some 7,800 workers over five years is deemed to be necessary.

6.3 Project Management

6.3.1 Implementation System

The Five Year Afforestation Programme will, in principle, be implemented with loans for land owners provided by domestic financial institutions, free aid by the SFN for small-scale land owners, free aid by saw millers for small-scale land owners and loans by agricultural cooperatives for small-scale land owners. Meanwhile, the Government of Paraguay will provide loans for domestic financial institutions which in turn will provide loans for land owners, saw millers and agricultural cooperatives. Funds provided by overseas donors are assumed to be the main source of the original funds. The loan conditions of domestic financial institutions for the implementation of the Five Year Afforestation Programme are described below.

Loan amount	:	up to 75% of the required fund
Loan period	:	10 years (maximum of 12 years)
Grace period	:	2 – 3 years
Annual interest rate	:	Guarani-based loan – 20 – 30%; US$-based loan – 4 – 8%

| Collateral | : | registered real or movable property, including land and house |
| Guarantee | : | joint and several liability by guarantor with equal or higher creditability than the borrower if real property cannot be provided as collateral. |

6.3.2 Application, Approval and Inspection of Afforestation Work

The application, approval, inspection and other processes of afforestation work under the Five Year Afforestation Programme will be much simpler than the existing processes.

6.4 Project Evaluation

6.4.1 Financial Analysis

Afforesters are classified into two categories, i.e. medium to large and small afforesters, depending on the scale of afforestation work in the recommended afforestation areas. For medium to large afforesters, a model is established for each of pine, eucalyptus and paraiso. In the case of small afforesters, an agroforestry model using paraiso is established. Firstly, however, the profitability of a production forest alone, excluding farming, is examined.

The financial internal rate of return (FIRR) of a production forest of paraiso wood is calculated to be 23.6%, confirming the high level of profitability of this type of afforestation work. The FIRR of a production forest of eucalyptus wood is calculated to be 21.9%, confirming the high profitability of this type of afforestation work as in the case of a paraiso forest. The FIRR of a production forest of pine wood is calculated to be 11.6%. Although this rate of return is below that of paraiso and eucalyptus, it is still a well acceptable rate of return.

The FIRR of a small-scale production forest of paraiso is 28.5%, confirming a very high rate of return for this type of work. Agroforestry is to be conducted for some three years after planting at a production forest site referred to above. This incidental production activity improves the productivity of the land, further contributing to enhancement of the high rate of return to be achieved by a production forest alone. With the inclusion of the project implementation cost, incidental costs such as institutional strengthening cost and consultant cost, and, costs for contingencies, the FIRR is still high at 17.1%, indicating the high level of profitability of the project as a whole.

6.4.2 Economic Analysis

The economic feasibility of an afforestation project in Paraguay is examined below, mainly dealing with the medium to large-scale production forest model.

① Feasibility of Exclusive Afforestation Model

The Economic Internal Rate of Return (EIRR) of paraiso of 41.4% is extremely high. Eucalyptus enjoys a high FIRR and shows an adequate EIRR of 18.7%, indicating its economic viability. Although the production period of pine is quite long, its EIRR of 18.5% is excellent.

② Addition of Opportunity Cost

The next step is to examine the general impacts of an afforestation project on the actual economy by adding the economic opportunity cost associated with the conversion of land use.

In the case of paraiso, feasibility can be maintained with a very high opportunity cost. This means that afforestation using paraiso is feasible even at first class farming land or pasture land. In the case of pine, although its production period is quite long, the resulting economic benefit is quite high. Accordingly, the feasibility of an afforestation project can be maintained when farming land or pasture land with average productivity is converted. In the case of eucalyptus, it is difficult to maintain the economic feasibility unless an afforestation site is converted from farming land or pasture land of which the productivity is below average.

CHAPTER 7   RECOMMENDATIONS

Based on the judgement of the present management situation of forests and forestry-related policies and system and also on the availability of various reference materials and data, the following recommendations are made to promote the Afforestation Plan (Master Plan) and to facilitate the implementation of the Five Year Afforestation Programme.

1. Promotion of afforestation work using a loan scheme

2. Clarification of the status of the state forestry authority in the national administrative structure and strengthening of its organization

3. Development of the domestic regime to secure external funds required for the implementation of the Afforestation Programme

4. Establishment of effective measures to combat the depletion and degradation of natural forests

5. Gathering and management of statistical data and scientific data on forests and forestry and the establishment of an afforestation experiment and research system

6. Promotion of industrial afforestation through collaboration with the wood industry

7. Effective promotion of the Five Year Afforestation Programme

CHAPTER 1   OUTLINE OF THE STUDY

CHAPTER 1

OUTLINE OF THE STUDY

1.1   Background of the Study

In Eastern Paraguay, some 8 million ha (some 55% of the total area of the Eastern Region) is said to have been covered by natural forests in 1945. However, the area is now facing a risk of their disappearance due to the large-scale development of cultivated land and felling to produce timber. The predicted tight supply situation of timber in the future, therefore, makes the securing of a stable supply of timber an urgent task.

The Government of Paraguay enacted the Afforestation Promotion Act (Act No.536) in 1995 to improve the living environment of the public and to ensure the sustainable use of national land and forest resources. In view of the fact that most land is privately owned, this Act is designed to enhance the incentives for the afforestation efforts of landowners. The government subsidises 75% of the cost of afforestation work carried out in accordance with the procedure set forth by the Act. While the Act has created the legal framework for the promotion of afforestation, the progress of actual afforestation has been slow, mainly because of a funding shortage.

Under these circumstances, the Government of Paraguay made a request to the Government of Japan in October, 1998 to conduct a development study for the formulation of a afforestation plan. In response, a preliminary study team (for discussions on the S/W) was dispatched to Paraguay in October, 1999 and the S/W was concluded on 9th November, 1999.

1.2   Objectives of the Study

The Study has the following objectives.

(1) The Afforestation Plan (M/P) will be formulated for the Eastern Region of Paraguay (some 15.98 million ha) together with the preparation of a land cover map and the selection of recommended afforestation areas.

(2) The Five Year Afforestation Programme which will be required to implement the afforestation work (project) will be formulated.

(3) Technology transfer and guidance on the survey techniques for each survey items, planning processes and basic concept, etc. will be made to engineers of the counterpart (C/P) organization.

1.3　Study Area

(1) Study Area

The Study Area is the Eastern Region (some 15.98 million ha) of Paraguay which accounts for approximately 39% of Paraguay's total land area of 40.68 million ha.

(2) Recommended Afforestation Areas

Certain municipal areas in the Eastern Region are selected as recommended afforestation areas with the potential for the creation of production forests based on the Phase 1 survey results.

1.4　Scope of the Study

The Study consists of Phase 1 and Phase 2 as shown in Table 1-1 and was conducted over two fiscal years.

Fig. 1-1   Study Area

Table 1-1   Components of the Study

Phase	Work Description	Main Study (Survey) Purposes
Phase 1	I. Preliminary Preparatory Work in Japan	• Preparations for the Study and formulation of the study implementation plan (analysis of existing materials, preparation of the list of planned materials to be gathered; preparation and explanation of and discussions on the Inception Report and preparation of the technology transfer plan, etc.) • Preliminary analysis of the satellite data to be used for the preparation of the land cover maps
	II. First Field Survey	• Explanation of and discussions on the Inception Report and preparation of the technology transfer plan • Surveys on the natural conditions, socioeconomic conditions and forestry/forest products industry in the Study Area • Field verification survey for the preparation of the draft land cover maps • Preparation and explanation of and discussions on Field Report I
	III. First Domestic Work in Japan	• Preparation of the draft land cover maps • Installation of the relevant data to GIS • Selection of candidate cities and areas for recommended afforestation • Preparation and explanation of the Progress Report • Preparation of the draft specifications for the subcontracted afforestation intention survey
Phase II	IV. Second Field Survey	• Finalisation of the recommended afforestation areas • Discussions and survey on the zoning of the recommended afforestation areas and preparation of the Afforestation Plan for the Eastern Region (M/P) • Field verification survey for the draft land cover maps • Installation of the draft land cover maps to GIS • Implementation of the afforestation intention survey (subcontracted) • Gathering of information and materials relating to project evaluation (financial analysis and economic analysis) • Preparation and explanation of and discussions on the Interim Report
	V. Second Domestic Work in Japan	• Preparation of the land cover maps and installation to GIS • Preparation of the Draft Afforestation Plan for the Master Plan
	VI. Third Field Survey	• Survey and gathering of the relevant information relating to the formulation of the Five Year Afforestation Programme and preparation of the Afforestation Manual • Gathering of information and materials relating to project evaluation (financial analysis and economic analysis) • Preparation and explanation of and discussions on Field Report II
	VII. Third Domestic Work in Japan	• Preparation and explanation of and discussions on the Draft Final Report and preparation of the Draft Afforestation Manual • Preparation of the materials to be used in the technology transfer seminar
	VIII. Fourth Field Survey	• Explanation of and discussions on the Draft Final Report and Draft Afforestation Manual • Preparation and holding of the technology transfer seminar
	IX. Fourth Domestic Work in Japan	• Preparation of the Final Report and Afforestation Manual

1.5 Relationship Between the Study and the EDEP

1.5.1 Outline of the EDEP

(1) Purpose of the EDEP and Outline of Development Strategies

Through joint work with the Government of Paraguay, the JICA formulated (i) development strategies to contribute to the strengthening of the international competitiveness of Paraguay and (ii) a draft project implementation plan and compiled the work results in the Final Report for the Study on Economic Development in Paraguay (EDEP) in November, 2000. The purpose of this study was the formulation of economic development strategies to facilitate the economic development of Paraguay by means of improvement of the agricultural productivity, departure from the dependence on agriculture, diversification of industries, industralisation and the promotion of exports so that Paraguay can properly prepare itself for changes of the economic environment following its participation in the MERCOSUR.

The finalised development strategies are (1) strategy to overcome the factors constraining the general competitiveness (inter-sectoral strategy), (2) sector-specific strategy and (3) cluster strategy.

The first strategy consists of the qualitative improvement of human resources development to strengthen the export competitiveness, improvement of the institutional finance system, improvement of the export promotion and export support systems and the establishment of a quality certification system, etc. while the second strategy consists of the promotion of the development of the agricultural, industrial and transport infrastructure, etc. The third strategy identifies six model clusters of "assorted feed", "vegetables", "fruits", "cotton", "timber" and "metal processing" for their consolidation. These development strategies are ranked based on their importance and priority and are regarded as constituting actions plans to be implemented between 2001 and 2006.

(2) Outline of Timber Clusters

A timber cluster, which is one of the strategic clusters identified by the EDEP, provides model processes from planting and the production of timber using Melia azedarach (Paraiso gigante) which is a fast growing species with relative ease of creating added value and aims at (i) promoting planting projects through agroforestry to secure raw materials in a sustainable manner and (ii) enhancing the export competitiveness of this species by means of increasing its added value with improved design and processing skills for wood products. Here, based on the assumption that small farmers will be the

main actors for production, the creation of a forestry association is planned so that this association will conduct planting, cutting, hauling, sawing, drying and marketing to ensure a sustainable supply of raw wood.

(3) Action Plan for Timber Clusters

The concrete action plan for timber clusters is analysed by the Study for Project Implementation and Management Based on the Cluster Strategy (by Action para el Desarrollo, a NGO) as summarised below. Item 1) and Item 2) represent the core economic activities.

1) Measures to increase the added value in the timber processing sector

An increase of the added value will be attempted by means of shifting to the export of highly processed products, expansion of promising overseas markets, improvement of market access, planning of a market survey and human resources development.

2) Stable supply of raw materials for processing

As one important precondition for 1) above is the securing of forest resources, afforestation options (agroforestry and silvopasture, etc.) using Paraiso gigante are recommended.

3) Legal and organizational development relating to forestry

1.5.2 Relationship Between the Planned "Afforestation Plan for the Eastern Region" and "Timber Clusters"

(1) Basic Concept

In view of the continued rapid decrease of natural forests, one of the few realistic options for the forestry sector to maintain the prospect of self-reliant development and to increase its contribution to Paraguay's economy is to encourage the creation of production forests as a move to shift from natural forests to artificial forests in order to restore the decreased forest resources.

During the transitional process, competition with neighbouring countries is not feasible if such forestry-related industries as the timber industry and wood processing industry intend the application of conventional machinery, know-how and design based on the characteristics of natural forests to the new situation without any alteration. It will be

both expensive and painful for these industries to adapt to the new situation. At the same time, however, this provides them with the opportunity to become highly value-added industries. The provision of technical, financial and institutional assistance for these industries is of great significance for the economic development of Paraguay.

Meanwhile, given the situation of land ownership in Paraguay, it will be necessary for the creation of production forests to rely on the commitment of the private sector. There must be a strong prospect for the products (planted trees) to be sold at a reasonable price in the form of timber if afforestation is to be accepted as a viable investment activity by the private sector. The existence of well-established timber and wood processing industries to add high product value is the most powerful basis to ensure the profitability of afforestation work. Conversely, successful afforestation projects to ensure a stable supply of raw materials is an essential condition for the development of these industries.

It is, therefore, necessary to ensure strong linkage between and the parallel development of forestry-related industries and the afforestation sector and the timber cluster initiative can be described as providing a guideline for the general development of the forestry sector as a whole in the said direction.

Any attempt to implement the timber cluster initiative must obviously take the long production period, which is a unique characteristic of afforestation work, into proper consideration. In fact, the timetable for timber clusters anticipates the commencement of afforestation work well become commencement of the development of the related industries.

The Afforestation Plan (M/P) to be formulated by the Study sets forth the basic issues for the promotion of afforestation work in the Eastern Region and constitutes the guideline for the formulation of an implementation programme. The Five Year Afforestation Programme aims at implementing the Afforestation Plan (M/P) in a concrete manner. The implementation project under the Five Year Afforestation Programme is perceived as Phase 1 and concentrates solely on afforestation work. The Phase 1 project will be conducted on a relatively small scale. In Phase 2, the technical and financial viability of forestry-related industries will be further examined in detail based on the analysis results of the progress of the Phase 1 project, the trends of the timber market and other relevant matters.

The timber cluster initiative only mentions Paraiso gigante as a planting species. While the Study recognises that Paraiso gigante is an important species, it also considers pine

and eucalyptus as viable planting species because of the past successful use as planting species in Paraguay and their increasing market presence supported by excellent growth. The inclusion of such species will increase the variety of afforestation work to provide the necessary flexibility to accommodate different technical levels and intentions of those planning to conduct afforestation work.

In short, the afforestation project under the Five Year Afforestation Programme to be formulated by the Study means the actual implementation of the timber cluster initiative while the Afforestation Plan (M/P) offers the future prospect for the timber cluster initiative.

CHAPTER 2 PREPARATION OF LAND COVER MAP FOR THE EASTERN REGION

CHAPTER 2

PREPARATION OF LAND COVER MAP FOR THE EASTERN REGION

This chapter describes the preparation of the land cover map using satellite remote sensing data for its use to select target afforestation sites and to prepare a afforestation project. In addition, the new survey results are compared with the existing survey results on the forest area.

The work to analyse and classify land cover using satellite data was conducted in accordance with the flow shown in Fig. 2-1. Firstly, the draft land cover map was prepared, followed by a field verification survey designed to improve the accuracy of the land cover map. The finalised land cover map was prepared after corrections necessitated by the findings of the field verification survey.

The accuracy of the land cover map of 89.8% was assumed to be fairly high based on the findings of the field verification survey. The systematic arrangement of cases of erroneous classification under the Study should contribute to the improved accuracy of future land cover classification work using satellite images.

The flow of the land cover map preparation work is shown in Fig. 2-1.

```
┌─────────────────────────────────────────────┐
│      Satellite Data (LANDSAT) TM 14 scenes    /
└─────────────────────────────────────────────┘
                      ⇩
┌─────────────────────────────────────────────┐
│              Geometric Correction             │
│      (Correction of Geodeic Coordinates)      │
└─────────────────────────────────────────────┘
                      ⇩
┌──────────────────────────────┐      ┌──────────────────────────────┐
│  Preparation of False Colour  │  ⇨   │  Trial Land Cover Analysis and │
│            Image              │      │       Output (one scene)       │
└──────────────────────────────┘      └──────────────────────────────┘
                      ⇩                              ⇩
┌─────────────────────────────────────────────────────────────────────┐
│  Gathering of Supervised Data and Field Verification Survey of Test   │
│                          Analysis Map                                 │
└─────────────────────────────────────────────────────────────────────┘
                                    ⇩
┌─────────────────────────────────────────────────────────────────────┐
│      Full-Scale Analysis of Land Cover Categories Based on            │
│            Information Clarified by Field Survey                       │
└─────────────────────────────────────────────────────────────────────┘
                                    ⇩
┌─────────────────────────────────────────────┐
│      Preparation of Draft Land Cover          │
│      Map (Output Map and Digital Data)        │
└─────────────────────────────────────────────┘
                      ⇩
┌─────────────────────────────────────────────┐
│  Field Verification Survey for Draft Land Cover Map │
└─────────────────────────────────────────────┘
                      ⇩
┌─────────────────────────────────────────────┐
│  Finalised Land Cover Map Following Correction of Draft │
│  Land Cover Map (Output Maps and Digital Data)          │
└─────────────────────────────────────────────┘
```

Fig. 2-1   Flow of Land Cover Map Preparation Work

2.1   Preparation of Land Cover Map

2.1.1   Preliminary Analysis of Satellite Data

Using 14 scenes of satellite data (Landsat TM) covering the Study Area, satellite images (infrared colour images) were prepared for the field verification survey as explained below.

(1) Preparation and Adjustment of Satellite Data

The latest as well as good satellite data covering the Study Area are the 14 scenes of Landsat TM data shown in Table 2-1 and Fig. 2-2.

Table 2-1   Orbit and Date of Observation of Selected Satellite Data

No.	PATH	ROW	DATE
1	224	76	1999/5/9
2	224	77	1999/5/9
3	224	78	1999/7/12
4	224	79	1999/7/12
5	225	75	1999/6/1
6	225	76	1999/6/1
7	225	77	1999/6/1
8	225	78	1999/6/1
9	225	79	1999/6/1
10	226	75	1999/7/10
11	226	76	1999/7/10
12	226	77	1999/5/23
13	226	78	1999/5/23
14	226	79	1999/5/7
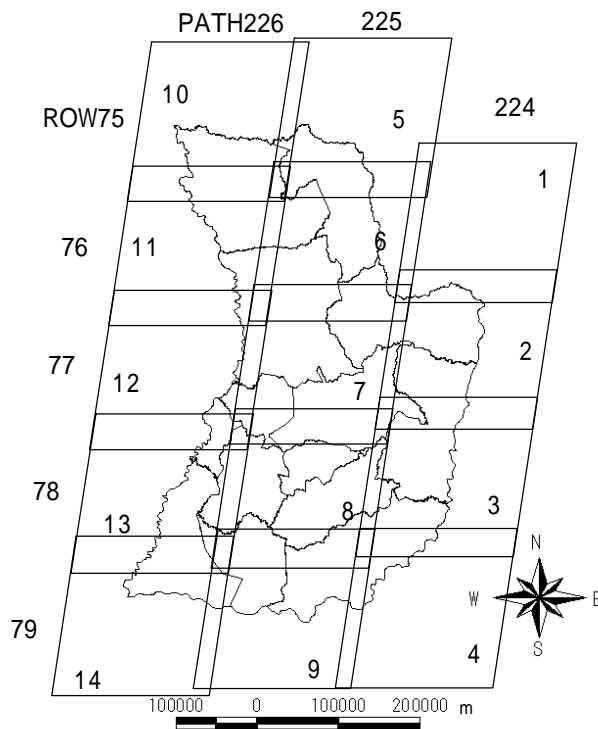
Fig. 2-2   Geographical Coverage of Landsat Scenes

(2) Geographical Correction

Geographical correction was conducted by adjusting the image coordinates to latitude
and longitude to make the image data overlap with the existing topographical map (scale:
1/25,000) of Paraguay.

(3) Preparation of Infrared Colour Images

False colour images (generally called infrared colour images) with a scale of 1/25,000
were prepared. For these images, red, green and blue were assigned to TM Band 4 (near
infrared region), Band 5 (short-wave infrared region) and Band 3 (infrared region)
respectively. The preparation process of the infrared colour images and a product
example are shown in Photograph 2-1 and Photograph 2-2 respectively.
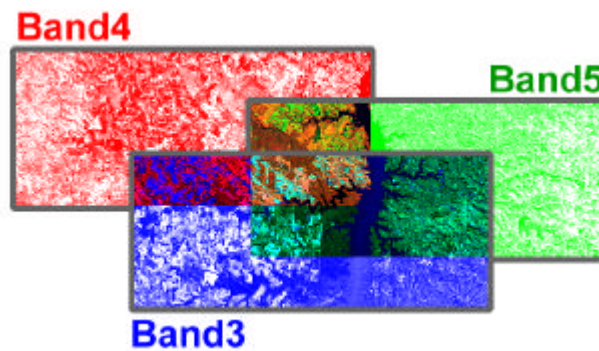
Photograph 2-1   Preparation of Infrared Colour Image
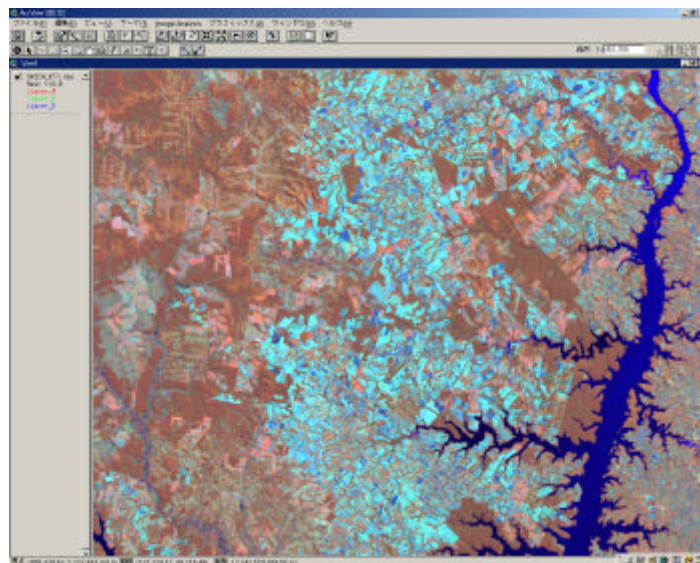
Photograph 2-2   Example of Infrared Colour Image

(4) Test Analysis

After selecting the central area where the forests are relatively better preserved than in other areas and where many land cover categories are found, the crown density and state of land cover, etc. were analysed for test purposes.

2.1.2   Field Verification Survey

(1) Aerial Investigation Using Aircraft

①   Planning of Aerial Investigation Routes

Prior to the verification survey on the ground, an aircraft was used to conduct aerial investigation, the routes of which were planned to make the priority observation of the following sites.

- Sites with poor access, making the implementation of a ground survey difficult
- Sites where the tone on a false colour image differs from other areas
- Sites with different natural conditions and land use in the Eastern Region

②   Aerial Investigation Method

Aerial investigation was conducted to compare the false colour images with the ground vegetation as well as the land use situation and also to use a GPS camera to produce photographs capable of confirming the geographical positions so that the false colour images could be compared with the situation on the ground.

(2) Field Verification Survey

①   Selection of Target Sites for Ground Verification Survey (Training Areas)

Sites requiring a field verification survey were selected for each of the 14 false colour images (scenes), taking the following matters into consideration.

- Sites with relatively large scale of land use, enabling verification of the land cover and land use blocks on the satellite images
- Sites corresponding to the typical land cover categories
- Sites belonging to categories where erroneous classification tends to occur during analysis

② Field Verification Survey Method

The position of each training area selected on the image was verified on site using the GPS system and its latitude and longitude were recorded. In addition, the site conditions, forest type and situation of land use, etc. were recorded in the field notebook and photographs of the site were taken.

③ Implementation of Field Verification Survey

Two teams were formed to conduct the field verification survey over a wide area in a short period of time. These teams were assigned to conduct the said survey in the northern part and the southern part of the Study Area.

The number of training areas for the field verification survey was 212 for the southern part and 237 for the northern part, totalling 449 areas. These are listed in Table 2-2 by district and land cover category.

Table 2-2　　Number of Field Verification Survey Sites

Land Cover Category / District	Forest		Cultivated Land	Grassland	Urban Area/ Settlement	Others	Total
	Natural Forest	Artificial Forest					
Concepción	5	0	2	28	0	0	35
Amambay	19	2	23	36	0	0	80
S. Pedro	8	3	15	35	0	0	61
Canindeyú	11	7	6	12	1	0	37
Dpto. Central	4	0	4	11	3	3	25
Cordillera	1	2	3	6	0	0	12
Caaguazú	5	1	9	11	1	0	27
Alto Paraná	12	7	23	7	0	0	49
Paraguarí	5	1	4	3	0	0	13
Guairá	1	1	3	1	1	0	7
Caazapá	3	3	4	5	0	0	15
Ñeembucú	3	1	0	9	0	0	13
Las Misiones	5	3	8	10	1	0	27
Itapúa	7	5	24	9	2	0	47
Chaco	1	0	0	0	0	0	1
Total	90	36	128	183	9	3	449

2.1.3 Examination of Classification Categories for Land Cover Map

The classification categories for the land cover map shown in Table 2-3 were agreed as suitable through consultations with the counterpart organizations, i.e. the SFN and the DOA, based on the situation of land use established by the field verification survey.

Table 2-3   Classification Categories for Land Cover Map

Primary Category	Secondary Category	Tertiary Category	Description
Forest	Natural Forest	High Forest (Dense to Medium)	Forest with relatively little human impact with a dense to medium density of high trees
		High Forest (Sparse)	Forest with relatively high human impact due to cutting, etc. with a sparse density of tall trees
		Low Forest	Forest dominated by low trees because of natural constraining factors in terms of the soil and topography, etc. or low forest in the process of regeneration after cutting
		Bamboo Forest	Forest dominated by bamboo
		Shrub Land	Land dominated by shrubs due to natural constraining factors in terms of the soil and topography, etc. or shrub land in the process of forest regeneration or abandoned pasture land and others
	Artificial Forest		Artificially created forest
Cultivated Land	Dry Cultivated Land		In addition to general cultivated land, this category includes orchards, ___ and ___ plantations
	Paddy Fields		Paddy rice fields
Grassland	Natural Grassland	Unflooded or Seasonally Flooded	Natural grassland not subject to flooding throughout the year or subject only to seasonal flooding; mainly used as pasture land
		Permanently Flooded	Natural grassland subject to permanent flooding and dominated by bog plants or aquatic plants; unused or hardly used in most cases
	Artificial Grassland		Artificial grassland seeded for intensive stock raising
Urban Area/ Settlement			In addition to urban areas, this category includes suburban residential areas/rural settlements/village areas
Water Body			Water bodies, including rivers and lakes
Others			Bare land and quarries, etc.

A strong request has been made, particularly by the SFN, to classify wildlife reserves, protected forest areas, ecological and special conservation areas and lowland flood areas on the Land Use Plan Map for the Eastern Region for the present purpose. It has been agreed that

these categories will be considered at the stage of preparing the land cover map or during the GIS analysis.

2.1.4　Analysis of Satellite Images and Preparaton of Draft Land Cover Map

Based on the field verification survey results and the satellite image data, a catalogue of supervised data was prepared and the draft land cover map were prepared through primary classification. The flow of this satellite image analysis is shown in Fig. 2-3 while an example of a draft land cover map is shown in Fig. 2-4.

As a primary classification exercise (based on the spectral characteristics), each pixel of the satellite images was classified under a land cover category based on its spectral characteristics.

```
┌──────────────────────────────┐   ┌──────────────────────────────┐
│ Field Verification Survey Results │   │      Satellite Image Data      │
└──────────────────────────────┘   └──────────────────────────────┘
                        │
        ┌──────────────────────────────────────────────┐
        │    Preparation of Catalogue of Supervised Data    │
        └──────────────────────────────────────────────┘
                        │
        ┌──────────────────────────────────────────────┐
        │  Primary Classification                          │
        │  (Classification Based on Spectral Characteristics) │
        │     1) Separation and extraction of water bodies  │
        │     2) Separation and extraction of clouds        │
        │     3) Classification of forest areas             │
        │     4) Separation and extraction of bamboo forests│
        │     5) Interpretation and extraction of artificial forests │
        │     6) Estimation of crown density of forests     │
        │     7) Extraction of shrub land and non-forest items │
        └──────────────────────────────────────────────┘
                        │
        ┌──────────────────────────────────────────────┐
        │       Addition of Geographical Information       │
        └──────────────────────────────────────────────┘
                        │
        ┌──────────────────────────────────────────────┐
        │ Adjoining of Scenes for Classification Data for Land Cover │
        │        Map and Classification of Sheets          │
        └──────────────────────────────────────────────┘
                        │
        ┌──────────────────────────────────────────────┐
        │       Preparation of Draft Land Cover Map        │
        └──────────────────────────────────────────────┘
```

Fig. 2-3　　Flow of Satellite Image Analysis
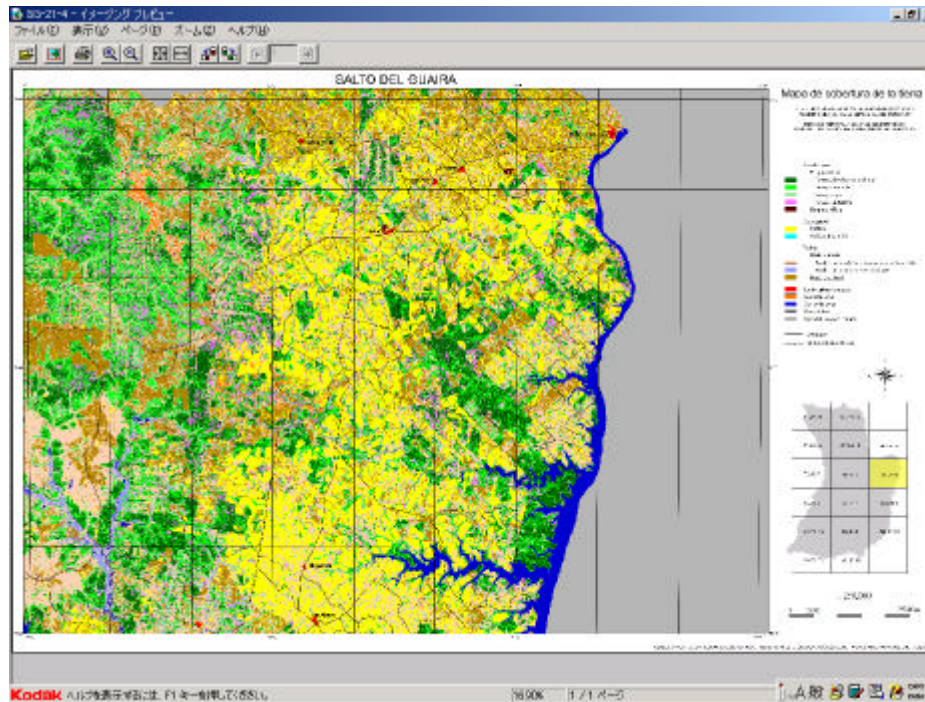
Fig. 2-4　　Draft Land Cover Map

(1) Separation and Extraction of Water Bodies

Pure water bodies were interpreted and separated using the spectral characteristics of near infrared rays.

(2) Separation and Extraction of Clouds

Clouds were separated and extracted using the spectral characteristics.

(3) Classification of Forest Areas

The crown density of forests was analysed to extract forest areas (separation of forest areas from non-forest areas).

(4) Identification of Bamboo Forests

Within forest areas, bamboo forests were separated using the supervised classification method.

(5) Interpretation and Extraction of Artificial Forests

Artificial forests were rare as their characteristics were very clear. Artificial forests in the Study Area were extracted based on the field survey data and image interpretation results.

(6) Estimation of Crown Density of Forests (Identification of High Forests, High Sparse Forests and Low Forests)

Forest areas were classified into high forest (dense to medium), high forest (sparse) and low forest categories by comparing the crown density of each stand established by the field verification survey with the crown density value based on satellite data.

(7) Classification of Shrub Land and Non-Forest Items

In the case of shrub land and non-forest items, supervised data on the images was collected based on the field verification results. To supplement the supervised data, areas on the images which appeared similar to those observed by the field verification survey, covered a large area and showed little presence of other categories were identified as additional training areas. Classification was conducted using the maximum likelihood method based on supervised data established in the manner described above.

In the case of urban areas, application of the maximum likelihood method was not necessarily appropriate because of the mixed presence of various land cover categories. It was, therefore, decided to determine these areas by means of interpretation while referring to the topographical map.

2.1.5 Field Verification Survey for Draft Land Cover Map (Second Field Survey)

Verification work was conducted during the second field survey period as described below using the false (infrared) colour images and draft land cover map.

(1) Identification of Sites with High Possibility of Erroneous Classification

Those sites with a possibility of erroneous classification on the draft land cover map were identified using the false colour images and field survey results and were marked on the false colour images as well as on the draft land cover map.

(2) Implementation of Field Verification Survey

In addition to the field confirmation of those sites with a high possibility of erroneous classification, the contents of the draft land cover map were verified throughout the Study Area, mainly focusing on those areas near a main road because of their good access. In the course of this verification work, the correctness or error of the land cover classification results was checked. In the case of erroneous classification results being

found, the cause(s) of the erroneous classification was examined by means of observing the site conditions.

The field verification survey routes with a total length of some 4,500 km are shown in Fig. 2-5.
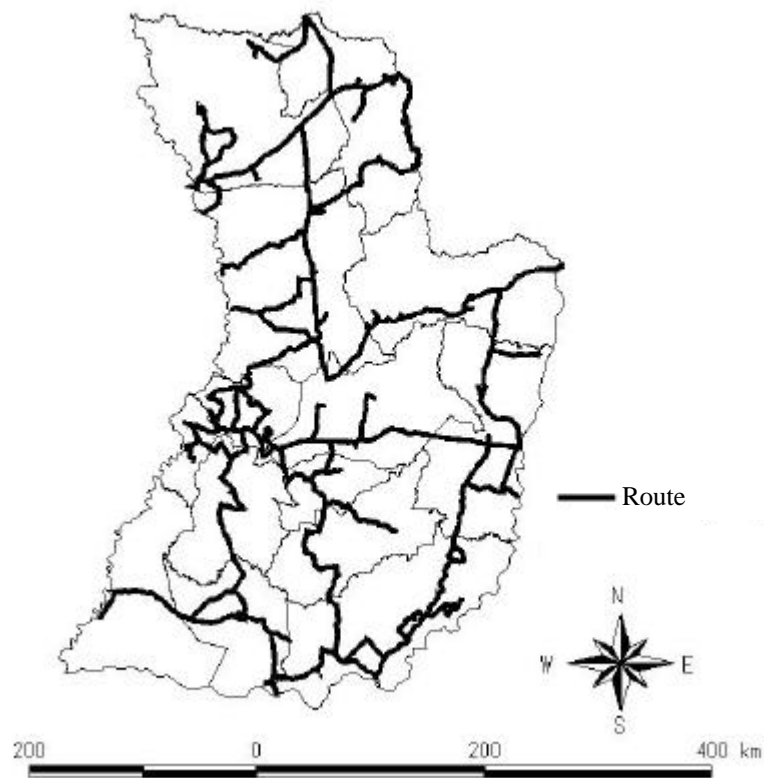
Fig. 2-5   Field Verification Survey Routes

2.1.6   Field Verification Survey Results and Their Incorporation in Analysis Work

The problems of the classification results found by the field verification survey were listed for each scene and their causes were analysed. The results of this work are described below.

(1) Problems Due to Similarity of Spectral Reflectance Characteristics

    1) Causes

The Landsat TM data consists of seven bands (1 to 3: visible region; 4: near infrared region; 5 and 7: intermediate infrared region; 6: far infrared region). For preparation of the draft land cover map, supervised data of spectral reflectance information was prepared for each land cover category based on the field verification survey results and digital analysis of the images was conducted using the maximum likelihood method. Accordingly, there was a change of erroneous classification between land cover categories with similar spectral reflectance characteristics.

The false colour images used for the Study are composite colour images (generally called infrared colour images) where red, green and blue are assigned to TM Band 4, TM Band 5 and TM Band 3 respectively.

Fig. 2-6 is a schematic diagram me indicating the colours shown by the main land cover categories on the false colour images. When the spectral reflectance characteristics are similar, the colour tones on the false colour images are also similar. There appears to be a possibility of erroneous classification between those categories which are overlapping or adjacent to each other on this diagramme. In fact, the field verification survey confirmed that erroneous classification had occurred between such categories.

    2) Correction Measures

If erroneous classification results occur due to similar spectral reflectance characteristics, it is useful to improve the classification accuracy by means of the interpretation technique in addition to the classification of digital images using the maximum likelihood method. When pixels are erroneously classified, their correct classification categories are judged based on the topographical conditions, situation of land cover and distribution of various categories in adjacent areas and minute differences in tone. Each pixel is then classified in the correct category by specifying the area by means of masking. This technique ensures the correct classification of each pixel even if some categories are similar in terms of the spectral reflectance characteristics.
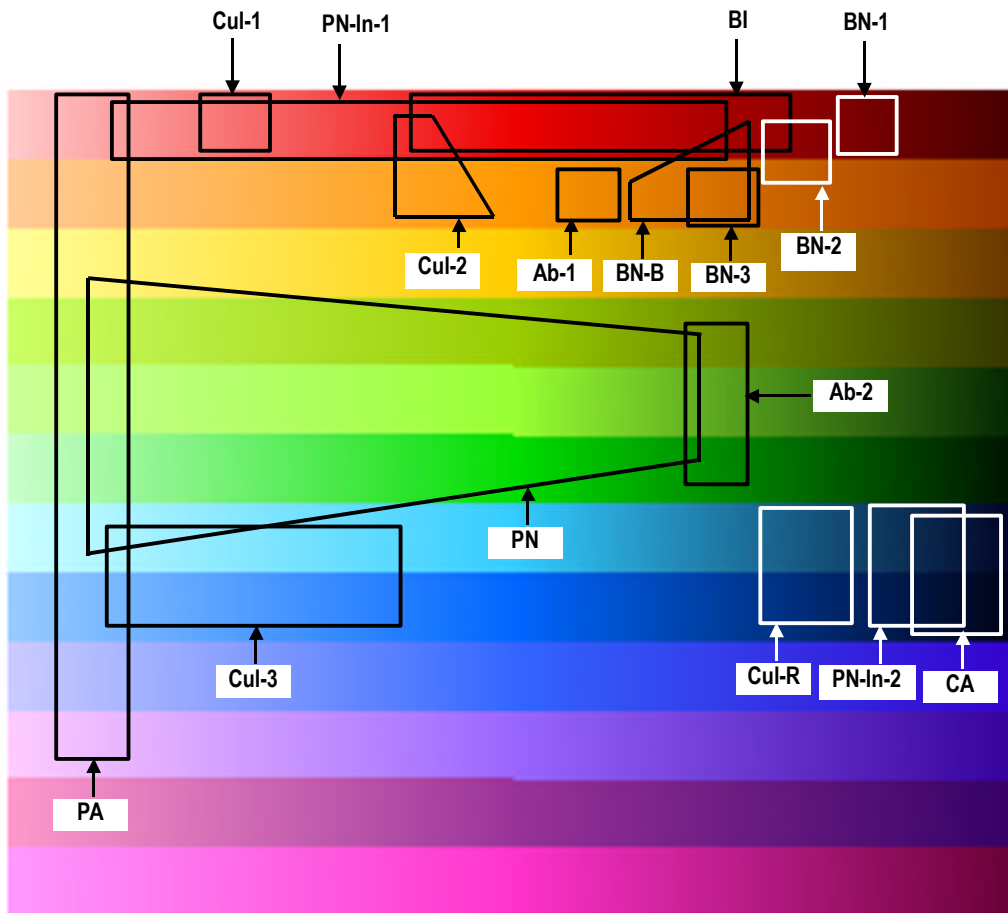
Symbol	Classification Category	Symbol	Classification Category
BN-1	High forest (dense to medium)	Cul-R	Paddy field
BN-2	High forest (sparse)	PN	Non-flooded or seasonally flooded natural grassland
BN-3	Low forest	PN-In-1	Permanently flooded grassland (vegetation above water surface)
BN-B	Bamboo forest		
BI	Artificial forest	PN-In-2	Permanently flooded grassland (vegetation below water surface)
Cul-1	Dry farmland (sugar cane)		
Cul-2	Dry farmland (cultivated wheat and maize)	PA	Artificial grassland
Cul-3	Dry farmland (crops with high soil exposure and cropless during off-season	Ab-1	Shrub land (regenerated at cut-over sites)
		Ab-2	Shrub land (due to natural constraining factors
		CA	Water body

Fig. 2-6   Schematic Diagramme of Colour Tones by Land Cover Category on
Infrared Colour Images

For example, cultivated land with wheat may be erroneously classified as low forest because of their similar spectral reflectance characteristics. In the case of a wheat cultivation area with scattered low forests, accurate identification of the erroneously classified sites on the land cover map is difficult. In such a case, the necessary corrections are planned in the following manner.

Firstly, areas classified as forest on the draft land cover map are extracted to prepare satellite images indicating only these areas. As forests and wheat cultivation sites

can easily be separately classified based on visual interpretation of the texture patterns and tones, the subject sites are judged to be either forest or cultivated land to correct the land cover map.

(2) Problems Caused by Small-Scale Mixture of Land Cover Categories

    1) Causes

In areas where small farming households are concentrated, cultivated land, grassland and housing sites form small clusters. Many crops are cultivated, including cassava, maize, sugar cane, sweet potatoes, pineapples, cotton and bananas. In addition, the amount of vegetation and the soil exposure rate greatly vary from one place to another with a mixed presence.

The pixel size of the Landsat TM data is 30 m× 30 m on the ground. In the above-mentioned areas of small-scale farming households, cultivated land, grassland and housing sites smaller than this pixel size are often mixed together. A pixel with the mixed presence of land cover categories with different spectral reflectance characteristics is called a mixel. As such a mixel produces mixed spectral reflectance information of more than one category, supervised data based on the spectral reflectance characteristics of individual land cover categories is not necessarily appropriate. This is the likely cause of erroneous classification results.

    2) Correction Measures

Areas such as those dominated by small-scale farming households which show different spectral reflectance characteristics to other areas due to the presence of many mixels are subject to reclassification using the masking technique. This reclassification work is conducted for each area because of the different characteristics based on the type of crop cultivated and the size of the cultivated land.

(3) Problems Caused by Submerged Vegetation Due to Flooding

    1) Causes

There were some areas which were interpreted as grassland on the satellite images taken in May but which were classified as water bodies on the satellite images taken in June because of the submersion of grassland. Because the satellite data in June showed the spectral reflectance characteristics of water, the areas were classified as water bodies.

These areas are considered to constitute non-flooded and seasonally, shallow flooded areas where bog or aquatic plants are believed to grow. Based on the basic ideas for the land cover map, the classification of these areas as permanently flooded natural grassland is more appropriate.

2) Correction Measures

When grassland is submerged, the corresponding satellite data shows the spectral reflectance characteristics of a water surface, indicating the values of TM Band 4 (red; near infrared region) and TM Band 5 (green; short-wave infrared region) of zero or near zero. In contrast, the value of TM Band 3 (blue; infrared region) shows only a slight difference between a proper lake and flooded grassland. Use of the value of TM Band 3 is, therefore, appropriate for the classification of seasonally flooded grassland.

(4) Classification of Artificial Forests

In the case of artificial forests, it was judged that analysis of the digital images by the maximum likelihood method using supervised data would not achieve highly accurate results because of the similar spectral reflectance characteristics to those of other categories, such as natural forests. As a result, visual interpretation was used for classification purposes. On the false colour images, it was possible to classify mature as well as large-scale eucalyptus plantations due to their appearance in bright red. However, the classification of afforestation sites of pine and Paraiso gigante, small afforestation sites and young afforestation sites was found to be impossible. Accordingly, those afforestation sites which were interpreted on the false colour images and those of which the existence was confirmed by the field verification survey using the draft land cover map were classified on the final land cover map.

For the more detailed indication of afforestation sites on the land cover map, it will be necessary for the SFN to obtain information on such sites for its addition to the maps using the GIS function.

(5) Observation Timing of Satellite Images Suitable for Preparation of Land Cover Map and Site Conditions

The observation timing of the satellite images used and the site conditions was checked to establish the suitable observation timing for the preparation of land cover map.

1) Conditions of Cultivated Land (Dry Farmland)

The likely problems associated with the categories used for the land cover map are (i) similarity of the spectral reflectance characteristics and (ii) different spectral reflectance characteristics of the same object depending on the timing of satellite observation. In the case of cultivated land in particular, the state of growth and the type of crop cultivated differ depending on the season. It is, therefore, necessary to prepare a farming calendar as a future reference material.

For this reason, a farming calendar for cultivated land was prepared based on the field survey results for May through July and existing reference materials and interview results for other months. Fig. 2-7 shows the seeding and harvesting periods based on this farming calendar while Table 2-4 shows the site conditions and the characteristics of the corresponding images.

Fig. 2-7 suggests that May through July are suitable months for observation to classify the crops on cultivated land. As wheat is only seeded while maize is ready for harvesting in this period, which shows the highest variety in terms of crop growth, their classification appears easier. Prior to this period, interpretation is difficult as many crops still appear green in colour. Interpretation is also difficult after this period because cultivated land shows the state of almost bare land due to the immediate aftermath of seeding.

The rotated cultivation of wheat and soybeans is conducted on much large-scale cultivated land in Paraguay. If this rotation is used for interpretation purposes, separation from cultivated land on which other crops are grown or other land cover categories is possible.

	1	2	3	4	5	6	7	8	9	10	11	12
trigo (Wheat)					seeding	seeding			harvest ↔	harvest		
soja (Soybeans)			seeding ↔								seeding	seeding
maíz (Maize)	seeding	seeding	harvest ↔	harvest			seeding	seeding	seeding	seeding	seeding	seeding
algodón (Cotton)			harvest ↔	harvest						seeding	seeding	seeding
caña (Sugar Cane)			seeding	seeding	harvest ↔	harvest	seeding	seeding		harvest ↔	harvest	harvest

----- Epoca de Sienbra (Seeding Period)   ↔ Epoca de Cosecha (Harvesting Period)

Fig. 2-7   Farming Calendar for Cultivated Land

Table 2-4   Field Survey Findings

Crop	Situation (May through July)	Characteristics of Image
Wheat (trigo)	In May and June, much wheat grows to a height of some 200 cm after initial seeding. By June, much wheat has reached a height of 70 – 80 cm. As dead soybean stalks were observed in some areas of cultivated land, it was confirmed that wheat is cultivated after the harvesting of soybeans.	The sites appeared light blue or blue on the May and June images and orange on the July images.
Soybeans (soja)	No field confirmation was made as the harvest season had already ended. Wheat was seeded after soybeans in almost the same places. At fallow land, the growth of accidentally dropped seeds was observed together with the planting of radishes (nabo).	As above as wheat was growing at the time of observation.
Maize (maíz)	As the seeding season differs from one area to another, stalks grow in the range of 80 – 180 cm.	The sites appeared pink or light orange on the images.
Cotton (godón)	Cotton had already been harvested and nearly dried with a height of some 80 cm. Many trucks carrying cotton were observed heading towards cotton mills or gathering sites.	The sites could not be confirmed because of their small size. They exist in areas of small-scale farming households.
Sugar Cane (caña)	Sugar cane is a perennial plant, lasting for some five years. The observed height was 80 – 250 cm in this pre-harvesting or harvesting season depending on the site. At pre-harvesting sites, places with a high soil exposure rate were observed in patches.	Careful attention is required as sugar cane appears light orange to dark red depending on the stage of growth.

– 25 –

2) Conditions of Grassland

The site conditions and image characteristics of grassland are described in Table 2-5. In order to distinguish artificial grassland from natural grassland (non-flooded), May through July are believed to be suitable months. As much artificial grassland tends to be created at hill top areas with only few areas of grassland observed at flat land with moist soil, interpretation is easier with the additional use of topographical information.

As described in Table 2-5, natural grassland (permanently flooded) may be erroneously classified as a water body in some seasons. Classification using either satellite images of different times or images taken in a season with little rainfall is, therefore, proposed.

Fig. 2-8 shows the level of rainfall by month to examine the suitable observation timing. The rainfall of less than 100 mm is relatively low from June to August and it is advisable that images taken during this period be selected. The satellite images for 1999, however, indicate that some sites are natural grassland in May but water bodies in June. This is due to the fact that the actual amount of monthly rainfall differs from one year to another, further illustrating the importance of using satellite images for two different times.

Table 2-5   Field Survey Findings (Grassland)

Category	Situation (May through July)	Characteristics of Image
Artificial Grassland	No died grass patches were observed. The main grass species observed were Estrellita, Pacto colonial, Brizanda and Braquiaria. The last two were seeded in a mixed manner at the observed site and appeared to be the most popular. Artificial grassland is often created at hill tops.	The tone showed a wide range from bright pink to light blue. Artificial grassland can be separated from natural grassland based on topographical information (artificial grassland is often found at higher ground than the surrounding area).
Natural Grassland (Non-Flooded)	Many sites were found to be dead, showing brown in general, Many were black due to burning. The grass height varies, creating shadows.	The tone was diverse, from yellow to light blue. Natural grassland can be separated from artificial grassland based on topographical information (natural grassland is often found at lowland).
Natural Grassland (Permanently Flooded)	Even though these sites are permanently flooded, they should be described as wetland rather than flooded areas. In some places, the feet of cattle were below the water line. Rich natural grassland was observed in places which appeared as water bodies on the images.	Some of the sites classified as water bodies because of being dark blue on the image taken in June were a bluish green on the May image, indicating natural grassland. Careful attention must be paid to the significant variations of the tone depending on the season or year.
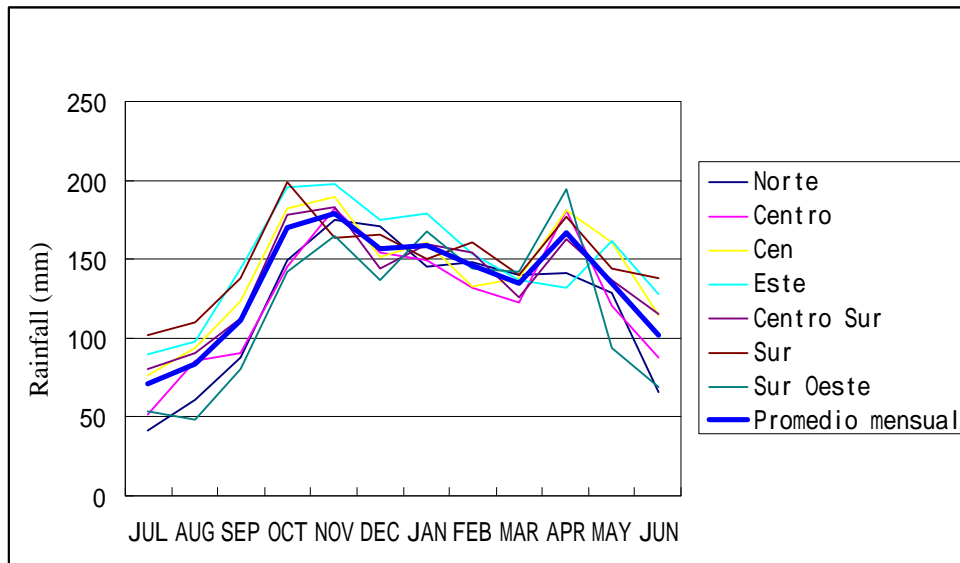
Source: Ministry of Agriculture and Livestock (MAG), Agropastoral Production, 1998/99

Fig. 2-8   Monthly Rainfall (Mean Values for 1971 – 1998)

3) Conditions of Forests

Seasonal changes of the conditions of forests were not observed by the field survey. As no differences were observed on the satellite images, consideration of the specific timing for observation is unnecessary.

2.1.7   Finalisation of Land Cover Map

Using the correction measures described in 2.1.6, the land cover map was finalised. The measures mainly adopted are explained below. The accuracy of the land cover map was examined using the accuracy judgement table.

① If erroneous classification due to the similarity of the spectral reflectance characteristics was found, the classification accuracy was improved by the interpretation technique in addition to the classification of the digital images by means of the maximum likelihood method. To be more precise, if there was any possibility of erroneous classification, the correct classification category was judged based on the topographical conditions, the conditions and distribution of the land cover in the adjacent area and minute differences in tone. The site in question was then classified in the correct category by specifying the area using the masking technique.

② In the case of areas of small-scale farming households which showed different spectral reflectance characteristics due to the presence of many mixels, the masking technique

was used to separate these areas for reclassification. This work was conducted for each site (area) as the local characteristics differed depending on the type of crop(s) cultivated and the size of the cultivated land.

③ There were some sites which were interpreted as flooded grassland according to the May images but as water bodies on the June image because of the submersion of the grassland. As the value of the TM Band 3 (yellow; infrared region) fluctuates, showing a minor difference between a proper water body (lake, etc.) and flooded grassland, the value of this Band 3 was used to identify flooded grassland.
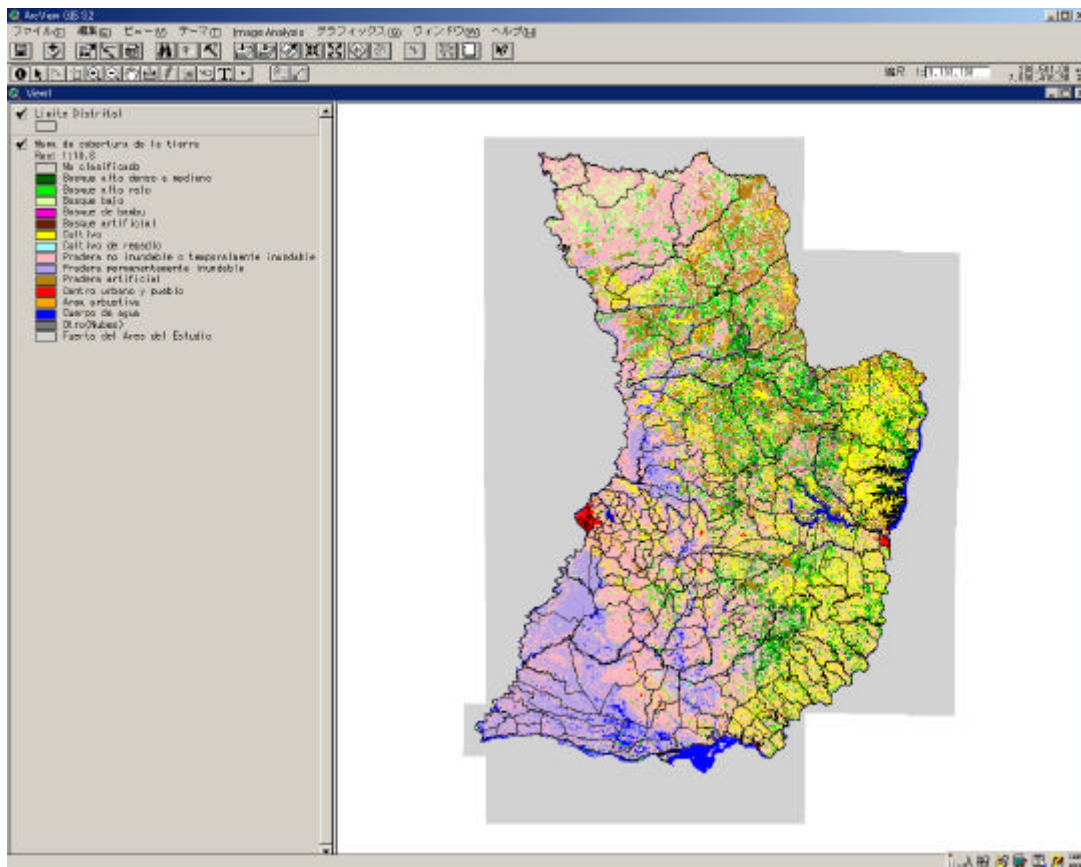
Fig. 2-9   Land Cover Map

Table 2-6 which is an accuracy judgement table was prepared to facilitate understanding of the trend of erroneous classification on land cover map and also to evaluate the classification accuracy. Here, sample points were selected by the systematic extraction method using the latitude and longitude lines (10' for both) and the classified categories on the land cover mapwere compared with the interpreted categories based on the field survey findings. As a result, the general accuracy was evaluated to be 89.8% (465 points/518 points× 100).

Table 2-6   Accuracy Judgement Table

Classification Class		Reference Class												Total
		Forest						Cultivated Land		Grassland			W.B.	
Primary Category	Secondary (Tertiary) Category	1	2	3	4	5	6	7	8	9	10	11	12	Total
Forest	1. Natural Forest (High Forest: Dense to Medium)	24												24
	2. Natural Forest (High Forest: Sparse)		31											31
	3. Low Forest			50										50
	4. Bamboo Forest			1	4									5
	5. Shrub Land					2					3			5
	6. Artificial Forest						1							1
Cultivated Land	7. Cultivated Land (Dry Farmland)							69		4		3		76
	8. Cultivated Land (Paddy Field)								1					1
Grassland	9. Natural Grassland (Non-Flooded)							6		131	3	10		150
	10. Natural Grassland (Permanently Flooded)									5	64			69
	11. Artificial Grassland							3		14		57		74
Water Body	12. Water Body												31	31
	Total	24	31	51	4	2	1	78	1	155	70	70	31	518
	Average Accuracy (%)	100.0	100.0	98.0	100.0	100.0	100.0	88.5	100.0	84.5	91.4	81.4	100.0	
	Accuracy of Primary Category (%)						99.1		88.6			85.4	100.0	
	General Accuracy (%)							89.8						

Note 1: "Classification Class" means the result of the classification work for the land cover map while "Reference Class" means the interpreted category based on the field survey findings.

2.2　Forest Area: Comparison with Existing Study Results

The total forest area of the land cover map prepared using satellite images taken in 1999 is 3,974,271 ha. In contrast, the study (Land Use and Deforestation in the Eastern Region of Paraguay: 1984 – 1991) conducted by the Department of Forest Engineering, Faculty of Agricultural Science, National University of Asuncion using satellite items taken in 1991 put the total forest area of the Eastern Region at 3,341,958 ha. Their comparison shows that the forest area of the land cover map prepared under the Study is larger than the previous figure by 632,313 ha (approximately 4% of the total land area of the Eastern Region). This difference can be attributed to the different techniques used rather than indicating an increase of the forest area.

The land cover map for the Study was prepared by means of the analysis of digital images. Consequently, all forest land covering an area of 30 m by 30 m (0.09 ha), which is the ground coverage of one pixel of Landsat TM data, is classified as forest.

In contrast, according to the report published by the National University of Asuncion, the land use and deforestation map was prepared by visual interpretation instead of digital analysis. It is said that forests of a minimum size of 5 mm by 5 mm on satellite images (scale: 1/25,000) were extracted. This size is equivalent to a ground surface area of 1.25 km by 1.25 km or 156 ha. Consequently, small forest land is not classified as forest and is excluded from the total forest area.

Table 2-7 compares the results of the forest area studies using satellite images taken in 1991 and 1999 respectively. The difference lies with the minimum unit for the forest area which is 156 ha for the study of 1991 images and 0.09 ha for the study of 1999 images. There is a difference between the visual interpretation technique and the digital image analysis technique. As the land cover map can be incorporated into the GIS, the reclassification of forests is possible by designating small forests. When forests with a minimum area of 156 ha, which is the basic unit used for the study of 1991 images, are extracted from the analysis results of 1999 images using the GIS, the forest area for 1999 is reduced to 2,619,142 ha, indicating a decrease of 722,816 ha from the 3,341,958 ha in 1991. Fig. 2-10 shows the findings of the present Study on the distribution of forests which are classified into two sizes: forests of 156 ha or larger and smaller forests. For the purpose of comparison, Fig. 2-11 shows the distribution of forests of 156 ha or larger analysed by the GIS.

One principal objective of preparing the land cover map under the Study was its use as a layer of the GIS for (i) the selection of target afforestation areas and (ii) the preparation of a

afforestation project. As even small forests would not be considered for afforestation because of the present land use as forest, these areas were classified in the category of forest.

Table 2-7   Comparison Between Two Forest Area Studies

	Study of 1991 Satellite Images	Study of 1999 Satellite Images
Study Title	Land Use and Deforestation in the Eastern Region of Paraguay: 1984 – 1991 (Spanish)	Study for Afforestation Plan for Eastern Region of Paraguay (Spanish and English)
Year of Satellite Images Taken	1991	1999
Land Cover Map Preparation Method	Visual interpretation and analysis	Analysis of digital images
Minimum Unit for Forest Area	156 ha	0.09 ha (30 m× 30 m)
Total Forest Area	3,341,958 ha	3,974,271 ha
Area of Forests of 156 ha or Larger	3,341,958 ha	2,619,642 ha
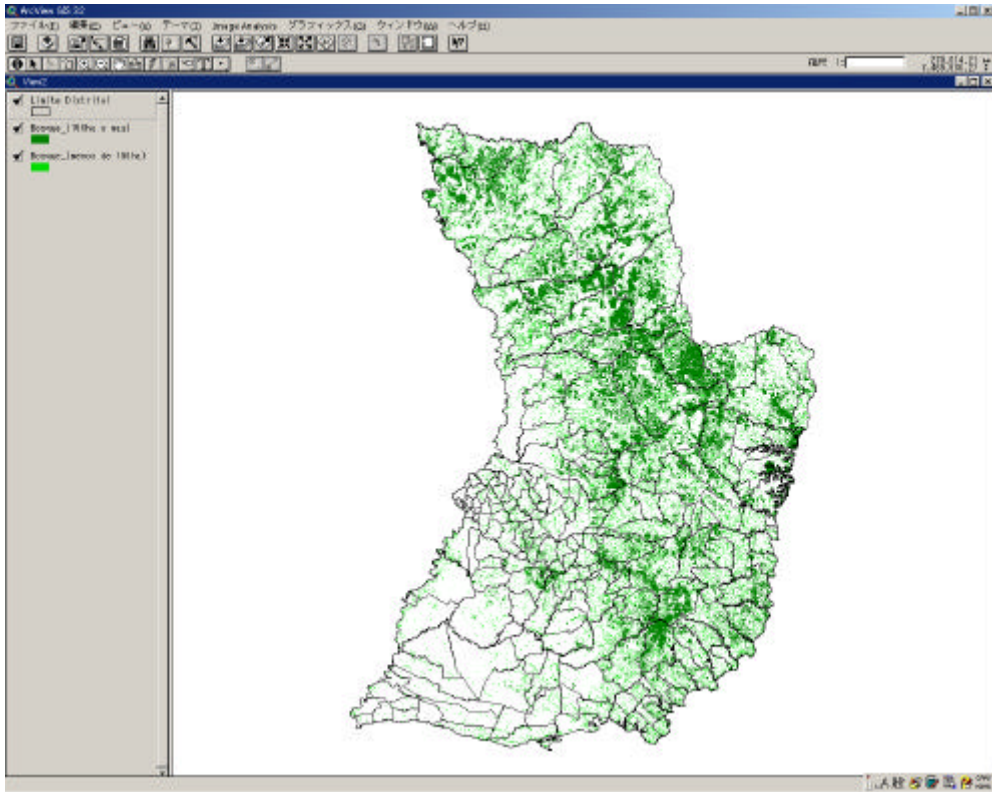
Fig. 2-10   Forest Distribution (green: 156 ha or larger; yellowish green: less than 156 ha)
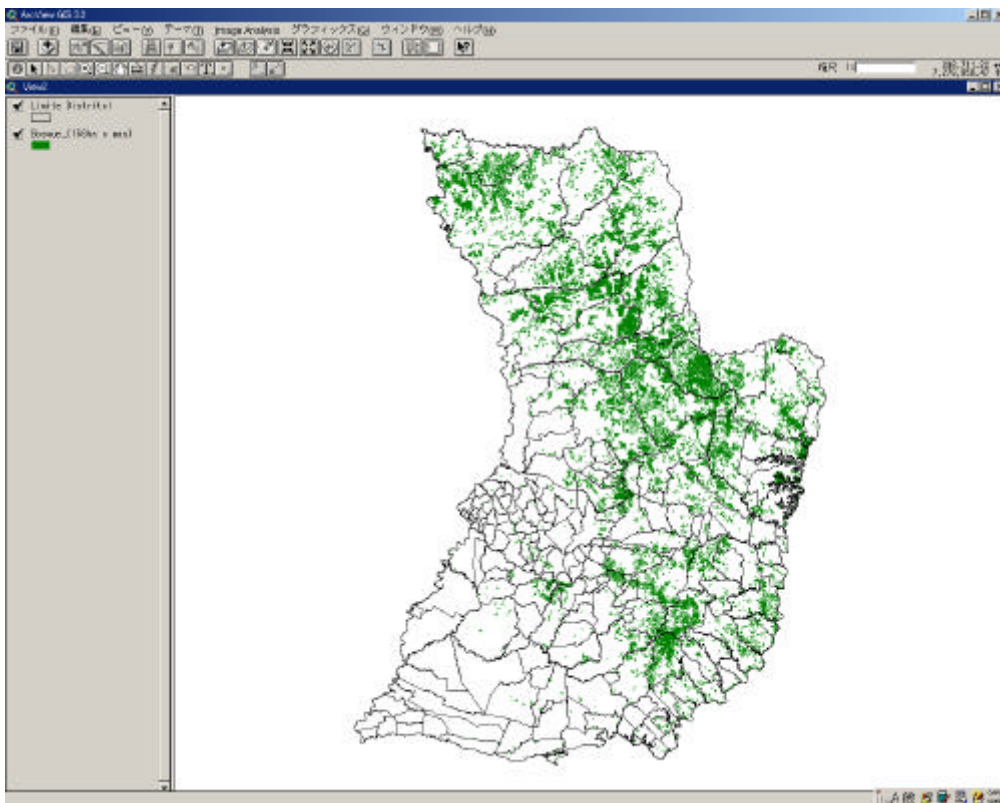
Fig. 2-11   Forest Distribution (156 ha or larger)

CHAPTER 3   SELECTION OF RECOMMENDED AFFORESTATION AREAS

CHAPTER 3

SELECTION OF RECOMMENDED AFFORESTATION AREAS

Areas with the potential for the development of production forests in the Eastern Region were selected in accordance with the processes described below in order to establish the recommended afforestation areas.

3.1　Selection of Recommended Cities for Afforestation

The candidates for the recommended cities for afforestation were selected in the following manner (see Table 3-1).

① Cities where the total area of farm land (including cultivated land, fallow land, pasture land and forest land, etc. of which the size is less than 20 ha) is less than 50% of the total area of farm land in the 1991 Agricultural and Livestock Census were initially selected.

② Removal of cities with a high percentage of urbanised areas: based on discussions at the Steering Committee, the following five cities were removed from the list of recommended cities for afforestation because of their advanced stage of urbanisation.

　　Fernando de la Mora; Limpio; Luque; San Lorenzo; Asuncion

③ Each of the following evaluation factors were classified in five categories and were given a score ranging from 4 to 0 depending on the selection priority for the recommended cities for afforestation.

a) Land Use Capacity

The productive capacity of forest land, which was a factor for the selection of the recommended cities for afforestation, was examined using the land use categories adopted by the existing Land Use capacity Map for the Eastern Region (Mapa de Capacidad de Uso de la Tierra de la Region Oriental). Cities with a higher land use capacity on this map were given higher priority. The score for each city was finalised by calculating the weighted average of the scores for each land use capacity category for the city.

b)   Distance from a Forestry Office

Cities nearer to a forestry office were given higher priority. The forestry offices considered were the SFN, eight district forestry offices (at Amambay, Canindeyu, San Pedro, Concepcion, Caaguazu, Alto Parana, Itapua and Caazapa), two district forestry sub-offices (at Capitan Bado and Caaguazu) and three forestry centres (at Alto Parana, Itapua and Capiibary).

In order to determine the score for each city, a circular line was drawn around each forestry office using 30 km from the forestry office as the unit. The score for each city was finalised by calculating the weighted average of the scores based on the size of the area belonging to each city in each ring.

c)   Forest Area Ratio

Using the draft land cover map prepared under the Study, the ratio of the forest area in the area of the city was calculated for each city and higher priority was given to cities with a smaller forest area ratio. The forests for this purpose were natural forests (high forests, low forests and bamboo forests) and artificial forests, excluding shrub land.

d)   Road Density

Higher priority was given to those cities with a higher density of motorways, paved roads, unpaved roads and passable roads in the dry season as identified in the Digital Cartography of Paraguay (Cartografia Digital del Paraguay).

e)   Area Ratios of National Parks and Reserves

Higher priority was given to those cities with a smaller ratio of national park and reserve areas. National parks and reserves were extracted from the Land Regulation Map for the Eastern Region 1995 (Mapa de Ordenamiento Territorial de la Region Oriental) and the Woodland Reserves – Eastern Region – (Cobertura Boscosa – Region Oriental) (1997, DOA-BGR).

f)   Number of Sawmills

Higher priority was given to those cities with a larger number of sawmills.

Table 3-1   Selection Criteria for Recommended Cities for Afforestation

I	Selection of cities where the total area of farm land (including cultivated land, fallow land, pasture land and forest land, etc. of which the size is less than 20 ha) is less than 50% of the total area of farm land in the 1991 Agricultural and Livestock Census				
II	Removal of cities with a high percentage of urbanised areas				
III	Factor	Category	Score	Weighting Index	Remarks
	1. Land Use Capacity	I – II	4	2	The weighted average of the scores for each land use capacity category for the city is used as the score for the city in question. The land use categories adopted by the Land Use Map for the Eastern Region are used here.
		III	3		
		IV – V	2		
		VI	1		
		VII – VIII	0		
	2. Distance from a Forestry Office (km)	0 – 30	4	3	The weighted average of the score for the land size of the city within each area of a 30 km radius of a forestry office is the score for the city in question.
		30 - 60	3		
		60 - 90	2		
		90 – 120	1		
		120	0		
	3. Forest Area Ratio (High, Low, Bamboo and Artificial Forests) (%)	0 – 5	4	1	The forest area ratio is calculated for each city using the Draft Land Cover Map prepared under the Study.
		5 – 10	3		
		10 – 20	2		
		20 – 30	1		
		30 -	0		
	4. Road Density (Motorways, Paved Roads, Unpaved Roads and Passable Roads in Dry Season) (m/ha)	4 -	4	1	The road density is calculated for each city.
		3 – 4	3		
		2 – 3	2		
		1 – 2	1		
		0 – 1	0		
	5. Ratio of National Park and Reserve Areas (%)	0 – 5	4	1	The ratio of natural park and reserve areas is calculated for each city.
		5 – 10	3		
		10 – 25	2		
		25 – 50	1		
		50 -	0		
	6. Number of Sawmills	10 -	4	1	The number of sawmills is determined for each city.
		5 – 9	3		
		2 – 4	2		
		1	1		
		0	0		

④ The priority ranking of each factor was decided to give different weighting to each factor. Out of the six factors, "the distance from a forestry office" was given a weighting index of 3 while "the land use capacity" was given a weighting index of 2. All other factors were given a weighting index of 1.

⑤ The final score was calculated for each city by totalling the score of each factor which was achieved by multiplying the original score by the relevant weighting index.

⑥ As the total score representing the middle category for each factor was 18, those cities scoring 18 or higher were selected as the recommended cities for afforestation.

As it was found to be impossible to classify extensive pasture land and abandoned cultivated land on the Draft Land Cover Map, these were not used as factors for the selection of the recommended cities for afforestation.

The list of the recommended cities for afforestation, selected in accordance with the above processes, is given in Table 3-2. A total of 106 cities were selected.

3.2 Selection of Recommended Afforestation Areas

The selection criteria for the candidate recommended afforestation areas are described below. The recommended afforestation areas are those areas of the recommended cities for afforestation from which the following areas have been removed.

① High forests, low forests and bamboo forests among natural forests: high forests, low forests and bamboo forests among natural forests marked on the Draft Land Cover Map have been removed.

② National parks and reserves: national park and reserve areas have been removed using the Land Regulation Map for the Eastern Region 1995 and the Woodland Reserves – Eastern Region.

③ Areas with a low land use capacity: areas in land use capacity categories VII and VIII have been removed.

④ Areas with a low road density: areas with the minimum distance from a motorway, paved road, unpaved road or passable road in the dry season have been removed using the Digital Cartography of Paraguay.

⑤ Areas with poor soil: areas classified in the following soil categories on the Soil Survey Map of the Eastern Region (1995): Lithic Hapludol, Lithic Eutrodox, Lithic Kandiudox, Lithic Udipsamment and Lithic Udorthent, have been removed.

⑥ Steep slopes: areas (of at least 100 ha each) with an inclination of 20° or higher have been removed based on the inclination established for each 50 m× 50 m mesh because of the perceived difficulty of conducting highly efficient mechanised work.

⑦ Flooded areas: flooded areas have been removed using the Digital Cartography of Paraguay and the Land Cover Map prepared under the Study.

⑧ Urban areas and settlement areas: urban areas and settlement areas marked on the Draft Land Cover Map prepared under the Study have been removed.

In the case of those areas where the process of transition from natural forest to farm land or pasture land is taking place, they do not conform to any of the selection criteria for the recommended afforestation areas because of the impossibility of clearly determining the situation of land use and/or land ownership.

Based on the above selection criteria, a total area of 4,054,000 ha was selected as the recommended afforestation areas in the recommended cities for afforestation (Table 3-2 and frontspiece).

Table 3-2   Areas of Recommended Cities for Afforestation and Recommended Afforestation Areas

(Unit: ha)

Code	District	Recommended City for Afforestation	Recommended Area for Afforestation								
			Total	Artificial Forest	Dry Farmland	Paddy Field	Non-Flooded/ Seasonally Flooded Grassland	Artificial Grassland	Shrub Land	Water Body	Others (Clouds and Cloud Shadows, etc.)
0103	CONCEPCIÓN	HORQUETA	117,928	0	27,870	0	52,745	36,882	149	282	0
0104	CONCEPCIÓN	LORETO	39,915	0	10,587	0	25,759	3,428	8	133	0
0201	SAN PEDRO	SAN PEDRO DE YCUAMANDYYU	119,795	0	13,593	0	68,118	36,615	792	677	0
0203	SAN PEDRO	CHORE	55,659	0	23,540	0	15,895	15,721	377	126	0
0204	SAN PEDRO	GRAL.ELIZARDO AQUINO	44,838	0	15,711	0	20,234	8,522	111	260	0
0206	SAN PEDRO	LIMA	23,937	0	2,221	0	15,076	6,118	45	477	0
0207	SAN PEDRO	NUEVA GERMANIA	77,519	0	15,496	0	31,118	28,570	1,565	770	0
0208	SAN PEDRO	SAN ESTANISLAO	138,680	656	34,085	0	49,225	52,069	1,854	791	0
0210	SAN PEDRO	TACUATÍ	59,576	0	7,267	0	20,787	30,298	1,081	143	0
0214	SAN PEDRO	ISIDORO RESQUÍN	28,625	0	4,042	0	10,763	13,475	35	310	0
0215	SAN PEDRO	YATAITY DEL NORTE	17,425	0	8,149	0	6,991	2,126	79	80	0
0302	CORDILLERA	ALTOS	5,689	0	821	0	4,851	10	6	1	0
0304	CORDILLERA	ATYRÁ	8,269	0	1,790	0	6,470	6	0	3	0
0306	CORDILLERA	EMBOSCADA	1,152	0	102	0	938	1	2	109	0
0307	CORDILLERA	EUSEBIO AYALA	16,825	0	2,360	0	14,041	412	0	12	0
0308	CORDILLERA	ISLA PUCÚ	7,278	0	2,011	0	4,541	725	0	1	0
0309	CORDILLERA	ITACURUBI DE LA CORDILLERA	6,128	16	635	0	4,627	843	0	7	0
0312	CORDILLERA	MBOCAYATY DEL YHAGUY	14,870	0	2,781	0	11,349	358	0	382	0
0313	CORDILLERA	NUEVA COLOMBIA	2,743	0	293	0	2,445	4	0	1	0
0317	CORDILLERA	SANTA ELENA	9,189	0	1,610	0	7,255	304	0	20	0
0318	CORDILLERA	TOBATÍ	13,435	33	2,356	0	11,039	3	0	4	0
0319	CORDILLERA	VALENZUELA	13,279	0	1,990	0	10,207	1,065	0	17	0
0401	GUAIRÁ	VILLARRICA	20,260	0	3,017	0	17,202	0	0	41	0

Code	District	Recommended City for Afforestation	Recommended Area for Afforestation								
			Total	Artificial Forest	Dry Farmland	Paddy Field	Non-Flooded/ Seasonally Flooded Grassland	Artificial Grassland	Shrub Land	Water Body	Others (Clouds and Cloud Shadows, etc.)
0404	GUAIRÁ	CORONEL MARTÍNEZ	8,538	141	1,813	0	6,382	57	0	145	0
0405	GUAIRÁ	FÉLIX PÉREZ CARDOZO	7,805	0	1,174	0	6,573	0	0	58	0
0407	GUAIRÁ	COL. INDEPENDENCIA	35,145	0	14,134	0	20,026	915	0	70	0
0408	GUAIRÁ	ITAPÉ	11,001	0	2,266	0	8,555	41	0	139	0
0411	GUAIRÁ	MBOCAYATY	14,502	0	1,953	0	12,203	243	0	103	0
0414	GUAIRÁ	SAN SALVADOR	10,008	0	744	0	9,236	0	0	28	0
0415	GUAIRÁ	YATAITY	4,214	0	470	0	3,588	0	0	156	0
0501	CAAGUAZÚ	CORONEL OVIEDO	46,537	59	10,388	0	35,204	743	0	143	0
0504	CAAGUAZÚ	DR. CECILIO BÁEZ	8,155	0	1,443	0	5,474	1,237	0	1	0
0505	CAAGUAZÚ	SANTA ROSA DEL MBUTUY	16,933	25	6,239	0	7,180	3,382	78	29	0
0506	CAAGUAZÚ	DR. JUAN MANUEL FRUTOS	47,497	0	13,238	0	26,125	4,203	1,167	214	2,550
0507	CAAGUAZÚ	REPATRIACIÓN	46,448	0	14,094	0	29,498	2,479	0	347	30
0508	CAAGUAZÚ	NUEVA LONDRES	16,161	0	1,255	0	14,831	63	0	12	0
0509	CAAGUAZÚ	SAN JOAQUÍN	25,125	0	3,340	0	15,765	6,004	1	15	0
0510	CAAGUAZÚ	SAN JOSÉ DE LOS ARROYOS	35,165	14	6,109	0	28,509	139	0	394	0
0511	CAAGUAZÚ	YHÚ	117,639	139	15,224	0	72,091	29,094	236	855	0
0512	CAAGUAZÚ	J.E. ESTIGARRIBIA	46,560	0	20,869	0	20,783	1,244	0	3,664	0
0513	CAAGUAZÚ	R.I.3 CORRALES	11,041	0	3,728	0	6,205	12	0	1,096	0
0514	CAAGUAZÚ	RAUL A. OVIEDO	60,786	2	17,459	0	20,668	14,187	157	8,313	0
0516	CAAGUAZÚ	MARISCAL F.S. LOPEZ	68,337	0	17,882	0	27,185	12,609	835	9,826	0
0517	CAAGUAZÚ	LA PASTORA	9,885	0	1,932	0	7,427	515	0	11	0
0519	CAAGUAZÚ	SIMON BOLIVAR	13,192	0	2,714	0	9,372	1,101	0	5	0
0601	CAAZAPÁ	CAAZAPÁ	39,388	0	4,081	0	34,764	0	0	543	0
0602	CAAZAPÁ	ABAÍ	30,531	0	5,491	0	17,147	7,285	0	608	0
0603	CAAZAPÁ	BUENA VISTA	5,753	0	895	0	4,849	0	0	9	0
0605	CAAZAPÁ	GRAL. HIGINIO MORÍNIGO	10,771	0	1,035	0	9,693	0	0	43	0

Code	District	Recommended City for Afforestation	Recommended Area for Afforestation								
			Total	Artificial Forest	Dry Farmland	Paddy Field	Non-Flooded/ Seasonally Flooded Grassland	Artificial Grassland	Shrub Land	Water Body	Others (Clouds and Cloud Shadows, etc.)
0607	CAAZAPÁ	SAN JUAN NEPOMUCENO	30,332	683	2,049	0	27,431	26	0	143	0
0610	CAAZAPÁ	YUTY	59,361	0	4,434	259	53,070	25	0	1,573	0
0701	ITAPÚA	ENCARNACION	18,134	0	6,872	0	11,254	0	0	3	5
0702	ITAPÚA	BELLA VISTA	16,096	0	7,825	0	8,228	0	0	43	0
0703	ITAPÚA	CAMBYRETA	11,592	0	2,880	0	8,691	0	0	20	1
0704	ITAPÚA	CAPITAN MEZA	51,926	35	28,618	0	23,170	0	0	103	0
0705	ITAPÚA	CAPITAN MIRANDA	14,123	42	6,806	0	7,275	0	0	0	0
0706	ITAPÚA	NUEVA ALBORADA	9,896	0	4,807	0	5,069	0	0	20	0
0707	ITAPÚA	CARMEN DEL PARANA	16,697	6	5,535	115	10,862	23	0	153	3
0708	ITAPÚA	CORONEL BOGADO	36,794	0	2,810	541	32,233	48	0	1,159	3
0709	ITAPÚA	CARLOS A. LOPEZ	40,643	0	22,257	0	18,277	0	0	109	0
0710	ITAPÚA	NATALIO	21,289	0	9,933	0	11,334	0	0	22	0
0711	ITAPÚA	FRAM	26,594	0	13,131	0	13,407	47	0	9	0
0714	ITAPÚA	HOHENAU	16,326	1	7,738	0	8,246	325	9	7	0
0715	ITAPÚA	JESUS	9,243	0	4,153	0	4,065	1,025	0	0	0
0716	ITAPÚA	JOSE LEANDRO OVIEDO	7,490	0	749	2	6,699	4	0	36	0
0717	ITAPÚA	OBLIGADO	24,104	22	12,932	0	11,069	0	0	81	0
0718	ITAPÚA	MAYOR OTAÑO	11,924	0	5,505	0	5,246	1,040	0	131	2
0720	ITAPÚA	SAN PEDRO DEL PARANA	31,067	0	5,212	0	25,724	28	0	103	0
0721	ITAPÚA	SAN RAFAEL DEL PARANA	78,515	0	42,773	0	35,584	0	0	158	0
0722	ITAPÚA	TRINIDAD	5,942	0	1,890	0	4,024	0	10	18	0
0723	ITAPÚA	EDELIRA	37,072	0	18,229	0	18,779	0	0	64	0
0724	ITAPÚA	TOMAS ROMERO PEREIRA	30,682	0	14,719	0	15,926	0	0	37	0
0726	ITAPÚA	LA PAZ	18,794	0	11,046	0	7,748	0	0	0	0
0728	ITAPÚA	SAN JUAN DEL PARANA	4,513	0	1,018	0	3,482	0	0	11	2
0729	ITAPÚA	PIRAPO	44,144	152	28,969	0	14,906	0	0	117	0

Code	District	Recommended City for Afforestation	Recommended Area for Afforestation								
			Total	Artificial Forest	Dry Farmland	Paddy Field	Non-Flooded/ Seasonally Flooded Grassland	Artificial Grassland	Shrub Land	Water Body	Others (Clouds and Cloud Shadows, etc.)
0904	PARAGUARÍ	GRAL. CABALLERO	13,454	0	1,234	0	12,157	41	0	22	0
0905	PARAGUARÍ	CARAPEGUÁ	28,082	0	5,980	0	22,069	15	6	12	0
0906	PARAGUARÍ	ESCOBAR	16,565	0	1,572	0	14,249	739	0	5	0
0909	PARAGUARÍ	PIRAYÚ	12,370	0	1,031	0	10,712	592	6	29	0
0913	PARAGUARÍ	SAPUCAI	7,975	0	290	0	6,562	1,090	0	33	0
0915	PARAGUARÍ	YAGUARÓN	17,077	73	2,589	0	12,784	1,618	0	13	0
0917	PARAGUARÍ	YBYTYMÍ	26,321	102	2,340	0	23,244	372	0	263	0
1002	ALTO PARANÁ	PRESIDENTE FRANCO	6,225	0	3,294	0	2,792	31	0	108	0
1003	ALTO PARANÁ	DOMINGO M. DE IRALA	25,918	0	16,008	0	9,746	33	0	116	15
1004	ALTO PARANÁ	JUAN L. MALLORQUIN	18,647	0	5,152	0	12,849	128	0	518	0
1005	ALTO PARANÁ	HERNANDARIAS	84,868	2,795	38,658	0	19,522	21,911	0	1,982	0
1006	ALTO PARANÁ	ITAKYRY	67,868	0	27,318	0	24,872	14,352	790	536	0
1007	ALTO PARANÁ	JUAN E.OLEARY	16,617	0	4,592	0	9,653	98	0	2,274	0
1008	ALTO PARANÁ	ÑACUNDAY	64,536	0	40,755	0	22,955	303	0	429	94
1009	ALTO PARANÁ	YGUAZÚ	51,486	55	20,354	0	18,426	4,124	0	8,527	0
1010	ALTO PARANÁ	LOS CEDRALES	32,127	0	18,330	0	13,301	79	244	173	0
1011	ALTO PARANÁ	MINGA GUAZÚ	40,659	14	12,069	0	23,303	4,408	121	744	0
1012	ALTO PARANÁ	SAN CRISTOBAL	58,741	0	27,312	0	25,101	5,847	0	481	0
1013	ALTO PARANÁ	SANTA RITA	44,494	0	26,943	0	16,515	1,007	0	29	0
1014	ALTO PARANÁ	NARANJAL	55,701	204	33,711	0	21,579	158	0	49	0
1015	ALTO PARANÁ	SANTA ROSA DEL MONDAY	63,505	0	32,900	0	28,134	1,901	140	430	0
1016	ALTO PARANÁ	MINGA PORÁ	54,993	0	41,258	0	9,527	3,521	494	193	0
1017	ALTO PARANÁ	MBARACAYÚ	70,280	12	49,242	0	16,112	3,977	0	937	0
1104	CENTRAL	GUARAMBARÉ	2,830	0	287	0	2,277	241	14	11	0
1117	CENTRAL	YPACARAÍ	6,951	56	516	0	5,725	199	0	455	0
1301	AMAMBAY	PEDRO JUAN CABALLERO	221,515	31	15,310	0	89,476	113,234	2,765	225	474

Code	District	Recommended City for Afforestation	Recommended Area for Afforestation								
			Total	Artificial Forest	Dry Farmland	Paddy Field	Non-Flooded/ Seasonally Flooded Grassland	Artificial Grassland	Shrub Land	Water Body	Others (Clouds and Cloud Shadows, etc.)
1303	AMAMBAY	CAPITAN BADO	171,311	0	18,418	0	66,047	76,104	10,482	193	67
1401	CANINDEYÚ	SALTO DEL GUAIRÁ	98,651	160	42,536	0	17,389	30,280	0	8,280	6
1402	CANINDEYÚ	CORPUS CHRISTI	99,473	0	46,514	0	21,181	30,098	1,571	69	40
1403	CANINDEYÚ	SAN ISIDRO DEL CURUGUATY	89,237	37	15,756	0	26,981	43,853	2,107	503	0
1407	CANINDEYÚ	GRAL. F. CABALLERO ALVAREZ	222,221	190	149,825	0	34,318	35,981	1,415	488	4
		Total	4,054,122	5,755	1,327,281	917	1,902,366	722,034	28,752	63,721	3,296

Note: All figures for the area are estimated values by the GIS. Several 30 m× 30 m grids, each representing one pixel of Landsat TM data, were combined to form a 100 m× 100 m grid for estimation purposes.

**CHAPTER 4   ANALYSIS OF CURRENT
CONDITIONS OF RECOMMENDED
AFFORESTATION AREAS AND
THEIR SURROUNDING AREAS**

CHAPTER 4

ANALYSIS OF CURRENT CONDITIONS OF RECOMMENDED AFFORESTATION AREAS AND THEIR SURROUNDING AREAS

4.1 Current Conditions of Recommended Afforestation Areas and Their Surrounding Areas

4.1.1 Natural Conditions and Socioeconomic Conditions

(1) Temperature, Rainfall and Wind Velocity

The mean annual temperature in and around the recommended afforestation areas is approximately 21 – 24°C and is generally higher in the northwestern part. The mean monthly temperature of approximately 24 – 28°C is high from December to February and is low from June to August (approximately 15 – 20°C).

The annual rainfall range is approximately 1,400 – 1,800 mm. It is high in the eastern part and gradually decreases towards the western part. In general, the monthly rainfall of more than 100 mm each month is high from October to May and is low in July and August when the figure is less than 100 mm in many areas (Fig. 4-1).

At many sites, a wind velocity of 5 m/sec or stronger is observed more than 1,000 times a year. The observed frequency of such wind velocity is particularly high 3,000 – 5,000 times a year at Pedro Juan Caballero (Amambay District), Encarnacion (Itapua District), Asuncion (Central District) and Concepcion (Concepcion District). The dominant wind directions are south and north to northeast. Strong winds are not often observed at Caazapa (Caazapa District), San Pedro (San Pedro District) and Coronel Oviedo (Caaguazu District) (see Appendix A-2). May through October, particularly July through September, are windy months. While the maximum wind velocity is generally around 15 – 20 m/sec, wind velocity of 44 m/sec is observed at Pedro Juan Caballero (Amambay District).

(2) Topography and Soil

The recommended afforestation areas are areas with an elevation of some 100 – 600 m sandwiched between Paraguay River to the west and Parana River to the east and south. The elevation gradually rises from the southwest to the mountain range in the northeast, showing gently undulating topography in general.
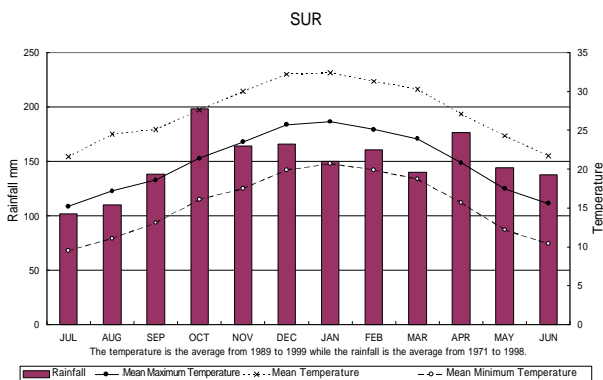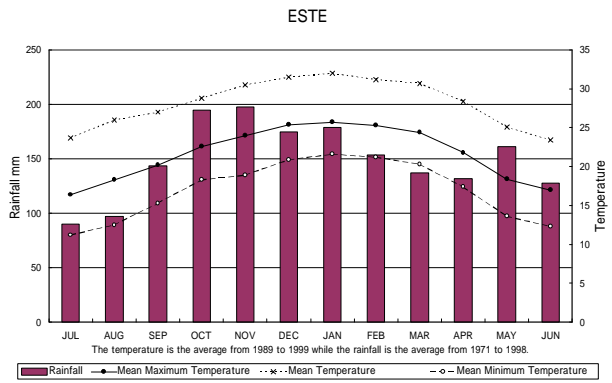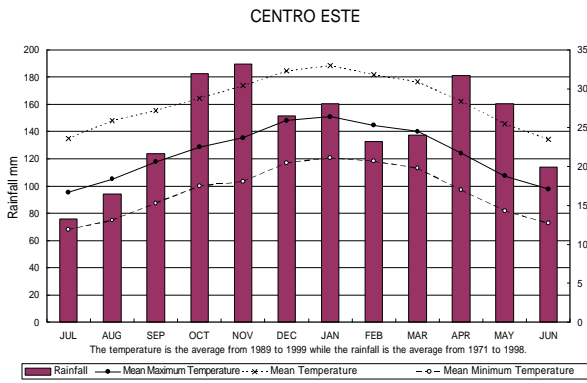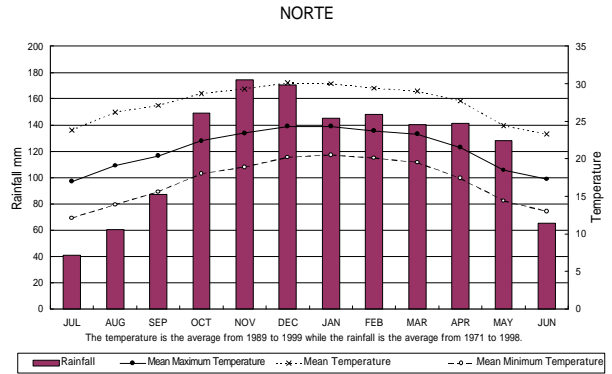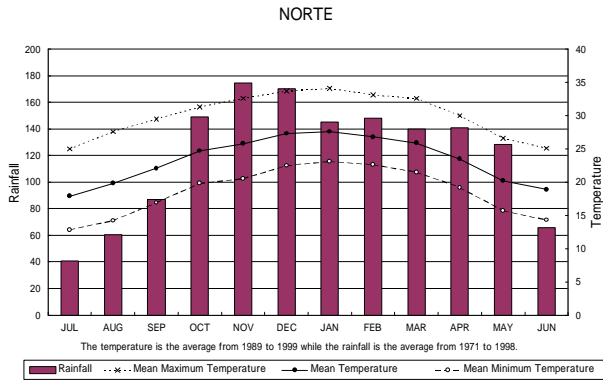
Fig. 4-1   Mean Monthly Temperature and Mean Monthly Rainfall

The dominant soils of the recommended afforestation areas are soil originating from basalt and soil originating from sandstone. The former is fertile red soil called terra rossa and is distributed along Parana River, forming agricultural areas. The latter is reddish yellow and is called asuncion soil, the fertility of which is inferior to that of terra rossa. This soil is liable to erosion and areas of this soil are used for farming and pasturage. According to the Soil Classification Map for the Eastern Region prepared in 1995, the soil at the recommended cities for afforestation is classified into such US Soil Taxonomy units as Ultisols, Alfisols, Inceptisols, Mollisols, Vertisols, Oxisols and Entisols as shown in Table 4-1.

(3) Land Use

According to the Land Cover Map prepared under the Study, the category of non-flooded and seasonally flooded grassland covers the largest area of 1.9 million ha or 47% of the total area of the recommended afforestation areas, followed by dry farmland with 1.33 million ha (33%) and artificial grassland of 0.72 million ha (18%) (Table 3-2).

The survey on afforestation intentions, conducted as part of the Study, established the land use per land owner household in the recommended cities for afforestation as shown in Table 4-2. According to this table, each land owner in the recommended cities for afforestation possesses an average of 508.9 ha of land, consisting of 307.7 ha of pasture land, 108.3 ha of forest, 85.6 ha of farm land and 7.3 ha of others. By size of land ownership, the average size of land ownership for those with up to 20 ha of land is 10.8 ha, consisting of 4.6 ha of farm land, 4.5 ha of pasture land and 1.5 ha of forest, indicating a higher ratio of farm land and pasture land. In the case of land owners with 20 – 500 ha of land, the average size of land ownership is 115.4 ha, consisting of 64.5 ha of pasture land, 29.7 ha of farm land and 18.8 ha of forest. For land owners with more than 500 ha of land, the average size of land ownership is 2,348 ha, consisting of 1,440.1 ha of pasture land, 520.5 ha of forest and 356.2 ha of farm land. The ratio of pasture land is high in the case of medium and large-scale land owners. In general, the ratio of farm land in possession decreased with a larger size of land ownership while the ratios of pasture land and forest increase.

Table 4-1　　Area by Soil Unit in the Eastern Region and Recommended Cities for Afforestation

Upper row: area (ha),　　Lower row: ratio (%)

	DEPTO.	Soil Unit									
		TOTAL	ULTISOL	ALFISOL	INCEPTISOL	MOLLISOL	VERTISOL	OXISOL	ENTISOL	TIERRAS MISCELANEAS	WATER
Recommended Cities for Afforestation	CONCEPCIÓN	364,929	166,192	110,186	0	0	0	0	79,100	9,043	408
		100.0	45.5	30.2	0.0	0.0	0.0	0.0	21.7	2.5	0.1
	SAN PEDRO	1,557,817	924,022	544,509	41,095	0	902	0	33,141	12,187	1,961
		100.0	59.3	35.0	2.6	0.0	0.1	0.0	2.1	0.8	0.1
	CORDILLERA	189,041	45,937	91,038	10,321	0	0	0	39,976	0	1,769
		100.0	24.3	48.2	5.5	0.0	0.0	0.0	21.1	0.0	0.9
	GUAIRÁ	236,002	67,372	145,602	0	0	0	0	10,206	11,084	1,738
		100.0	28.5	61.7	0.0	0.0	0.0	0.0	4.3	4.7	0.7
	CAAGUAZÚ	1,049,844	430,133	402,266	340	0	30,804	15,413	10,839	157,811	2,236
		100.0	41.0	38.3	0.0	0.0	2.9	1.5	1.0	15.0	0.2
	CAAZAPÁ	615,455	402,756	87,300	7,032	0	0	46,282	33,197	38,221	668
		100.0	65.4	14.2	1.1	0.0	0.0	7.5	5.4	6.2	0.1
	ITAPÚA	1,054,781	759,060	12,209	15,301	0	0	137,612	118,505	1,311	10,782
		100.0	72.0	1.2	1.5	0.0	0.0	13.0	11.2	0.1	1.0
	PARAGUARÍ	201,819	2,538	158,322	0	12,061	107	0	27,642	0	1,148
		100.0	1.3	78.4	0.0	6.0	0.1	0.0	13.7	0.0	0.6
	ALTO PARANÁ	1,259,717	551,712	286,279	0	0	22,540	260,294	45,756	84,260	8,877
		100.0	43.8	22.7	0.0	0.0	1.8	20.7	3.6	6.7	0.7
	CENTRAL	13,611	298	8,085	0	0	654	0	3,943	0	631
		100.0	2.2	59.4	0.0	0.0	4.8	0.0	29.0	0.0	4.6
	AMAMBAY	893,661	296,990	10,152	388,623	36,532	107	0	158,526	0	2,731
		100.0	33.2	1.1	43.5	4.1	0.0	0.0	17.7	0.0	0.3
	CANINDEYÚ	1,130,954	451,788	234,768	0	0	0	339,819	70,260	17,792	16,526
		100.0	39.9	20.8	0.0	0.0	0.0	30.0	6.2	1.6	1.5
	TOTAL	8,567,630	4,098,798	2,090,716	462,712	48,593	55,114	799,420	631,092	331,709	49,476
		100.0	47.8	24.4	5.4	0.6	0.6	9.3	7.4	3.9	0.6
Eastern Region		15,627,638	5,595,909	5,165,389	903,699	158,345	267,068	892,814	2,078,986	430,540	134,888
		100.0	35.8	33.1	5.8	1.0	1.7	5.7	13.3	2.8	0.9

Table 4-2   Land Use Area per Land Owner in Recommended Cities for Afforestation
(Survey on Afforestation Intentions)

(Unit: ha)

		Scale of Land Ownership								Total
		20ha	20 100ha	100 200ha	200 500ha	500 1,000ha	1,000 5,000ha	5,000ha 10,000ha	10,000ha	
Number of Replies		103	266	60	67	25	79	5	3	608
Land Use Category	Farming Field	4.57	12.85	31.71	94.83	186.80	256.42	1,930.00	1,771.67	85.59
	Pasture Land	4.46	27.81	94.64	183.25	354.72	1,413.30	2,800.00	8,925.00	307.74
	Forest	1.52	9.05	20.43	55.93	141.04	465.32	2,120.00	2,470.00	108.28
	Others	0.24	0.96	5.05	5.67	9.24	34.33	50.00	100.00	7.33
	Total	10.79	50.66	151.83	339.68	691.80	2,169.38	6,900.00	13,266.67	508.93

Note: As the figures are rounded, the total area of different land use categories may not be identical to the total of the
land owned.

(4) Population

The estimated population of the recommended cities for afforestation in 2000 was
2,297,000, accounting for 41.8% of the total population of Paraguay and 42.9% of the
population of the Eastern Region. By sex, the number of males (51.7%) was some 80,000
more than the number of females (48.3%). The population of those of 15 years of age or
older was 1,324,000 or 57.6% of the total population. As the nationwide ratios of males
and those of 15 years of age or older were 50.4% and 60.4% respectively, the
recommended cities for afforestation showed a higher proportion of males and a lower
proportion of those of 15 years of age or older than the respective national average
figures. These facts can be explained by the relatively small urban areas where the ratio
of females or employed was high. The average population of cities for which
afforestation is recommended is 22,000 with the largest and smallest cities being San
Estanislao (San Pedro District) with a population of 121,000 and La Paz (Itapua District)
with a population of 3,000 respectively (Table 4-3).

The unemployment rate in Paraguay in the period from 1997 to 1998 was 14.3%,
consisting of the actual unemployment rate of 5.4% and the potential unemployment rate
of 9.5%. By sex, the unemployment rate for males was 9.2% while that for females of
22.4% was much higher. The unemployment rate in urban areas was 13.9% compared to
14.9% in rural areas. In urban areas, the unemployment rate was high among males while
the unemployment rate was high among females in rural areas. Particularly noticeable
was the high potential unemployment rate for females in rural areas (Table 4-4).

Table 4-3   Population of Recommended Cities for Afforestation (Estimate for 2000)

Division	District	Code	City	Population			15 Years of Age or Older
				Total	Males	Females	
Paraguay				5,496,450	2,771,821	2,724,629	3,320,855
Eastern Region				5,360,137	2,700,258	2,659,879	3,237,619
Recommended Cities for Afforestation	CONCEPCIÓN	0103	HORQUETA	54,299	28,164	26,135	28,928
	CONCEPCIÓN	0104	LORETO	19,710	10,014	9,696	10,484
	SAN PEDRO	0201	SAN PEDRO DE YCUAMANDYYU	32,311	16,853	15,458	19,157
	SAN PEDRO	0203	CHORE	50,231	26,793	23,438	27,430
	SAN PEDRO	0204	GRAL.ELIZARDO AQUINO	24,263	13,130	11,133	14,441
	SAN PEDRO	0206	LIMA	8,855	4,651	4,204	5,122
	SAN PEDRO	0207	NUEVA GERMANIA	23,905	12,648	11,257	13,005
	SAN PEDRO	0208	SAN ESTANISLAO	120,982	65,407	55,575	67,337
	SAN PEDRO	0210	TACUATÍ	7,894	4,416	3,478	4,528
	SAN PEDRO	0214	ISIDORO RESQUÍN	26,255	13,913	12,342	13,581
	SAN PEDRO	0215	YATAITY DEL NORTE	15,712	8,358	7,354	8,931
	CORDILLERA	0302	ALTOS	9,599	5,096	4,503	5,813
	CORDILLERA	0304	ATYRÁ	11,125	5,731	5,394	6,660
	CORDILLERA	0306	EMBOSCADA	9,022	4,650	4,372	5,290
	CORDILLERA	0307	EUSEBIO AYALA	16,529	8,364	8,165	10,086
	CORDILLERA	0308	ISLA PUCÚ	7,081	3,486	3,595	4,217
	CORDILLERA	0309	ITACURUBI DE LA CORDILLERA	7,658	3,748	3,910	4,945
	CORDILLERA	0312	MBOCAYATY DEL YHAGUY	4,547	2,433	2,114	2,713
	CORDILLERA	0313	NUEVA COLOMBIA	3,594	1,921	1,673	2,194
	CORDILLERA	0317	SANTA ELENA	5,505	2,887	2,618	3,258
	CORDILLERA	0318	TOBATÍ	21,298	11,350	9,948	12,329
	CORDILLERA	0319	VALENZUELA	5,840	3,156	2,684	3,458
	GUAIRÁ	0401	VILLARRICA	50,935	24,612	26,323	31,840
	GUAIRÁ	0404	CORONEL MARTÍNEZ	6,324	3,413	2,911	4,052
	GUAIRÁ	0405	FÉLIX PÉREZ CARDOZO	4,808	2,536	2,272	2,911
	GUAIRÁ	0407	COL. INDEPENDENCIA	36,358	19,248	17,110	20,180
	GUAIRÁ	0408	ITAPÉ	6,468	3,340	3,128	3,837
	GUAIRÁ	0411	MBOCAYATY	5,974	3,110	2,864	3,653
	GUAIRÁ	0414	SAN SALVADOR	3,472	1,782	1,690	2,071
	GUAIRÁ	0415	YATAITY	3,800	1,797	2,003	2,425
	CAAGUAZÚ	0501	CORONEL OVIEDO	75,697	37,552	38,145	46,198
	CAAGUAZÚ	0504	DR. CECILIO BÁEZ	6,236	3,201	3,035	3,417
	CAAGUAZÚ	0505	SANTA ROSA DEL MBUTUY	12,271	6,324	5,947	7,129
	CAAGUAZÚ	0506	DR. JUAN MANUEL FRUTOS	25,772	13,482	12,290	14,672
	CAAGUAZÚ	0507	REPATRIACIÓN	31,573	16,111	15,462	17,747
	CAAGUAZÚ	0508	NUEVA LONDRES	4,314	2,174	2,140	2,536
	CAAGUAZÚ	0509	SAN JOAQUÍN	21,545	11,291	10,254	11,242
	CAAGUAZÚ	0510	SAN JOSÉ DE LOS ARROYOS	17,976	9,181	8,795	10,648
	CAAGUAZÚ	0511	YHÚ	44,588	23,478	21,110	23,515
	CAAGUAZÚ	0512	J.E. ESTIGARRIBIA	22,602	11,778	10,824	12,443

Division	District	Code	City	Population			15 Years of Age or Older
				Total	Males	Females	
	CAAGUAZÚ	0513	R.I.3 CORRALES	10,753	5,624	5,129	5,626
	CAAGUAZÚ	0514	RAÚL A. OVIEDO	30,844	16,478	14,366	16,600
	CAAGUAZÚ	0516	MARISCAL F.S. LÓPEZ	7,335	3,921	3,414	4,324
	CAAGUAZÚ	0517	LA PASTORA	5,454	2,811	2,643	3,173
	CAAGUAZÚ	0519	SIMON BOLIVAR	4,600	2,372	2,228	2,634
	CAAZAPÁ	0601	CAAZAPÁ	21,448	10,959	10,489	12,617
	CAAZAPÁ	0602	ABAÍ	21,326	11,253	10,073	11,679
	CAAZAPÁ	0603	BUENA VISTA	6,368	3,393	2,975	3,650
	CAAZAPÁ	0605	GRAL. HIGINIO MORÍNIGO	6,476	3,402	3,074	3,556
	CAAZAPÁ	0607	SAN JUAN NEPOMUCENO	26,269	13,667	12,602	14,330
	CAAZAPÁ	0610	YUTY	30,489	15,399	15,090	16,768
	ITAPÚA	0701	ENCARNACION	103,506	51,841	51,665	64,457
	ITAPÚA	0702	BELLA VISTA	9,456	5,008	4,448	5,447
	ITAPÚA	0703	CAMBYRETA	20,678	10,334	10,344	12,064
	ITAPÚA	0704	CAPITAN MEZA	23,990	12,409	11,581	12,844
	ITAPÚA	0705	CAPITAN MIRANDA	7,642	3,809	3,833	4,614
	ITAPÚA	0706	NUEVA ALBORADA	7,156	3,800	3,356	3,965
	ITAPÚA	0707	CARMEN DEL PARANA	5,685	2,781	2,904	3,517
	ITAPÚA	0708	CORONEL BOGADO	17,512	8,688	8,824	10,666
	ITAPÚA	0709	CARLOS A. LOPEZ	18,310	9,661	8,649	9,880
	ITAPÚA	0710	NATALIO	21,879	11,170	10,709	11,279
	ITAPÚA	0711	FRAM	6,833	3,489	3,344	4,014
	ITAPÚA	0714	HOHENAU	17,063	8,486	8,577	10,273
	ITAPÚA	0715	JESUS	5,762	3,010	2,752	3,402
	ITAPÚA	0716	JOSE LEANDRO OVIEDO	4,158	2,115	2,043	2,118
	ITAPÚA	0717	OBLIGADO	10,364	5,384	4,980	6,296
	ITAPÚA	0718	MAYOR OTAÑO	12,866	6,802	6,064	6,800
	ITAPÚA	0720	SAN PEDRO DEL PARANA	39,097	19,749	19,348	20,133
	ITAPÚA	0721	SAN RAFAEL DEL PARANA	21,454	11,633	9,821	11,641
	ITAPÚA	0722	TRINIDAD	4,598	2,546	2,052	2,635
	ITAPÚA	0723	EDELIRA	28,823	15,142	13,681	14,909
	ITAPÚA	0724	TOMAS ROMERO PEREIRA	30,626	15,990	14,636	15,923
	ITAPÚA	0726	LA PAZ	2,847	1,524	1,323	1,661
	ITAPÚA	0728	SAN JUAN DEL PARANA	5,091	2,640	2,451	2,997
	ITAPÚA	0729	PIRAPO	7,716	4,119	3,597	4,396
	PARAGUARÍ	0904	GRAL. CABALLERO	7,895	4,170	3,725	4,781
	PARAGUARÍ	0905	CARAPEGUÁ	33,408	17,052	16,356	21,896
	PARAGUARÍ	0906	ESCOBAR	9,472	4,861	4,611	5,504
	PARAGUARÍ	0909	PIRAYÚ	15,093	7,583	7,510	9,306
	PARAGUARÍ	0913	SAPUCAI	7,315	3,760	3,555	4,530
	PARAGUARÍ	0915	YAGUARÓN	25,871	13,373	12,498	15,455
	PARAGUARÍ	0917	YBYTYMÍ	8,157	4,321	3,836	4,858
	ALTO PARANÁ	1002	PRESIDENTE FRANCO	73,790	36,760	37,030	44,610

Division	District	Code	City	Population			15 Years of Age or Older
				Total	Males	Females	
	ALTO PARANÁ	1003	DOMINGO M. DE IRALA	9,592	5,093	4,499	5,459
	ALTO PARANÁ	1004	JUAN L. MALLORQUIN	17,878	8,976	8,902	10,144
	ALTO PARANÁ	1005	HERNANDARIAS	77,003	38,956	38,047	45,750
	ALTO PARANÁ	1006	ITAKYRY	21,365	11,466	9,899	11,651
	ALTO PARANÁ	1007	JUAN E.OLEARY	15,907	8,062	7,845	9,315
	ALTO PARANÁ	1008	ÑACUNDAY	19,406	10,237	9,169	11,318
	ALTO PARANÁ	1009	YGUAZÚ	16,007	8,624	7,383	9,779
	ALTO PARANÁ	1010	LOS CEDRALES	18,699	9,940	8,759	10,576
	ALTO PARANÁ	1011	MINGA GUAZÚ	58,682	30,713	27,969	34,294
	ALTO PARANÁ	1012	SAN CRISTOBAL	9,131	4,903	4,228	5,287
	ALTO PARANÁ	1013	SANTA RITA	17,778	9,278	8,500	10,922
	ALTO PARANÁ	1014	NARANJAL	13,938	7,316	6,622	8,760
	ALTO PARANÁ	1015	SANTA ROSA DEL MONDAY	16,600	8,702	7,898	9,791
	ALTO PARANÁ	1016	MINGA PORÁ	21,574	11,638	9,936	12,504
	ALTO PARANÁ	1017	MBARACAYÚ	21,224	11,561	9,663	12,649
	CENTRAL	1104	GUARAMBARÉ	18,384	9,275	9,109	11,116
	CENTRAL	1117	YPACARAÍ	18,281	9,079	9,202	11,717
	AMAMBAY	1301	PEDRO JUAN CABALLERO	110,887	54,392	56,495	62,482
	AMAMBAY	1303	CAPITAN BADO	16,292	8,586	7,706	9,784
	CANINDEYÚ	1401	SALTO DEL GUAIRÁ	23,663	12,498	11,165	14,483
	CANINDEYÚ	1402	CORPUS CHRISTI	19,533	10,490	9,043	11,785
	CANINDEYÚ	1403	SAN ISIDRO DEL CURUGUATY	48,138	25,683	22,455	26,199
	CANINDEYÚ	1407	GRAL. F. CABALLERO ALVAREZ	34,864	18,327	16,537	21,522
				2,297,229	1,188,663	1,108,566	1,323,538

Source: DIRECCION GENERAL DE ESTADISTICA, ENCUESTAS Y CENSOS: ESTIMACION Y PROYECCION DE LA POBLACION POR DISTRITO SEGUN SEXO Y GRUPOS DE EDAD PERIODO 1990-2000

Table 4-4   Unemployment Rate in Paraguay (1997 – 1998)

(Unit: %)

	Actual Unemployment Rate			Potential Unemployment Rate			Total Number of Unemployed		
	Total	Male	Female	Total	Male	Female	Total	Male	Female
Total	5.4	4.5	6.8	9.5	4.9	16.7	14.3	9.2	22.4
Urban Areas	6.9	6.2	7.8	7.6	5.2	10.7	13.9	11.1	17.7
Rural Areas	3.2	2.6	4.8	12	4.5	27	14.9	7	30.6

Source: SITEMA DE LAS NACIONES UNIDAS, DIRECCION GENERAL DE ESTADISTICA, ENCUESTAS Y CENSOS: SISTEMA DE INDICADORES SOCIO-ECONOMICOS Y DEMOGRAFICOS, 1999

(5) Agriculture

The planting area by agricultural product in 1999 (1998 for wheat) for districts where the recommended afforestation areas are situated was 1,165,000 ha for soybeans, 343,000 ha for maize, 242,000 for cassava, 188,000 ha for wheat and 147,000 ha for cotton. Compared to 1991, the planting area of soybeans showed a 111% increase while that of cotton decreased by 62% (Table 4-5).

Table 4-6 shows the area of use of farm land by crop per land owner household as established by the survey on the recommended cities for afforestation conducted under the Study. Crops with a large cultivation area per household were wheat (32.4 ha), soybeans (17.1 ha) and sugar cane (15.2 ha). By scale of land ownership, the top ranking crops were cassava (1.1 ha), cotton (0.8 ha) and maize (0.5 ha) for land owners with up to 20 ha. For those owning between 20 ha and 500 ha of land, maize (11.8 ha), wheat (10.0 ha) and sugar cane (2.8 ha) were the three top ranking crops. For large land owners with 500 ha or more, wheat (180.3 ha), sugar cane (93.0 ha) and soybeans (65.5 ha) were the most popular crops. The preference of crops for planting among small land owners differed from that among large land owners. The former appeared to prefer cassava, cotton and maize while the latter appeared to prefer wheat, soybeans and sugar cane.

The size of unused land per farming field owner was 2.4 ha. The figure was 0.4 ha for those with up to 20 ha, 3.0 ha for those with 20 – 500 ha and 2.0 ha for those with 500 ha or more. The ratio of unused land in the total land area owned was relatively high among medium-scale land owners. 13% of households possessing farm land had unused land. The reasons cited for this were limited management ability and low land productivity.

Table 4-5   Production of Main Crops by District in 1991 and 1999

	Region	District	Temporary Crops												
			Soybeans			Maize			Cassava	Wheat			Cotton		
			Planted Area	Production Volume	Yield	Planted Area	Production Volume	Yield	Planted Area	Planted Area	Production Volume	Yield	Planted Area	Production Volume	Yield
			ha	t	kg/ha	ha	t	kg/ha	ha	ha	t	kg/ha	ha	t	kg/ha
1999 (1998 for Wheat)	Districts with Recommended Afforestation Area(s) in Eastern Region	CONCEPCION	180	248	1,378	9,300	16,275	1,750	9,200	0	0	-	8,171	9,315	1,140
		SAN PEDRO	38,623	72,997	1,890	42,000	71,400	1,700	43,000	2,800	2,688	960	31,000	40,424	1,304
		CORDILLERA	0	0	-	5,000	6,250	1,250	12,000	0	0	-	1,048	981	936
		GUAIRA	500	660	1,320	13,000	19,500	1,500	13,000	0	0	-	3,400	4,267	1,255
		CAAGUAZU	72,003	176,623	2,453	37,770	67,986	1,800	46,600	27,400	32,880	1,200	33,140	45,004	1,358
		CAAZAPA	72,507	187,721	2,589	28,742	66,107	2,300	23,325	20,000	23,000	1,150	13,100	13,742	1,049
		ITAPUA	361,083	974,924	2,700	65,000	162,500	2,500	27,000	70,000	42,000	600	21,050	23,660	1,124
		PARAGUARI	0	0	-	15,222	17,871	1,174	14,000	0	0	-	7,800	9,095	1,166
		ALTO PARANA	425,555	1,106,443	2,600	70,500	211,500	3,000	23,000	52,200	57,420	1,100	19,676	26,622	1,353
		CENTRAL	0	0	-	1,318	1,318	1,000	1,500	0	0	-	850	850	1,000
		AMAMBAY	38,794	96,869	2,497	15,000	40,500	2,700	6,000	7,500	10,500	1,400	1,000	1,200	1,200
		CANINDEYU	156,103	435,840	2,792	40,000	120,000	3,000	23,134	8,000	11,600	1,450	6,635	8,513	1,283
		Total	1,165,348	3,052,325	2,619	342,852	801,207	2,337	241,759	187,900	180,088	958	146,870	183,673	1,251
	Districts Without Recommended Afforestation Area in Eastern Region	MISIONES	400	680	1,700	7,200	10,800	1,500	4,784	0	0	-	4,034	5,139	1,274
		NEEMBUCU	0	0	-	5,500	4,125	750	1,000	0	0	-	4,300	4,773	1,110
		Total	400	680	1,700	12,700	14,925	1,175	5,784	0	0	-	8,334	9,912	1,189
	Eastern Region		1,165,748	3,053,005	2,619	355,552	816,132	2,295	247,543	187,900	180,088	958	155,204	193,585	1,247
	Paraguay		1,165,748	3,053,005	2,619	356,602	817,233	2,292	247,746	187,900	180,088	958	166,204	202,283	1,217
1991	Districts with Recommended Afforestation Area(s) in Eastern Region	CONCEPCION	187	359	1,920	9,986	14,587	1,461	9,365	119	122	1,025	23,740	30,036	1,265
		SAN PEDRO	17,367	26,806	1,544	27,614	44,994	1,629	22,770	14,270	19,779	1,386	78,234	124,755	1,595
		CORDILLERA	12	14	1,167	9,448	8,893	941	11,432	85	108	1,271	9,268	10,795	1,165
		GUAIRA	237	425	1,793	10,378	13,907	1,340	11,822	23	47	2,043	16,745	23,845	1,424
		CAAGUAZU	21,799	41,893	1,922	30,325	45,137	1,488	31,028	6,710	11,177	1,666	80,011	130,249	1,628
		CAAZAPA	8,931	16,355	1,831	17,673	30,945	1,751	13,489	370	530	1,432	27,279	39,495	1,448
		ITAPUA	210,523	364,113	1,730	39,522	78,086	1,976	25,510	63,979	99,986	1,563	55,723	88,366	1,586
		PARAGUARI	414	1,217	2,940	15,671	14,987	1,022	15,754	413	623	1,495	25,413	32,478	1,278
		ALTO PARANA	228,504	456,299	1,997	38,062	79,725	2,095	14,160	53,616	84,110	1,569	34,672	60,203	1,736
		CENTRAL	3	6	2,000	1,689	1,636	969	3,336	4	7	1,750	3,061	3,873	1,265
		AMAMBAY	15,288	30,441	1,991	8,246	15,026	1,822	4,381	7,407	13,313	1,500	5,198	8,957	1,723
		CANINDEYU	49,030	94,200	1,921	20,993	39,888	1,900	6,755	5,970	9,415	1,577	22,691	39,986	1,762
		Total	552,295	1,032,128	1,869	229,607	387,811	1,689	169,802	152,966	239,217	1,564	382,035	593,038	1,552
	Districts Without Recommended Afforestation Area in Eastern Region	MISIONES	159	181	1,138	7,467	7,634	1,022	3,785	614	918	1,495	11,441	14,863	1,299
		NEEMBUCU	2	3	1,500	5,470	4,924	900	1,802	4	6	1,500	10,374	11,545	1,113
		Total	161	184	1,143	12,937	12,558	971	5,587	618	924	1,495	21,815	26,408	1,211
	Eastern Region		552,456	1,032,312	1,869	242,544	400,369	1,651	175,389	153,584	240,141	1,564	403,850	619,446	1,534
	Paraguay		552,657	1,032,675	1,869	243,215	401,339	1,650	175,572	153,837	240,538	1,564	414,691	631,728	1,523

Year	Region	District	Mate (Tea) Area (ha)	Mate (Tea) No. of Trees Planted	Mate (Tea) Production Volume (t)	Sweet Oranges Area (ha)	Sweet Oranges No. of Trees Planted	Sweet Oranges Production Volume (t)	Sour Oranges (for Aromatics) Area (ha)	Sour Oranges No. of Trees Planted	Sour Oranges Production Volume (t)	Bananas Area (ha)	Bananas No. of Trees Planted	Bananas Production Volume (t)	Tung Trees Area (ha)	Tung Trees No. of Trees Planted	Tung Trees Production Volume (t)
1999 (1998 for Wheat)	Districts with Recommended Afforestation Area(s) in Eastern Region	CONCEPCION	296	176,070	713	583	143,177	4,807	15	63,282	59	920	1,053,505	6,164	0	0	25
		SAN PEDRO	2,600	1,574,109	4,160	785	174,659	31,250	5,714	41,085,604	108,560	2,500	2,698,202	17,000	2	1,470	8
		CORDILLERA	4	2,785	15	620	175,609	21,114	1,200	9,882,391	19,200	1,200	1,411,035	9,840	0	0	0
		GUAIRA	3,500	3,794,747	10,444	160	59,107	8,200	90	158,325	360	210	276,394	2,688	2	2,287	24
		CAAGUAZU	750	594,693	1,725	1,421	342,691	27,990	900	3,390,034	8,100	2,500	1,052,816	5,497	2	1,470	28
		CAAZAPA	4,118	3,768,786	10,295	370	109,517	11,470	250	428,179	1,438	246	313,505	3,198	19	7,914	61
		ITAPUA	12,452	10,778,735	31,130	4,000	1,344,058	61,198	88	94,308	616	525	664,531	4,600	10,397	4,870,281	40,550
		PARAGUARI	17	5,524	30	240	67,771	9,325	35	186,656	665	530	727,224	5,000	0	0	0
		ALTO PARANA	1,594	1,239,991	3,825	1,218	316,376	19,920	0	0	0	600	869,902	5,100	25	9,981	337
		CENTRAL	3	1,220	8	133	35,226	1,714	4	9,400	12	100	114,557	700	0	0	0
		AMAMBAY	2,800	2,305,613	4,676	200	51,053	3,300	8	4,872	15	200	250,275	1,500	0	0	0
		CANINDEYU	4,000	2,649,220	6,800	387	109,621	5,695	100	150,381	500	400	505,698	2,720	0	0	0
		Total	32,134	26,891,493	73,821	10,117	2,928,865	205,983	8,404	55,453,432	139,525	9,931	9,937,644	64,007	10,447	4,893,403	41,033
	Districts Without Recommended Afforestation Area in Eastern Region	MISIONES	60	44,993	150	450	106,528	9,590	17	15,241	51	600	854,843	4,500	3	4,410	9
		NEEMBUCU	0	0	2	1,200	241,380	13,435	2	28,688	30	235	284,498	1,370	0	0	0
		Total	60	44,993	152	1,650	347,908	23,025	19	43,929	81	835	1,139,341	5,870	3	4,410	9
	Eastern Region		32,194	26,936,486	73,973	11,767	3,276,773	229,008	8,423	55,497,361	139,606	10,766	11,076,985	69,877	10,450	4,897,813	41,042
	Paraguay		32,194	26,936,485	73,973	11,959	3,318,493	230,632	8,423	55,497,361	139,606	10,949	11,317,203	69,988	10,450	4,897,813	41,042
1991	Districts with Recommended Afforestation Area(s) in Eastern Region	CONCEPCION	163	52,280	192				19	77,906	103	840	756,196	6,992	2	3,860	58
		SAN PEDRO	1,881	862,861	3,185				5,599	39,624,920	122,149	2,103	2,014,526	19,227	5	1,822	14
		CORDILLERA	15	10,379	41				2,595	21,409,711	38,424	1,256	1,303,057	11,105	0	39	1
		GUAIRA	3,392	2,702,650	9,993				103	197,251	563	202	371,542	3,151	6	2,282	27
		CAAGUAZU	457	320,126	1,117				1,351	4,995,430	13,465	1,097	1,307,544	10,993	5	5,143	44
		CAAZAPA	975	690,870	2,391				178	329,247	1,225	210	359,871	3,089	26	2,828	37
		ITAPUA	11,236	7,430,602	30,229				84	101,967	650	478	581,219	5,242	10,832	4,769,270	45,594
		PARAGUARI	19	8,733	42				76	420,412	1,538	521	690,807	5,522	0	424	11
		ALTO PARANA	1,444	918,310	3,616				236	586,915	1,578	595	641,734	5,895	28	7,264	71
		CENTRAL	5	2,049	18				7	18,185	119	196	197,162	1,691	2	2,196	11
		AMAMBAY	2,934	1,587,746	4,891				11	9,667	14	276	226,173	1,950	0	100	1
		CANINDEYU	3,966	2,116,600	6,770				52	99,866	393	333	336,415	2,803	1	992	9
		Total	26,487	16,703,206	62,485				10,311	67,871,477	180,221	8,107	8,786,246	77,660	10,907	4,796,220	45,878
	Districts Without Recommended Afforestation Area in Eastern Region	MISIONES	27	15,296	69				17	24,272	88	505	602,969	5,114	5	1,562	11
		NEEMBUCU	0	127	0				5	16,790	28	227	217,700	1,692	0	42	0
		Total	27	15,423	69				22	41,062	116	732	820,669	6,806	5	1,604	11
	Eastern Region		26,514	16,718,629	62,554				10,333	67,912,539	180,337	8,839	9,606,915	84,466	10,912	4,797,824	45,889
	Paraguay		26,514	16,718,640	62,554				10,354	67,922,748	180,348	9,030	9,628,467	84,620	10,912	4,797,825	45,890

Source: 1) MINISTERIO DE AGRICULTURA Y GANADERIA: CENSO AGROPECUARIO NACIONAL 1991
2) MINISTERIO DE AGRICULTURA Y GANADERIA, DIRECCION DE CENSOS Y ESTADISTICAS AGROPECUARIAS: PRODUCCION AGROPECUARIA, 1998/99

Note: 1) Only those districts with a recommended afforestation area(s) are listed.
2) In the case of sour oranges, the leaves are distilled to extract petit grain which is an aromatic raw material.

Table 4-6　　Cultivated Area by Crop per Household in Recommended Cities for Afforestation

(Average of Valid Replies Based on Results of Survey on Afforestation Intentions)

Item			Scale of Land Ownership								
			20ha	20 100ha	100 200ha	200 500ha	500 1,000ha	1,000 5,000ha	5,000ha 10,000ha	10,000ha	Total
Number of Replies			92	208	43	53	17	44	3	2	462
Type of Crop	Tipos de cultivos										
Wheat	Trigo	(ha)	0.228	3.531	10.372	35.302	69.412	243.636	0.000	0.000	32.408
Soybeans	Soja	(ha)	0.087	3.447	9.674	46.396	18.235	41.136	733.333	0.000	17.143
Cotton	Algodón	(ha)	0.793	1.024	2.186	1.208	5.882	1.705	0.000	0.000	1.340
Paddy Rice	Arrozc/r	(ha)	0.000	0.001	0.465	0.000	0.000	0.000	0.000	0.000	0.044
Dry Field Rice	Arrozs/r	(ha)	0.000	0.000	0.047	0.000	5.882	0.000	0.000	0.000	0.221
Potatoes	Papa	(ha)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fruit Trees	Arboles	(ha)	0.196	0.321	0.302	0.047	0.471	1.659	0.000	0.000	0.392
Sugar Cane	Caña de	(ha)	0.503	1.500	6.047	5.462	31.706	6.432	0.000	2,657.500	15.248
Cassava	Mandioca	(ha)	1.068	1.327	1.651	1.434	1.971	2.159	0.000	0.000	1.406
Maize	Maíz	(ha)	0.530	1.024	3.977	2.198	17.824	16.489	66.667	0.000	3.848
Other Vegetables	Verduras	(ha)	0.022	0.085	0.395	0.028	0.147	1.205	0.000	0.000	0.203
Fallow Land	Barbecho	(ha)	0.182	0.738	0.419	0.038	30.059	8.295	0.000	0.000	2.308
Unused Land	s/uso	(ha)	0.424	1.596	5.198	6.906	0.471	2.750	0.000	0.000	2.358
Others	Otros	(ha)	1.087	1.838	7.128	13.840	92.647	134.477	16.667	0.000	19.620

(6) Livestock Industry

There were 5,892,000 head of cattle (5,404,000 beef cattle and 488,000 dairy cattle) in districts with recommended afforestation areas in 1999, accounting for 87.6% of the total head in the Eastern Region and 61.1% of the total head in Paraguay. Other than cattle, pigs, horses, sheep and goats were raised (Table 4-7).

Table 4-8 shows the number of domestic livestock per stock farm owner based on the findings of the survey on afforestation intentions conducted on the recommended cities for afforestation as part of the Study. The average number by type of animal was 371.5 for beef cattle, 10.0 for dairy cattle, 9.4 for sheep, 9.2 for horses, 1.9 for pigs and 1.1 for goats. By scale of land ownership, a land owner with up to 20 ha had an average of 6.8 beef cattle, 5.4 dairy cattle, 1.0 horses, 0.6 sheep, 0.3 pigs and 0.1 goats. A land owner with 20 – 500 ha had an average of 79.1 beef cattle, 11.2 dairy cattle, 4.0 sheep, 3.2 horses, 1.1 pigs and 0.5 goats. A land owner with more than 500 ha had an average of 1,588.6 beef cattle, 34.9 horses, 33.4 sheep, 9.0 dairy cattle, 5.8 pigs and 3.9 goats. While beef cattle were the main type of livestock raised by every category of land owner, dairy cattle appeared to be popular among small-scale land owners.

Table 4-9 shows the area of unused land per stock farm owner and the feasible size of cattle raising in the recommended cities for afforestation. Each stock farm had an average of 3.3 ha of unused land. To be more precise, a land owner with up to 20 ha had 0.3 ha of unused land. This figure increased to 1.8 ha for a land owner with 20 – 50 ha and 10.5 ha for a land owner with more than 500 ha. The main reason for the existence of unused land was limited management ability. 60% of the people interviewed said that 1 – 2 head of cattle could be raised per ha of natural grassland. In the case of artificial grassland, the feasible number of head which can be raised varied from less than two per ha to 2 – 3 per ha or more than three per ha.

Table 4-7　　Number of Livestock Raised in Eastern Region (as of 1st June, 1999)

(Unit: head)

Region	District	Cattle			Horses Equinos	Sheep Ovinos	Goats Caprinos	Pigs Porcinos	Chickens Gallinaceas
		Beef Carne	Dairy Leche	Total					
District with Recommended Afforestation Area in Eastern Region	CONCEPCION	679,138	27,122	706,260	20,454	29,044	5,689	76,985	674,585
	SAN PEDRO	941,847	57,045	998,892	47,045	39,544	5,654	237,145	1,419,458
	CORDILLERA	240,325	31,100	271,425	10,989	9,201	1,396	73,523	680,458
	GUAIRA	204,176	15,425	219,601	15,112	13,112	1,598	84,122	880,559
	CAAGUAZU	489,005	78,345	567,350	18,079	21,325	5,702	204,122	1,821,321
	CAAZAPA	248,704	6,698	255,402	28,457	30,544	6,315	125,033	902,365
	ITAPUA	528,326	54,312	582,638	35,784	32,857	5,984	335,646	2,118,785
	PARAGUARI	440,115	35,005	475,120	26,766	28,433	3,354	104,345	1,299,823
	ALTO PARANA	325,296	75,244	400,540	10,524	9,745	6,312	232,446	1,284,358
	CENTRAL	88,144	56,822	144,966	5,045	1,856	1,561	52,115	2,402,548
	AMAMBAY	594,149	14,122	608,271	11,235	13,896	2,708	37,948	239,584
	CANINDEYU	625,188	36,296	661,484	12,399	7,856	3,993	105,663	656,366
	Total	5,404,413	487,536	5,891,949	241,889	237,413	50,266	1,669,093	14,380,210
District without Recommended Afforestation Area in Eastern Region	MISIONES	415,253	11,085	426,338	23,445	31,889	1,509	37,852	320,745
	NEEMBUCU	412,152	11,195	423,347	32,141	40,878	8,225	23,415	203,633
	Total	827,405	22,280	849,685	55,586	72,767	9,734	61,267	524,378
Eastern Region		6,231,818	509,816	6,741,634	297,475	310,180	60,000	1,730,360	14,904,588
Paraguay		8,959,091	688,124	9,647,215	350,854	398,111	121,774	1,763,564	15,047,853

Source:　MINISTERIO DE AGRICULTURA Y GANADERIA, DIRECCION DE CENSOS Y ESTADISTICAS AGROPECUARIAS: PRODUCCION AGROPECUARIA
　　　　　1998/99
Note:　　Dairy cattle include Dutch Jersey cattle. Vacunos para leche, solo incluye razas Holando Jersey.

Table 4-8   Number of Livestock Raised per Stock Farm Owner in Recommended Cities for Afforestation

(Unit: head)

Scale of Land Ownership	Number of Replies	Beef Cattle B.Carne	Dairy Cattle B.leche	Horses Caballos	Sheep Ovejas	Goats Cabras	Pigs Cerdos	Others Otros
20ha	70	6.7	5.4	1.0	0.6	0.1	0.3	1,429.2
20 100ha	229	34.6	10.1	2.2	3.0	0.3	0.6	1,615.8
100 200ha	53	122.2	13.3	4.1	5.3	0.9	3.0	2.6
200 500ha	51	234.2	13.9	6.6	7.3	1.0	1.3	1.3
500 1,000ha	22	436.0	8.8	11.1	12.7	3.2	5.0	0.0
1,000 5,000ha	71	1,340.2	8.6	37.8	38.6	4.5	6.5	3.1
5,000 10,000ha	5	6,340.0	20.0	110.0	69.0	0.0	3.0	0.0
10,000ha	3	8,000.0	0.0	16.7	0.0	0.0	0.0	0.0
Total	504	371.5	10.0	9.2	9.4	1.1	1.9	933.5

Table 4-9   Area of Grassland per Stock Farm and Feasible Number of Cattle to be Raised in Recommended Cities for Afforestation
(Findings of Survey on Afforestation Intentions)

Item	Scale of Land Ownership								Total
	20ha	20 100ha	100 200ha	200 500ha	500 1,000ha	1,000 5,000ha	5,000 10,000ha	10,000ha	
Number of Replies	79	251	57	57	24	76	5	3	552
Area of Each Land Use Category per Stock Farm (Average) (ha)									
Natural Grassland	4.0	1.3	77.1	51.4	285.5	58.8	11,749.4	0.0	141.4
Artificial Grassland	1.5	0.5	47.2	42.4	185.2	56.5	10,500.3	6,800.0	157.6
Unused Land	0.3	0.1	5.2	5.8	27.5	1.2	78.0	0.0	3.3
Total	5.8	1.8	129.5	99.6	498.1	116.5	22,327.7	6,800.0	302.2
Feasible Number of Cattle to be Raised (Number of Replies)									
Feasible Number on Natural Grassland									
≤ 0.25 head/ha	0	6	0	0	0	1	0	1	8
0.25< ≤ 0.5 head/ha	1	7	0	2	1	4	0	0	15
0.5 < ≤ 1 head/ha	4	26	2	5	1	13	0	0	51
1 < ≤ 2 head/ha	38	103	27	24	10	27	0	2	231
2 head/ha<	14	30	4	6	2	10	0	0	66
Feasible Number on Artificial Grassland									
<2 head/ha	12	42	10	16	9	30	4	1	124
2 – 3 head/ha	5	38	10	15	5	9	1	0	83
>3 head/ha	10	61	14	10	5	17	0	0	117

Note: The average ratio of artificial grassland used for grazing among those responding is 86.1%.

(7) Agriculture and Forestry-Related Economic Indices

In Paraguay, the agricultural sector (including agriculture, livestock raising, forestry and hunting) still plays an important role in the national economy as its share of the GDP is 27% (quick report for 2000) which is comparable with the GDP share of the industrial sector.

Within the agricultural sector, agriculture proper accounts for some 60% of the total production value while livestock raising and forestry account for 30% and 10% respectively. The main agricultural products are soybeans, cotton, wheat, cassava, maize, sugar cane and various beans and potatoes. Medium to large-scale farmers mainly cultivate soybeans and wheat (secondary crop) and small-scale farmers mainly cultivate cotton, cassava and beans. The main forestry products are logs for timber and agricultural use and fuelwood (for firewood and charcoal), accounting for 38% and 56% of the total production volume respectively.

The agricultural sector produces Paraguay's main export products and accounts for approximately two-thirds of the total export value. These products earned US$ 540 million in foreign currencies and US$ 630 million in 2000 (based on quick report). The main agricultural products for export are soybeans, cotton, timber and beef. While soybeans top the list of export products, timber has been among the top three products for the last few years, constituting a leading export product of Paraguay.

Despite such importance, however, the export value of the main agricultural products, including timber, has been steadily declining since the late 1990's, presumably because of the following two reasons.

① Decline of the export volume: Typical products of which the export volume has declined are cotton, timber and wheat. In the case of cotton and wheat, the decline of their domestic production volumes in the period in question may have contributed to the export decline. In the case of timber, while the domestic production volume has stayed almost level, the export volume has shown a declining trend.

② Sluggish commodity prices in the international market: The prices of international commodities have declined since the financial crisis in Southeast Asia in the late 1990's. One under-current for the declined prices of primary products may have been the noticeable decrease of the global population growth rate in the 1990's. The international market prices of such main export items of Paraguay as soybeans, cotton, wheat and maize continuously declined from the mid-1990's to 1999,

constituting the main factor for the declined export earnings of Paraguay. In fact, the unit export prices of the main agricultural products for export from Paraguay during this period fell almost across the board.

The international market prices of primary products have shown signs of recovery in the 2000's for some products and the export value of Paraguay's agricultural products in 2000 (quick report) increased by 18% on the previous year.

Table 4-10 shows the export performance of Paraguayan wood products in the last five years (1996 – 2000). Both the total export value and volume which had been declining until 1999 recovered in 2000. Despite the steady decline of the unit prices of processed products in these years, the general export unit prices have shown an increasing trend because of the gradually increasing export ratio of highly value-added products as shown in Fig. 4-2. This must be described as a welcome development for the forestry sector in Paraguay.

Table 4-10   Export Performance of Wood Products in Last Five Years

| Export Value (US$ '000)	1996	1997	1998	1999	2000
Sawn Timber	$34,128	$38,036	$28,000	$17,392	$20,683
Processed Products	$59,890	$62,686	$41,656	$41,407	$54,379
Total	$94,018	$100,722	$69,656	$58,799	$75,062
Export Volume (tons)	1996	1997	1998	1999	2000
Sawn Timber	316,693	320,773	227,739	144,656	187,817
Processed Products	112,430	122,301	83,234	84,519	122,067
Total	429,123	443,074	310,973	229,175	309,884
Share of Processed Products (%)	26%	28%	27%	37%	39%
Unit Prices for Export (US$/kg)	1996	1997	1998	1999	2000
Sawn Timber	$0.11	$0.12	$0.12	$0.12	$0.11
Processed Products	$0.53	$0.51	$0.50	$0.49	$0.45
Total	$0.22	$0.23	$0.22	$0.26	$0.24
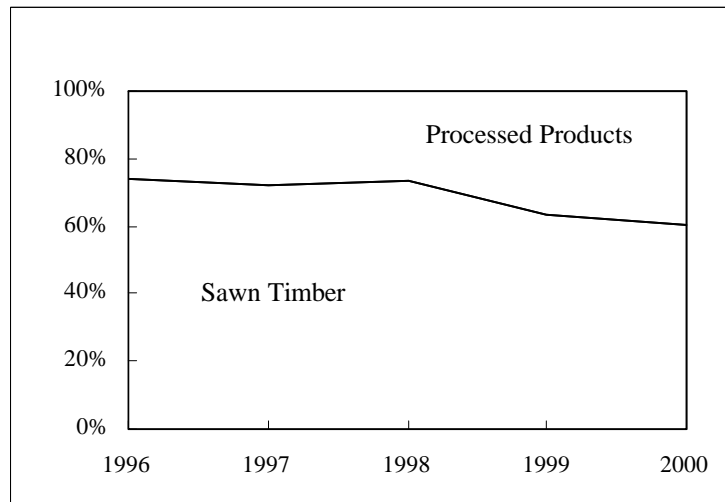
Fig. 4-2　　　Volume of Wood Exports: Shares of Processed Products and Sawn Timber

(8)　Economic Conditions of Land Owners

The survey on afforestation intentions conducted under the Study found that the average annual income and expenditure per land owner in the recommended cities for afforestation were G157,558,000 and G90,624,000 respectively. By scale of land ownership, those with up to 20 ha had an average annual income of G9,188,000 and expenditure of G5,651,000. For those with 20 – 500 ha, the average annual income ranged from G23,630,000 to G110,968,000 and the average annual expenditure ranged from G20,225,000 to G13,741,000 depending on the actual scale of land ownership. For those with more than 500 ha, the average annual income ranged from G255,770,000 to G5,813,333,000 and the average annual expenditure ranged from G148,040,000 to G4,683,333,000 depending on the actual scale of land ownership. As expected, both the average annual income and expenditure figures are higher for larger land owners. The average amount of borrowing among those borrowing in the last two years was G158,443,000. By scale of land ownership, the average amount of borrowing was G21,937,000 for those with up to 20 ha, G108,060,000 – G11,502,000 for those with 20 – 500 ha and G414,450,000 – G3,000,000,000 for those with more than 500 ha (Table 4-11).

The breakdown of the annual income per land owner household, established by the survey on afforestation intentions, shows that 55% and 41% of the total income came from stock raising and farming respectively. By scale of land ownership, the combined income from stock raising and farming accounted for more than 90% of the total income in all categories. The ratio of income from farming was the highest among those with up

to 20 ha at 63% while the ratio of income from stock raising was higher than that of farming income for those with more than 20 ha (Table 4-12).

The survey on afforestation intentions also revealed that the annual labour force per land owner household was 1.4 persons for home labour, 3.1 persons for all year round employed labour and 3.6 persons for seasonally employed labour. In the case of land owners with up to 20 ha, the corresponding figures are 1.8 persons, 0.2 persons and 0.9 persons respectively, indicating that home labour is the principal labour force. Home labour, all year round employed labour and seasonally employed labour for land owners with 20 – 500 ha ranged from 1.2 to 1.6 persons, 0.6 to 1.7 persons and 1.4 to 3.3 persons respectively. For land owners with more than 500 ha, home labour, all year round employed labour and seasonally employed labour ranged from 0 to 1.0 persons, 6.0 to 204.3 persons and 2.0 to 136.7 persons respectively. The degree of dependence on home labour decreases with an increase of the land ownership size. Employed labour is the main type of labour for land owners with 100 ha or more (Table 4-13).

4.1.2　Current Conditions of Forestry

(1) Forest and Forestry Policies

　　1)　Development of Forest and Forestry-Related Laws

　　　　The swift development of agriculture and stock raising throughout the 1960's and 1970's coupled with the development of the road network caused a rapid decline and degradation of forest resources in the Eastern Region. The forest area which stood at some 8.8 million ha (approximately 55% of the total area of the Eastern Region) in 1945 declined to some 5.49 million ha (approximately 34% of the total area of the Eastern Region) in 1975, recording a some 38% decrease of the forest area. In order to deal with the serious forest crisis, forest and forestry-related laws were actively introduced.

　　　　Some of the main laws are outlined below. In Paraguay, forests are regarded as places for the development of agriculture and stock raising. As a result, forestry and wood industries have developed as by-products in the development process of agriculture and stock raising and there has been a lack of policies to actively promote forestry and wood industries.

Table 4-11　Annual Income/Expenditure and Borrowing per Land Owner Household in Recommended Cities for Afforestation
(Findings of Survey on Afforestation Intentions)

		Scale of Land Ownership								Total
		20ha	20　100ha	100　200ha	200　500ha	500　1,000ha	1,000　5,000ha	5,000　10,000ha	10,000ha	
Average Annual Income	Number of Replies	94	251	52	62	24	68	5	3	559
	Amount (G'000)	9,188	23,630	101,228	110,968	255,770	573,920	1,306,237	5,813,333	157,558
Average Annual Expenditure	Number of Replies	95	254	54	63	24	69	5	3	567
	Amount (G'000)	5,651	13,741	60,225	60,953	148,040	293,487	482,217	4,683,333	90,624
Amount of Borrowing in Last Two Years	Number of Replies	10	36	5	12	4	7	2	1	77
	Amount (G'000)	21,937	11,502	108,060	64,883	414,450	518,571	980,000	3,000,000	158,443
Amount of Borrowing Repaid	Number of Replies	12	37	5	13	4	7	1	1	80
	Amount (G'000)	5,939	4,533	93,360	48,969	234,850	400,714	180,000	800,000	75,835

Table 4-12　Breakdown of Annual Income per Land Owner Household in Recommended Cities for Afforestation (Average of Replies: %)
(Findings of Survey on Afforestation Intentions)

		Scale of Land Ownership								Total
		20ha	20　100ha	100　200ha	200　500ha	500　1,000ha	1,000　5,000ha	5,000　10,000ha	10,000ha	
Number of Replies		96	252	58	64	26	75	5	3	579
Ratio in Total Income (%)	Farming	63.2	41.7	33.8	39.3	32.7	18.9	10.0	32.7	40.6
	Stock Raising	29.2	54.5	63.6	57.4	63.8	76.4	90.0	67.3	55.1
	Forest	0.0	0.0	0.0	1.6	0.4	2.3	0.0	0.0	0.5
	Others	7.6	3.8	2.6	1.7	3.1	2.4	0.0	0.0	3.8
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 4-13　Annual Labour Force per Land Owner Household in Recommended Cities for Afforestation
(Findings of Survey on Afforestation Intentions)

	Scale of Land Ownership								Total
	20ha	20　100ha	100　200ha	200　500ha	500　1,000ha	1,000　5,000ha	5,000　10,000ha	10,000ha	
Number of Replies	98	247	58	62	26	71	5	3	570
Home Labour (persons)	1.8	1.6	1.2	1.4	1.0	0.8	0.2	0.0	1.4
All Year Round Employed Labour (persons)	0.2	0.6	1.6	1.7	9.9	6.0	16.6	204.3	3.1
Seasonally Employed Labour (persons)	0.9	1.4	3.3	2.2	13.8	6.8	2.0	136.7	3.6

① Law No.422 (Forest Law, 1973) and Government Ordinance No.11681 Regarding Forest Management (1975)

The Forest Law was introduced to promote the conservation and enrichment of forest resources, the promotion of reforestation as well as afforestation and the conservation of headwater areas, rivers and lakes by means of imposing the duty of rational use and management of forests, forest lands and renewable natural resources upon public as well as private forest owners from the viewpoint of public interest as well as public obligation. It sets forth provisions regarding the following matters.

a. Permission and authorisation regarding forest development and movement of timber

b. Exemption of planted sites from real estate tax as a means of facilitating guidance and supervision

c. Exemption of investment in reforestation/afforestation from income tax

d. Exemption of forestry equipment and materials from import tax

e. Financial subsidies

At the time of the enactment of the Forest Law, the SFN was established as the organization to execute the Forest Law.

② Forest Law-Related Government Ordinances and Laws

In connection with the enforcement of the Forest Law, the following laws and government ordinances were also enacted and enforced.

i. Government Ordinance No.18831 on Environmental Conservation (1986)

This ordinance introduced concrete regulations regarding forest development in view of the fact that the development pressure on forests did not ease even after the enforcement of the Forest Law. The main components of this ordinance are described below.

a. Preservation of 100 m wide forest belts on both banks of rivers to conserve rivers and lakes

b. Prohibition of development activities in forests of which the inclination of the land is 15% or steeper

c. Preservation of minimum 100 m wide forest belts in each forest development block of 100 ha

d. Preservation of a minimum 25% of forest area by any owner of at least 20 ha of land. Should this requirement not be met, planting of trees in an area equivalent to 5% of the land owned.

ii. Government Ordinance No.14047 on Regulation of Commercial Cutting of Natural Forests (1992)

This ordinance introduced a permit system for the commercial cutting of natural forests with a view to gradually reducing the volume of cutting and the requirement for a special permit where artificial planting of 1 ha, natural regeneration of 4 ha or the enrichment of 3 ha of natural forest became compulsory for the cutting of 200 m^3 of natural forest.

iii. Government Ordinance No.24489 (1972) and Law No.515 (1994) on Prohibition of Export of Logs, etc.

These aimed at developing the wood industry of preventing a decline of the value of raw wood due to the illegal trading of logs and promoting employment in the forestry sector.

③ Law No.536 (Afforestation Promotion Law, 1995) and Government Ordinance No.9425 (Enforcement Regulations for the Afforestation Promotion Law, 1995)

The enactment of a series of laws and government ordinances developed the legal framework for the conservation and rehabilitation of forest resources and the natural environment. However, the lack of qualitative regulations for forest use in each area and the fiscal as well as organizational shortcomings failed to fully achieve the intended effects of these laws and government ordinances, resulting in the continued cutting of natural forests as well as continued cutting primarily focusing on excellent species. Consequently, the decrease and degradation of forests and forest resources could no be prevented.

While different reference materials give different figures, the forest area in the Eastern Region of Paraguay is said to have declined to some 5.3 million ha (approximately 33% of the total area of the Eastern Region) in 1984 and further to some 3.34 million ha (approximately 21% of the total area of the Eastern Region) in 1991. During this time, afforestation work was quite inactive as only some 11,000 ha of land had been afforested by 1994. The continual decrease

and degradation of forests further aggravated concern in regard to the unstable supply of logs for the wood industry, insufficient opportunities for local employment and the deterioration of the environment.

In order to combat this situation, the Afforestation Promotion Law was enacted in 1995 to introduce the positive incentive of granting an afforestation subsidy.

This law aims at encouraging "afforestation" by means of granting a government subsidy to cover 75% of the afforestation cost to those who have formulated a plan and have conducted activities of forest regeneration (promotion of natural regeneration or enrichment of natural forest) or afforestation (hereinafter reffered to as "afforestation" to mean both type of activities) in priority areas of forestry (these persons are reffered to as "afforesters" hereinafter).

a.   An "afforester" registers the target site for "afforestation" as the forestry
                                                " plan and conducts afforestation work
       within one year of approval of the plan by the SFN. A subsidy is provided
       after the SFN has inspected and approved that the survival rate is 80% or
       higher.

b.   After "afforestation", a subsidy is provided to cover the tending and
       management cost (weeding, climber cutting, prevention of diseases and
       pests and pruning) for the first three years after inspection and approval by
       the SFN.

c.   Tending after the third year is conducted by the afforester who has the
       obligation to replant the site after final cutting and to manage the sites as
       forests.

d.   The preparation of documents and the implementation of inspection are, in
       principle, conducted by a forestry engineer and approved by the SFN. In
       the case of land owners with not more than 20 ha, however, the SFN is
       responsible for plan formulation and inspection.

e.   The SFN submits the necessary budget request to the Ministry of Finance
       based on applications made by potential afforesters in the previous fiscal
       year.

f.   Preferential treatment in regard to the real estate tax is applied to the
       afforestation site in question. The site is also placed outside the scope of
       the Farmland Reform Law.

The enforcement situation of this law, the situation of afforestation progress, moves to revise parts of the law and anticipated problems in the future are described later.

2) Other Measures Relating to Forestry

① "Basic Measures and Actions Relating to Nature and Its Functions" (Ministry of Agriculture and Livestock: MAG, 1998)

These measures were introduced by the MAG for the main purposes of increasing the production volume as well as the productivity of agricultural and livestock, properly considering the environment in production processes and modernising the related systems.

In regard to the forestry sector, basic principles were introduced for avoidance of large-scale cutting or indiscriminate cutting and for conservation of soil, water quality and catchment areas through the preservation of natural forests and the promotion of afforestation and agroforestry.

The main targets were to increase the annual area of afforestation from 2,500 ha in 1997 to 10,000 ha in 1998, to reduce the cutting volume of natural forests to 50% of the average volume for the last five years and to increase the area of agroforestry by 20%.

② "Agroforestry Programme" (MAG, 1998)

There has been an increasing tendency for small farmers in rural areas to sell their land due to economic hardship caused by the small size and declining productivity of the land and to move to urban areas, resulting in a decline of agriculture and forestry.

This programme was introduced to provide practical education and training for small farmers through the promotion of afforestation, agroforestry and silvopasture based on the Afforestation Promotion Law mentioned earlier. Its aims are to improve their social and economic conditions, to promote their self-reliant management and to reduce the cutting pressure by them on natural forests.

Examples of the concrete activities implemented so far include the afforestation to secure the supply of fuelwood and to conserve headwater areas, the

cultivation of citrus fruits, mate, bananas and coffee, etc. in the remaining natural forests, the establishment of wind break forests along the land boundaries, the encouragement of the breeding of exotic as well as indigenous trees and fruit trees and the establishment of seed banks.

3) Recent Developments of Forestry Policies

Despite the enactment and enforcement of a number of laws, government ordinances and related measures, awareness of the importance of forests among land owners is still much lower than their awareness of the importance of agriculture and stock raising. Coupled with the fiscal situation and the fragile forest management organization of the government as well as local governments, the state of national measures to support forests and forestry is still inadequate.

Under these circumstances, there have been some moves to propose the desirable national forestry administration and forestry policies. These moves are outlined next.

① "National Plan (1999 – 2003)" (1999)

This plan was formulated by the Technical Committee for Future Development of Paraguay, the members of which are representatives of the President's Office, the Parliament and various political parties, etc. The plan provides guidelines for the government to formulate integrated policies from the social and economic aspects to meet the diverse demands of the public, including vitalisation of economy, reduction of poverty, environmental conservation and achievement of social fairness.

Accordingly, its contents cover wide-ranging issues, from government reform to social policies, measures to combat poverty and vitalisation of the economy. The important issues relating to forestry are listed below.

a. Concept of National Plan

The policies to be implemented in various field shall pay due attention to the promotion of the rational use of natural resources and must include environmental conservation measures.

b. Government Reform

The government shall have the authority to set forth regulations and policies to conserve the biological diversity and environment while

reforming the government structure to enable the implementation of the rational as well as sustainable management of natural resources and environmental conservation across its ministries and agencies.

c. Vitalisation of Economy, Productivity and Competitiveness

Given the current problems of the declining forest resources which are the supply sources for forest products and the weak organization, finance and technical expertise of public and private bodies which provide the basis for the country's economic competitiveness, "the establishment of a sustainable forestry production system" which can overcome these problems is set as the target.

New forest and forestry policies will be formulated in response to the necessity to promote the conservation and rational use of natural resources and to fundamentally reform the existing laws and management systems relating to the enrichment of natural forests and forestry production, etc.

Agricultural, stock raising and forestry development projects will include measures to ensure the conservation of genes, species, ecosystem, soil, water resources and biological diversity.

② Direction for Forest and Forestry Policies in Paraguay (National Forestry Commission, March, 2000)

This was prepared by the National Forestry Commission (Mesa Forestal Nacional), the members of which are representatives of the public and private sectors involved in forestry, and is designed to clarify the problems of the forest and forestry sector and to make recommendations for the direction of forestry policies in Paraguay towards 2020. The main components of this document are outlined below.

i. Current Conditions of Forestry Sector

a. The development of agriculture and stock raising since the 1970's has been achieved at the expense of natural forests. Forestry production has relied on the cutting of natural forests and has not been conducted in a sustainable manner. As a result, forest resources have dramatically decreased in a short period of time, creating a crisis

situation for the supply of wood for export and the domestic wood industry together with negative impacts on the environment.

    b.   Afforestation promotion measures based on the Afforestation Promotion Law have virtually stalled because of the financial problems of the government.

    c.   Paraguay enjoys excellent soil, climate, human resources and biological diversity with good potential for economic growth, creation of employment and increased income in the forestry sector through the supply of wood. Nevertheless, the system to promote investment in the forestry sector is inadequate.

ii.   Principles of Forestry Policies

    a.   Process of transformation, enabling collaboration of the use of forest resources, guidance on the investment direction, technological innovation and organizational reform, etc. to improve the potential for future development

    b.   Education to facilitate understanding of the wood production function and environmental function of forests

    c.   Participation of the public in the decision-making process of policies

    d.   Decentralisation of policy implementation

    e.   Elimination of the discretionary power of the administration

    f.   Guarantee of fair public access to information

iii.   Priority Targets of Forestry Policies

    a.   Promotion of sustainable forest management by preventing the rapid decrease and qualitative decline of forests and restoring forest resources

    b.   Increase of the economic value of forests by promoting afforestation for economic development, production of industrial materials and creation of local employment

    c.   Development of the investment environment in the forestry sector

    d.   Improvement of the competitiveness of the forestry sector

    e.   Modernisation of the wood industry

f. Strengthening of the management system of forest conservation areas to promote the conservation of biological diversity and ecotourism

iv. Contents of Forestry Policies

a. Administrative bodies and private enterprises: reform of administrative bodies to transparent, participatory and decentralised bodies and strengthening of the management ability and technological expertise of the private sector to meet the challenges of the international market

b. Forest management and conservation: enhancement of forest resources, protection of wildlife conservation areas and promotion of the conservation of biological diversity

c. Management and inspection: improved transparency of the forest management system through restriction of the discretionary power of the government and the promotion of public participation

d. Fund supply and incentives: development of an achievable financial mechanism (creation of a forest fund, use of the CO_2 trading mechanism and fund raising activities overseas) to promote the sustainable management of forest resources

e. Strengthening of competitiveness: improvement of the international competitiveness through strengthening of the information sector to make inroads in the international market, increased added value of the forest products, promotion of research and education and human resources development

f. Sustainability of legal framework: review of the contradictions, duplications and lacks of forest, forestry and environment-related laws and regulations to rebuild the legal framework, taking various international conventions and treaties into consideration

g. Education and extension: intensification of the education and enlightenment on sustainable forest management and environmental issues, re-education of government officials and the mass media and introduction of national campaigns and local events

v. Targets for 2020

a. Secured nature reserves   : 10% of the national land

b. Increase of tourists visiting nature reserves : one million people/year

c. Area of natural forests managed as : 1.5 million ha
    production forests

d. Log production from natural forests : 3 million m^3/year

e. Afforestation area : one million ha

f. Log production from artificial forests : 20 million m^3/year

g. Workers employed full-time in forestry and : half a million workers
    forest products industry

h. Export value of forest products : US$ 1.6 billion/year

i. Amount of carbon sequestration : 14.5 million tons/year

4) History and Problems of Afforestation Work Under Afforestation Promotion Law

① Historical Changes of Afforestation Area

The newly afforested area under the Afforestation Promotion Law amounted to some 29,800 ha from 1995 to 2000 (Table 4-14). As this figure suggests, the Afforestation Promotion Law has considerably stimulated afforestation work which was fairly inactive prior to the enforcement of this law. Table 4-14 shows the afforestation area approved by the SFN in relation to the procedure to receive a subsidy. In reality, the area of afforestation is believed to be larger than the figures in the table as afforestation has taken place at some sites without the approval of the SFN, thereby forfeiting the right to receive a subsidy. There are also some sites which have been planted based on the relevant afforestation plans but not yet inspected by the SFN.

Table 4-14   Afforestation Area Based on Afforestation Promotion Law

(Unit: ha)

Scale of Afforestation	1995	1996	1997	1998	1999	2000	Total
Up to 20 ha	-	-	517	2,511	174	36	3,238
More than 20 ha	743	3,698	11,308	7,280	305	3,255	26,589
Total	743	3,698	11,825	9,791	479	3,291	29,827

Source: SFN (survey in October, 2001)

There have been more than 8,000 SFN-approved afforestation plans covering a total area of more than 110,000 ha as shown in Table 4-15. This means that the

Afforestation Promotion Law has indeed stimulated the volition of land owners to afforestation. However, the actual number of plans of which the implementation has been approved by the SFN, subsequently receiving a subsidy, is only 2,332 (27.7%), covering an area of 24,834.4 ha (21.9%).

Table 4-15   Approval of Afforestation Plans and Completed Plans

	Number	Area (ha)
Approved Afforestation Plans	8,426	113,612.5
Afforestation Plans of Which Completion Has Been Approved	2,332	24,834.4
Afforestation Plans of Which Completion Has Not Yet Been Approved	6,094	88,778.1

Source: SFN (as of September, 2001)

② Historical Changes of Budget Size

Table 4-16 shows the budget allocated in relation to the enforcement of the Afforestation Promotion Law. Because of the severe governmental financial difficulties, the budget allocated by the Ministry of Finance drastically declined in FY 1999. The allocated budget for FY 2000 was further reduced to a mere G2 billion.

Table 4-16   FY 2000 Budget for Subsidy Under Afforestation Promotion Law

(Unit: G billion)

Fiscal Year	Original Budget	After Revision
1997	9.23	9.03
1998	0	20.602
1999	11.5 (8.0)*	12.124 (7.8)*
2000	2.0	2.0
2001	2.0	2.0

Source : SFN
Note   : Figures in brackets should be financed by the revenue of the SFN.

Such a substantial budget cut made the granting of a subsidy for the implementation of already approved afforestation plans difficult, increasing the accumulated debt of the government to afforesters and declining greatly the

volition of land owners to afforestation. The total budget size requested for FY 2002 is G5,009.35 million (G5,000 million for the Ministry of Finance budget and G9.35 million for the SFN budget). This request has passed the review by the Ministry of Finance and is awaiting the approval of the Parliament although an actual increase of the budget compared to the previous year can hardly be anticipated given the fiscal situation of the government.

③ Move to Revise the Afforestation Promotion Law

On 20th December, 2000, Law No.1639 (Partial Revision of the Afforestation Promotion Law) came into existence to solve the problem of delayed subsidy payment and the accumulated debt of the government. The main revisions are explained below.

a. Article 10 of Afforestation Promotion Law (payment period and interest on delayed payment): The Ministry of Finance shall pay the approved subsidy within 70 days of the date of submission of the document confirming afforestation work (previously 30 days). The wording "payment by the government of interest on delayed payment" was deleted.

b. The President shall be given the power to issue government bonds up to a maximum amount of G50 billion. These bonds shall be used for the payment of government debt originating from the application of Law No.536.

c. Conditions for the issue of government bonds: redemption period of five years; annual interest: average annual inflation rate for the last five years + 2%.

d. Payment of government debt originating from the application of the Afforestation Promotion Law: cash payment for afforesters of up to 5 ha and payment in the form of government bonds for afforesters of more than 5 ha.

e. The recipients of government bonds issued under this law shall be able to use such bonds to pay up to 30% of their tax liabilities or to repay loans made by the BNF (National Industrial Bank), CAH (Agricultural Development Credit Union), FOG (Stock Raising Fund) and FDC (Small Farmers Development Fund) for afforestation work under Law No.536.

f. The Ministry of Finance shall be able to buy back the government bonds held by the financial institutions referred to in e. above.

For the enforcement of the Law for Partial Revision of Afforestation Promotion Law, the enactment of the relevant government ordinance as well as ministerial ordinance by the government is necessary. While Government Ordinance No.14889 has recently been enacted (on 4th October, 2001), it is said to be still insufficient as there are issues which must be set forth by ministerial ordinances of the MAG and the Inland Revenue. As a result, no government bonds have so far been issued. The main components of Government Ordinance No.14889 are listed below.

a.   The government bonds to be issued are non-negotiable bonds.

b.   The Ministry of Finance has exclusive authority regarding the issue of the government bonds in question while the application for a subsidy in the form of government bonds is made via the MAG.

c.   The MAG submits a list of qualified afforesters to receive a subsidy in the form of government bonds to the Ministry of Finance.

Reflecting the opinions of many people that Law No.1639 and Government Ordinance No.14889 are disadvantages to afforesters and financial institutions, a draft law for the partial revision of Law No.1639 was submitted to the Lower House on 9th August, 2001. The main components of this draft law are to delete the wording "up to 30%" in Article 5 of Law No.1639 and to make "the government bonds negotiable". Because of this development, the enforcement of Law No.1639 is expected to be further delayed.

④   Problems of Afforestation Promotion Law

The creation of a system backed by law to grant an afforestation subsidy has made significant progress. However, there has been an increasing number of cases where an afforester who has formulated an afforestation plan, followed the necessary procedure, conducted planting and applied for a subsidy fails to receive the subsidy because of the substantial reduction of the budgetary appropriation by the Ministry of Finance in 1999 after enforcement of the law, bringing the accumulated government debt to G37.2 billion by FY 2000. Given the extremely weak fiscal base, the following problems must be solved to continue the subsidy under the Afforestation Promotion Law.

i.   As the Afforestation Promotion Law restricts its funding source to the general budget of the government, it is subject to the tight fiscal measures

adopted by the government. It will, therefore, be difficult to enlarge the budget to facilitate the effective implementation of the Afforestation Promotion Law in the foreseeable future.

ii. The Afforestation Promotion Law only stipulates the necessary procedure and fails to define its purpose and its superior laws. As a result, there is no undisputable justification for the input of government budget to afforestation work. Moreover, the government finds it difficult to put forward a national future vision regarding forests to be created.

iii. The existing high level subsidy system is not a realistic subsidy system as it can lead to speculative afforestation activities to obtain a subsidy and/or makeshift work to receive a cash subsidy. Because of the limited budget size, it is difficult to enlarge the total afforestation area using this system.

iv. The existing system involves time-consuming as well as expensive procedures for both afforesters and the SFN, hampering the smooth implementation of afforestation work.

v. Under the present system, it is impossible to implement the Law within the budgetary limit, causing an increase of government debt.

(2) Administrative Organization Responsible for Forestry

1) Organizational Structure

The forestry administration is under the jurisdiction of the SFN which was established in conjunction with the Forest Law enacted in 1973. Following the launch of the SEAM pursuant to Law No.1561 in July, 2000, the SSERNMA together with its two subordinate offices, i.e. the DOA and the Directorate of National Parks and Wildlife, was transferred to the SEAM. At the same time, the SFN was placed under the direct control of the Minister of Agriculture and Livestock (Fig. 4-3).

At present, the future organizational status of the SFN is uncertain as the Law Concerning the Creation of the National Forestry Institute has been submitted to the Parliament for the purpose of creating an independent body from the MAG to strengthen the forestry administration.

The Head Office of the SFN currently has four departments, i.e. Forest Management, Afforestation, Administration and Forest Education, Extension and Investigation which controls four local centres and nurseries. The SFN has forestry offices in the main areas. In the Eastern Region, there are forestry offices in eight districts, i.e. Amambay, Concepcion, Caazapa, Caaguazu, Itapua, Canindeyu, San Pedro and Alto Parana. These forestry offices are assigned to mainly conduct the following activities.

- Control and monitoring of the cutting of natural forests, featuring all processes from cutting to the sale of forest products
- Issue of permits for the transportation of forest products and the supervision of and permission for the customs clearance of forest products for export
- Collection of levies on cutting, vigilance, etc. and their payment to the forestry fund
- Supervision of afforestation work
- Administrative work relating to the afforestation subsidy and forestry extension

No administrative staff responsible for forestry are appointed at the district and municipal levels and the forestry administration is directly handled by the SFN Head Office and its local offices.

2) Staff Deployment

As of April, 2000, the SFN had 81 staff members (18 graduates) at its Head Office, 143 staff members (16 graduates) at its forestry centres, etc. and 116 staff members (13 graduates) at its forestry offices, etc.

The staffing level of the SFN which conducts on-site guidance and management over a huge area appears to be fair but the ratio of graduates is rather low. There is a shortage of vehicles, fuel supply and travelling cost funds, all of which hinder the activities to materialise various forestry measures. Under the tight financial policy of the government, the efficient execution of the budget by means of rationalisation and the simplification of administrative procedures throughout the public sector together with human resources development and improvement of the flexibility of responding to local needs are required to promote the adequate management of forest resources, including protection of the natural environment.
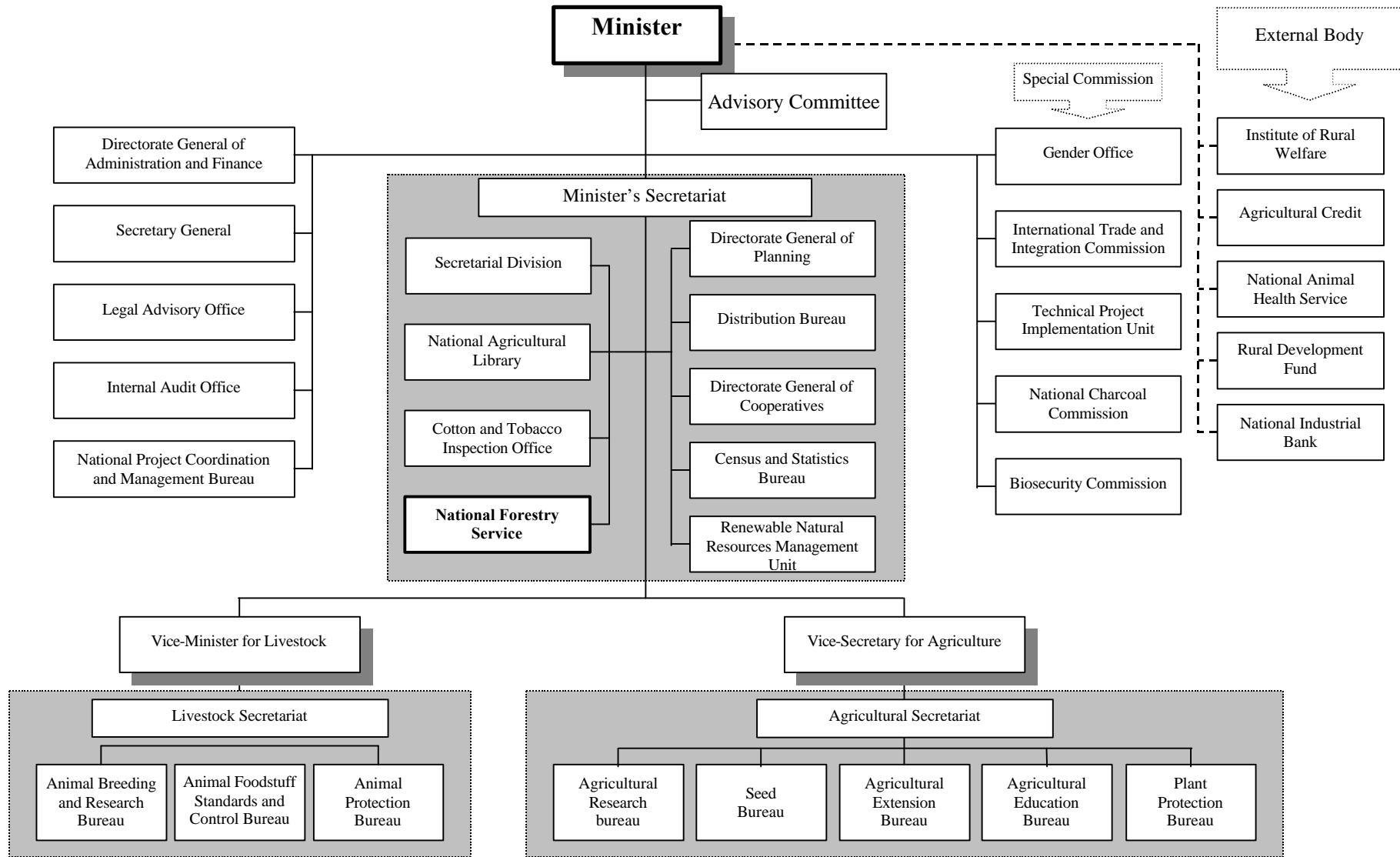
Minister

External Body

Advisory Committee

Special Commission

Directorate General of Administration and Finance

Gender Office

Institute of Rural Welfare

Minister's Secretariat

Secretary General

International Trade and Integration Commission

Agricultural Credit

Secretarial Division

Directorate General of Planning

Legal Advisory Office

National Agricultural Library

Distribution Bureau

Technical Project Implementation Unit

National Animal Health Service

Internal Audit Office

Cotton and Tobacco Inspection Office

Directorate General of Cooperatives

National Charcoal Commission

Rural Development Fund

National Project Coordination and Management Bureau

National Forestry Service

Census and Statistics Bureau

National Industrial Bank

Renewable Natural Resources Management Unit

Biosecurity Commission

Vice-Minister for Livestock

Vice-Secretary for Agriculture

Livestock Secretariat

Agricultural Secretariat

Animal Breeding and Research Bureau

Animal Foodstuff Standards and Control Bureau

Animal Protection Bureau

Agricultural Research bureau

Seed Bureau

Agricultural Extension Bureau

Agricultural Education Bureau

Plant Protection Bureau

Fig. 4-3　Organizational Structure of Ministry of Agriculture and Livestock

Director

- Secretary General
- Human Resources Office
- Technical Advisory Unit
- Forest Supervision Unit

Division

- Forest Management Department
  - Forest Registration
  - Permits (Timber Movement Permits)
  - Technical Planning
- Afforestation Department
  - Afforestation Registration (up to 20 ha)
  - Statistics
  - Afforestation Registration (more than 20 ha)
- Administration Department
  - Accounting
  - Supplies
  - General Services
- Forestry Education, Extension and Investigation Department
  - Alto Parana Forestry Centre
  - Itapua Forestry Centre
  - Capiibary Forestry Centre
  - Nurseries for Forestry Extension
  - Forestry Techniques Extension Centre

Forestry Office

- Amambay
- Canindeyu
- San Predro
- Concepcion
- Caaguazu
- Alto Parana
- Itapua
- Caazapa
- Chaco
- Central

Fig. 4-4   Organizational Structure of SFN

(3) Current Conditions of Forests

    1) Composition of Forests in Paraguay

According to data compiled by the UNA, forests in Paraguay can be classified in three categories, i.e. continuous high forest, degraded high forest and isolated open forest, based on the characteristics of the vegetational composition.

Continuous high forests form the most important forest vegetation and continually spread over a wide area. Their crown layer is dominated by high trees of 25 – 35 m and their productivity is high because of their distribution on fertile soil. Because of these characteristics, they are liable to pressure by agriculture and stock raising. Degraded high forests (including isolated wet low forests found on highland grassland) are similar to continuous high forests. Because of pressure by agriculture and stock raising, the process of degradation has progressed to the point that trees of high economic value have already been cut, leaving medium height trees of 15 – 25 m. Compared to these two forest categories, isolated open forests are characterised by a lower tree density as well as a lower tree height. They are distributed in groups on the vast natural grassland.

The areas covered by these three types of forests in the Eastern Region in 1991 were reported to be 13.7%, 4.7% and 2.5% respectively.

    2) Change of Forest Area in Eastern Region of Paraguay

Forests in the Eastern Region of Paraguay covered some 8,311,000 ha or approximately 52% of the region's total land area in 1945. By 1991, the forest area had drastically decreased to some 3,342,000 ha or approximately 21% of the total land area (Land Use and Forest Disappearance in the Eastern Region of Paraguay: Part I, Faculty of Agriculture, NUS, May, 1994).

The socioeconomic background for such a drastic change of the forest area is said to be attributable to several reasons. Firstly, large-scale forest development took place to create farm land in the 1960's and the development of the road network increased the number of new settlers. These phenomena were particularly noticeable in the Concepcion District in the north and the Paraguari District and Itapua District in the south. The completion of roads linking Asuncion to Ciudad del Esto and Encarnacion in the 1970's formed a triangular area of the most developed agricultural and stock raising in the country, making Paraguay a net exporting country of agricultural products. In the 1980's, an increase of the population led to

the birth of new urban areas and the subsequent requirement for more agricultural land and timber production resulted in expansion of the farming scale through mechanisation at the sacrifice of the forest area which drastically decreased. The population increase continued in the 1990's and the opening of new roads further facilitated the creation of farming field which was assisted by intensive cutting to produce logs and burning for land clearance. These phenomena were not confined to the triangular area mentioned earlier but were observed nationwide.

The continuation of such irrational forest use resulted in destruction of the natural environment. To be more precise, localised soil erosion due to extraordinary rainfall, drought and abnormally high temperatures are said to have been observed in recent years with adverse impacts on agricultural and livestock production (Bosque del Paraguay, JICA-SFN, 1998).

Meanwhile, the institutional arrangements under the Forest Law and others are designed to ensure the survival of forests at a certain proportion or at specified sites. Having recognised the importance of the rational use of natural resources, the MAG has adopted the basic principle of avoiding clear cutting and a qualitative decline of forests. Nevertheless, the decrease of forests is still continuing because of (i) insufficient policy collaboration between government offices, (ii) non-observance of laws and regulations by land owners and (iii) insufficient guidance by the SFN.

Under these circumstances, the enactment of the Afforestation Promotion Law shows the government's commitment to making an important first step to achieving the restoration of forests because of concern regarding the present situation where forests are rapidly disappearing in Paraguay as a whole. However, the government is facing problems relating to the implementation of its forest and forestry policies, particularly a funding shortage, and must try to find ways of overcoming such problems.

(4) Background of Decrease of Natural Forests

While the principal purpose of the Afforestation Plan for the Eastern Region is to increase the forest area in the region by means of planting, one important target of the Plan is to stop the rapid decrease of the natural forest area.

There appears to be a consensus of opinion that even though the Government of Paraguay intends to protect natural resources, the fact is that forests have been indiscriminately destroyed.

Social, political and economic factors appear to lie behind the rapid decrease of natural forests. It is essential that the government investigate the causes of the destruction of natural forests and implement effective prevention measures if the government plans to request overseas financial aid for new afforestation projects.

1)   Indiscriminate Settlement to Natural Forests

The Agricultural Land Law enacted in 1943 defines forests (natural forests) as land which can be developed but which has not yet been developed. Another article states that undeveloped land may be subject to expropriation.

(Note: Afforested sites are not regarded as unproductive.)

Meanwhile, the Agricultural Land Reform Law gives the IBR (Instituto de Bienestar Rural: Rural Welfare Institute) the power to acquire or expropriate land to provide places for dwelling and production for landless farmers. However, because of historical reasons, there is little state-owned land in Paraguay and land subject to expropriation is almost inevitably privately-owned land.

Using this law as the legal basis, a large number of landless farmers appear to have settled in natural forests and their occupation of forests and applications for development to the IBR appear to have been tolerated. Some of these farmers (according to information provided by international organizations) cut natural forests during or even prior to the development application process. Moreover, there are many landless farmers who have been given land several times by the IBR. The destruction of natural forests is said to be systematically conducted, led by some timber companies, further encouraging the cutting of natural forests by landless farmers.

The socioeconomic background for such settlement is the presence of many poor people in Paraguay (estimated to be some 1.7 million). Although the purpose of the law is to provide dwelling as well as farming sites for landless farmers, who account for the majority of the poor, at low cost, natural forests are suitable targets because of the prospect of immediate income for landless farmers who settle in a natural forest, defined as "non-productive" land by the law, and cut natural trees.

Furthermore, large-scale land owners tend to cut natural forests because of their concern in regard to the intrusion of landless farmers to their land, further accelerating the decrease of natural forests.

In order to rectify this situation, proposals to revise these laws are said to have been submitted to the current parliamentary session. The planned revisions include the punishment of those landless farmers who have applied for settlement more than once, revision to change the body responsible for the enforcement of the Agricultural Land Law and revision of the Agricultural Land Law itself. However, it is uncertain whether or not revisions to solve all of the problems will be successfully passed by the Parliament and there is no way of knowing at present if the revised laws and regulations will end the traditional cycle of invasion, cutting and sawing.

2) Impacts of Extensive Stock Raising

Stock raising in Paraguay is characterised by the extensive method where the number of animals per unit area is relatively small. As the maintenance cost, including the fertiliser application cost, of pasture land is low in the case of this method, the land fertility is severely reduced within 10 years. Once such a situation arrives, stock farm owners designate existing pasture land as fallow land and develop new pasture land within the areas owned by them. Natural forests often become the targets of this development and, therefore, natural trees are cut to make way for pasture land.

Natural trees produced in this manner are by-products for land owners and are sold in the market regardless of the timber market situation, possibly causing a collapse of the price of timber. One way of avoiding the almost incidental cutting of natural trees is to intensify land use to increase the productivity of the unit land. As this is a question of how to use private land, the government cannot, in principle, interfere. Nevertheless, it may be possible to induce the intensification of land use by reducing the price of basic N-P-K fertiliser (by means of a subsidy) and the implementation of educational activities by related government offices.

(5) Current Situation of Afforestation Sites

1) Afforestation Area in Eastern Region of Paraguay

① Afforestation Area as of 1991

Table 4-17 shows the afforestation area based on the agricultural and livestock census in 1991. While afforestation activities were low in the Western Region, the afforested area in the Eastern Region doubled in the 10 years from 1981. The actual figure was a mere 15,000 ha, however, far below the forest area lost due to development.

Table 4-17   Afforestation Area in Agricultural and Livestock Census

(Unit: ha)

Region \ Species	Year of Census	Eucalyptus	Pine	Indigenous Species and Others	Total
Eastern Region	1991	2,918	2,934	9,288	15,139
Western Region	1991	7		6	13
Total	1991	2,925	2,934	9,294	15,152
	1981	2,022	1,682	3,370	7,074

② Implementation Situation of Afforestation Under Afforestation Promotion Law

From 1995 to 2000, some 30,000 ha were afforested as shown in Table 4-18. By district, the Canindeyu and Itapua Districts are ranked higher with 15% each, followed by the Concepcion, Caazapa and Alto Parana Districts with 12% each.

Since 1999, there has been a sharp decline of afforestation work. At present, some land owners are said to be staying away from implementation of planting in view of the delayed subsidy payment to afforesters because of the shortage of the budget funding for the afforestation subsidy. Accordingly, the afforestation performance in 2001 is expected to be very low.

Table 4-18   Afforested Area Under Afforestation Promotion Law

(Unit: ha)

Scale of Land Ownership	1995	1996	1997	1998	1999	2000	Total
Up to 20 ha	-	-	517	2,511	174	36	3,238
More than 20 ha	743	3,698	11,308	7,280	305	3,255	26,589
Total	743	3,698	11,825	9,791	479	3,291	29,827

Note: SFN survey (October, 2001). It is said that there are other afforestation sites which have not yet been inspected by the SFN but their actual sizes are unknown.

2)   Scale, Species and Age of Afforestation Sites

The scale of each afforestation site is approximately 0.3 – 4.0 ha for land owners with up to 20 ha or as large as 200 – 300 ha for large-scale land owners. Most large plantations of enterprises are relatively new. The main planted species are eucalyptus (mainly E. camaldulensis and E. grandis), pine (P. elliottee and P. taeda) and paraiso (Melia azedarach). Some sites are planted with "*Tung*" for oil extraction

and with peteruv and incienso (which are indigenous species and which are planted for experimental purposes). Some trees are more than 30 years old although most trees are 1 – 15 years old.

Paraguay has only a short history of afforestation and pine and paraiso have only recently begun to be used to produce ordinary timber at sawmills. The reputation of the logs produced from the planted trees is fairly high among the sawmills which use them. Eucalyptus is hardly used to produce ordinary timber. However, pine and eucalyptus are popularly used to produce ordinary timber in neighbouring Argentina and Brazil. Improved eucalyptus species are also planted in Paraguay at some afforestation sites to produce high quality timber in the future.

Judging from these facts, there should be a real demand for planted trees consisting of the species mentioned above in both the domestic and international markets to replace the dwindling natural trees. Furniture and plywood made of paraiso in particular enjoy a high reputation even today.

3) Growth Situation at Afforestation Sites

Fig. 4-5 and Fig. 4-6 show the growth situation at afforestation sites based on the field survey results for these sites and existing data.
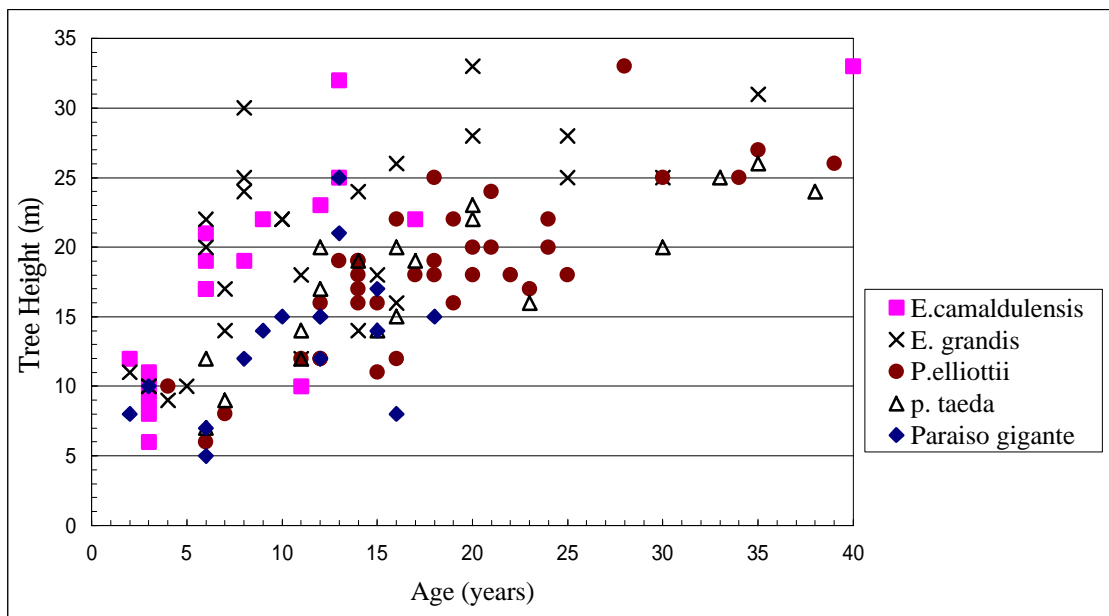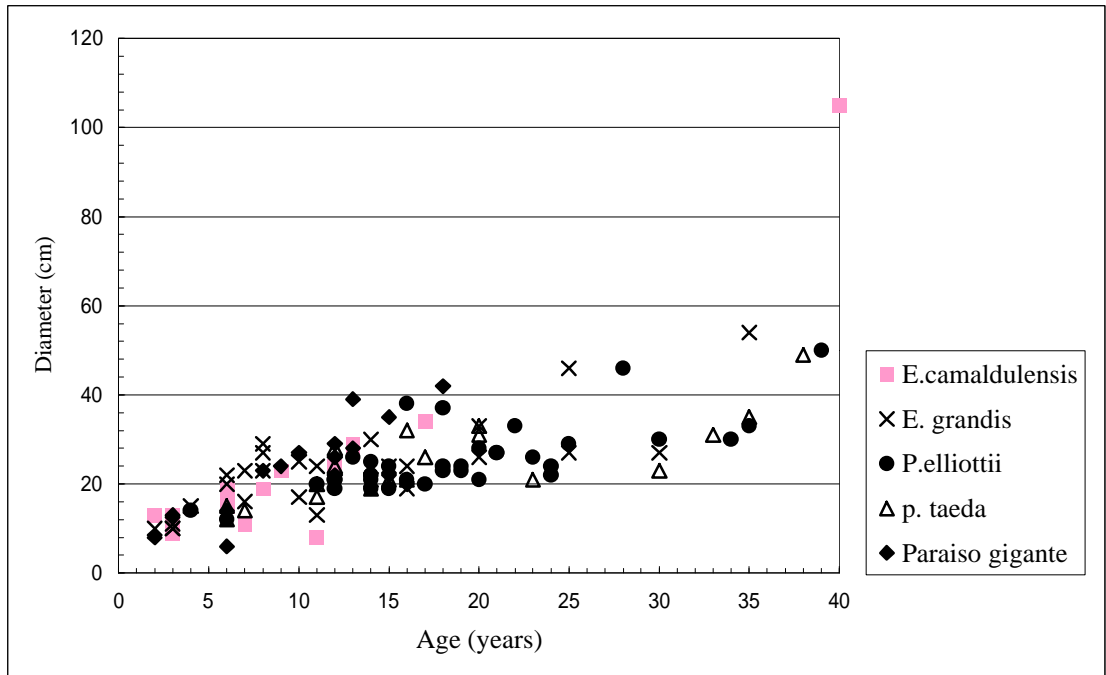

Fig. 4-5   Height Growth of Planted Trees

Fig. 4-6　　Diameter Growth of Planted Trees

As the data does not include E. camaldulensis and Paraiso gigante of more than 20 years of age, it may be unsuitable for general evaluation of the growth situation. Nevertheless, the following inferences can be made.

In terms of height growth, all five species show vigorous growth up to approximately 20 years of age with their growth slightly slowing thereafter. In general, both E. camaldulensis and E. grandis show the most excellent growth in a similar fashion, followed by P. elliottee and P. taeda which also grow in a similar fashion to each other. Paraiso gigante shows similar growth to that of P. elliottee and P. taeda up to around 10 years of age but its growth performance then becomes inferior to that of other species. The average tree height at around 20 years of age is approximately 25 m for E. grandis and P. elliottee, approximately 20 m for P. taeda and approximately 15 m for Paraiso gigante. (The growth performance of E. camaldulensis is inferred to be similar to that of E. grandis and P. elliottee.)

In terms of diameter growth, all species again show vigorous growth up to around 15 years of age with their growth slightly slowing thereafter. In general, E. camaldulensis and E. grandis show better diameter growth than others, followed by Paraiso gigante.

The average diameter at around 20 years of age is approximately 35 cm for E. grandis and approximately 25 cm for P. elliottee and P. taeda. (E. camaldulensis is inferred to have a similar performance to that of E. grandis). What is particularly noticeable is the relatively vigorous diameter growth of Paraiso gigante from a young age and it is observed that some 12 year olds are more than 40 cm in diameter.

4) Damage by Diseases and Pests

① Damage by Diseases

In the case of paraiso, some 12 – 13 year old trees show yellowing of the leaves and a slowing down of the growth, leading to die-back from the top. At some sites, however, all of the planted trees are growing healthily without suffering from this disease. At the present stage, research on the cause of disease has only been conducted on several cases and no effective prevention method has yet been established.

Mr. Alfred Stauffer of the UNA reports the following observations on the symptoms, causes and provisional measures to prevent the disease as outlined below.

a. Symptoms

i. The leaves on extreme branch have shrunk to one-third of the size of normal leaves and have yellowed.
ii. Normal leaves show signs of being worn out.

b. Possible Causes

i. Phytoplasma, an intermediate microbe between a bacteria and a virus, is transported by insects, damaging the vessels of a tree. The symptoms appear 2 – 3 years later (in the case of a. (i)) (even though white spots are observed on the stem, their damage is small).
ii. Basdiomycetes, a type of mushroom, may be responsible (in the case of a. (ii)).

c. Measures to Combat the Disease

Even though effective measures have not yet been established, the following actions are recommended.

- Removal of trees suffering from the disease
- Removal of weeds which provide habitat for insects
- Bud pruning from a young age to avoid infection from pruning tools
- Collection of seeds from healthy trees in a group of trees infected by the disease
- Avoidance of damage to the stem or roots during forestry activities
- Application of oil to the cut ends after the pruning of branches of 2.0 – 2.5 cm in diameter
- Avoidance of planting at permanently wet land
- Spraying of clorothalonil or similar chemicals to prevent round spots appearing on the leaves by Serospora meliae and Phyllostica azedarachis (both mushroom species) at nurseries

② Damage by Pests

Substantial damage at afforestation sites is caused by particular types of ants (locally called ysau and akeke). The control of these ants is an important factor for successful afforestation and the work is recognised as being an essential component of forestry activities in most areas. At present, damage by ants is the only significant pest damage.

5) Motive for Afforestation

The actual motive for afforestation varies from one afforester to another. Recent afforestation work by small-scale land owners has often been conducted to cash in on the home labour force under the Afforestation Promotion Law and in anticipation of future earnings. Some sites are planted without any specific reason except on the recommendation of the forestry office or based on personal preferences.

The afforestation work of enterprises mainly aims at earning future income through the sale of timber wood and/or securing the supply of raw wood for their own sawmills.

(6) Agroforestry

Actual cases of agroforestry are mainly associated with small-scale land owners. There are cases of agroforestry in the Central Region which are part of European assistance for sustainable agricultural production by settlers. Other cases assisted by the BID are observed in the Northern Region. Both projects have now been completed.

Paraiso is an overwhelmingly popular afforestation species combined with agricultural crops, followed by eucalyptus. Popular crops are maize, beans, mandioka, cotton, papayas, bananas, pineapples and citrus fruits. Combination with mate is sometimes observed. Because of the cultivation of agricultural crops, tending of the planted trees is said to be hardly conducted. Nevertheless, as the afforestation site is near the home, pruning is said to be adequately conducted, partly because of guidance provided by the SFN.

Some large-scale land owners are also engaged in agroforestry by allowing the cultivation of agricultural crops by local farmers at their afforestation sites. This practice is designed to prevent the illegal invasion of their land and to reduce the cost of tending afforestation sites through indirect economic assistance for farmers.

These facts suggest the importance of selecting an appropriate site of an appropriate size to allow sufficient daily management to prevent or alleviate damage by diseases when opting for agroforestry, particularly agroforestry involving paraiso. The introduction of agroforestry appears to be possible at large-scale afforestation sites in combination with the agricultural crops cultivated by local farmers. It must be noted, however, that there are land owners who are worried about the permanent settlement by farmers if cultivation is permitted at large-scale afforestation sites.

(7) Production of Seedlings

1) Sufficient Supply of Seedlings for Afforestation

Most of the seedlings for afforestation work are produced by afforesters at home. Small-scale land owners often purchase seedlings from the SFN's nurseries. Afforesters are confident of being able to produce the required number of seedlings to cope with the scale of afforestation which is several times larger than the present scale as a long time is not required for the growth of seedlings. Most seedlings are produced in pot.

2) Guidance and Extension System for Seedling Production Techniques

Nurseries belonging to the SFN have been established in most district under the national guidance and extension system for seedling production techniques (Forestry Techniques Extension Centre, three forestry centres and seven local nurseries with a total production capacity of some 14 million seedlings). There are seed collecting forests of eucalyptus, pine and paraiso. The Forestry Techniques Extension Centre

has a seed storage. For the promotion of the planned plan, these facilities must be actively utilised to produce the required high quality seedlings.

3) Research on Production of Excellent Seeds and Seedlings in Private Sector

Leading afforestation enterprises in Paraguay are conducting research on breeding by means of crossing (mainly eucalyptus) and planting experiments (for example, it is hoped to achieve annual growth of 45 m^3/ha for 10 year olds).

In Brazil, research on breeding is actively in progress featuring eucalyptus and pine (it is hoped to achieve annual growth of 50 m^3/ha for 20 year old E. grandis and 30 m^3/ha for 25 year old P. taeda).

As such, the private sector is playing a leading role in efforts to secure a future advantage in the international market by means of the improved quality of the produced wood, increased unit growth and cost reduction through a shorter growth period. It is necessary for Paraguay to make serious efforts to secure excellent seeds and seedlings to establish advantageous trading terms in the international market for the timber to be produced from its artificial forests.

(8) Example of Promoting Afforestation by Grouping of Small Farmers

In its guidelines for agricultural and stock raising policies, the Government of Paraguay classifies those conducting farming and stock raising in three groups, i.e. industrial farming group (large-scale stock farm owners and owners of large-scale industrial farms), medium-scale commodity crop producers' group and small farmers' group. While expressing its continuous support for the first two groups, the government considers support for the small farmers' group and landless farmers who are inferior to the other two groups in terms of their financial and technical strength to be the highest priority task.

In an example of efforts to promote agroforestry by grouping small farmers coupled with the provision of financial assistance to facilitate the permanent settlement and stabilisation of the daily lives of small farmers, the Timber Association of Lower Canindeyu has inherited an agroforestry project (ALA) covering 200 ha in the Canindeyu District which was jointly conducted by the UE and Government of Paraguay in the past and commenced new work in 2000. This work is outlined next.

1) The management body is the Canindeyu Agroforestry Development Commission which have five representative members of the following in accordance with its articles of association.

> Timber Association
> IBR
> SFN
> Farmers
> Canindeyu Government (Chairman)

(At present, the Commission is run by three members as the representatives of the IBR and SFN are absent.)

2) The conditions to receive payment to cover the cost of afforestation are (i) proper registration of the land and (ii) registration with the Commission (a signature is required). No conditions are specified in regard to the cutting of trees before maturity and other events. The introduction of additional conditions (compulsory tending for 6 – 7 years after planting, etc.) is being considered.

3) In 2000, payment has been made for 96 ha (87 afforesters). For the remaining 142 ha, the results of supplementary planting are currently being inspected and payment will be made as soon as the results have passed the inspection.

4) In regard to the afforestation fund, $G5,000/m^3$ of timber will be collected from members of the Timber Association in 2001 in addition to the accumulated fund in the past. It is planned to collect G150 million a year from 23 members (G20 million has been collected so far). In addition, the District Government is expected to contribute some G50 million/year.

5) In regard to the future, only supplementary planting to the planted site conducted last year is planned for this year (2000). Afforestation of 300 ha is planned in 2002. Funding has been secured to cover the planned work in 2002.

6) At present, 219 farmers of eight settlements are participating. The number of participating farmers has been increasing because cash payment has actually been made.

7) Afforestation work is conducted as part of agroforestry. Paraiso is the predominant species used for planting although some indigenous species have been planted by a

small number of farmers. Popular crops are cassava, beans and maize but many crops are actually cultivated because there are no restrictions on crops.

8) Each household in the settlements involved owns 5 – 10 ha of land. Those with 5 ha of land use the land in their possession entirely for cultivation and plant trees over additional land of 1 ha. Those with 10 ha of land still have 1 – 3 ha of natural forest. These natural forests have undergone selective cutting at least once and some farmers use them as natural nurseries.

9) There is no large machinery, such as tractors. All work is conducted using animals and manpower.

10) In regard to planting, seedlings and ant extermination equipment are purchased by the Commission and provided to the farmers free of charge. Farmers provide labour for nursing work. The work method at the afforestation sites is decided by each farmer. There is no set planting density (the general standard is 883 seedlings per ha). Fertiliser is only applied for the cultivation of cotton.

11) A technician who is a graduate of the Forestry College is employed to provide technical guidance for farmers.

4.1.3　Current Conditions of Forest Products Industry

(1) Cutting and Hauling

Most forests in Paraguay are privately-owned with a very small number of national forests and public forests. The forest owners are diverse, ranging from stock farmers to farmers and timber producers. Stock farmers have the largest share of forest ownership. Many forests are incidental forests to stock farms and farm land and are still exposed to farmland development except those forests which have been kept in catchment areas and on sloping land and other land which is unsuitable for stock raising.

Cutting is generally conducted by timber producers and few people specialise in cutting and hauling. Many timber producers possess the necessary equipment and working teams for cutting and hauling. It is not unusual for timber producers to prepare a forest cutting plan and to conduct the actual cutting on behalf of forest owners.

As far as the scale of forest cutting is concerned, 63% of cutting is conducted in accordance with a medium-scale forest management plan which is applicable to

medium-scale forests of not larger than 500 ha as set forth in Article 26 of Law No.422 (Forest Law, 1973). 22% of cutting is conducted under a land use plan to convert forests to farm land and pasture land, etc. while 8% of cutting is conducted under a large-scale forest management plan which is applicable to forests of larger than 500 ha. Finally, 7% of cutting is conducted under a small-scale forest management plan which is applicable to forests of up to 50 ha. One serious problem faced by forestry in Paraguay is that nearly one-quarter of timber production is associated with the development of farm land and is responsible for the disappearance of forests (Table 4-19).

Table 4-19   Forest Cutting Based on Different Plans

Type of Forest Plan	Cutting Volume (m^3)	%
Large-Scale Forest Management Plan (> 500 ha)	58,270	8.0
Medium-Scale Forest Management Plan (> 50 – 500 ha)	461,014	63.1
Land Use Plan	163,160	22.3
Small-Scale Forest Management Plan ($\geq$ 50 ha)	48,343	6.6
Total	730,787	100.0

Source: SFN, Permitted Distribution of Forest Products (1999)

In regard to the cutting method, clear cutting is adopted for cutting under a land use plan while single tree selective cutting is adopted for cutting under other plans. The cutting system consists of a chainsaw, a large tractor equipped with a towing device and a crane. In general, the chainsaw is used for cutting, trimming and bucking, the tractor is used for skidding and the crane is used for loading. In the case of cutting in artificial forests, a cutting plan must be submitted to the SFN for approval if clear cutting is planned (Ministerial Ordinance No.176, MAG, 1999) (Decision by the SFN, No.0176199). Final cutting is generally conducted in the form of clear cutting. No notification is required for thinning. The first thinning is conducted by means of line thinning or a combination of line thinning and single tree thinning. From the second thinning onwards, single tree thinning is conducted. The generally small size of artificial forests means a small production volume. As the trees are rather thin and light, the final cutting and thinning processes are often manually conducted. A chainsaw is used for cutting and the logs are often hauled manually although a tractor may be used depending on the circumstances.

Such high performance forestry machinery as harvesters and grapple saws have not yet been introduced in Paraguay because of the scarcity of artificial forests to which these machines are suited. Most logs come from natural trees and are thick and heavy.