参考資料　2.

年次計画の改訂の基本的な考え方

○改訂の趣旨

当プロジェクトは発足当初、活動開始が約1年遅れた。このため5年のプロジェクトを実質4年で実行することになり、当初の計画のままでは、計画と実行が実情に合わないので、年次計画の改訂案を作成したものである。これに従い、日伯協力して、プロジェクト期間内に目的を達成するよう努力することが必要である。

○主な内容の変更

①　流域管理

・事業の内容――量水えんてい等の建設は約10カ月遅れたものの、ほぼ完成した。残りの施設はプロジェクト期間内に建設するが、今までの工事により、これらの施設を使って流域管理分野の研究協力を進めることが可能となった。このため、今後2年間に当初予定した研究協力項目を完遂できるよう計画を改訂した。実施項目が多いため、スケジュールとしてはかなりきついかも知れない。なお、C試験地はダム建設にあまり適当でないため計画からはずした。

②　伐出技術

・事業の内容――長期専門家の派遣は1981年3月からと予定より遅れたが、現在、技術移転は順調に進んでおり、今後2年間に当初予定した研究項目を完遂できる予定である。改訂計画は当初計画より、より具体的なものとし、作業能率、安全研究等を加えた。

・専門家の派遣――当初予定どおり

・研修受入――カウンターパートの決定が遅れ、研修受入が遅れていたが、1981年度中に1名受入可能となった。

③　リモートセンシング

・事業の内容――当初予定のほかにブラジル側の強い要望により材積表、収穫表の作成手法にも力を入れることとした。またコンピューター関係にも重点をおいている。

・専門家の派遣――長期専門家の派遣は当初なかったが、ブラジル側の強い要望により短期派遣の計画を長期に変更した。

・研修受入――リモートセンシング分野での研修受入を増やしたほか、コンピューターの研修受入も行うこととした（実施済）。

○小径木利用

・事業内容――当初計画と基本的に変らないが、1982年、1983年の2年にわたり指導を行うこととした。

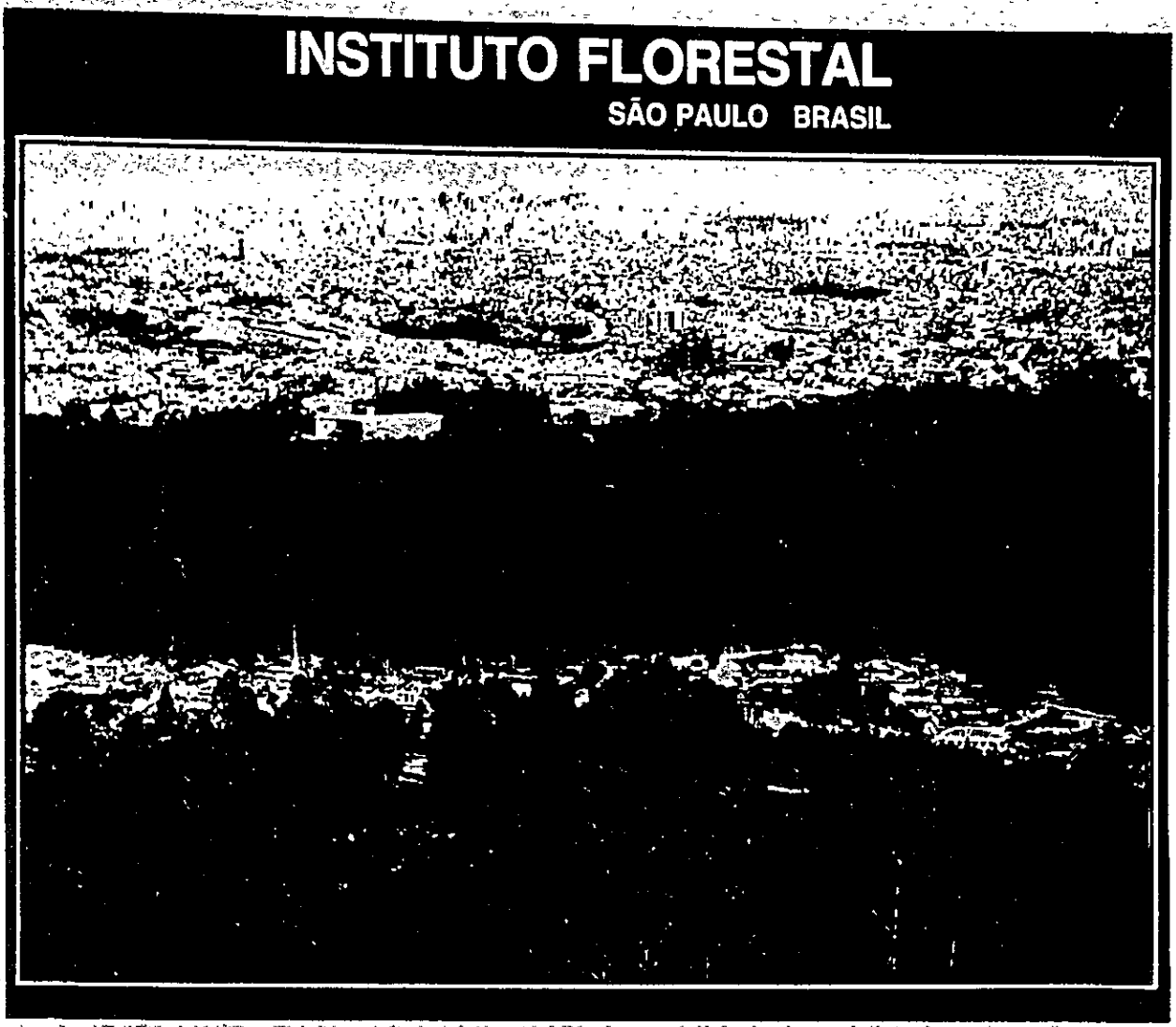
・専門家の派遣――当初予定どおり、短期派遣で対応し、1981年度はダブルバンドソーの操作、取付を行う。

・研修受入――1982年1名、1983年1名を予定

・総括の受入研修――森林院責任者訪日によるプロジェクト全体運営の中間打合せと協力内容の見直しのために、1982年に計画した。

参考資料　3.

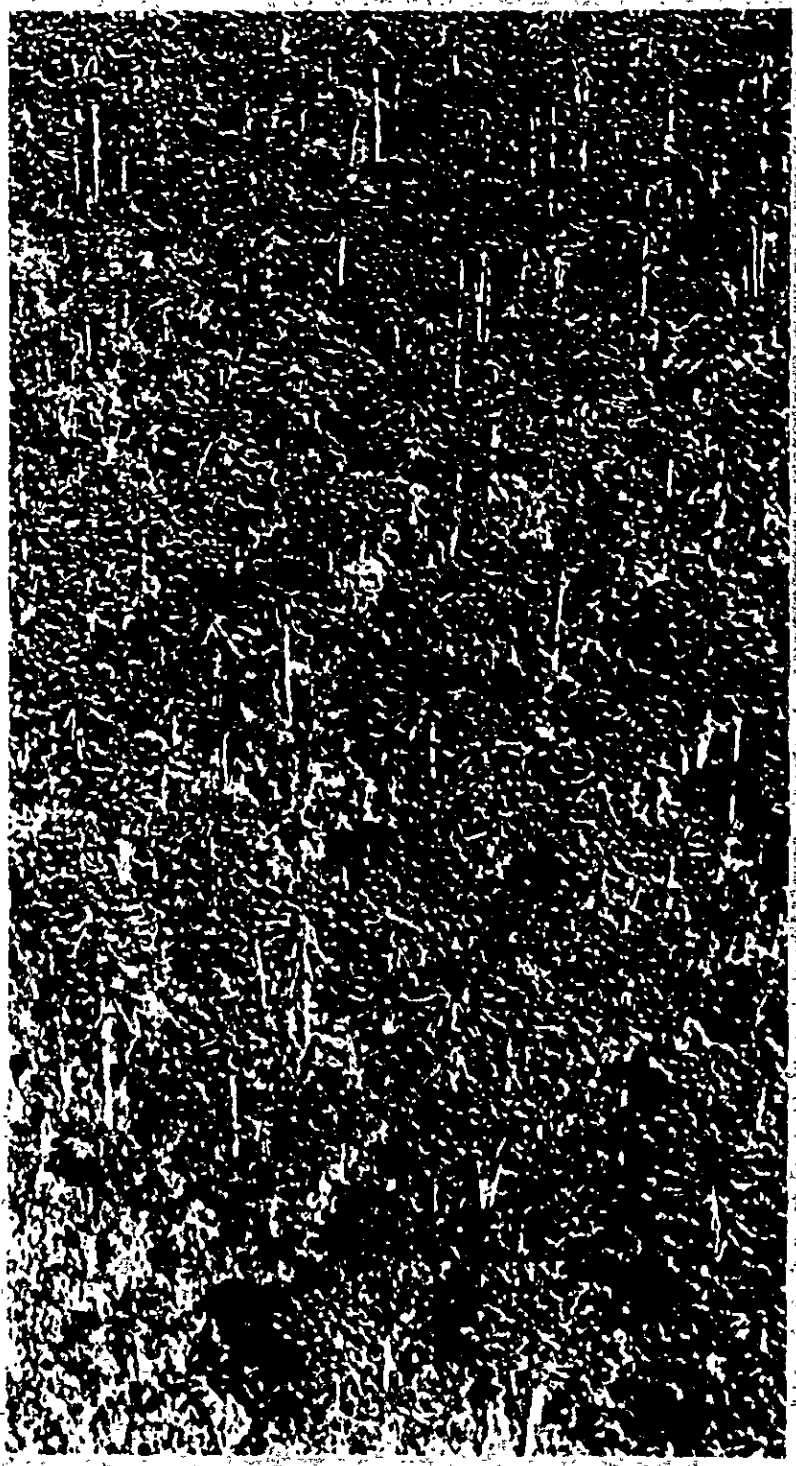
ブラジルサンパウロ森林院概要



Instituto Florestal de São Paulo

The headquarters of the Instituto Florestal in the Parque Estadual do Capão

This publication is a report of the work that the Instituto Florestal de São Paulo has undertaken with the goal of preserving the remains of the native forests, subsidizing reforestry with necessary research, and actuating rational forestation over a large portion of the state's territory. It is a tribute to all who recognize the inestimable environmental, economic, cultural and aesthetic value of forests and who continue the fight to eliminate predatory activity within the country, replacing it with a conscientious attitude in regard to the forestry problem.



Alberto Löfgren the first director of the Horto Botânico

Arboretum at Horto Botânico in São Paulo at the beginning of the century

Eighty-four years of fighting against devastation

When the Jesuit Manuel de Nobrega climbed the Serra do Mar in 1554, to found the City of São Paulo and make way for the conquest of the plateau, more than 80% of the Paulista territory was covered by dense native forests which occupied an area of about 20 million hectares. By 1920, almost 370 years later, more than half of the forest cover still survived because of resistance to pioneering and the expansion of agriculture and stock-farming Then came the industrial development phase, and in barely half a century the devastation reached alarming levels. By 1973, the primitive forest was reduced to 8.75% of the territory, with more than 2 million hectares concentrated almost exclusively in the Serra do Mar range because it was protected by the irregular topography.

Keeping in mind that international standards recommend the maintenance of at least 30% of the forest cover, the Instituto Florestal de São Paulo has been struggling for 84 years to live up to this ideal through the protection of the remaining forests, the promotion of reforestation and the rational utilization of these resources.

It has accomplished some impressive victories, such as the creation of native forest reserves, reforestation of a significant portion of the Paulista territory, and principally the dissemination of the conservational ideals that mark its activity since the last century and which today are more necessary than ever

These ideals had already taken effect in the Province of São Paulo at the end of the nineteenth century The coffee monoculture, which was firmly established by 1850, demanded the sacrifice of hectares and hectares of forests to continue its expansion. The railway followed a similar path because wood provided cheap fuel for steam-engines. The use of wood for domestic use in the City of São Paulo, averaged 840 hectares a year and caused enormous scars in the whole green belt of the capitol, principally on the north slope of the Serra da Cantareira The warnings of José Bonifácio, "The Father of Independence", still echo as they did in 1821, to the "Deputies" of the Province of São Paulo about the destruction of the forests, when word came from the outside on the movement, in the USA, Sterling Morton pushed the issue until he managed to create the American Forestry Service; in Japan, the Minister of Education ignited a popular campaign for the protection of trees; in Argentina, an identical campaign was coordinated by Oswaldo Magnasco, the Minister of Public Instruction; here, popular pressure and the governing classes increased the desire to control predatory activity of native forests.

Horto Botânico

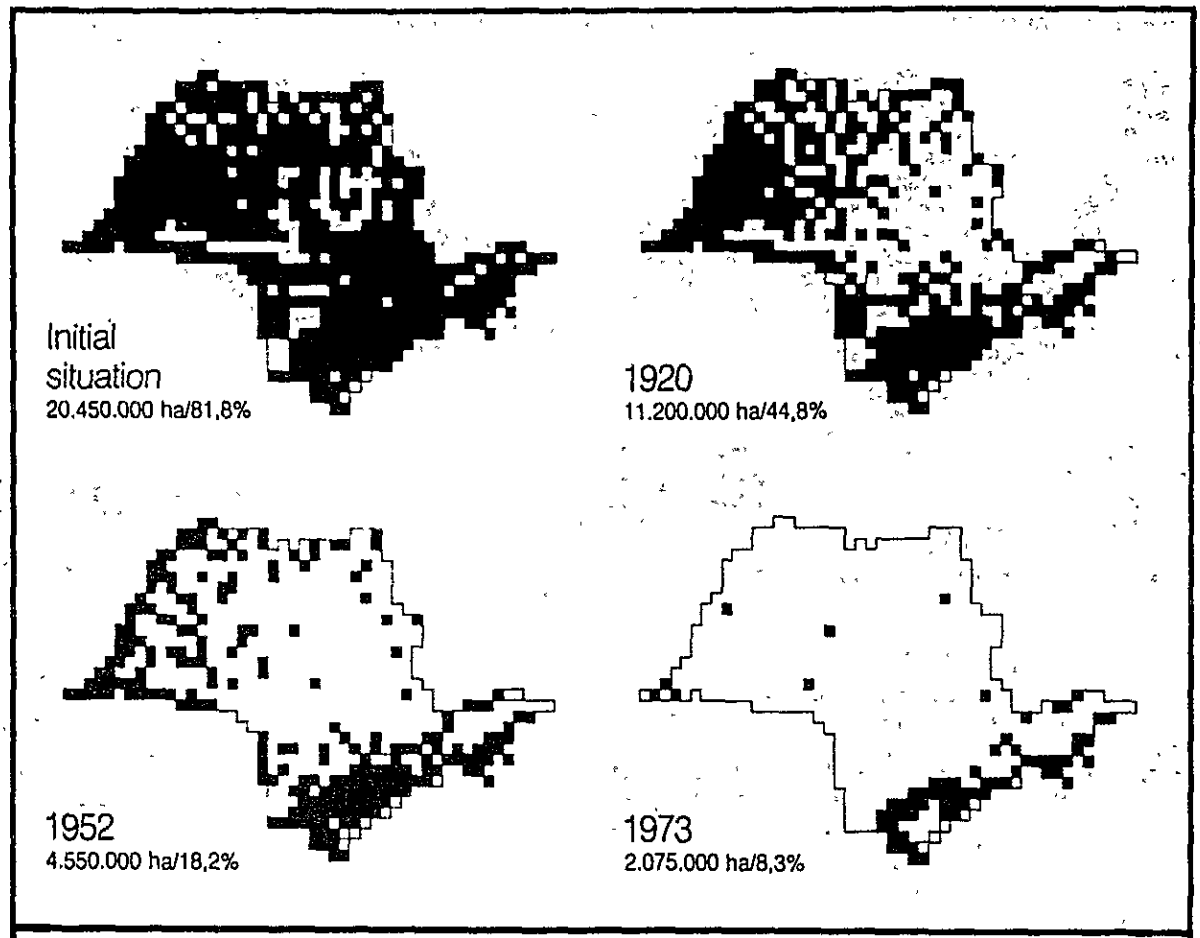
It was in this atmosphere that the Government of the Province created the Horto Botânico de São Paulo in 1896, which at that time was connected to the Geographical and Geological Commission of the Secretary of Agriculture and was the embryo for the present Instituto Florestal. Its first director and naturalist was the Swede Alberto Lofgren, who concentrated his efforts in botanical and forestation studies of the national species and exotic forests· many species were imported from the botanical gardens of Calcutta, Singapore, Sidney, Middelburg, the Phillipines and Cuba, or were collected from the interior of the province. Emphasis was given to the plantation of the Brazilian pine *(Araucaria angustifolia)*, specimens of which still survive today at the Horto Florestal The work gained such international recognition that in 1901, the Austrian Botanical Commission headed by Count Wettestein van Werdershein, proposed that the Horto Botanico be modelled after the famous Botanical Garden of Buitenzog Today on the island of Java, Bogor is considered a true treasure of tropical flora, and any western naturalist of fame has been obliged to train here

The study of the scientists however, did not succeed in avoiding the continuous devastation; in 1907, 6 million hectares of the native forest had already been cut down.

The government demanded urgent solutions from the forestry authorities in light of this situation It was further aggravated by the abuses of the railroads, which broke their agreement of using only imported charcoal and began to supply their locomotives almost exclusively with wood from the native forests When a vegetal substitute to feed the boilers became pressing, the Companhia Paulista de Estradas de Ferro set the example. Since 1904 the company had managed to introcuce *Eucalyptus* spp as a species of rapid growth

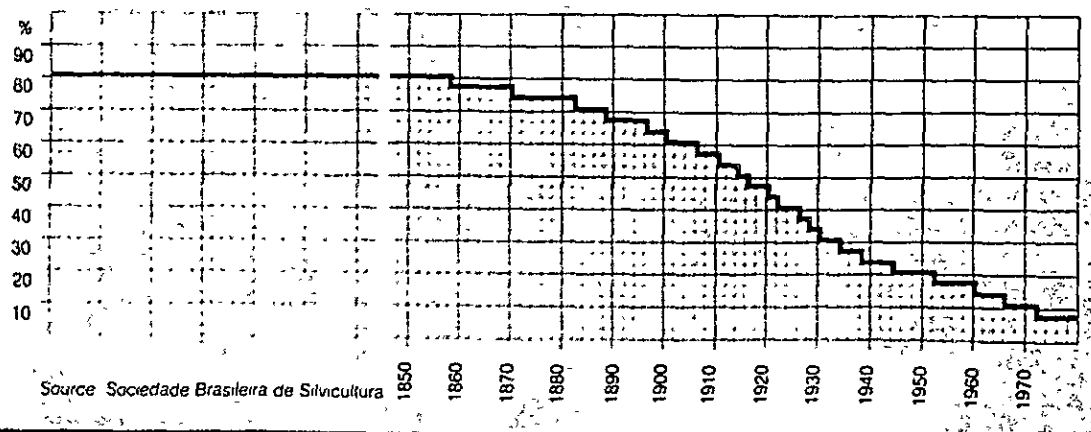
The Serviço Florestal

Faced with these circumstances, in 1911 the Horto Botanico transformed itself into the Serviço Florestal and radi-

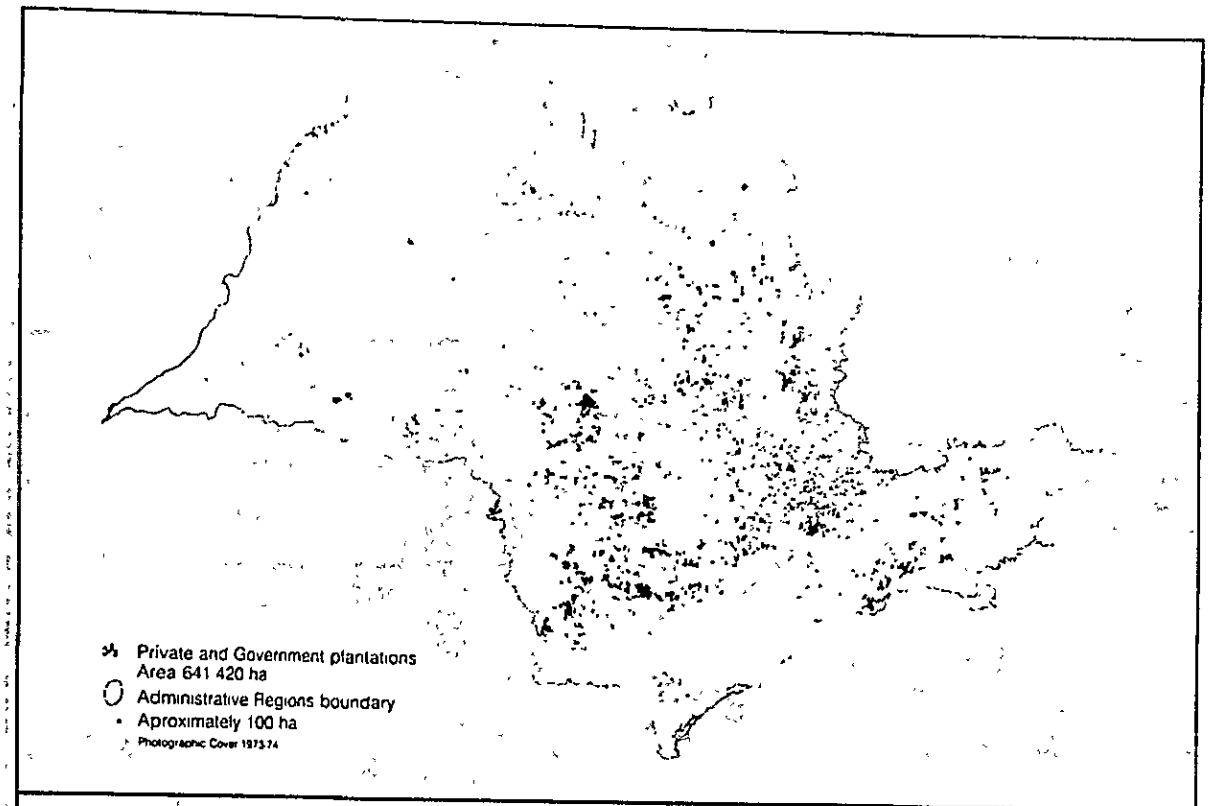


Forest devastation in the State of São Paulo

Forest Cover



Source Sociedade Brasileira de Silvicultura



Reforestation in the State of São Paulo

cally changed its objectives, which became "the scientific study of the dendrological flora and the restoration of state's forests". Edmundo Navarro de Andrade was chosen to direct it, and is considered to be the "Father of the National Cultivation of Eucalyptus " During the 6 years of his administration, priority was given to the production and incentivation of this exotic species; seeds of original trees were imported from Australia and Ásia and disseminated all over the country. The campaign was augmented in the following decades, and in 1962 on the occasion of the 2nd world Eucalyptus Conference held here, Brazil was recognized as the retainer of the largest planted area of this kind.

Despite all this work devastation continues, not due to deficiencies of the Serviço Florestal, but because of flaws in legislation which continue to persist and also because of the proper political-administrative organization The Serviço Florestal sees itself obliged to create a network of parks and reserves with the goal of protecting species of primitive ecosystems. The first effort towards this goal dates back to 1912, with the annexation of the Estação Biologica do Alto da Serra which was later converted into a forest reserve. This action expanded the following years to the eventual establishment of the Instituto Florestal, which today retains a significant physical inheritance of 12 parks and 20 reserves This constitutes an area of 700 thousand hectares which is almost 3% of the Paulista territory.

Therefore, although we can see that the diffusion of *eucalyptus* cultivation was the chief concern, the study of indigenous species was not relegated to second place. In 1925, the Serviço Florestal began the installation of the Arboretum of Vila Amália, in the Parque Estadual da Capital. Studies of autoecology, principally of native species, was undertaken with the purpose of examining its reforestational potential. There is collection of more than two hundred species, that includes the "jequitibá" *(Cariniana estrellensis)*, "peroba" *(Aspidosmerma* peroba*)*, "ipê-roxo" *(Tabebuia heptaphylla)*, "pau-marfim" *(Balfourodendron riedelianum)* and "araribá" *(Centrolobium tomentosum)*, which continues to be a source of invaluable information

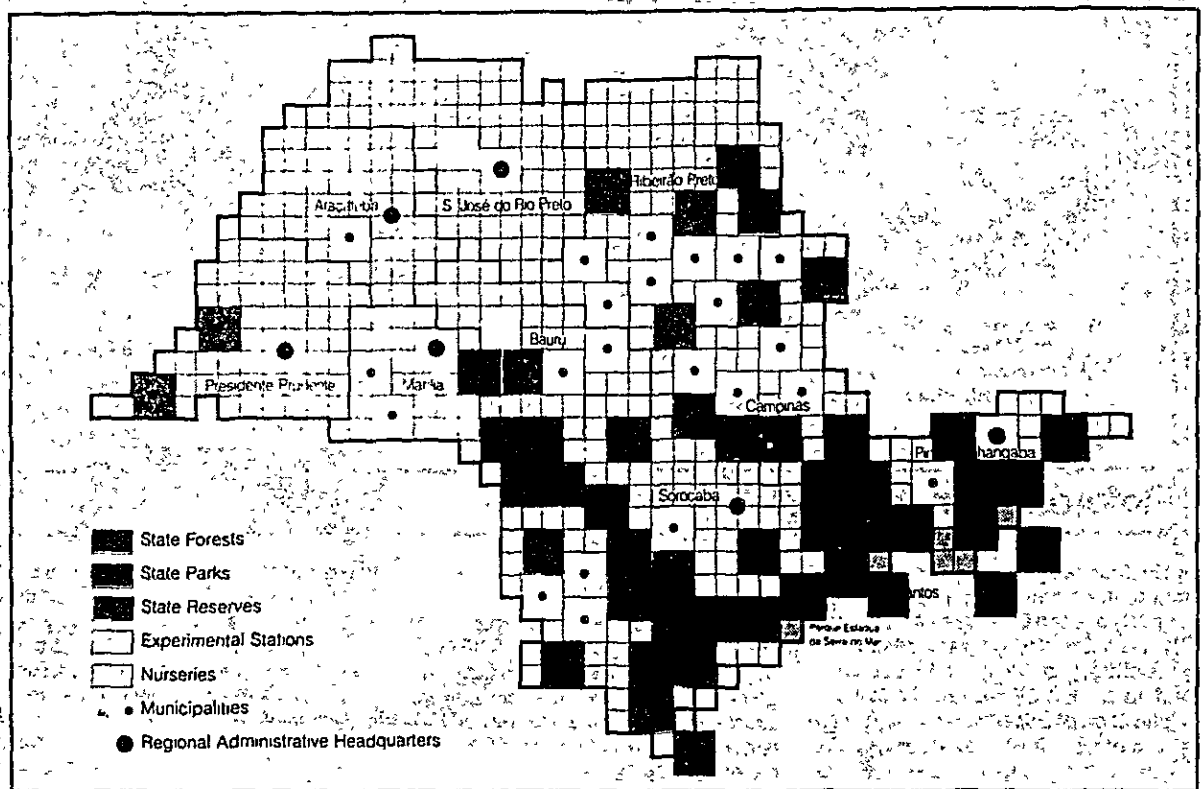
After the decade of the 30's, São Paulo began a dizzying industrial development with an explosive increase in population The necessity for wood products increased to meet the ever changing patterns of consumption. In the hard-wood sector the state was reasonably well provided for, having dominated the cultivation of *eucalyptus* In the soft-wood and longfiber sector, the situation was critical, owing to the exhaustion of the Brazilian Pine reserves in the south of the country which had been the traditional supplier for both the internal and external markets It was vital to find an alternative species for the Brazilian pine, since it had proved to be very demanding and problematic in regard to reforestation and cost This necessity caused the state to commence the era of pine cultivation.

The first attempt began in 1948, when the Serviço Florestal introduced the Chilean pine *(Pinus radiata)* It resulted in failure, in part to the inadaptability of the species and to the attack of the *Diplodia pinea fungus*

This attempt, however, provided Paulista forest-cultivation with enormous experience in the cultivation of exotic pines. Research and experiments expanded principally with species originating from the south of the United States and from Central America. In 1958 the Paulista government launched a gigantic operation with the purpose of consolidating pine cultivation in the state. The strategy changed substantially, instead of dedicating itself only the tasks of information and technical assistance, the government itself assumed the role of a forestry enterprise. In its network of nurseries and forests, it planted more than 100 million *Pinus elliottii* saplings

Research and Instruction

These experimental forests were not created only for commercial exploitation Far more than that, the principles of research and instruction of modern fo-



Localization of installations of the Instituto Florestal - 1980

Eucalyptus urophylla at the present Botanic Botanical Garden (origin of the first plantations of the species in the State of São Paulo)

restry were taught, functioning as a catalyst for new private reforestation. The Serviço Florestal did not limit itself to proclaim methods; it carried them out itself, assuming the role of pioneers in difficult areas that are not well known.

Private iniciative responded to the campaign initially with caution, then with increasing optimism. In 1966, the Federal Government instituted a system of fiscal incentives for reforestation. When the private sector found the way already paved by state action, they assumed leadership of extensive plantations in São Paulo.

An aerophotogrammetric survey taken in 1972/73 revealed that the reforestation totalled 641,420 hectares (2,58% of the Paulista territory), which is a major addition to the 2,175,310 hectares of the remaining native forestes (8,75% of the territory). This significant increase in the reforested areas is an indication that the reconstruction phase of our natural inheritance is gaining ground while predatory activity is slowly giving way. Within the context of historical dynamics this will surely lead to a rational and scientific silviculture.

Forest Inventory

A consistent forestry policy presupposes a greater necessity of increasing the system of evaluation of the resources. In 1973, with the recommendation of the Economic Forestry Zoning of the State, a team of photointerpretation was organized to evaluate the native vegetation cover and reforestation through points of systematic sampling (each point representing 1 km^2) based on aerial photographs on a 1:25,000 scale.

The work evolved to both the detail of reforestation as well as the mapping of the phytophysiognomical units of vital importance to expedite plans of managing the park and reserve areas. In 1975 the development of a semi-automatic system for timber inventory was proposed with the assistance of electronic equipment for the investigation of photographs on a closed-circuit television The data concerning the aerophotographical patterns were developed by the Instituto Florestal and the engineering of the system will be carried out in collaboration with the Universidade de Campinas.

The inventory now in progress is being concentrated in regions with good prospectives for the implantation of forests. Its aim is to obtain data on the area, geographical location, types of vegetation, species, age classes, volumetric yield, patrimonial situation and other elements requiring periodic updating It is based on aerial photos on a 1:40,000 scale and on the topographical sheets on a 1:10,000 scale of the Cartographic Plan of the State.

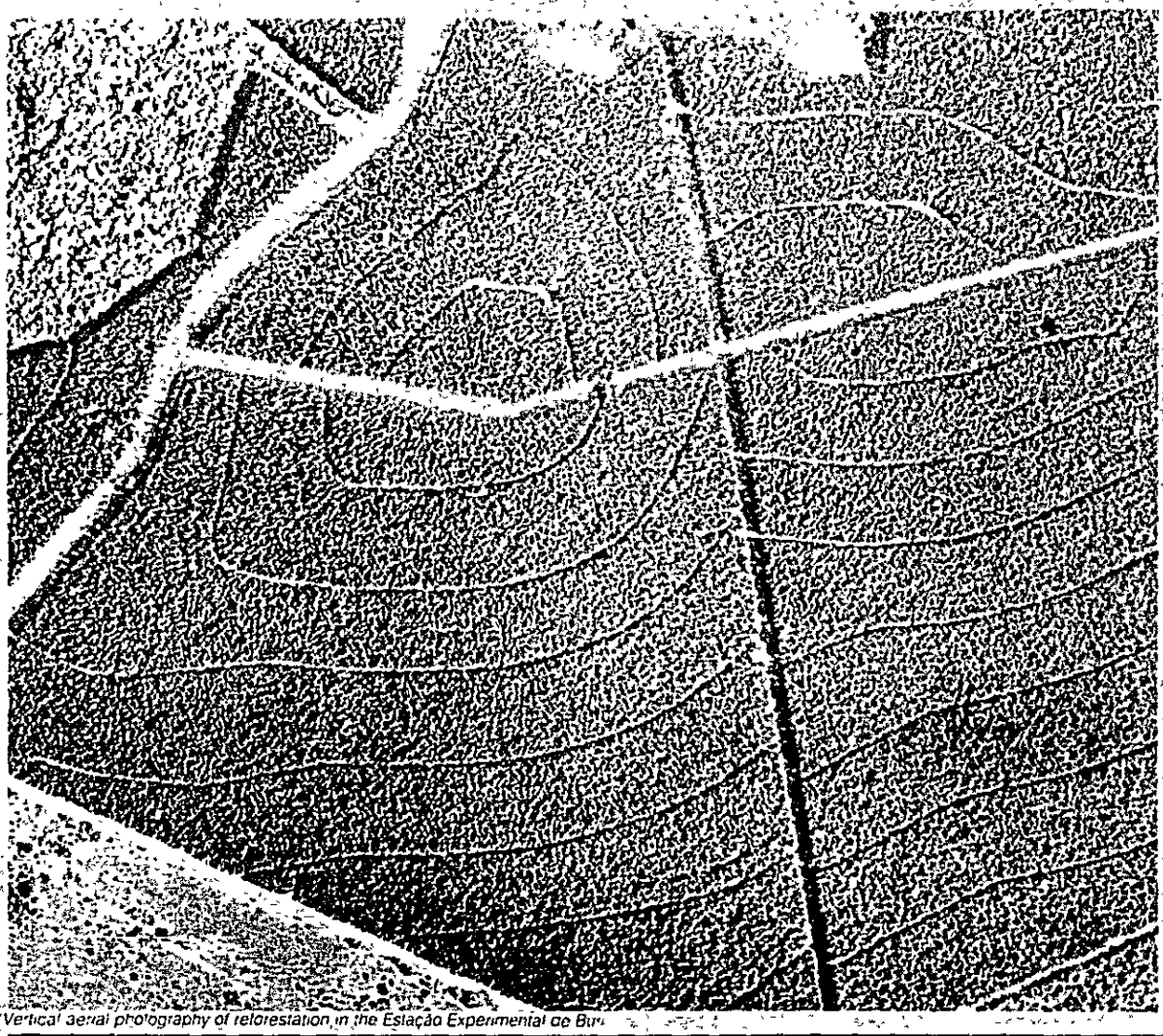
The first phase of the work which has already been published, covered 29 municipalities of the Sorocaba region and has conformed with the recent aerophotographical survey of the State of São Paulo in 1977. In progress at the present time is an inventory of the Vale do Paraiba region. It will then proceed to cover the Greater São Paulo and Campinas regions.

Photo interpretation work in the Instituto Florestal

Forest Inventoy

Cover types
According to aerophotogrammetric survey by sample points 1972/1973

Regions	Surface (ha)	Mata (%)	Capoeira (%)	Cerradão (%)	Cerrado (%)	Campo cerrado (%)	Campo (%)	Refores tation (%)
Grande São Paulo	805.100	15,67	17,13	—	—	—	0,30	7,25
Litoral	1.546.600	56,02	9,13	—	—	—	0,01	0,83
Vale do Paraiba	1.429.100	11,59	9,08	—	—	—	1,12	2,63
Sorocaba	4.059.400	11,69	8,19	0,19	1,77	1,57	0,62	5,79
Campinas	2.705.800	3,35	2,86	0,04	2,69	0,90	—	5,15
Ribeirão Preto	3.660.800	1,98	2,28	1,39	9,94	1,37	—	1,61
Bauru	1.623.400	2,45	2,32	0,94	7,35	0,30	—	3,15
S. José do Rio Preto	2.722.300	2,07	3,19	0,80	1,82	0,03	—	0,58
Araçatuba	1.903.100	1,57	3,40	0,13	1,80	0,01	—	0,26
Presidente Prudente	2 507.700	3,77	4,37	0,09	0,49	0,15	—	0,35
Marilia	1.896.700	2,83	2,12	0,22	3,05	0,03	—	0,98
Totals	24.860.000	8,33	4,99	0,42	3,16	0,60	0,18	2,58



Vertical aerial photography of reforestation in the Estação Experimental de Bur

Forest Inventory

Reforestation by owners

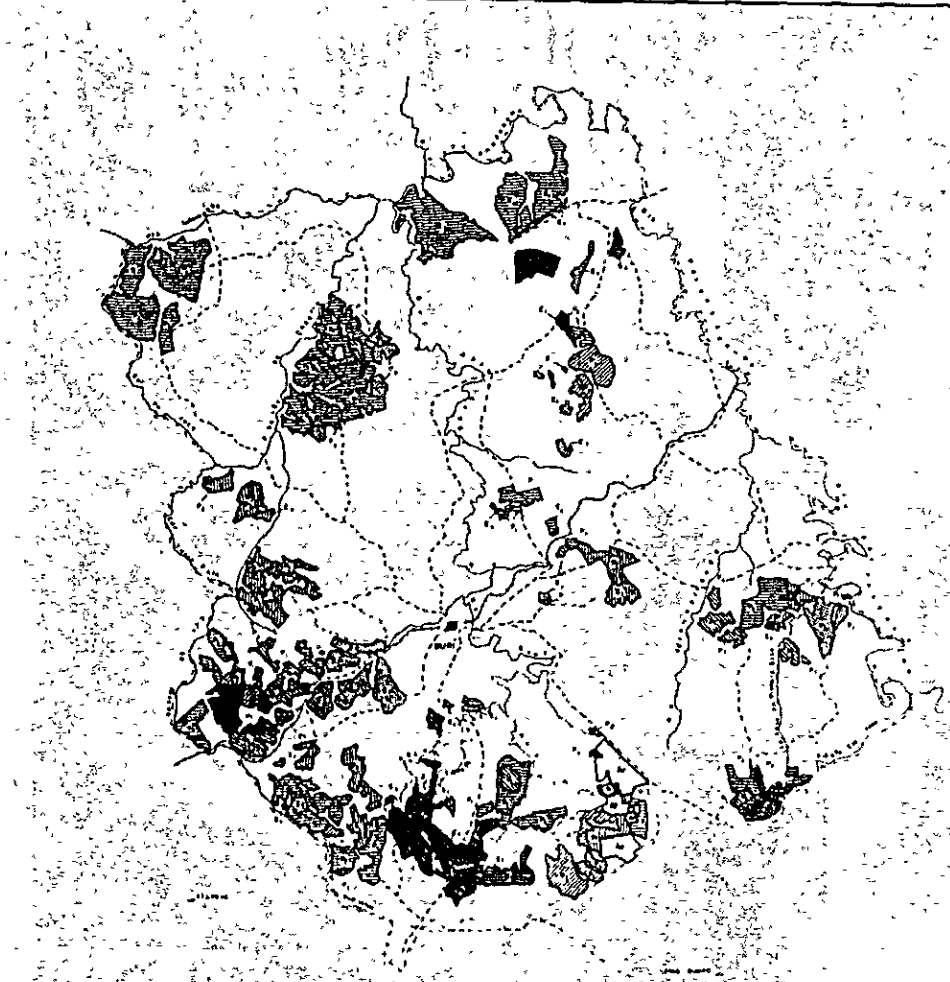
According to aerophotogrammetric survey by sample points

Region	Area	Reforestation		Eucalyptus		Others	
	(ha)	(ha)	(%)	(ha)	(%)	(ha)	(%)
Grande São Paulo	805.100	2.340	0,29	53 450	6,64	2.580	0,32
Litoral	1.546.600	6.220	0,40	6.550	0,43	—	—
Vale do Paraíba	1.429.100	4.790	0,34	32.810	2,29	—	—
Sorocaba	4.059.400	88 930	2,19	141.620	3,49	4.370	0,11
Campinas	2.705.800	8 550	0,32	129.170	4,77	1.650	0,06
Ribeirão Preto	3 660.800	2.470	0,07	56 180	1,53	190	0,01
Bauru	1.623.400	21.650	1,33	29.730	1,83	—	—
S. José do Rio Preto	2.722.300	—	—	15.830	0,58	—	—
Araçatuba	1.903.100	1.990	0,10	2.940	0,16	—	—
Presidente Prudente	2.507.700	2.150	0,09	6 590	0,26	—	—
Marília	1.896.700	2.980	0,15	15.690	0,83	—	—
Totals	24 860.000	142.070	0,57	490 560	1,97	8 790	0,03

Forest Inventory

Reforestation by geners
Mapping - Sorocaba region
According to systematic aerophotogrammetric survey
1977

Sub-regions	Surface (ha)	Pinus		Eucalyptus		Totals	
		(ha)	(%)	(ha)	(%)	(ha)	(%)
Tatuí	235.500	—	—	1 250,25	0,53	1.250,25	0,53
Botucatu	482.500	4.131,65	0,85	40 152,50	8,32	44.284,15	9,17
Avaré	666 300	20.835,45	3,12	40.468,90	6,07	61.304,35	9,20
Itapetininga	464.300	14.766,60		48 927,43	10,53	63 694,03	13,71
Totals	1.848 600	39.736.70	2,14	130.799,08	7,07	170.536,78	9,22



Area open to public a
...e Parque Estadual da Capital
...ght entrance hall of
...headquarters building

In the state parks, preservation, leisure and education

The state parks are areas of permanent preservation protected by law. The first to be mentioned is the Parque Estadual da Capital, which is located practically within the urban zone of the metropolitan area. Since its creation in 1896, it has served as the headquarters of the Horto Botânico and still shelters administrative headquarters of the Instituto Florestal do Estado de São Paulo. Its 174 hectares will have to be integrated into the Reserva Estadual da Cantareira, which has 5,600 hectares and is about to be elevated to the legal status of a state park.

The management plan proposal for the complex intends to expand the present 15 hectares at the public's disposal into an area of leisure and environmental education. The best distribution of the functions within the physical space are at present under detailed study for this multipurpose area.

Also located in the metropolitan area of Greater São Paulo is the Parque Estadual de Jaraguá, which is being preserved due to its natural and historical heritage. Jaragua peak with its quartzitic formation, was used as a reference point during the mining era. It was here that the first gold exploration in Brazil was located. Its area is covered with Latifoliate Forests, typical of the paulistano plateau.

The Parque Estadual de Campos do Jordão was the first to have a detailed management plan. It is situated in the Mantiqueira Range, near the border with the State of Minas Gerais. It has quite an irregular relief with altitudes that vary between 1,030 and 2,007 meters. Its climate is subtropical, mesothermic and has rainfall. The area possesses unique characteristics due to its location at the meeting of three floristic regions: the Araucaria — Podocarpus Forest, the Latifoliate Forest of the Atlantic Slope and the Brazilian Meridional Plains.

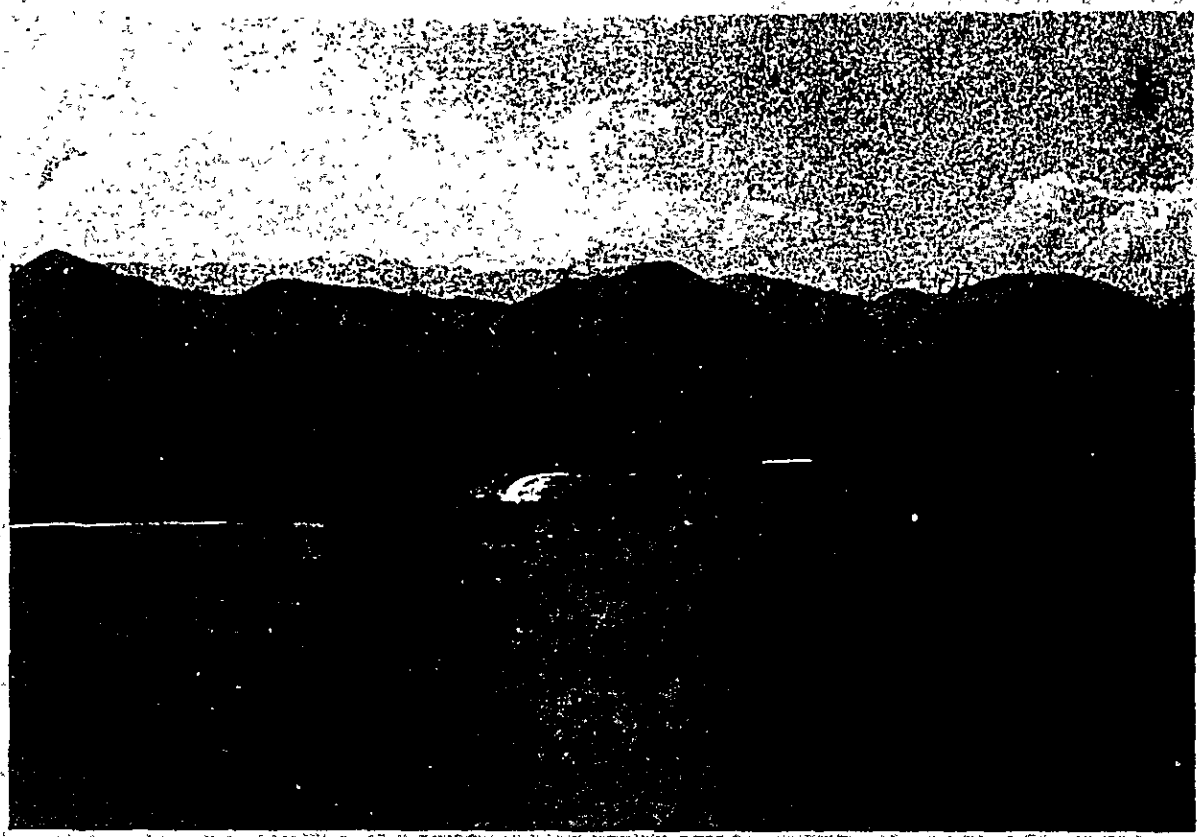
The analysis of the physical environment determined the zoning of the park, taking two chief objectives into consideration: preservation and recreation in view of the vocation for tourism in this region.

In the northeast region of the state the Parque Estadual de Vassununga is quite prominent due to the presence of innumerous specimens of "jequitibá" *(Carniana legalis)*, some of which are enormous. They are some of the last in the state, constituting a legacy of extraordinary and unique value.

Protective action of the Instituto Florestal extends to the coastlands as well; that includes several state parks. That of Ilhabela is situated on the island of São Sebastião on the north coast. With quite an irregular topography, it is covered by an exuberant forest with an immense variety and quantity of palm trees, ferns, mosses and epiphytes that are characteristic of a tropical region. Many wild animals are found here and its beaches are among the most beautiful in São Paulo.

The Parque Estadual de Ilha Anchieta was created in 1977 with the closing of the penitentiary that dominated the life of the island. The environment no longer has any natural aspects to it and its restoration is considered quite important. Since it is a sea environment characterized by a most diversified fauna, it will be the sanctuary for the Centro de Pesquisas e Desenvolvimento de Ciências Ambientais (Environmental Sciences Development and Research Centre). The Centro de Comunicação sobre Fauna Marinha (Sea Fauna Centre of Communication) is already being organized.

In the extreme southern part of the state, the Parque Estadual da Ilha do Cardoso maintains national importance for being the only island that has not been exploited, thus being able to furnish incalculable data in studying the



Serra do Mar Mountain Range shelters the largest state park of Sao Paulo

formation of tropical forests on islands. Its different relief levels permit the observation of the profile of the vegetation cover: Dune, Swamp, Salt Marsh Vegetation and Tropical Latifoliate Forest. Apart from studying the ecological aspects of different ecosystems, mapping of the vegetation and a survey of the forest is being conducted.

Cardoso Island is a part of the lagoon-estuary complex of Iguape-Cananéia, and constitutes one of the three principal regions of shrimp and oyster reproduction of Meridional Brazil. It houses a research center integrated for forest, botanical, marine, oceanographic, geological and biological study.

The majority of native forests remaining in São Paulo are situated in the Serra do Mar range, and are of exceptional importance to the preservational ideal exactly because of what remains. Previously divided into several parks and reserves — Serra do Mar, Rio Branco, Cubatão, Pedro de Toledo, Itan-

The Jaquitibas stand out at the Parque Estadual de Vassununga

haém, São Vicente, Itariri, Curucutu, Natividade da Serra, Cunha e Caraguatatuba — the whole area now belongs to the newly created State Park, Parque Estadual da Serra do Mar, and has further incorporated some extensive forest zones.

This big park has an irregular topography and is covered by an exuberant Tropical Rain Coast Latifoliate Forest, that is rich in species and contains a great variety of lianas, epiphytes, arborescent ferns and palms. The fauna is also varied in species, from the smallest mammals to the largest Brazilian forest animal, the Tapir *(Tapirus sp)*

Crossed by roads that link the plateau to the coast, the Parque de Serra do Mar has as tourist attractions, scenic viewpoints that were constructed during the Colonial period from where one can see the Santista Lowlands; the coastal plain with its profusion of rivers and the open sea.

The Parque Estadual da Ilha do cardoso (top) protects the last remains of the Tropical Forest in insulating and unexplored conditions bellow, the deactivated prison on the Parque Estadual da Ilha Anchieta

In the Reserva Estadual da Cantareira, the well-know "Ceboleiro" has a hollow trunk that can hold 10 men in it

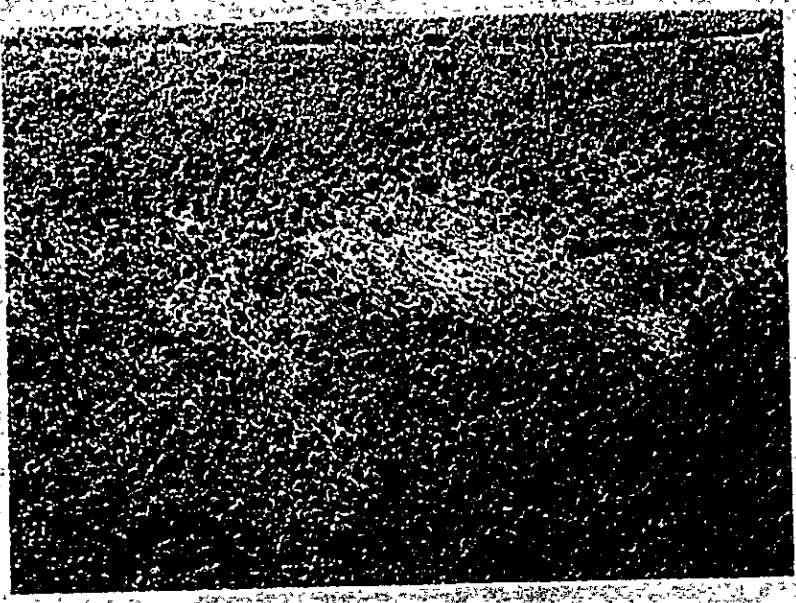
Reserves, a live laboratory

About 15 km from the center of São Paulo and extending into the municipalities of Caieiras, Mairiporã and Guarulhos, the Reserva Estadual da Cantareira is practically within the metropolitan area. For a long period of time it has been the principal water reservoir for the entire population. Today it contains reservoirs with the capacity of supplying 33 thousand litres per second, which is sufficient for 10 million inhabitants. Its present forest cover is a result of recomposition of old coffee and sugar cane plantations. The area has enormous potential for recreation and leisure activities, and its management plan foresees zones of intensive use, zones of extensive use, primitive zones and service zones. Research is being developed for study of the composition of the forest. The Cantareira reserve will soon be elevated to the status of state park.

Another important reserve is that of Morro do Diabo, which contains the last remnants of the forests in the western region of the state It is within the domain of the Mesophyte Subtropical Forest of Western and Meridional Brazil, and has a great variety of evergreen species. In its relief, evidence of the formation of sandstone appears It is one of the few habitats of the "mico-leão" monkey *(Leontopithecus rosalia chrysopygus)*, a species in extinction and of great scientific interest. Located in the western region is the Reserva Estadual da Lagoa São Paulo, which includes the fluvio-lagoon system zones connected to the Paraná River and will soon disappear due to the construction of the Porto Primavera Hydroelectric Plant

Among the reserves in the south of the state, the Reserva de Carlos Botelho has been employed for studies of native forest management. These studies cover three different areas: one for degraded forest, due to exploitation prior to state protection; another is of recuperated forests of more remote exploitation; and the third is of adult trees, characteristic of the Tropical Rain Forest of the Lowlands and the Slopes. In the degraded areas the objective is the replacement of the vegetation; in the recuperated areas, their improvement is desired; and in the adult tree zones, the activation of its productive potential through a uniformization of its components

The Reserva de Porto Ferreira besides having a Latifoliate Forest, is characterized by Cerrado Vegetation In it two research projects are under way on the units of the cerrado and of the forest by means of aerial photography



Reserva Estadual de Porto Ferreira - transition of cerrado jungle vegetation

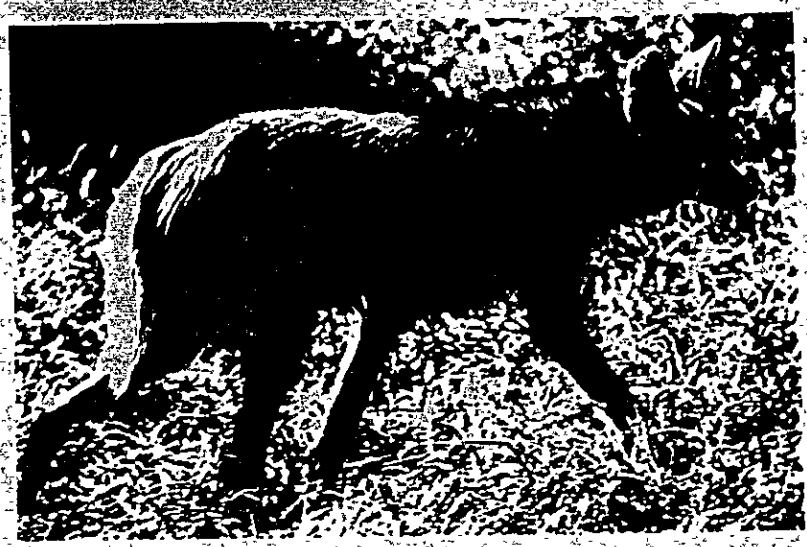
Reserva Estadual da Lagoa São Paulo will disappear with the construction of a hydroelectric plant

Care also with the wild fauna

The native forests under administration of the Instituto Florestal contain a variety of wild fauna, and is the object of great care and attention. The "mico-leão" which was previously mentioned, is a species in extinction that has motivated studies for raising and reproduction in captivity. Breeding of selected animals and their behaviour are both researched here and in the forests and fields.

Within this line of research which aims at the conservation of rare or threatened species, two other projects are under development. One studies the populational dynamics of the "campeiro" deer *(Ozotoceros bezoarticus)*, in a small semi-confined nucleus; the other researches the renal bionomics and parasitism of the "lobo-guará" *(Chrysocyon brachyurus)*, a species with preservation and breeding problems both in captivity and in the wild.

The "lobo guará" is one of the wild animals studied at the Instituto Florestal

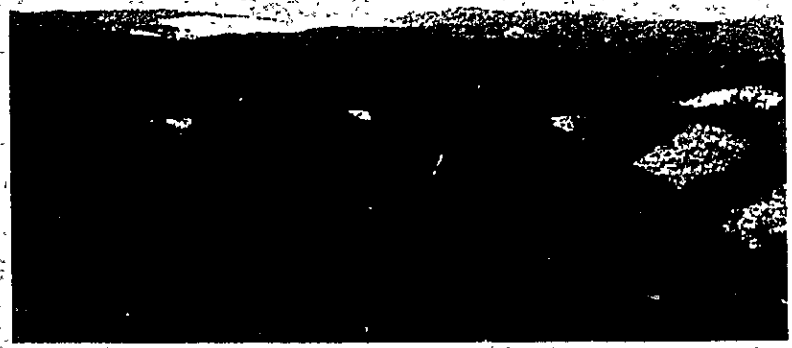


Protective reforestation in hydrographic basin

The Instituto Florestal has also concerned itself with the management of hydrological basins since 1961, when the state built dams to regulate the periodic flooding of the Paraiba River. The protection of reforestry was executed in three basins of retention that contain a total of 690 thousand saplings of various species of *Pinus*. The forest nurseries of Pindamonhangaba and Taubate were created principally to provide logistical support for protective reforestation.

Research programs in hydrology are now in progress in the Una River basin, which is a tributary of the Paraiba River in the Parque Estadual da Serra do Mar, and also in the Cantareira reserve. The objectives of these programs are to control the floods, provide protection against landslides, pcovide protection against superficial erosion, selection of ideal forest cover, choice of management in respect to profitability, study of the ideal spatial arrangement of the forest cover, and the study of the hydrological cycle of native forests.

For such studies, the Instituto Florestal will also count on the collaboration of the International Japanese Agency of Cooperation in accordance with a recently celebrated agreement.



The Octavio Vecchi Forestry Museum in the Parque Estadual da Capital maintains an important stock of exotic and native species

Environmental education, a constant preocupation

The state parks allocate areas to the public for leisure and recreation. It has been a major concern of the Forestry Institute to take advantage of the contact of the population with nature, to develop an environmental educational program in such a way as to sensitize them to the problems of conservation of our natural heritage.

Due to its location within the metropolitan area of São Paulo, the Parque Estadual da Capital is frequently visited and disposes of installations under expansion in relation to the transformation of the Cantareira reserve into a state park. In Campos do Jordão, the touristic natuce of the region provides incentive for public visits and educational programs, and will include the use of antique equipment such as the sawmill run by waterwheel to serve as a tourist attraction. On the Anchieta Island, the installation plan of the Center of Research and Development of Environmental Sciences takes into consideration not only the aspects of the research itself, but also those connected to leisure and environmental education. These types of programs will have to be extended to other park areas as well. The basic objective is to teach the population to use a forest without damaging it through visitor's centers, camping areas, excursion routes, hiking trails and other various programs.

Recently it was decided to implement areas of environmental recreation and education in planted forests. Eleven experimental stations of the Instituto Florestal have already been selected and are situated in outlying urban areas or close to medium-sized cities where the population itself demands new leisure areas.

The Instituto Florestal also promotes courses, lectures and exhibitions that are generally held at the Museu Florestal Octavio Vecchi, inaugurated in 1931 and located in the Parque Estadual da Capital. Considered for many years to be one of the most complete of its kind, the museum is now being remodelled to facilitate modern technological exhibitions.

The dissemination of technical scientific information and research is carried out through the publication of two periodicals: "Silvicultura em São Paulo" and "Boletim Técnico."

The public in contact with nature develop sensivity of their natura heritage. Top left wood carvings exhibited in the Forestry Museum

Genetic improvement for more productivity

Participation of forestry activity in the Brazilian economy is significant Data from the Instituto Brasileiro de Desenvovimento Florestal places the contribution at 5.8% in the national economy. Of the total energy consumed in Brazil in 1977, 22% originated from 118 million cubic meters of wood.

Reforestation from fiscal incentives amounted to an area of 3,500,000 hectares of *Eucalyptus* and *Pinus* from 1966 to 1979; conservative estimates anticipate the continuity of reforestation at an annual rate of 300 thousand hectares. Therefore, a demand of seeds with greater productive potential is required in view of increasing profitability of the forestry activity.

Within this framework, the Instituto Florestal de São Paulo has developed a program of genetic forestry improvement in collaboration with other entities in this sector. Their basic objectives are:

— a continuous increase in productivity;
— research of genetical characteristics of the species, seeking specific uses;
— adaptation of species of rapid growth for non-traditional uses, as a way of alleviating the pressure on the existent natural reserves;
— obtainment of improved seeds to meet demand.

Up to now, the more exotic species of rapid growth have required more attention, especially the *Pinus* and *Eucalyptus* species. Tests have already begun on the progeny of the species *Pinus elliottii* and *Pinus caribaea* var. *hondurensis*.

For the development program of the *Pinus*, the Instituto Florestal relys upon its own reserves as well as private plantations, that have a total of 52 thousand hectares and maintain an exchange of vegetative material from superior trees.

In respect to the *Eucalyptus*, which at the present time represents great economic importance to the country, priority is being directed to the improvement of species for the production of charcoal and use in sawmills.

One of steps taken by the genetic forest improvement program is the vegetative propagation of superior selected materials for banks and seed orchards. For the *Eucalyptus*, the techniques of grafting, earthing up and rooting have been used, with the latter two showing more promise; for the pine, grafting of the forked type "notch of the top" is profusely diffused because of excellent results.

The Instituto Florestal has also been participating in the Conservation Project of Genetical Research, which is led by the Brazilian enterprise Empresa Brasileira de Pesquisa Agropecuária It is contributing to studies of the "jequitibá" *(Cariniana legalis)*, the "aroeira" *(Astronium urundeuva)*, the "cumbaru" *(Dipterix alata)* and the "jacarandá-paulista" *(Machaerium villosum)*. Apart from the dendrological and phenological aspects, these studies seek a better knowledge of the areas of distribution, eva-

Pinus elliottii grafts in the Estação Experimental de Itapetininga

In Pederneiras the production area of Pinus caribaea var. hondurensis with a superior tree at 18 years old

Forest Genetic Improvement

Eucalyptus spp
1979

Species	Seed production area (ha)	Clonal seed orchard (ha)	Seedling seed orchard (ha)
Eucalyptus saligna	1,5	1,0	24,0
Eucalyptus grandis	3,0	—	—
Eucalyptus citriodora	120,0	—	5,0
Eucalyptus maculata	1,5	—	24,2
Eucalyptus resinifera	1,5	—	—
Eucalyptus robusta	1,0	—	19,3
Eucalyptus urophylla	2,0	1,0	14,0
Eucalyptus teriticornis	0,5	—	21,0
Eucalyptus pilularis	0,5	—	—
Eucalyptus umbra	—	—	18,7
Eucalyptus microcorys	1,5	—	—
Eucalyptus puntacta	1,0	—	25,0
Eucalyptus paniculata	0,5	—	24,0

Forest Genetic Improvement

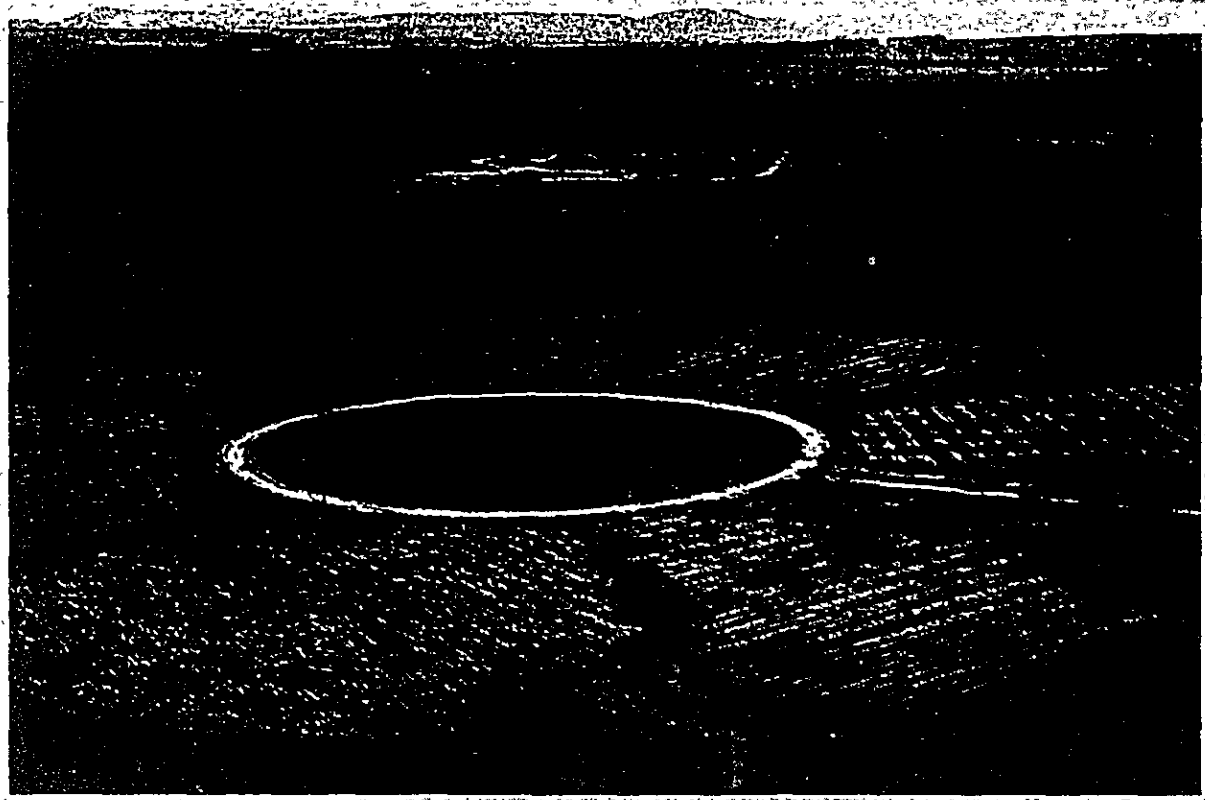
Pinus spp
1979

Species	Seed production area (ha)	Clonal seed orchard (ha)	N.º of clones	Grafts accomplished	Average survival percentage
Pinus elliottii	200	3,8	368	8.778	20%
Pinus taeda	65	—	42	1.679	—
Pinus caribaea var. caribaea	120	5,7	161	4.375	50%
Pinus caribaea var. hondurensis	800	12,7	351	10.124	50%
Pinus caribaea var. bahamensis	20	1,3	46	1 244	30%
Pinus oocarpa	50	3,1	99	2.481	50%
Pinus kesiya	400	12,37	552	13.005	60%
Totals	1.685	38,97	1.619	41.686	43%

luation of the remaining populations and the selection of representative trees that will furnish reproductive material for the constitution of germoplasmbanks.

One of the forest species in the south and southeastern regions that is is in a critical situation, is the *Araucaria angustifolia*. Because of this dangerous situation, it is the object of a program now in progress with the goal of not only preserving the genetical base of the populations representative of the species, but also of producing seeds of good quality. In 17 sites located in the States of São Paulo, Minas Gerais, Paraná and Santa Catarina, seeds were collected from 10 or more representative trees and the trees were distributed randomly among the population and separated by a minimum distance of 100 meters. Of saplings obtained, a progeny test was conducted and a populational base was established in the Itapeva Experimental Station.

Clona. orchard of *Pinus Kesiya* in Pederneiras



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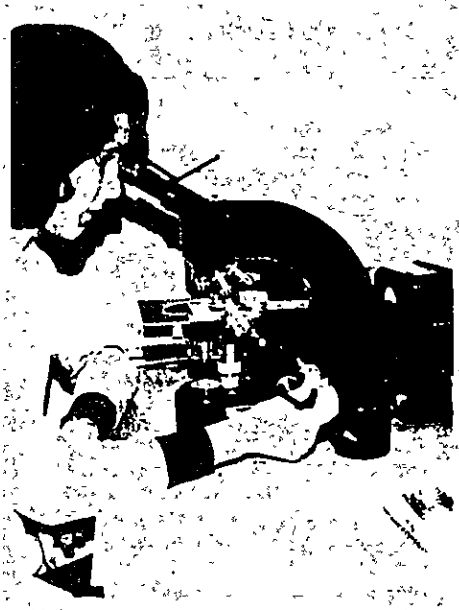
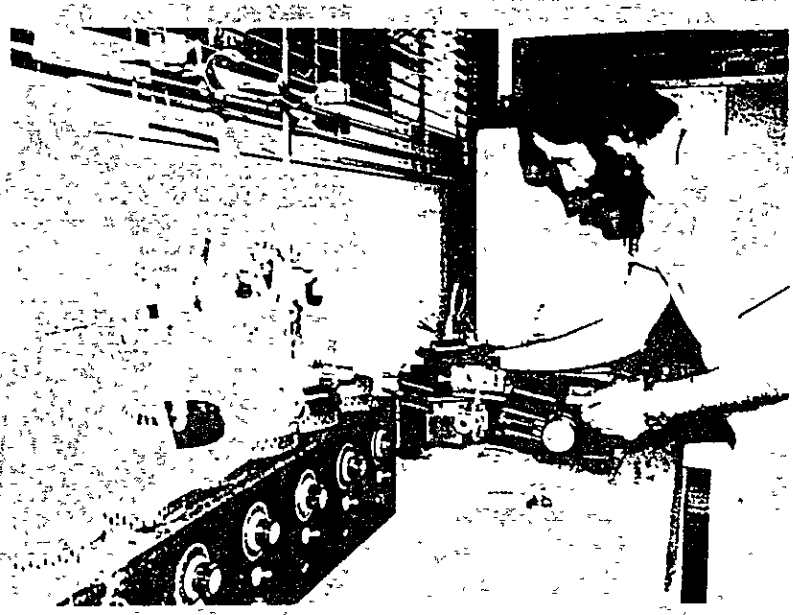




In the arboretums, the study of the species

Because of the threat of extinction that weighs heavily on innumerous native species, the Instituto Florestal was motivated to establish several arboretums with the intention of subsidizing its research and promoting scientific exchange with other institutions.

The experimental station of Mogi-Guaçú has recently criated an arboretum that is located in the central region of the State. The work began in 1976 with the collection of seeds from different native forests in several regions of the country. Positive results were obtained from the 600 species introduced and about half of them are already planted in a permanent place

With the support of a herbarium and a xiloteca which collects rich material, anatomic and systematic studies have been developed with the intention of describing and identifying forest species connected to phenological studies . The phytochemical laboratory compliments these studies by supplying data on extractives of forest species from a qualitative and quantitative viewpoint. The quality of wood, especially its basic density, is being studied to try and relate it to the anatomical characters of management and use.

Sustained production in reforestation

In the area of forest management, the Instituto Florestal has employed different systems of investigation and has utilized these operations to develop their research.

Dendrological studies have been developed not only in the state forests, but also in private commercial forests. It seeks to determine the site index in different regions of the state and to facilitate evaluation of the wood potential of these plantations.

The *Eucalyptus* spp are cut down using a 5 to 7 year cycle, when the objective is to obtain firewood, charcoal and cellulose

When the objective is to produce wood for sawills, the *Pinus* and *Eucalyptus* spp plantations practice selective cutting to remove inferior material. The plantations are utilized by means of a system developed by the institution itself.

The entire state area reforested with *Pinus* spp and *Eucalyptus* spp, is maintained though a process of sustained production to guarantee the physical base in which the majority of the research of the Institute is developed. Each plantation is divided into modules equal in number to the years of rotation, and pruned at various times. The final cutting down is performed at 25 years of age, when objective is the production of wood for a sawmill; immediately afterwards replacement of the module is made.

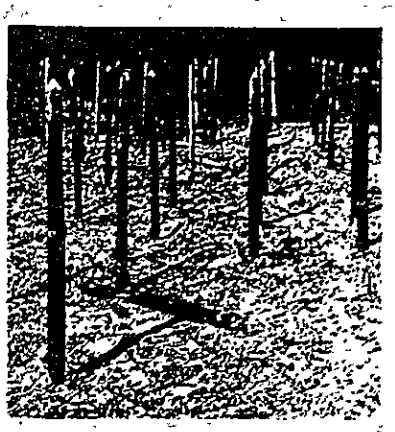
From the Pinus resin, turpentine and pitch

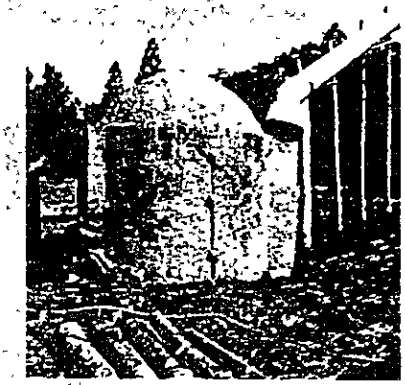
The extraction of resin from *Pinus elliottii* to obtain turpentine and pitch, has been economically important in other countries for decades, but has only been increased over the last few years in Brazil. In the Instituto Florestal 330 thousand trees were resined, and the initial results obtained showed an average production of 2.7kg per tree anually, in the *Pinus* var *elliottii* at 15 years of age.

Work was developed to improve production by using 10 phenotypes obtained from 70,000 trees which resulted in an average production of 8.5kg per tree annually. These 10 phenotypes will be used in the formation of a clonal orchard.

This initiative is a means of making the country self-sufficient. At the present time, there is consumption of 38 thousand tons of pitch with internal production having only reached 2 thousand tons. This has forced expenditures of $108 million dollares to import this raw material.

The planted forests of Instituto Florestal are kept in a system of sustained management and manual operations are utilized due to the size of the undertaking





In Tupi an charcoal kiln and condenser are used for studies on production of charcoal (above) in Itapira experiments with preserved fence posts (top). The subproducts of carbonization are being tested as wood preservers

Pioneer work in mineral nutrition

In the area of mineral nutrition, the Instituto Florestal assumed the pioneer role by conducting exploratory studies more than 25 years ago, when work of this nature was still being questioned. As a result of this, the 1st Panamerican Congress of Agronomy held in Brazil in 1954, had already registered the first works of the Institute.

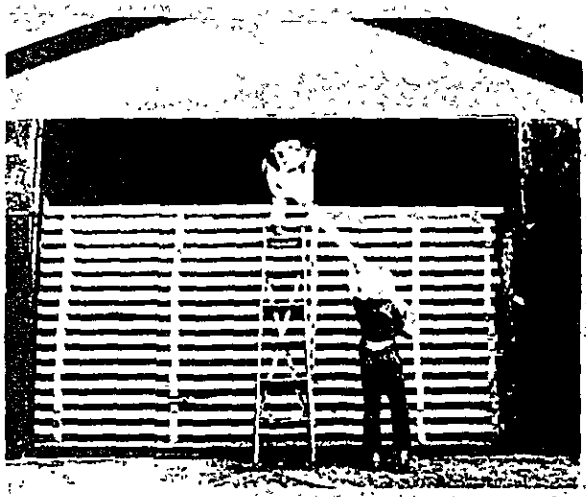
Commencing in 1975, a networks of systematic experimentation was installed in 16 localities that represented the most different edaphoclimatic conditions of the state. It was directed towards the pine species as well as the *eucalyptus* species, and is already providing preliminary results.

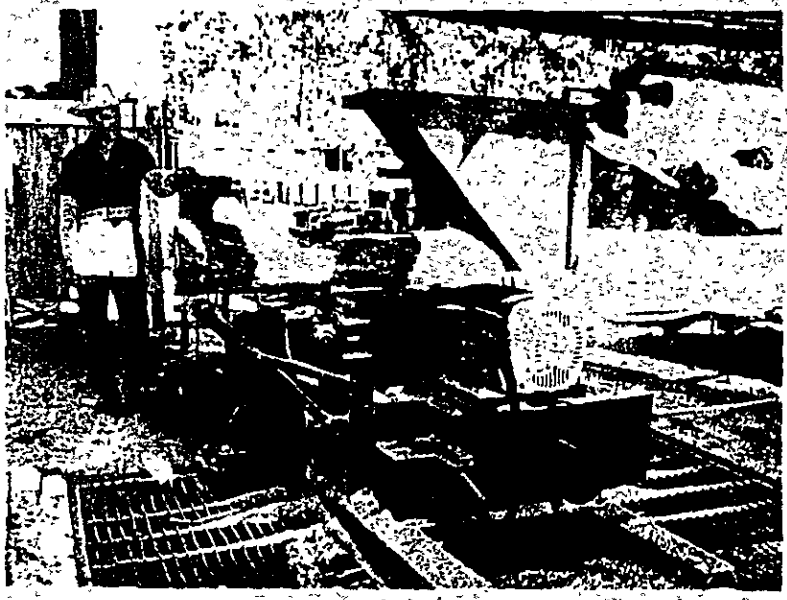
Recognizing the phosphorous deficiency in tropical soils, it is worth mentioning the formulation of experiments with different doses and forms of phosphates (soluble, natural and magmatic phosphate or phosphorite of Jacupiranga) in order to elicit a response from species with different levels of these elements in the soil

More yield for charcoal

The national steel industry which is based on vegetable charcoal energy, will have to produce 6 million tons of pig-iron by 1985. Production will demand 42 million cubic meters of wood. The national goals are based on a constant increase in production utilizing vegetable charcoal as way of saving funds.

Representing on an average of more than 50% of the cost of producing pig-iron, the charcoal obtained from wood has become worthy of studies seeking to increase its yield. Work accomplished by the Instituto Florestal along with the Departamento de Silvicultura da Escola Superior de Agricultura Luis de Queiróz covers three basic topics: selection, improvement and forestation of specific species for this activity; studies of the carbonization processes; and utilization of the by-products of carbonization.





25 thousand hectares of experimental plantations

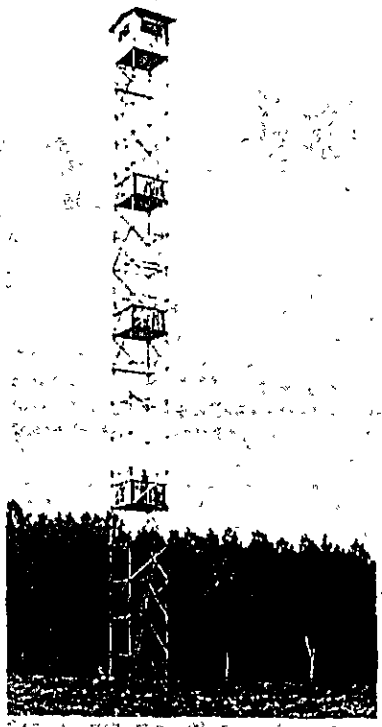
The *Pinnus* forests implanted in the State of São Paulo totals 190,000 hectares. Of these, 25,000 hectares are concentrated in the experimental stations of the Instituto Florestal, where research is directed towards production.

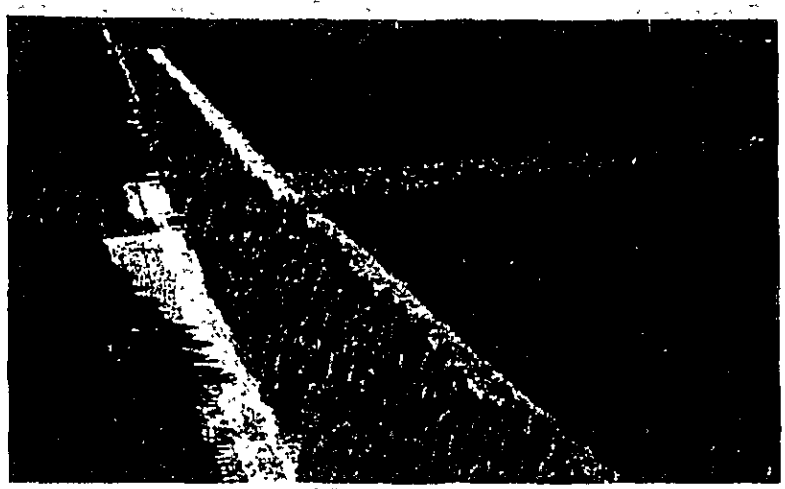
The principal concern is the development of more advanced management techniques with more adequate utilization of material resulting from thinning. Such material — pieces with a diameter of less than 13 centimeters — is today principally absorbed by the cellulose, paper and pressboard industries. Parallel to this, studies are being made to find the best alternatives to this type of wood, to help alleviate the demand of round material in the rural areas.

Pieces of more than 13 cm in diameter can be used for a better purpose. The Instituto Florestal carries out research to insure its mrtanical processing. The assembly of a double circular saw has been producing good results and the materials distributed on the civil contruction, packing and furniture markets has been well received.

Another project under way is the construction of modulated residential homes, utilizing wood of small diameter. The prototypes are being assembled in the parks reserves and experimental stations of the Instituto Florestal. These houses are quickly assembled at a low cost, are $54m^2$ and consume $7.29m^3$ of sawed wood, originating from 38 esteres of wood with bark.

State and Federal Agencies are quite interested in the results, because of the active part they played in initiating the preliminary studies on the potential of the system, to contribute to the reduction of the housing shortage.





Fungi and insects, enemies combatted

Protection against pathological agents have caused the Instituto Florestal to carry out periodic surveys of the health conditions of the nurseries and the forests, to dectect possible causes of damage to the production. The pathogenes *Cylindrocladium* spp and *Diaporthe cubensis*, are fungi frequently found in *Pinus* spp and *Eucalyptus* spp. The planted areas are being researched to evaluate its effects on the development of these species.

The resistance, susceptability and adaptability of the forest species to attacks are also being studied. The occurrence of insects in the forests populations of species introduced in the state, is being followed up due to outbreaks of pests in some areas. Subsequently the biology, the determining factors of the outbreaks, evaluation of the damage and the systematic identification of the agents are being studied to formulate necessary control measures

There are also experimental activities, among wich is a research on the deterioration of native woods and tropical pines exposed to the action of insects. Preliminary results have revealed the diversity and the behaviour of some potentially harmful insects which transfer themselves from the native forests to implanted populations.

Vigilance against fires

Forest fires have always been a constant concern, not only those of the state itself but those of private forests as well. The climatic conditions in São Paulo with very dry winters and cases of prolonged dry spells, have mobilized forestry industries, rural comunities and state initiative in regard the problem There have already been fires of large proportions, such as those of 1962 and 1975, which consumed extensive forests in the southern region.

The Instituto Florestal acts preventively with a series of measures to avoid the occurrence of fires. Among the measures taken, the first involves planted areas surrounded by clearings on all sides which are periodically conserved; the planting of barriers of broadleaf species between the pine forests; the construction of small dams to raise the relative humidity level of the air, and to provide easy access to water In areas of economic development, artificial cutting is performed with the objective of reducing the combustible material.

Vigilance is continuosly maintained by teams that are provided with motorcycles, radio equipment and observation posts, to facilitate quick detection of possible fires Fires are combatted with the help of water-trucks, or by traditional methods when places are not accessable.

In the park and reserve areas where land acess is more difficult, periodic checks by helicopter have been instrumental in preventing fires to reach greater proportions

Some of the preventative measures are already established by law, and the population has also been made sensitive to the problem to help reduce the incidence of accidental fires.

Reforestation of a third of the State, is a challenge to be won

The Instituto Florestal is a branch of the centralized administration of the Secretaria de Agricultura e Abastecimento do Estado de São Paulo. After the administrative reform of 1970, it became subordinate to the Coordenadoria da Pesquisa de Recursos Naturais. At the top of its administrative structure is the Diretoria Geral (Gen. Board of Dir.), which is counseled by the Conselho Tecnico (Technical Consel) and by the Assessoria de Programação (Planning Counsel). The execution of the activities is formulated by the Divisão de Dasonomia, the Div. de Florestas e Estações Experimentais, Div. de Reservas e Parques Estaduais and the Serviço de Comunicações Técnico-Científicas, which are all supported by the Div. de Administração.

The primary function of the Instituto Florestal, is to advise the state executive in elaborating the forest policy, and executing policies that basically cover three areas of activity: studies and research relative to forest resources; preservation of these resources, and the rational exploitation of forest resources.

With the assistance of all the available technical, scientific and cultural data, the Institute must prepare itself to overcome the challenges of the coming decades. Placing as its ideal goal, the development of a minimum of 30% of forest cover of the Paulista territory as recommended by international standards. The conditions for this exist. All we need to see are the 5 million hectares of marginal agricultural land today lying fallow, and whose only alternative is for forest use.

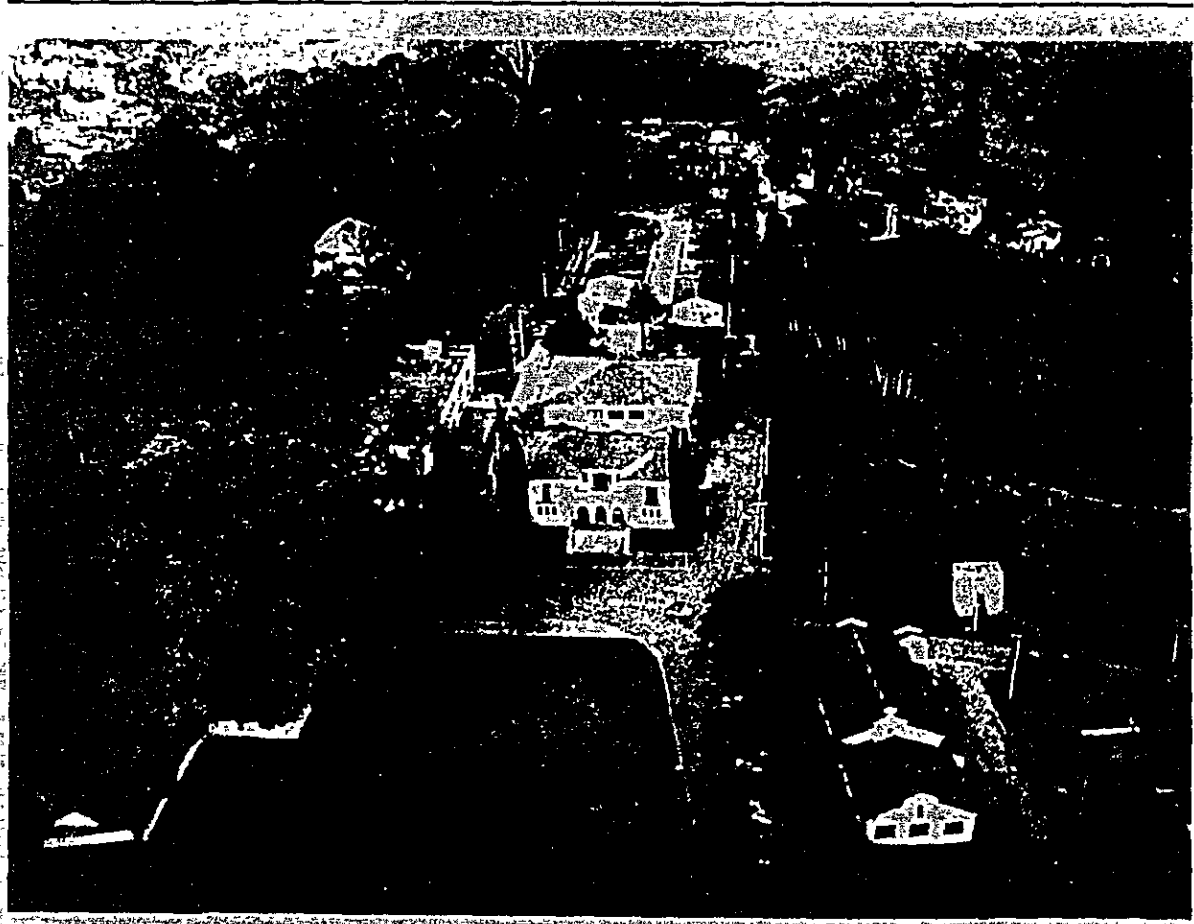
There is a long way to go before a rational policy of natural resources is definitely implemented in the State of São Paulo and predatory exploitation is eliminated. The government and population must be made conscious of the important environmental, economic, cultural and aesthetic role that the forest will have to perform in the life of the community.

Instituto Florestal

Installations and employees
1980

Installations	N.º	Área (ha)
State Parks	12	564.587
State Reserves	20	136 218
Experimental Stations	21	40 840
State Forests	10	17.012
Forest Nurseries	6	77
Totals	69	758.734

Employess	N.º
Superior level techniques and scientific researchers	87
Technical auxiliares	85
Artisans	154
Laborers	1.368
Guards	164
Administrative Personnel	196
Total	2.054



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ブラジルサンパウロ州混農林業研究の着手

この報告書はＦＡＯのコンサルタント事業としてニュージーランドの専門家がサンパウロ州における混牧林業の可能性について調査した結果を報告したものである。調査は、サンパウロ森林院から４人参加し、ワーキンググループがつくられ約１カ月かかって行われた。この目的は、地力が低下した放牧草地を回復させるために造林と畜産を組みあわせた土地利用を行う手法について今後サンパウロ森林院が研究をすすめるのに役立つように、混牧林業の可能性について調査し、報告するものである。

調査の結果、ヘクタール当り 1600 本の植栽を行い、放牧を行う等の各種の方法が示唆された。しかしながら、サンパウロ周辺の牧草は熱帯性のもので、ニュージーランドに育つ牧草と違うため、日陰で育つ適当な品種が見あたらないのが問題である。

INITIATION OF RESEARCH IN AGRO-FORESTRY IN SAO PAULO STATE, BRASIL

REPORT PREPARED FOR THE INSTITUTO FLORESTAL, STATE OF SAO PAULO, BRASIL, AS PART OF A CONSULTANCY ORGANISED BY FOOD AND AGRICULTURE ORGANISATION OF UNITED NATIONS.

*BY:-

A.I. PAGE B.SC. M.F.

ANZDEC LTD (NEW ZEALAND).

Cattle grazing 9 year old Pinus radiata, thinned to 200 s.p.ha and pruned to 6m. New Zealand.

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INTRODUCTION

This report has been prepared to assist the Instituto Florestal, Sao Paulo, Brasil, in preparing a research programme in agro-forestry. Although this term can be used to describe all forms of farming and forestry practised on the same area of land, it is used here specially to describe the management of livestock within developing forest plantations. The Portuguese expression silvo-pastorio, used in Sao Paulo, is perhaps the best term to describe this management system.

The consultancy was organised by the Food and Agriculture Organisation of United Nations and the terms of reference were as follows.

The consultant, under the general supervision of the Team Leader and in the closest collaboration with the Forestry Institute of Sao Paulo, will:

1. Initiate research related to agroforestry activities aimed at cattle production in conjunction with the plantation of pines and eucalyptus to recover deforested areas.
2. Prepare a brief report containing recommendations for follow up work by the Government.

This consultancy will be carried out in the areas of Forestry Institute, probably with the collaboration of Zootechny Institute of Sao Paulo.

Within the time available establishment of actual research trials on the ground was not possible. However, the Instituto Florestal has created a working group of four officers with whom I travelled around the state to view local conditions and discuss possibilities for research. The officers in this group are as follows:

1. Eng. Agr. Haroldo Monteiro da Silva (Coordinator)
   Instituto Florestal - Paraguacu Paulista
2. Eng. Agr. Jose Luiz Assini
   Instituto Florestal - Manduri
3. Eng. Agr. Oscar Zanquetta
   Instituto Florestal - in charge, cattle management
4. Eng. Agr. Odenir Buzzato
   Instituto Florestal - Mogi Guacu

This report describes my impressions and suggestions for future research work in agro-forestry and is my contribution to this working group. Experience drawn upon is mainly of research and management of livestock (sheep and cattle) rearing projects integrated with plantations of *Pinus radiata* established on pastoral land in New Zealand. The major differences in soils, climate and topography between New Zealand and Sao Paulo have been discussed at length with members of the group.

At the end of the tour of Sao Paulo state, a seminar was held at the Instituto Florestal, attended by some 60 staff members of the Institute and by Dr Keats Hall, FAO Team Leader in Brasilia. During the seminar the philosophy behind, and techniques involved in the practice of agro-forestry in New Zealand were described. Differences between New Zealand and Sao Paulo were discussed and suggestions were made for future research strategy in the state.

The Institute's four man working group will now draw up detailed research proposals which are to be submitted to the Director-General. There is little doubt that results of research work in this field will be of value to other states of Brasil where conditions are comparable to those in Sao Paulo. The

Institute has expressed its willingness to share these results with other interested organisations.

PRESENT SITUATION AND IMPLICATIONS FOR AGRO FORESTRY

The Instituto Florestal currently manages some 25,000 ha of forest plantation. The majority of this estate is softwood (Pinus elliottii, P. caribaea, P. oocarpa, etc) although various species of Eucalypt have also been planted. Planting continues at an estimated 600 - 1,000 ha per annum. Choice of species is now more rationalised than when planting started in 1958, with P. elliottii confined to the south, and tropical pines dominating elsewhere.

The various experimental stations throughout the state tend to be on poorer soils and, although pine growth is impressive, soil fertility is likely to be a major limitation to agro-forestry development. Regular, maintenance applications of fertiliser, as used in New Zealand pastoral farming, are not common (except in cropping) in Sao Paulo.

Plantation management in Sao Paulo is based on the philosophy of maximising volume yields. Hence trees are planted at spacing around 2,000 stems per ha (earlier plantings were as high as 4,000 stems per ha) and thinned up to five times to reach a final crop stocking of 250 stems per ha at age 20-25 years. Optimum rotation age has not yet been determined precisely. All thinnings are utilised, although royalties, particularly for early thinnings, are low. Under this system of management, pine plantations close canopy very quickly and canopy closure is maintained until the final thinning. Under such intense site occupation there is little or no scope for the growth of pasture species under the pines until after the final thinning. Even at this point competition for light and soil moisture may be severe.

Most experiment stations manage some cattle (the Institute manages 2,300 head overall). These are used to supply milk to the families employed on the stations and sometimes store beef stock are sold for fattening elsewhere. Consequently there is a degree of experience in the management of cattle within Institute staff which will be of considerable advantage if agro-forestry activities are expanded. Staff also have some knowledge of the relative feed values and growth potential of a range of grass species (e.g. Brachiaria decumbens) and legumes. Expansion of this knowledge in formal trials would not be difficult.

The potential advantages of agro-forestry such as reduced fire risk; reduced woody species competition to young trees; increased visibility within, and access to, plantations; contribution to a more stable rural economy and the possibility of increased earning capacity per hectare are well recognised.

Browsing damage to young pines by cattle appears to be uncommon (although trampling can be a problem in very young stands). This is in marked contrast to the New Zealand situation, where cattle cannot normally be introduced until the trees are around 3m tall, and is a further advantage to the development of agro-forestry.

Currently cattle are grazed mainly on some firebreaks and scattered areas of unplanted pasture generally close to station headquarters. Grazing within young stands is practiced in some areas (e.g. Fazenda Santa Maria and Itapetininga) and in some thinned stands of Eucalyptus, where water supplies and existing fencing permit. A seed orchard in well-grazed paspalum pasture exists at Luiz Antonio.

To some extent, therefore, further development of agro-forestry can be seen as the rationalisation and extension of existing techniques rather than the introduction of a new concept.

GENERAL DISCUSSION OF POSSIBILITIES FOR AGRO-FORESTRY

1. Increase in Existing Practices

The most immediate possibilities are seen in an increase in existing activities. The extent of grazing in any particular station is often limited by lack of fences, water and/or cattle. Trial work with cheap and effective electric fence systems (electric fences are considered vital to the success of many agro-forestry projects in New Zealand) could extend grazing on to more firebreaks and, by giving cheap pasture subdivision, allow the more rational used of available grazing. Where cattle numbers are limiting, or areas to be grazed are remote from headquarters, use of cattle from neighbouring land owners should be considered.

The Instituto Florestal owns a large area of currently idle land awaiting forestation. Where soils are suitable consideration could be given to developing this land into pasture to raise cattle and earn some income while awaiting forestation. The conditions so created would greatly increase the possibilities for agro-forestry once tree planting has taken place.

2. Grazing Within the Stand

For cattle grazing potential in plantations to be extended over a significant proportion of the rotation will require a change in silvicultural techniques. The success of agro-forestry in New Zealand (and, more significantly, its future potential) is related to a particular forest management philosophy. This philosophy contends that the future world markets for softwood will place a price premium on clear, defect-free material as existing supplies of such timber in North America, Scandinavia and U.S.S.R. become exhausted or too far from ports for successful exploitation. Pinus radiata is able to produce such material in relatively large diameter (65cm +) logs over rotations of 24-30 years. To do so, however, requires an intensive silvicultural programme involving:

- wide initial spacing. Ratio of planting spacing: final crop of approximately 5:1.
- early and heavy thinnings to waste to reduce the stands to final crop spacing (100 - 200 spha) as early as possible. Thinnings, in fact, take place as early as is allowed by the necessity to identify good form trees to constitute the final crop.
- intensive pruning schedules to control branch development and allow the production of a 6 metre butt log of clear timber laid down over a knotty core. The maximum diameter of this central defect core, containing pruned branch stubs and occlusion, should be around 20cm to maximise the value of the pruned butt log. To obtain such low defect core diameters requires extremely efficient and timely management of silvicultural operations. Pruning is generally carried out in 3 to 4 lifts with height of pruning controlled by individual tree height. Trees are pruned to 50-60% of their total height.

Such a silvicultural programme, in which the aim is to allow totally unrestricted diameter growth on the final crop trees, results in considerable under utilisation of the site. This spare site capacity can be utilised by pasture species (in New Zelaand generally a duo-culture of grasses, such as perennial rye grass, and legumes, such as white clover) and livestock grazed over a considerable proportion of the rotation.

FIGS. 1 & 2. Stages in silvicultural regime for silvo-pastoric in New Zealand

1. First pruning to 2m at tree height 4m. Residuals thinned to waste.

2. Siviculture complete. 200 s.p.h pruned to 6m.

The system involves a loss in total timber volume production - in the order of 20-30% - but it is projected that this is more than compensated for by the increased value of the timber produced and the financial returns from grazing.

(Note: In New Zealand such two-tier forest farming is often proposed for hill country already carrying pasture of medium to low quality (carrying capacities of around 2 cattle or 10 sheep per hectare per year). In such situations the agricultural industry tends to look at the financial aspects in a rather different way. To be successful, the returns from timber growing over the rotation period must pay for the cost of tree establishment and management and more than compensate for the grazing returns foregone at each end of the rotation).

There is currently very little data available in Sao Paulo to argue a case for or against the introduction of such a land management system. Basic information is required on such aspects as:

- physical response of the major pine species to heavy thinning and pruning schedules.
- growth and productivity of various pasture species and livestock on sites utilised to varying degrees by trees.
- market research to attempt to define, in different localities, future timber demand by log type as well as volume.
- determination of a possible price premium in some localities, for large diameter, pruned logs and whether such premium will be sufficient to compensate for lower volumes.

It is very unlikely that two-tier agro-forestry, similar to the New Zealand system briefly described above, will be applicable in more than a relatively small proportion of potentially forest areas. In New Zealand the system is still practiced on a relatively small scale - perhaps 5% of plantations - but the potential is very large. Some 4.5 million hectares are classified as hill country pasture land and it is estimated that between 5 and 10% of this could be suitable for two-tier forest farming. The potential in Sao Pualo cannot be estimated until a considerable amount of biological and economic research has been completed but there is little doubt that an increased research effort to expand the data base is worthwhile.

3. Intercropping

Intercropping forest-farming systems, in which trees are planted between the rows of agricultural crops, are practised in a number of different countries. During the tour there was no indication that such systems would be suited to the state of Sao Paulo. Rural populations tend to be geographically stable and agricultural crop production is concentrated on permanent, artificially fertilised areas.

4. Wildlife

A number of areas were seen where wild life such as deer, pigs and large native rodents were fenced within forested areas (e.g. Santa Barbara, Assis, Mogi Guacu). Although such projects are important from the point of view of fauna protection and increasing the recreational and educational value of the forests, there is little apparent scope for the farming of any wildlife species within forested areas. Deer farming, for antler velvet and venison, is rapidly expanding in New Zealand using a number of species of introduced deer. Such farms often possess considerable areas of forest land and deer will spend a proportion of their grazing time in such areas. The possibility of farming native (or introduced) deer in Sao Paulo could perhaps be considered by someone suitably qualified.

SUGGESTED RESEARCH STRATEGY

1. Use of Firebreaks and Other Idle Lands

Much progress could be made here by increases in management activity. There is an immediate need for very applied, management oriented, practical research on the following.

1.1 Study and training in the use of modern electric fence systems. In New Zealand, and possibly in other countries, there have recently been dramatic advances in electric fence technology. Mains powered units are now available which are completely safe yet produce an extremely effective 5,000 volt pulse (duration about 0,0003 seconds and frequency about 60 per minute) capable of energising a fence up to 60 km long. Vegetation threatening to engulf such a fence is killed at the point of contact under reasonable conditions but the fence will continue to function even when power leakage through touching wet vegetation is considerable. Somewhat less powerful battery, solar, wind and water powered units are available for more remote locations.

The major advantage of electric fencing systems are that construction costs for long, permanent fences are drastically reduced (by up to 75% in New Zealand) and various types of quickly erected temporary fence systems are available. Consequently their use greatly improves livestock grazing control.

The major disadvantage is that to be effective, electric fence systems must be properly and carefully installed, and maintained with an intelligent awareness of the basic principles of their operation. They cannot be simply purchased and erected by people unfamiliar with their operation and be expected to function efficiently.

Their value in forest grazing systems is so high, however, that training in their use would be an essential step in the development of agro-forestry in Sao Paulo.

1.2 A search for practical solutions to the problems of access to water for cattle. Such techniques as forest grazing scheme layouts to take advantage of natural water, establishment of water reservoirs, simple wind or water powered pumping systems and systems of water cartage require investigation.

1.3 Investigation of local demand for forest grazing from neighbouring landowners. Where a particular experiment station has insufficient cattle for all its potentially grazeable areas, or some locations are too distant from headquarters for satisfactory cattle management, grazing under a lease system by neighbouring landowners could still provide the forest with many of the advantages of agro-forestry. Considerable research and thought needs to be given to the design of lease agreements. As an example of the potential, in 1979 the New Zealand Forest Service earned NZ$150,000 (Cr$15,000,000.00) by leasing a total area of 73,000 ha for grazing by approximately 45,000 sheep and 30,000 cattle. Grazing fees vary very widely - between NZ$2 - NZ$30 (Cr$200 - Cr$3,000) per hectare per year - depending upon quality of pasture, length of lease, responsibility for fences and water, etc.

Forest grazing can become particularly valuable to the farmer in times of drought and in fact it was a serious drought in 1968 that stimulated agro-forestry in New Zealand.

1.4 Improved cattle production from grazing control. The level of expertise in cattle production generally in the state of Sao Paulo is unknown to the author. The impression gained from the study tour, however, was that cattle production could be increased by research and development of more intensive grazing systems including pasture rotation (see note on electric fencing above), separate grazing on better pasture of young stock, establishment of improved pasture species, etc.

1.5 Cost studies of pasture development on idle land before planting. It is appreciated that resources for the development of idle lands currently controlled by the Instituto Florestal are limited. Nevertheless some cost/benefit studies should be carried out to examine the potential for overall improved use of these resources if pasture development precedes plantation establishment.

2. Grazing Existing Stands

There is some overlap between this section and that immediately preceding it. However, of particular interest here is the need to investigate the grazing potential of older stands of pine (and Eucalyptus) which have received their final thinning to approximately 250 stems per hectare. The author's personal feeling is that the potential here is very limted. In the New Zealand situation it is at this point that pine plantations offer the least grazing potential.

Fig 3. Pinus Oocarpa age 21 years thinned to 200 r.p.ha (Plantations of CAFMA, Fazenda Monte Alegre, Agudos, S.P.). A few pasture species establishing.

However, research is warranted on the following aspects.

2.1 Shade tolerance of a range of pasture species. A great deal of work has been done on this subject elsewhere (e.g. Hawaii, Fiji) and consequently a literature review would be an important first step. This could be followed by nursery and field trials of the most promising species identified from the review. There are established techniques for the measurement of dry matter production per unit area and for the analysis of this production to determine feed value. Cooperation with an agricultural research organisation may be of benefit here.

2.2 Trials of pasture species establishment techniques in older, thinned stands. This work should include trials of seeding methods and density and ways of dealing with the often heavy litter layer found under old stands. The use of controlled burning and mechanical incorporation into the soil should be examined.

2.3 Effects of forest grazing on animal health. There is already evidence that cattle are more prone to infestation by ticks when grazed in shady situations. Constant monitoring of cattle health should be carried out to evaluate the significance of this and other health factors. The opportunity to compare liveweight gains of cattle grazed in forest situations with those grazed outside should be taken when and where it is possible.

3. Grazing in Young and Medium Aged Stands

As discussed above, the financially successful combination of trees and animals for a significant proportion of the rotation requires a plantation management system radically different from that currently practiced in Sao Paulo. To ascertain if such a change is justified, extensively or in selected areas, requires a complex of biological, management and economic studies. These studies breakdown into three major areas of research:

- behaviour of major forest tree species under different management regimes.
- productivity of pasture and livestock species and types under different plantation management regimes.
- studies in forest economics to assess local and regional demands in the future; possibilities of price premia for larger, faster grown logs, etc.

In designing a research programme for agro-forestry it is important that work in the various fields does not become out of phase. For example there would be little point in detailed economic studies of short rotation, clear wood production if the species available will not respond well to heavy, early thinning and pruning operations.

It is suggested that initial research should concentrate on the response of the major species to different silvicultural treatments. The suggested basic trial layout would consist of a control - current silvicultural practice - and three treatments. These three treatments differ by the intended final crop spacing. Three final crop spacings are proposed - 250, 175 and 100 stems p.. hectare. In New Zealand agro-forestry ratios of trees-planted to trees-in-the-final-crop vary between 3.5:1 and 7.5:1. For the initial trials in Sao Paulo a ratio of 5:1 is suggested. With treatment 1 as the control, the other three treatments are as follows:

	Treatment No:-		
	2	3	4
Initial spacing (stems/ha)	1250	875	500
Final crop spacing (stem/ha)	250	175	100

Pruning regimes for the various treatments should aim to minimise the diameter of the central defect core of the pruned log. Observations during the study tour suggest that neither P. elliottii nor the tropical pines are likely to develop the very large diameter branches that wide-spaced Pinus radiata produces on the more fertile New Zealand hill country pasture. It is possible, therefore, that the four and five stage prunings now being advocated in New Zealand, will not be required

It is strongly suggested, however, that pruning schedules be based on crop height and that during the pruning operation each tree be pruned to 50% of its particular height. In this way the larger, more dominant trees are not consistently under-pruned with a consequent increase in their knotty core diameter. Discussions with Instituto Florestal officers suggest that pruning to 50% of tree height would not be excessive. Thinning and pruning schedules would then be as follows:

	Thin to (s.p.ha.)			
Average mean crop height (m)	Treatment 2	Treatment 3	Treatment 4	Prune residuals to 50% of height. Mean pruning height therefore (m)
4	600	400	250	2
8	250	175	100	4
12	250	175	100	6

At each site chosen for these trials, each treatment should be replicated four times. Plot size should be 2 ha and each plot should be surrounded by a 30m buffer strip and the treatment schedule for each plot should extend half way into this strip. No tree measurements should be taken in the buffer strips. Annual recordings should be made of tree height and diameter at breast height (d.b.h.) and it is also recommended that at each pruning operation the diameter over stubs (d.o.s.) of the largest whorl pruned be measured. Sample measurements of d.o.s. have been found to be particularly useful in predicting knotty core diameters - and hence volumes of clearwood - with radiata pine in New Zealand.

Trial plots should, where possible, be grazed or hand cleared to prevent excessive under storey growth.

Such trials should be established at a number of locations in the state to allow coverage of the various species and conditions existing. A possible distribution is Pinus elliottii at Itapetininga and tropical pines at Paraguacu Paulista, Fazenda Santa Maria and Mogi Guacu.

To gain some time, plots could be established in already planted stands up to 2 years old, trees simply being removed systematically (i.e. no quality selection) to achieve the desired initial spacing. One area of tropical pine suitable for this was seen at Fazenda Santa Maria.

At least one of the trial areas, however, should be started from bare land and pasture and animal production trials superimposed on the basic trial. This would involve the establishment of one or two pasture types before the trial was planted. Each treatment would then require fencing to allow controlled grazing. Pasture production could be measured in each treatment by means of small, caged exclosure plots from which the pasture growth is regularly cut, analysed and assessed for dry matter production. Measurement of animal production is a more difficult task and various techniques are under development in New Zealand. Liaison with an agricultural research organization would be an advantage here.

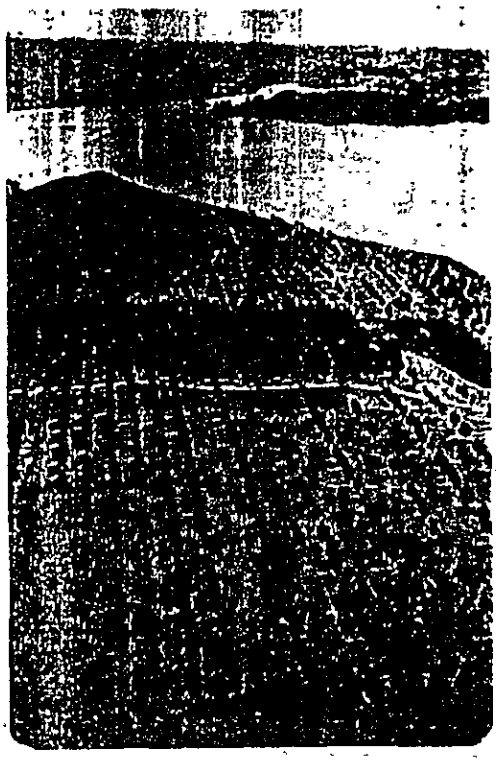

Fig. 4 Aerial view of agro-forestry trial at Tikitere, New Zealand showing range of initial planting spacings. First pruning completed.

This latter trial involves considerable expense and effort in establishment and regular measurement. Its site should, therefore, be chosen with care. AS agroforestry is only likely to be financially successful on the better soils, the site should have reasonable soil fertility, good access to water and be relatively easy to fence. A high level of cattle management expertise should be available. A possible site, of around 100ha in size, was seen at Mogi Guacu.

To hasten even further the acquisition of knowledge on the basic response of tree species to heavy thinning and pruning, much simpler versions of the above trials could be established in stands up to 4 or 5 years old. For example a small area of 4 year old Pinus oocarpa at Paraquacu has already been pruned to approximately 2 metres. Heavy thinning of a portion of this stand, and further pruning, could provide useful information.

Fig. 5. 4 year old Pinus oocarpa, pruned to 2m at Paraguacu Paulista. Possible site for pruning and spacing trial.

IMPLEMENTATION AND FURTHER WORK

The establishment and servicing of individual trials at each experimental station will be carried out by local staff. Overall coordination, however, needs to be centralized by one officer who should also be responsible for initiating the essential forest economics studies which must follow the collection of basic data on tree responses to various silvicultural treatments.

Forest economics and its relationship with differing silvicultural treatments of fast growing softwoods is a highly developed science in New Zealand and, perhaps to a lesser extend, in countries such as Australia and U.S.A. To tap this over seas knowledge and also to allow further development of agro-forestry management and research techniques, it is suggested that two members of the staff of Instituto Florestal should make study tours as follows:

1. A Tour of the Following Countries

   a) Costa Rica - Tropical Agricultural Research and Training Centre (CATIE), Turrialba

   b) Hawaii - University of Hawaii

   c) Fiji - Fiji Pine Commission

   d) New Zealand - General tour of Agro-forestry operations and research at Forest Research Institute, Rotorua

The aim of this tour would be to obtain information and experience on potential management of tropical pasture species under pines and agro-forestry research and management. The officer undertaking this tour should be management oriented and have a good knowledge of English.

2. A visit to New Zealand to study the latest techniques and information available on the economics of silviculture particularly as related to fast growing pine species. This officer should be the co-ordinator of the Sao Paulo agro-forestry research programme and should also have a good knowledge of English.

The duration of both tours would be about two months. If funds could be found it may be desirable to have an expert in forest economics visit Instituto Floresta for up to six months to assist in the development of forest economics studies in relation to agro-forestry.

In the event that initial research shows that agro-forestry has potential in Sao Paulo, it will be necessary to:

- intensify trial work along the most promising lines indicated by the earlier work.
- set up demonstration areas around the state which will serve as additional research areas and also demonstrate the feasability of the concept to land owners other than the Instituto Florestal. Extension work will be required to help private landowners set up their own agro-forestry projects.

PARAIBA VALLEY

A short tour of the Paraiba Valley was undertaken in the company of Dr Walter Emmerich. The purpose of this tour was to assess the possibilities of agro-forestry in the rehabilitation of degraded hill land above the valley.

The original clearing of this land and planting in coffee resulted in serious soil erosion. Coffee plantations were eventually abandoned and the land now carries poor pasture. Most of the land is owned by individual farmers in small to medium sized holdings.

There is little doubt in the author's mind that much of this land should be returned to forestry to protect the valuable lands in the valley bottom. Technically, this would not be difficult. There is little doubt that both pines and eucalypts would grow well on the hills. The land is close to industrial areas in the Paraiba valley where there are already three pulp and paper mills. These mills currently utilise eucalypt timber and so the large scale planting of pines should not be undertaken without careful research of future utilisation prospects. A further argument for the use of eucalypts is their proven value as a fuel source for smaller scale industries.

From the technical point of view two factors mitigate against agro-forestry in this area. Firstly the very low livestock carrying capacity of much of the land is not conducive to the financial success of agro-forestry. It is doubtful whether the additional management effort required would be justified by the very low grazing returns. Detailed economic studies would be required to confirm or refute this.

Secondly there is little scope for the combination of livestock with eucalypts as grown in Sao Paulo. Eucalypts timber for pulp and fuel wood uses is grown by means of close spacing, short rotations and reliance on coppice regrowth. Such a system leaves little room for utilisation of the site for other uses complementary to forestry.

Although there appears to be little scope for agro-forestry as such in this area, there is little doubt that forestry and farming, on discrete land types, would be mutually beneficial. The better, less steep farm areas would benefit from the protective effect of afforestation on the steeper, eroding lands above. Water yields would be steadied and the forest would provide shade, shelter and, possibly, valuable emergency grazing - albeit of very low quality - in times of drought. Financial returns are likely to be higher from forestry on these lands, although this point requires further research.

Up to now the problem has been considered only from the technical point of view. By far the biggest obstacle to afforestation in the area is the present ownership patterns. Individual farmers are likely to be very reluctant to take large areas of their farms out of production in anticipation of future financial yields from forestry. Even if these future returns can be shown to be higher than current incomes, land owners still have the problem of reduced annual incomes while they wait for forest maturation. This is a common problem in New Zealand, but a number of techniques have been at least partially successful in providing solutions.

a) Financial Incentives

On larger farms where the proportion of good quality grazing land is high, some farmers can be persuaded to commence afforestation schemes by means of low interest, government loans; government grants to cover a large proportion of forest establishment costs or tax relief on afforestation costs.

b) Land Lease

Long term leasing of forest land by government or private interest can provide an immediate income to land owners who cannot afford the waiting period to complete their own afforestation schemes. Leasing also has the advantage that land ownership is retained. The leasing agency can further improve the financial situation of the local land owners by providing at least part-time paid employment in the planting and management of the forests.

In New Zealand lease terms very from 35 to 99 years and payment is by various combinations of annual rental and a percentage of stumpage value at harvest. The short rotation possible with eucalypts in Sao Paulo may simplify the financial aspects of such leases (although this may be negated by the effects of very high inflation).

At the end of any lease period there remain the options of a further lease or the land owner can take back his now productive forest and continue to grow forest produce on a contract sale basis.

c) Land Sale

Rationalisation of land use can sometimes be achieved by the purchase of large areas by state or private organisation. Such organisation can then manage the land according to its best use potential or the better farm land areas can be aggregated into economic units and resold to individual farmers. Again in this situation the farmer can be offered part-time work in the forest and/or emergency grazing.

Social implications are often paramount when assessing the possibilities of any of the techniques described above. The author is not qualified to suggest which may be the most applicable in the Paraiba valley. It is suggested, however, that an important first step is the demonstration of the possiblities of land zoning and selected afforestation on a property typical of the area. A demonstration area could, perhaps, be acquired by purchase or by enlisting the cooperation of an interested land owner able to take the financial risks involved.

If such an area can be found, then a repeat of the agro-forestry trials described in the main report, with pine species would be worthwhile.

APPENDIX 1

Itinerary

August	2 - 4	Travel Auckland/Sydney/Los Angeles/Sao Paulo
"	5 - 6	Meet Staff of Instituto Florestal and general discussions on forestry in state of Sao Paulo
"	7	Further general discussion and planning of Itinerary for tour of state.
"	10	Drive to E.E. Munduri. Meet members of working group. Inspect P. elliotii plantations, sawmill, housing project.
"	11	Further discussion and inspection of plantations. Slides and discussion on New Zealand agro-forestry.
"	12	Travel to E.E. Santa Barbara. Visit plantations of private company CAFMA.
"	13	Travel to Itapetininga E.E. Inspect establishment operations.
"	14	Drive to Paraguacu Paulista, tour E.E.
"	17	To Assis, inspection of young stands and recreational facilities.
"	18	Drive to E.E. Luiz Antonio; inspect plantations and seed orchard.
"	19	Tour of Sao Simoa district including Faz. Santa Maria.
"	20	E.E. Moji Guacu.
"	21	Drive to Sao Paulo. Discuss impressions with Director Guenji Yamazoe.
"	24	Tour eastern Paraiba Valley with Walter Emmerich. To Campos do Jordao.
"	25	Travel across Paraiba valley to Cunha. Watershed project.
"	26	Travel back along Paraiba valley to Sao Paulo.
"	27	Work at Instituto Florestal
"	28	Seminar on silvo-pastorio at Instituto Florestal. p.m. fly Brasilia with Dr Keats Hall.
"	31	Brasilia. Discussions with Dr Hall, FAO team leader. Meet with UNDP Res. Rep. Dr P. Koenz. Discussions on agro-forestry research with Carlos Alberto Ferreira of EMBRAPA.

Sept	1	Fly to Rio and Rome.
"	2	Rome. Discussions with Latin America desk officer E. Bluhm
"	3	Rome. Discussions on report with R. Levingston, Project Operations Officer. Also brief discussions with A. Leslie Director, Forest Industries Division
"	4	Fly Singapore
"	5	Travel to New Zealand
"	6	Arrive Auckland

JICA