REPORT ON THE STUDY TOUR OF AMAZONIA, BRAZIL

from APRIL 19th till MAY 3rd, 1982

by

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CELOS

1982

C O N T E N T S

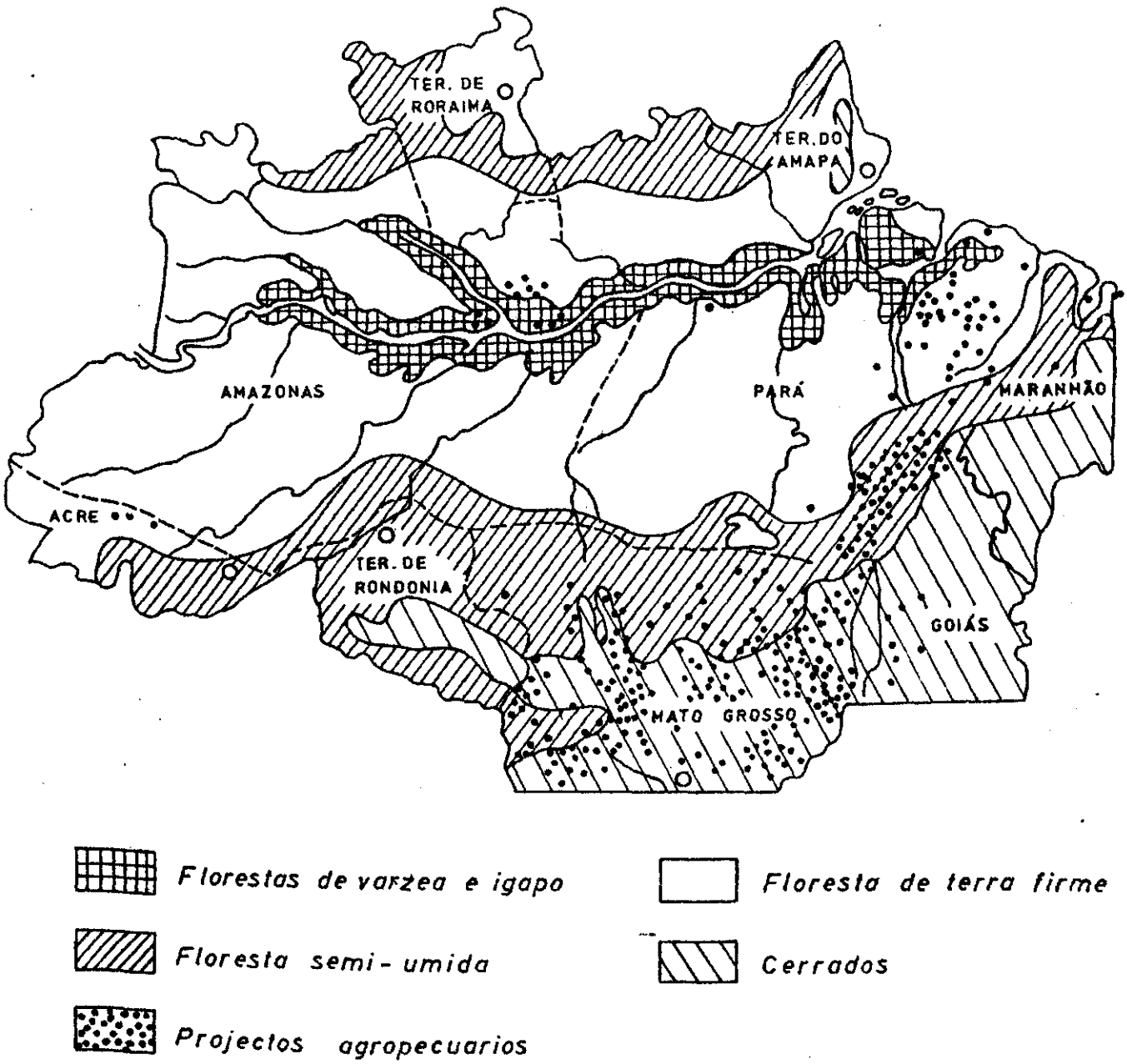

Fig. 1. Forest formation in Amazonia legal (from 30).

1. INTRODUCTION

The Amazonas catchment area contains the largest coherent area of tropical rainforests. The Brazilian part ('Amazonia legal') is about 5.000.000 km^2, of which more than half is covered by tropical rainforests, the balance is covered by water, semideciduous forests and savannah's (see Fig. 1). The tropical rainforests can largely be divided in 'terra firme' - forests, on so - called upland territory (95%) and in 'varzea' - and 'igapo' - forest (5%), respectively on annually inundated soils and in swamps.

The access to the hinterland has been by river. This resulted in an exploitation for timber of the 'varzea', followed frequently by a conversion of these forests into agricultural or pasture lands. The forests of the 'terra firme' have largely remained undisturbed. During the last ten years the pressure on these 'terra firme' forests, possibly quite comparable to the forests of Suriname, has grown and various dangers such as overexploitation, legal and illegal settlers, conversion into pasture lands, hydro electrical energy plants etc. threaten the forests now. The Brazilian government has seen these dangers and has started, in various places and by various agencies, research into the future management of these forests. These research plans, already partly in execution, are conform to the main research concern of the project LH/UvS 0

Hence a small delegation of the scientific staff of the project LH/UvS 01, consisting of the silviculturist and the ecologist/projectleader returned the visit of Dr. Mauro Silva Reis (now Director IBDF[*]) and colleagues to CELOS in 1979. They visited various research institutes and experimental forests in Amazonia, to form an idea of the Amazonian forest, to discuss matters with Brazilian forest scientists and to compare problems and possible answers to them. Unfortunately the planned visit to 'Jari' could not take place.

A tour like ours cannot be made without the assistance of many. We remember and are grateful to so many Brazilians inside and outside forestry, that it is impossible for us to mention them all. We like to make an exception here and to say thanks to Natalino, Niro, Keats and Tony for their assistanc by the preparation and execution of this tour.
Due to the fact that we do not speak Portuguese and due to the hectic pace of such short visits, some misunderstood facts, figures and perhaps theories might be used in this report. For this we can only apologize.

[*] see list of abbreviations, appendix 1

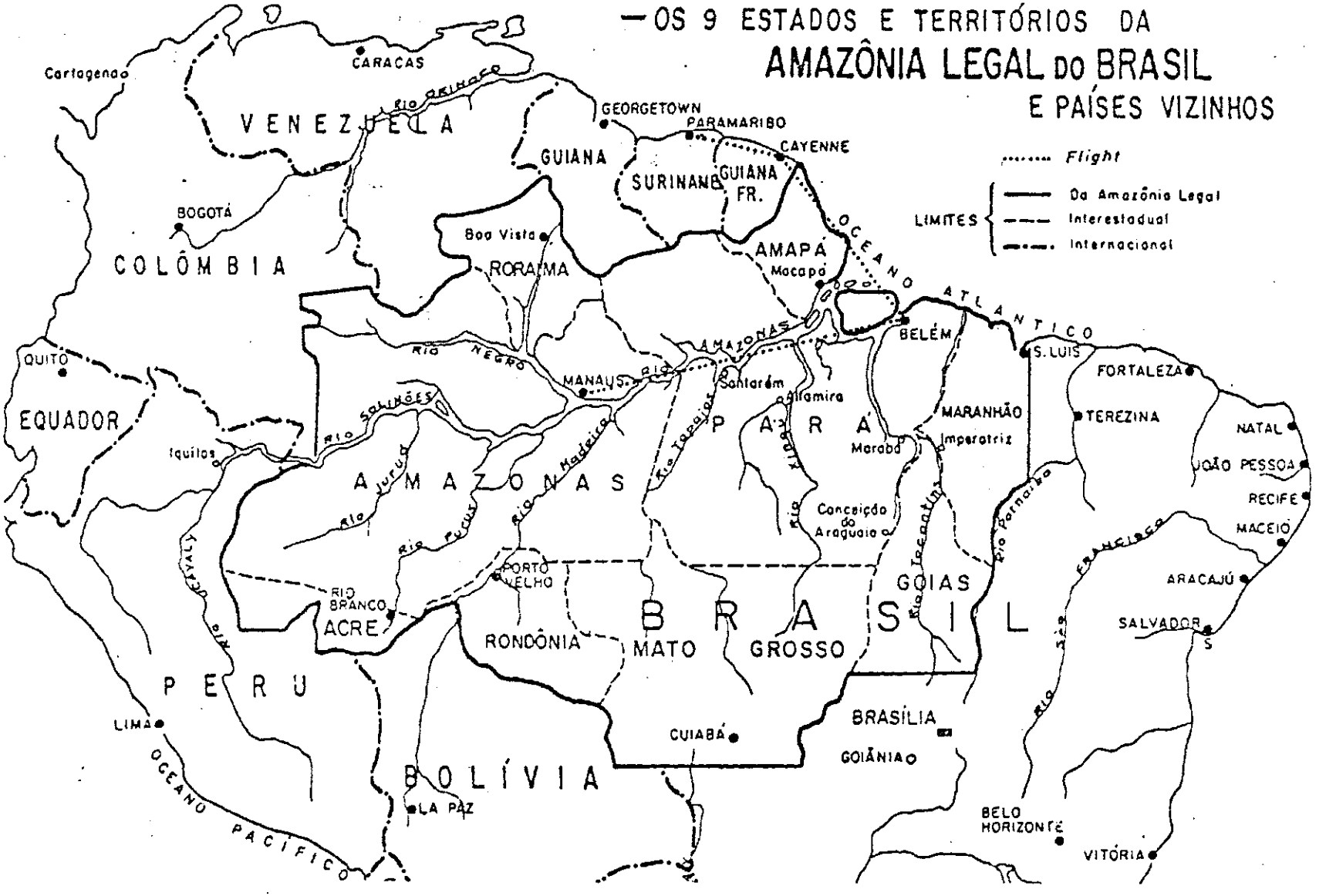

Fig. 2. Map of Amazonia with flightroute.

2. PROGRAM

April, 18th : - Bus Paramaribo Zanderij (departure 11.00 p.m.)

April, 19th : - Flight Zanderij-Belem (Fig. 2); met by Mr. J.N. Macedo Silva MSc.(EMBRAPA - CPATU).
+ Conference with Dr. C. Nascimento (Director EMBRAPA - CPATU), Mr. J.N.M. Silva MSc (coordinator Forestry, EMBRAPA - CPATU) and his collegues S. Brienza (agro-forestry) L. Marques (silviculture) and N. Vianna (seed phenology and seed production).
- Lunch with Mr. I.N.M. Silva
+ Conference with Dr. A.E. Silva Castro (Director IBDF - Para).

April, 20th : - Flight Belem - Santarem (Fig. 2)
+ Visit to the Tapajos National Forest (Fig. 3), km 114, with Mr. J.N.A. Silva, Mr. L. Marques, Mr. J. do Carmolopes (all CPATU), Mr. K.C. Hall (FAO - IBDF), Mr. H. Willstedt (FAO), Mr. R.R. de Almeida (IBDF) and Mr. R. Cavalcanti (IBDF - FAO).

April, 21th : + Visit to a natural regeneration of Vochysia maxima and other forest trees in an abandoned rubberplantation at Belterra with Mr. J.N.M. Silva and Mr. R. Cavalcanti.
+ Visit to the nursery at Belterra with Mr. L. Marques.
+ Visit to field trials on species, provenance and spacing at Belterra with Mr. T.L. Krüger (ESALQ - USP) and Mr. M. Kanashiro (EMBRAPA - CPATU).
+ Visit to the Tapajos National Forest km 67 and km 52 with Mr. J.N.M. Silva and L. Marques.
+ Working dinner with Mr. K.C. Hall, Mr. J.N.M. Silva, Mr. R.R. de Almeida, Mr. L. Marques and Mr. R. Cavalcanti.

April, 22th : + Introduction into the work of SUDAM - CTM by Mr. L.M. Pedroso (SUDAM - CTM).
- Journey by speedboat to Curua - Una (Fig. 3)
+ Visit to species - trials and regeneration experiments at Curua - Una with Mr. R.L. Silva Costa (CTM - SUDAM) and Mr. K.C. Hall.

April, 23th : + Visit to species trials and exploitation experiments at Curua - Una with Mr. P.C. Silva Vasconcelos (CTM - SUDAM) and Mr. K.C. Hall.
- Journey by speedboat to Santarem.
+ Discussion on the work of CTM - SUDAM with Dr. C.A. Carneiro Lopes (director CTM - SUDAM) and Mr. Cavalcanti.

April, 24th : + Preparing report; holiday.

April, 25th : - Flight Santarem - Manaus (Fig. 2)
+ Preparing report; holiday.

April, 26th : + Introduction into the work of INPA by Dr. H. Bergamin Filho (Director INPA) and Mr. N. Higuchi MSc (Head Silvicultural Department INPA).
+ Visit to INPA - Department of Botany (Head Dr. M.F. da Silva), the INPA - Subdepartment of Hydrology (Head Dr. W. Franken) and the INPA - Library.
+ Visit to the ORSTOM - group (Dr. I.L. Guillaumet) in the INPA - Department of Ecology.
+ Visit to Ducke National Forest with Mr. N. Higuchi.

April, 27th : + Visit to the EEST (formerly km 60 at Highway BR 174) with Mr. N. Higuchi and Dr. W. Franken.

April, 28th : + Visit to the Laboratory for Wood Technology of CPPF/INPA with Mr. F. Lemon de Almeida.
+ Conference with Dr. D.B. Arkcoll (INPA - Department of Agroecology).
+ Conference with Mr. N. Higuchi.
+ Conference with Dr. H.O.R. Schubart (Deputy - Director of INPA, Department of Ecology) (Schmidt).
+ Visits to the INPA - Laboratory for Cellulose and Paper (Head Mr. A.A. Correa) (De Graaf)
+ Conference with Mr. P.A. Grieger (Director of IBDF - Amazonas).
- Dinner with Mr. N. Higuchi

April, 29th : - Holiday
- Brought to the airport by Mr. N. Higuchi.
- Flight Manaus - Belem, met at the airport by Mr. J. do Carmo Lopes (EMBRAPA - CPATU).

April, 30th : - Conference at the Silvicultural Department of EMBRAPA - CPATU with Mr. M. Kanashiro and Mr. J. do Carmo Lopes.
+ Conference at the Section Forestry at FCAP with Mr. A. Oliveira MSc and Mr. A.L. Holanda MSc.
+ Conference with Dr. C. Pandolfo, General Director of the Department of National Resources of SUDAM.
+ Conference with Dr. J.L.C. Dubois, representative of IICA in Brazil.

May, 1st : - Preparing report.

May, 2nd : - Holiday.
+ Preparing report.
- Flight Belem - Zanderij.

May, 3rd : - Bus Zanderij - Paramaribo (arrival 3.30 a.m.).

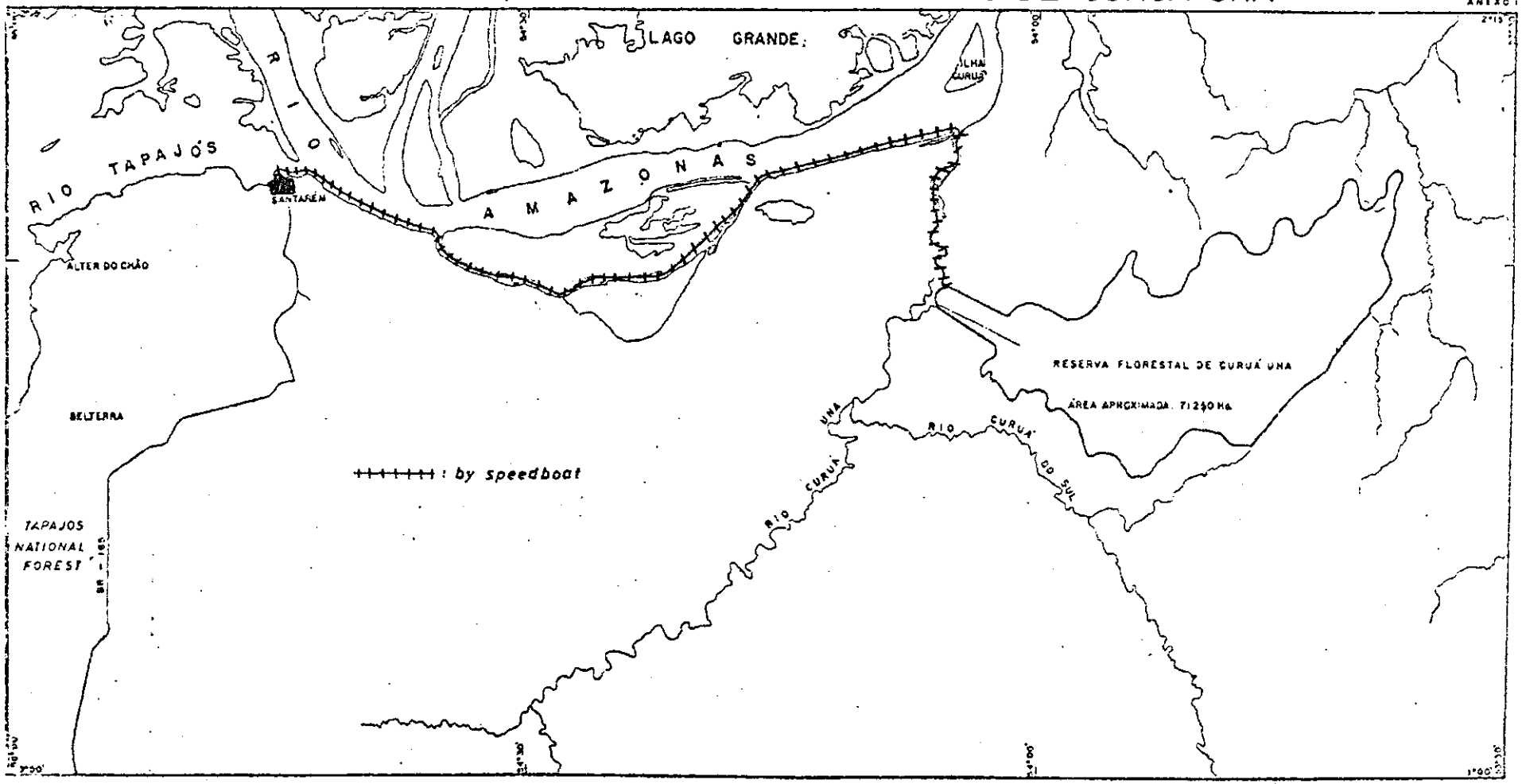

Fig. 3. Map of the neighbourhood of Santarem.

3. THE INSTITUTIONS, THE FORESTS, THE DISCUSSIONS

3.1. Monday, April 19th

EMBRAPA - CPATU

On the first morning in Brazil, Mr. J.N. Macedo Silva, who met us at the airport, introduced us to the forestry team of EMBRAPA - CPATU. This team consists of eleven scientists, four of whom are doing postgraduate courses (MSc) now, four technicians, five people for the laboratory, an administrative staff of four and about fifty labourers in the field. They have now about 600 ha of research plots (200 ha natural regeneration, 200 ha species trials and nursery and 200 ha enrichment planting in secondary forests).

The forestry department of EMBRAPA - CPATU started in 1978 and took over FAO - work, which started in 1975. Their research (19 projects in 67 experiments) centres around five themes:
1. Forest management, including logging
2. Silviculture
3. Genetical improvement
4. Agroforestry
5. Ecology

This includes research in the Tapajos National Forest, started in 1979, on logging intensity and on natural regeneration. It is expected that the results can be included in the management plan for this forest. For details: see the report on the visits to the Tapajos National Forest on April 20th and 21st.

Much time and energy is directed into research on possibilities of the recuperation of the productivity of secondary vegetations. The approach of EMBRAPA - CPATU includes both monoculture plantations and enrichment plantings. FAO started this work in 1975 with species trials. The five best species are now being tried in spacing trials. EMBRAPA - CPATU continued this research and started new trials with both indigenous and exotic species, with an emphasis on the former. For more details see the visit to Belterra on April 21st.

In connection with these trials EMBRAPA - CPATU is doing quite a lot of work on phenology, production, storage and germination of seeds and on nursery technique. For more details see the visit to Belterra on April 21st.

We did not visit due to lack of time the EMBRAPA - CPATU work on agroforestry near Belem. One of the systems, which they are working upon, consists of:
year 0 Clearing and burning the secondary forest.
Planting food crops like rice, corn, cassave, bananas.
year 2 Planting forest trees like Cordia and Bagassa.
This system is now in the fourth year and still showing promise.
Other systems include the planting of a mixture of Cordia goeldiana, and Carapa guianensis with coffee and cocoa. These experiments started in 1981, so one will have to wait for the results.

Also we did not visit nor discuss, while the responsible scientist was on leave, the ecological work of EMBRAPA - CPATU on autecology of Cordia alliodora and C. goeldiana (both indigenous and very promising species), on nutrient cycling (planned for the Tapajos National Forest), and on the microclimatology of the forest after exploitation.

This introductory conversation was broken up many times by talks on the possibilities of natural regeneration. As mentioned above EMBRAPA - CPATU has worked since 1979 on natural regeneration. EMBRAPA - CPATU thinks natural regeneration very promising but has very little experience with it. They were also very anxious to hear our opinion on it. This discussion with the forestry team of EMBRAPA - CPATU was concluded with a conference with Dr. C. NASCIMENTO, the director of EMBRAPA - CPATU.

IBDF

In the afternoon Mr. J.N.M. SILVA took us to IBDF, to have a conference with Dr. A.E. SILVA CASTRO, the director (Delegado) of IBDF - Belem. IBDF is, according to Dr. SILVA CASTRO, comparable to a State Forest Service and is responsible for, among other things:
- Forest Policy and Forest Laws
- Forest Inventory
- Forest Planning
- Nature Conservation

One of the main fields of action of IBDF in Para is the granting of land - and timber concessions. Owners or buyers of forestlands (companies, private people, settlers) are allowed to clearcut 50% of the forest for agricultural or pastural purposes. The location of this area to be cut is alloted in consultation with IBDF. The balance must be kept intact as a forest. Ecologically this policy is not sound: the remaining parts of the forest will probably be scattered over the area in small patches, not in one big coherent area, as is necessary for a normal development of the forest. This ecological damage has to be added to the damage already caused by the clearcutting of 50% of the forest.

The penalty for offenders of this policy (cutting more than 50%; selling the forested lot to a third party, who again clearcuts 50%), if caught at all, is the forced purchase of forest lands, to compensate for the damaged area. The check on the just execution of this policy is very difficult.

Next to these more general tasks, IBDF is engaged in special projects:
- Management of the Tapajos National Forest (see the visit to this forest on April 20th and 21st).
- Improvement of the quality of sawmills
- Stimulation of reafforestation with Pinus
- Stimulation of plantings of Cocos nucifera, Eleais guianensis and Bertholletia excelsa. This last species, because of the nutritional value of the nuts, is protected.

During the conference Dr. CASTRO made it clear to us that IBDF understands the need to conserve and protect big areas of the Amazonian forests and that IBDF is planning to do so. Among the politicians in Brasilia this concern lives also. One senator thinks IBDF is not doing enough. Dr. CASTRO did not think this criticism necessary. IBDF makes every decision after taking into account all the aspects, inclusive those of nature conservation

3.2. Tuesday, April 20th

TAPAJOS NATIONAL FOREST

When arriving at km 114 in Tapajos Forest Reserve (see Fig. 3), we first got a short briefing about the Forest Reserve and the experiments to be seen. The Reserve comprises an area of 600.000 ha, along the Tapajos River, from Belterra in the North to nearly the Trans Amazonian Highway in the South. The North-South road from Santarem to Itaituba is the eastern border. This area of unexploited forest was selected after an inventory done by IBDF. The topography is flat, but welldrained, with virtually no creeks. A forest management production area of 136.000 ha, plus 35.000 ha of reserve, was projected. With an annual cut of 4000 ha selective exploitation, more than thirty years of harvesting can be expected, and this would fit well into a polycyclic forest management system.

Legal and illegal settlers came in with the road, but the situation now is under control. No more clearing for agriculture is allowed in the Tapajos Forest Reserve itself.

Soil data of the area were not available, but from an IPEAN publication (no 33) some data might be used. These data are from soil profiles along the Transamazonian Highway, more to the south, with roughly the same type of soil (Latosol Amarelho textura media). These soils can be called very poor in nutrients.

The logging- and silvicultural experiments are done by IBDF and EMBRAPA in close coöperation. At km 114 an exploitation/silviculture experiment of 144 ha has been started recently. Basic thought is, as said above, a polycyclic system. The title and objective freely translated, of the experiment as given in a preliminary report of EMBRAPA (no 5) are:"Determination of the best intensity of exploitation in a polycyclic management system of the humid tropical high forest".

(Objectives:)
a Determination of the best reduction of basal area of the primary forest, leading to a shorter cutting cycle in the polycyclic system as envisaged.
b Study of the increment of the forest by continuous monitoring.
c Determination of the time for silvicultural intervention to keep basal are increment, and thus volume production, high.
d Amelioration of the composition of the residual forest, by eliminating progressively the undesirable species.
e Determination of growth models to make possible a prognosis of future production.

The experiment consists of four treatments in four replications. Treatment plots have an area of 9 ha. Treatments given are:

T1: traditional exploitation with a lower diameter limit of 45 cm dbh
T2: reduction of basal area by felling with 20%
T3: do, with 40%
T4: do, with 60%

In T2 - T4 the lower diameter limit of exploitation is 55 cm dbh. Traditional exploitation is light. In this experiment many more species (40) were listed for exploitation than are common with the sawmill industry.

Of the total volume of timbersize trees per ha (220 m^3/ha) some 90 m^3 (larger than 45 cm dbh) are listed species. Attempts are being made to promote the marketing of lesser known species, to raise the quantities of timber harvested per ha. So far the sawmills in the state of Para have used the logs they could buy from colonists clearing their lands, and the mills could afford to be critical on species and log quality. From the viewpoint of the silviculturist this species promotion is a dangerous exercise, as harvesting more than, say, six large trees per ha causes heavy damage to the residual forest. It is better to concentrate on species of high value, and take only low volumes per ha, as this is far less destructive for the forest and the advanced regeneration of the highly desirable species in it.

The exploitation in the experiment under review takes ca 12 trees per hectare, amounting to ca 60 m^3/ha timber volume. This is quite high, and it will cause large gaps in the forest. If these gaps can be easily colonized by rapid-growing desirable species the problem will not be great, but otherwise they will not produce timber for a long time unless artificially replanted with fast growing species. The situation in Tapajos Forest is not exactly comparable with the situation in Suriname, as total forest biomass, soil quality and the list of desirable species differ considerably.

Field work had started recently, and we could witness the felling of some trees, on a walk of some kilometers made though the forest. It was noted that the forest vegetation was not very homogeneous, a common feature of tropical high forest. The biomass of the virgin forest seemed to us to be definitely higher than in the virgin forest at Kabo Suriname. Basal area was found to be ca 36 m^2/ha with the first inventory of IBDF. Higher standing volumes might allow for higher volumes harvested without undue forest destruction, but in a polycyclic system much depends on the presence of enough intermediate sized trees (say 15-45 cm dbh) to produce enough volume for the next harvest. Only when a good amount of such intermediate sized trees can survive the exploitation (and possible silvicultura treatments) will a second harvest be worthwhile within twenty or thirty years. Saving sound trees of desirable species and of commercial size might help to provide sufficient volume for the next harvesting operation, as well as the silvicultural treatments to keep volume increment optimal.

The diameter limit method applied in the Tapajos exploitation studies, readily results in a very heavy exploitation in locations where many trees of listed species grow together. It might be better to use another system for marking trees to be felled, e.g. harvesting (painting) of trees selected by experienced people with some silvicultural education, limiting the number (or volume) taken locally, and thus spreading the impact of harvesting.

Tree species we saw being felled were: Manilkara huberi, Goupia glabra, Hymenaea courbaril, Vatairea sp, Ocotea rubra. Logs had good size and length, often being more than 20 m long.

For the silvicultural research a set of 48 permanent sample plots of ¼ha each (50 x 50 m) was staked out at random, at a rate of three sample plots per treatment plot. The plots were recorded before exploitation and will be recorded again periodically after treatment. All trees above 5 cm dbh are measured and classified. The total are recorded is 12 ha (3 ha per treatment). This research task and especially the field work, is already a heavy workload with the existing facilities. The resulting increment and other data will be adequate to choose the best treatment of the four, but for more detailed research there might be too few trees in the higher diameter classes to make sensible groups according to species or diameters. In polycyclic management systems the competition status of trees varies much with the size and the diameter classes used should be 10 cm wide rather than 20 cm in studies on competition, mortality and increment. And the largest trees are the most important for increment, so a lack of data about large trees is a serious problem. Expanding field work is not easy and cheap, and especially intermediate staff is hard to get, both in Brazil and in Suriname.

In the LH/UvS 01 project in Suriname the deficiency of intermediate staff to supervise the important collecting of field data was partly compensated for by training-in-the-field of intelligent and literate labour. Being dedicated and "bush proof" is very important, more so than having diplomas. But even with a perfect team to do the recording, the responsible scientist should spend many weeks per year in the forest with the recording team, to increase his knowledge of the situations in his experiments. This keeps one from having a bureaucratic vision on the work, but the approach often has to be defended against the easily increasing paperwork in the office.

3.3. Wednesday, April 21st

BELTERRA

Belterra, a former rubber plantation, started in 1937 by the Ford Motor Cy, is located about 40 km south of Santarem (see Fig. 3). The area is about 3000 ha, the height about 175 m a.s.l. The climate can be classified as Ami (Köppen) with an annual rainfall of 2100 mm and a dry period between August and November with less than 60 mm a month (from 5). Other sources give a much lower rainfall for Santarem. The mean temperature is 24.9°C, the monthly mean varies between 24.3°C and 26.1°C. The soils are predominantely poor yellow latosols, with much clay (all data from 5). Data from one soil-pit in Belterra indicate a chemically much better soil than the soil at Kabo

When the Ford Motor Cy left in 1949, the Ministry of Agriculture took over. The maintenance of the plantation was neglected and the production declined: against 13 ton of latex per day in the 1940's, the production now is only about 2 tons a day.

Since 1978 the silvicultural department of EMBRAPA-CPATU has used part of this area for experiments. Three sites were visited:

a. Natural regeneration of forest trees in an abandoned rubber plantation.

When the Ford Motor Cy left, weeding in part of the plantation was stopped completely (pers. comm. of one of the labourers of the plantation, now working for EMBRAPA-CPATU). Seeds from old Vochysia maxima mother trees 600 m away came in (parrots) and germinated. Today these trees are 32 years old, have a height of about 26 m, a commercial stem of about 17 m and a DBH of 45-50 cm. Other forest species (Jacaranda copaia, Didymopanax morototoni, Tachigalia sp., Simarouba amara) penetrated also, but not as abundantly as V. maxima. These trees have now a dominant position above the crown layer of the Hevea-trees. The stem form of most trees is good. In the understorey, to about 3 m in height, an abundant natural regeneration of the same species shows promises for the future. No lianas were seen. The Hevea-trees are still tapped. In 1981 a plague of caterpillars defoliated the V. maxima trees completely, but the recovery was good. The soil (Terra preta dos Indios) is considered poor, but is, for Suriname standards, probably good.

It is the intention of EMBRAPA/CPATU to make an inventory of these stands, to get information for a decision about exploitation. The wood of V. maxima is used as a substitute for Cedrela. This was discussed intensively. We thought this a very good method to ameliorate the abandoned rubber plantation into producing forest again. The dominant V. maxima trees are looking healthy and are apparently still growing very well. A middle layer of forest species is absent. Hence, to our opinion an exploitation should be postponed.

b. Nursery

At Belterra, EMBRAPA-CPATU is developing a nursery with an ultimate production of 120.000 seedlings a year. Of the planned 12 ha 2 are in use now.

The seeds are collected in the Tapajos National Forest, some 50 km away, from selected plus-trees, around which the vegetation was cut down, to facilitate the collection. In the future these seeds of 50 species from 10 trees each, will be collected in a planned phenological garden of 400 ha in the Tapajos National Forest. In the 200 ha already inventoried 154 species were found.

A part of the collected seeds is sent to Belem, for identification and laboratory-experiments on dry weight, viability and storage. The intention of the forestry department of EMBRAPA-CPATU to move the seed laboratory from Belem to Belterra to avoid transport problems is justified.

The remaining seeds are germinated in the Belterra nursery and used in experiments on nursery-techniques (time of planting out, type of pot), planting-techniques (with rootball or with naked roots) and in field trials (species, provenance, spacing, enrichment plantation in secondary vegetation). The seedlings, when about 25 cm high, are planted in pits of 20x20x20 cm.

The most important species in the nursery now is Cordia goeldiana. The seeds of this species have a short viability and germinate after 30 days. The optimal date for planting out lies between 75 and 90 days after sowing. This is a local species, which provides a good timber and shows promise for the amelioration of secondary forest.

c. Provenance-, species- and spacing trials

In an area of about 200 ha various species-, provenance and spacing trials are carried out. In general the designs of these experiments are such that a statistical analysis of the results will be possible. Details can be found in item 5 of the literature list. The area (secondary forest) was cleared by bulldozer and ploughed before planting. Several of the experiments were visited and discussed:

1. Provenance trial of Cordia alliodora, 2 years old. Best provenance: Turrialba, Costa Rica, which is now 5 m high and has a good form. Unfortunately no Amazonian provenance were included: at the start of the experiment it was not yet known that C. alliodora is indigenous in Amazonia.

2. Species trial of Eucalyptus, 2 years old. Best species: E. tereticornis and E. urophylla, now 7 m high, at 1½ year 5 m high. But the variation in the species is great. During this visit the first signs of the presence of Diaporthe cubensis on E. grandis (growing well, at 1½ year 5 m) were found.

3. Species trials with autochtonous species, 1 year old.
   - Dinizea excelsa, 2-2½ m high
   - Laetia procera, 2-2½ m high. This species grows to timber-size in Amazonia and produces a good timber
   - Tachigalia sp., 2½-3 m high, diameter at groundlevel 5-8 cm. This species is probably the most promising one
   - Dalbergia sp., ½ m high
   - Swietenia macrophylla, 1-1½ m high, 25-50% of the trees attacked by Hypsipyla

4. Provenance trial of Cedrela odorata 3½ months old. This trial is carried out in cooperation with CFI, Oxford, who provided the seeds. No Amazonian provenance are included, only two from the south of Brazil. All the seedlings are already attacked by Hypsipyla. In line-plantation of the same age in secondary forest (not seen) up till now no recorded attack by Hypsipyla was found.

5. Spacing trials with Didymopanax morototoni, 2 years old. Spacing: 2x3, 3x3, 3x4 and 4x4 m. D. morototoni is growing very well, now 6 m high. The different spacing has not yet influenced the growth or the form essentially.

6. In the afternoon a short visit was brought to the species trials in the Tapajos National Forest at km 52. These trials, planted in 1975-1977 as elimination trials, contain 90 species, each with five replications of 36 trees. The spacing was $1\frac{1}{2}x1\frac{1}{2}$, but in the fastest growing plots a thinning was executed. The trials were weeded twice every year. After five years the five best species are (will be) selected for further examinations. These species are:
   - Cordia goeldiana (9-10 m height, 10-15 cm DBH)
   - Didymopanax morototoni
   - Bagassa guianensis
   - Jacaranda copaia

   Other species of interest are:
   - Terminalia ivorensis: now dying back, but the growth had been better than C. goeldiana
   - Simarouba amara: growing well, in comparison to Suriname very well. Selection on forking and heavy branches seems possible.

TAPAJOS NATIONAL FOREST

In the afternoon another exploitation/silviculture experiment was visited at location km 67 in the Tapajos Forest Reserve. This experiment is titled (translated): Influence of two intensities of exploitation on the increment of the residual forest (see no. 5). Its objectives are:

a. To confirm the influence of two intensities of exploitation, expressed in minimum diameter limits for felling, on the increment of the residual forest.
b. To estimate the rate of increment of single species, species groups or the whole population.
c. To estimate probable rotation periods and/or felling cycles.
d. To determine the right time for silvicultural interventions with a view to maximize the increment.

The two treatments are: T1 exploitation with a minimum diameter limit for felling of 45 cm.
T2 exploitation with a minimum diameter limit for felling of 55 cm.

The exploitation was done in 1979, with powersaws, and a 160 HP wheeled skidder. Road transport was done with a Scamia 260 HP truck of 25 tons load capacity. The area exploited for the experiments was 64 ha, and per ha 73 m^3 was taken, with a list of 64 species which were accepted. The cost of the timber per m^3 delivered at the mill in Santarem was (in Sept. '79) 7,00 US$.

Before exploitation an inventory of trees larger than 15 cm dbh was done following the Malaysian system to know more about available regeneration. A stocking index of 89% was found for commercial and potential species combined, which is quite a high value. No silvicultural measures to induce more regeneration were considered necessary. The competition index was found to be high, (34%) indicating the need for measures to reduce competition. Lianas were cut and undesirable species in the understorey were ringed, to promote increment on desirable species.

In 1981 36 permanent sample plots (of 50x50 cm) were staked out and recorded. All trees above 5 cm dbh are measured periodically, and seedlings are counted in subsampling plots. An individual tree description plus a forest classification per 10x10 m subplot is made in the permanent sample plots, following a system developed by Mr. Hutchinson. Much the same system is now used in the Kabo experiments in Suriname, and this opens possibilities for detailed comparisons between both experiments in Tapajos and Kabo.

The exploited forest now, in 1982, has only a few spots with creepers and lianas, and the vegetation consisted mainly of trees, of secondary or primary species. Our impression was that competition still was high for trees smaller than 15 cm dbh. No information was yet available about stocking level of listed species.

3.4. Thursday, April 22nd

CURUA-UNA

Forestry research at Curua Una was started in 1958 with an FAO-project. Main objective then was to do species trials, to find increment data etc. of native and exotic tree species. In 1963 a series of natural regeneration trials was started. Most of the elder species trials date from about 1960. A new series of plantations was started with promising species quite recently. Many data from the research at Curua Una have been used in a detailed report about a number of timber tree species published in 1979 (no 7). In our account here only some information is given about what we noticed in the field.

The old species trials were replicated more or less on two soil types, viz the planalto soils with a high clay content, and the flanco soils, with a sandy structure. The following species were shown:
Pinus caribaea hondurensis (planted in 1961). Reasonably good, comparable with the results at Coesewijne and Blakawatra.
On flanco soils: mean height (at 21 years age) 23.7 m
mean increment 25.8 m^3/year
On planalto soils: mean height (at 21 years age) 18.5 m
mean increment 13.8 m^3/year.
The mean height on the flanco soils is quite high when compared with the topheight of site class I in Suriname (at 20 years age 28.1 m). Volume production is comparable with Suriname's site class I on flanco, and site class IV on planalto. It is concluded at Curua Una that Caribbean Pine prefers the sandy soils. There is much natural regeneration of pine. The Jari project has taken much information from the pine experiment at Curua Una.

- Jacaranda copaia (1960). Very good growth, nicely straight and high, with good crown development. Diameters above 30 cm (dbh) already present. Growth is better on planalto than on flanco.
- Carapa guianensis (1959). Good growth, but badly forking. Hypsipyla shootborer ubiquitous, maybe even attacking the seeds. The larvae in the fallen fruits are now being identified in the laboratory.

- Cedrela odorata (1960). Reasonably good growth, crown development much better than in Suriname. Best sites were, just as in Suriname, the locations halfway the top and the bottom of the slope.
- Eucalyptus citriodora (1960). Best species of all 38 Eucalyptus tested here. This Eucalypt species has the best volume production, together with Pinus caribaea hondurensis.
- Copaifera multijuga (1960). Nice trees, straight stems, good diameter increment. Best growth on flanco soils. This tree produces a medicinal oil, which is tapped by boring over or two big holes (one inch in diameter) in the lower part of the stem. Afterwards these holes are plugged with wooden plugs.
- Goupia glabra (1960). Best timber producer of the local species tested, together with Copaifera, on the flanco soils. Naturally sown trees are better than planted ones.
- Simarouba amara ( ). Good growth. Better on planalto than on flanco soils.
- Virola surinamensis ( ). Nicely straight and high. Good growth on planalto, died off early on flanco soils.
- Vochysia maxima ( ). Good growth, good form.
- Swietenia macrophylla (1959). Very bad growth, crooked end shoot, for reason of the shoot-borer attacks.
- Terminalia amazonica (1960). Not very high. Reasonable growth.
- Anacardium giganteum (1960). High, good form, thin crowns.
- Parkia multijinga (1960). High, good form.

More recent plantations have been made of promising species. We noticed:
- Didymopanax (1975). Very rapid growth and good form.
  Timber used for e.g. matches.
- Aucoumea klaineana ( ). Many forks, just as in Suriname, but reasonable growth.
- Gmelia arborea (1970). Reasonable growth, but badly formed.
- Aniba duckei (1973). Planted in lines under partial shade.
  Selectively weeded to keep some overhead shade.
  Reasonable form, but slow growth under these conditions.
- Carapa guianensis (1973). Group planting (50 cm x 50 cm in the group, with 20 m x 5 m between groups) in high forest, without additional release. Only groups near the road did well, other groups in unbroken forest showed poor growth.
- Leucaena leucocephala (1982). Planted in lines cut through low reasonably forest. No growth yet visible.
- Bertholletia excelsa (1978). Planted on clearedarea after burning, in combination with Aniba fragrans and Vochysia maximum, Bertholletia is not difficult to plant.
- Euscylophora paraensis ( ). Timber comparable with Fagara pentandra in Suriname. Tree is quite different however. Very brushy and dark crowns when planted in the open, with short stems.

At Curua Una a number of plus-trees are selected from some thirty, mainly native, species. Seeds are collected from 10 individual plus trees per species, on different time schedules. We saw a Parkia pendula selected, and reference was made to species as Vouacapoua americana, Manilkara huberi and Vochysia spp.

The natural regeneration trials of 1963 were laid out in four large blocks of six hectares each. Experimentation was started with a light exploitation. Only three of the four blocks then got a silvicultural treatment (a, b or c).
Treatment a: Nearly all trees felled, without extraction. Burning of residues locally. Seed-bearing trees were kept during three years and then these were felled too. The next seven years no weeding treatment was given, untill the tenth year, when an inventory was done. Since then the stand was cleared annually, for better accessability. There are now (1982) a lot of good trees of desirable species, most of intermediate size, but some already above 40 cm dbh.
Treatment b: Nearly all trees felled or poisoned, except some seed-bearing trees. No burning at all. Seed trees felled after some years (three?) and no weeding until the tenth year, which brought the inventory named under treatment a. Since that time annually the stand is cleared from all weed species, as in treatment a.
Treatment c: Before exploitation locally bare spots of 20x20 m were made, to induce regeneration of desirable species. Two years after this, exploitation was done, and then all trees were felled, as in treatment a and b. Again seven years of neglect, and after the inventory in the tenth year an annual clearing. Nearly all listed (desirable) species were shown to be regenerated at the inventory in year 10. The fourth block of six hectares was left without silvicultural treatment. The annual clearing in the other three blocks has resulted in stands purely composed of desirable species, which look very much like a plantation. In some aspects these stands reminded us of Expt. 65/3 in Suriname, but lacking the understorey of small desirable and weed species. Growth appeared to be better than in Expt. 65/3, but the lack of an understorey made comparison difficult. The recent experiments on natural regeneration in Curua Una follow quite other lines of thought than these monocyclic systems of forest regeneration.

3.5. Friday, April 23rd

CURUA UNA

An exploitation/silviculture experiment started in 1979 (publication no 8) was shown to us by Mr. VASCONCELOS, who is supervising this experiment now. Exploitation just had finished in 1982. The experiment is laid down in two large blocks of each 100 hectares (1000 m x 1000 m). One block was heavily exploited, as 20 trees per ha had been taken, (ca 70 m^3/ha), the other block was exploited much lighter, ca. 8 trees per ha. Exploitable diameters were 45 to 120 cm dbh, following the limits specified by the sawmill. Felling was done by powersaw, skidding with wheeled skidders. In the heavily exploited block of forest many secondary species were seen growing, the vegetation was not accessible in most places. In the lightly exploited block, such spots with secondary forest were scare and the stand still was accessible.

In both exploitation blocks 100 permanent sample plots of 20 m x 25 m had been laid down randomly. This makes a total area recorded of 5 ha per treatment. All individual trees of all species above 5 cm dbh were described and measured before and after exploitation, and their location was registred on maps of each sample plot. Seedlings and samplings smaller than 5 cm dbh were subsampled in 5 m x 5 m plots in the permanent sample plots. No paint rings were made on the stems, only a small tag was attacked 30 cm above the point of measurement. The permanent sample plots are recorded every two years, subsample plots (seedlings etc.) every year. A team of four can record 0,2 ha per day.

The forest roads at Curua Una are well made but not wide. Cars could not pass each other without muchslowing down. The cost of building these roads was estimated at 3000 US$ per km in 1976.

3.6. Monday, April 26th

INPA

In the morning we were received by Dr. H. BERGAMIN FILHO, Director of INPA and Mr. N. HIGUCHI, MSc., Head of the Silvicultural Department of INPA. INPA is responsible for the scientific research in many fields in Amazonia, and has a scientific staff of 300 man and a labour staff of about 700 man. It is divided into nine departments:

- Health and Tropical Disease
- Hydrobiology
- Chemistry of Natural Products
- Technology of Natural Products
- Agronomy, including Soil Science.
- Botany
- Ecology
- Zoology
- Silviculture

The main office of INPA is located in Manaus (Amazonas), smaller offices are in Belem (Para; Departments of Archaeology and Antropology at the Goeldi Museum) in Rio Branco (Acre) and Porto Velho (Rondonia).

The research priorities of INPA are:

- Healthof the people: The ecology of the in Amazonia important diseases leishmaniasis, leprosy and malaria. The medical part is done elsewhere.
- Ecology of the forest: nutrient cycling and water balance of the tropical rainforest on the very poor soils of Amazonia.
- Ecological impact of modern technology:
  a. Ecological consequences of artificial lakes for hydro-energy, with research on three lakes (among them the Tucurui lake of 2500 km^2).
  b. Ecological consequences of bauxite- and iron-mining, inclusive the drafting of regulations to reduce the damage (restricting the amount of air- and waterpopulation, replanting).
  c. Ecological consequences of the paving of the road through Rondonia with bitumen,including research on demography, carrying capacity of the soil, agronomy, silviculture etc. The paving is financed by the Worldbank, who set aside 10.000.000 US$ for research.
- Woodtechnology of amazonian timbers. In cooperation with IDB/FAO a magnificent laboratory was built. The purpose is to enlarge the very low (1%) percentage of Amazonian timbers used by the industry.
- Cellulose, to produce a good pulp and paper from autochtonous species.
- Food technology, conservation of food, fish, fruit juices.
- Oils.

The research on these priorities is very often done by more than one department, the financing often coming from FAO, IDB, Worldbank, etc..

In coöperation with the University of Amazonas in Manaus, INPA organizes post-graduate courses, mostly on the MSc.-level, on various subjects, among them forestry. It is expected that the graduates will remain in Amazonia, to strengthen the scientific and governmental staff in the States in Amazonia with local people.

The Department of Silviculture of INPA, headed by Mr. N. HIGUCHI MSc., consists of seven research officers, six of them are studying for a MSc. - degree now. It is expected that most of them will finish this study in December 1982. The scientific staff will be enlarged in the next few months, when the research work on the special project 'Ecological Management of the Tropical Rainforest' starts. In this project the emphasis will be laid upon natural regeneration, although the old line of research, i.e. artifical regeneration, will be continued.

It is remarkable that in Amazonas the silvicultural research is done by INPA and not, as in Para, by EMBRAPA. The latter organization works in Amazonas only on agriculture.

After this introduction, short visits were made to the Department of Botany, which has a magnificent herbarium with more than 100000 vouchers of 474 families (see 15), to the Subdepartment of Hydrology, which investigates the waterbalances of two catchments areas, one of 1.3 km^2 and one of 23 km^2, and to the library.

The morning was concluded by a short talk with Dr. J.L. GUILLAUMET (ORSTOM) working in the Department of Ecology of INPA. Together with Dr. F. KAHN, A. and A. Dos SANTOS he has been working since 1979 on secondary succession and on the phytomass of primary and secondary forests. Due to the fact that Dr. GUILLAUMET was about to leave for Europe, no scientific discussion developed, but the contact will be continued.

DUCKE FOREST RESERVE

A short visit was paid to the Ducke Forest Reserve, with an area of 10,000 ha, not far from Manaus. Here some hundreds of hectares of experimental plantations have been realised. We saw Carapa guianensis from 1964, planted under light shade as well as in the open. Both grew well and looked healthy but under light shade the stems were far better formed although less thick a than in the open plantation. In the open, trees were forking and had short boles. A small plantation of Vouacapoua americana showed restricted growth and a busy habitus.

A visit to an undisturbed part of the forest reserve led us through a Manilkara surinamensis plantation, established some ten years ago, and now 5-8 m high. Trees had a good form, and looked healthy. The undisturbed forest looked familiar to us with our experience in Suriname, through the species composition was not the same as in Suriname. We saw a nice big tree of Cariniana micrantha, a close relative of C. pyniformis planted at Kamp 8, Suriname. Timber volume of this forest was given as 180-200 m^3/ha above 25 cm dbh, with a basalarea of 18-20 m^3/ha of trees above 25 cm dbh.

3.7. Tuesday, April 27th

EEST-INPA

This day was devoted to a visit of the experimental field station EEST, where the research connected with the special project 'Ecological Management and Exploitation of the Humid Tropical Forest' is carried out. This station is located along the highway BR 174, 60 km north of Manaus. The hydrological balance of two catchment areas will be investigated here. One catchment area with natural primary forest, that will remain undisturbed, is already under observation. The other will follow shortly. In this catchment area about 100 ha will be exploited or refined by poisoning part of the trees. Details of this silvicultural research are given in the report on the conference with HIGUCHI on April 29th.

Between these two catchment areas a third one acts as a buffer zone. The forests on these three catchment areas are, according to GUILLAUMET, if not the same, highly comparable. The forest contains about 150 trees thicker than 25 cm dbh per ha, with a basal area of about 20 m^3/ha of these 150 trees, about 30% are listed species. This list contains all the species used now and other species considered by INPA as valuable or potential trees.

During a short walk through the forest we got the impression that this forest is less luxuriant than the Kabo-forest in Suriname. Unfortunately no soil data could be get. To our opinion the soil here will be very sensitive to any interference in the ecosystem: on a road recently opened by bulldozer and on the path we walked along in the forest, water puddles remained. The water did not filtrate easily into the soil. It can be expected that in this ecosystem a skid road will be seen up to twenty years more after use.

Heavy rainstorms made the journey to this experimental station difficult and prohibited, caused by the danger of leishmanniasis infection, a longer stay in the forest. The roads, main- and secondary, are not paved by bauxite or laterite, and in rains the road surface of clay becomes very slippery. Mostly the roads are not built upon the watershed. Along the road erosion, waterlogging and settlers have caused much damage to the forest and soil.

3.8. Wednesday, April 28th

INPA and CPPF

First we were shown around the buildings and installations of CPPF at INPA. This department is just on the verge of a large expansion, adding many brand-new installations and more than 100 extra research workers to the existing institute. We saw woodprocessing machines being installed. The laboratory will be the most modern and elaborate of whole Brazil, for producing and testing wood specimens, laminate, plywood, particle wood or any other wood products. There will be in total ca. 4000 m^2 of laboratory space, comprising Wood Anatomy, Wood Chemistry, Entomology, Pathology etc. e

INPA - Department of Agro-ecology

Next came an interview with Dr. ARKCOLL, (INPA) of the Department of Agro-ecology. Dr. ARKCOLL gave an interesting review of his work on agroforestry (no. 19, 20), which work he has carried out now for more than five years at INPA. His research efforts concentrated on food production with trees, a promising issue. The species considered mainly were: Breadfruit, Jackfruit (both Artocarpus spp.) Pupunha palm (Bactris gasipaes) and Plantains (Musa spp.). The last named were scrapped from this list recently because of high soil fertility demands and diseases.

For establishing a plantation of fruit trees the approach was to start with food crops like upland rice, cassava, bananas etc., when the plot had been cleared, planting the fruit trees in between this first crop. This strategy allows the farmer to make a living with the first harvests of rice, cassava etc., while the trees grow up to fruit bearing size. In the end the land of the farmer is mainly accupied by orchards, which will continue to provide food for many years. Jackfruits and breadfruits can produce many hundreds of kilograms of fresh fruit annually per tree, if well cared for. It might be possible to grow all food calories needed by a person on a single tree. The pupunha palm delivers 10 to 20 tons (dry weight) of fruit per ha annually, but the ecological needs of this palm are not easily satisfied, it asks for fertile soils and is not very tolerant to drought.

Other local species, e.g. the Inga spp. and Pourouma cecropifoliae, got attention. We saw P. cecropifoliae in an experimental plantation visited on April 27th. This tree has large berries, which are used to make a fruit drink or wine

We had a discussion with Dr. ARKCOLL about possible nutrient reserves in poor soils as found in Amazonas and Suriname. He thought the traditional chemical soil analysis methods as developed for agricultural purposes not very fit for tree crops, as trees are able to extract nutrients from soils where annual crops fail. The difference between nutrient reserves found in traditional soil analysis and total reserves present might be in the order of magnitude of four to forty times.

Food production with trees indeed looks more promising than food production with traditional methods on the poor soils of the Amazon.

INPA - Department of silviculture

After the interview with Dr. ARKCOLL we had the opportunity to talk with Dr. HIGUCHI MSc. about his natural regeneration experiments which will start soon in the forest reserve EEST of INPA (see also April 18th). Projected in the experimental are now are four blocks of 24 ha each, with in each block six treatment plots of four hectare each. Three of the blocks will serve as replications of an exploitation/natural regeneration experiments, and one block will be used for artificial and natural regeneration experiments combined, using species like Swietenia, Didymopanax etc. The exploitation/natural regeneration experiment will test six treatments, which include a control (without logging treatment) and various levels of felling of the listed species (25% to 100% of the available basal area) and a poisoning treatment (50% of the total basal area). Treatment plots

are four hectare, measurement plots one hectare. An overall inventory of all trees above 25 cm dbh has been done in the treatment plots. Listed species comprise to 30% of the total basal area, with an exploitable volume (larger than 45 cm dbh) of not more than thirty of forty m^3 per ha. Milli-acre sampling was done conform methods used in South East Asia, and some results were e.g. a stocking index of listed species of ca. 15% (as compared with an usual 40% in Malaysia), and a number of ca. 39,000 seedlings and small saplings per hectare of all species, of which only 600 were listed species. The species list gives 50 trees species.

In polycyclic systems however the number of seedlings and small saplings is not as important as are continuously occuring opportunities for establishment and growth of such small individuals in the vegetation, to let these join the intermediate sized and timbersize trees. Regeneration e.g. of Goupia glabra is mostly absent in closed forest, as it needs large gaps to regenerate and grow. Thus possibilities of regeneration are easily misunderstood.

INPA - Department of Ecology

In the afternoon Dr. SCHMIDT visited Dr. SCHUBART of the INPA-Department of Ecology. Dr. SCHUBART has been working on litter decomposition for about a year. During the discussion it appeared that in general both parties had found comparable solutions for the problems encountered. An exeption was the bag of nylon gauze (mesh 2 mm) Dr. SCHUBART used. He punched 12 holes of 0.9 cm diameter along the margin. By this very simple and elegant solution, he made it possible for ants and termites to enter the litterbag and take part in the decompositionproces, while the loss of leafparts was kept to a minimum. It was agreed upon to keep contact and to exchange results and publications

INPA - Department of Cellulose and Paper

Late in the afternoon Ir. DE GRAAF paid a short visit to the research department of Mr. AZEVEDO CORREA. Here the pulping and papermaking qualities of many local species were tested. Especially bamboo was mentioned, along with the exotic species Pinus and Eucalyptus. There is a large area of bamboo forest near the border with Columbia. This crop is relatively easy to manage, because of its growth habit, delivering culms the whole year round. A complete installation for making of paper samples was available along with testing apparatus.

Charcoal was another subject of research in this laboratory. Powdered charcoal can easily be used as fuel when mixed with petroleum, which is important for Brazil to restrinct the energy imports. For pig iron production some 240,000 tons of charcoal are needed to produce 60 tons of iron, a costly affair as charcoal production involves transport over large distances. Eucalyptus provides good charcoal, whereas Gmelina does not.

IBDF

Our visit to Manaus was concluded by a visit to Mr. P. GRIEGER, Director of IBDF-Amazonas. Although the task of IBDF-Amazonas is the same as that of IBDF-Para, the work and the problems are different. In Amazonas IBDF has up till nownoneor only a few problems with authorized or non-authorized settlers, whereas this problem consumes quite a lot of time and energy of IBDF in Para.

In Amazonas IBDF concentrates on the protection of the fauna and on enrichment plantations of Bertholletia excelsa. Mr. GRIEGER considered these plantations (now 2500 ha) promising. The government bears the costs of the planting. Seedlings 25 cm high are planted, well protected by three vertical wooden shingles, along lines 2 m wide, cut in the primary forest. Around the seedlings the underbrush is also cut. The spacing is 20x12 m. The lines are weeded three times a year for the first three years.

The oldest plantations are now eight years old and, as could be seen on photographs, are growing well. According to Mr. GRIEGER, B. excelsa needs light, but the big trees in the surrounding forest are left intact. We could not find out how big a gap in which crown layer is needed for good growth of the Brazil nut.

Due to the shortage of time and the enormous distances (the nearest plantation is located on 200 km from Manaus, the oldest ones can be reached by plane only) it was not possible for us to visit a Bertholletia plantation.

Embroidering upon this theme, discussion arose about the possibilities and the dangers of natural and artificial regeneration. Mr. GRIEGER is fully aware of the benefits of the former as compared with the latter.

3.9. Friday, April 30th

EMBRAPA-CPATU

During a short visit to EMBRAPA-CPATU Mr. KANASHIRO arranged for us visits to FCAP, to Dr. Clara PANDOLFO (SUDAM) and to Dr. J. DUBOIS (IICA).

FCAP

Mr. KANASHIRO introduced us to M.F.D.A. OLIVIERA MSc., associate professor of silviculture and to A.C. HOLANDA MSc., associate professor of dendrology of the forestry department of FCAP. In total 16 lectures educate 40 students a year to a BSc.- degree in forestry. The department is very interested in the exchange of scientific staff, of students and of publications with Suriname.

SUDAM

At SUDAM we had a long and animated discussion in four languages with Dr. CLARA PANDOLFO, Head of the department of natural resources of SUDAM. Started from our impressions of the various visited forest - and experimental sites, a discussion on the possibilities and benefits of natural and artificial regeneration arose. We got the impression that Dr. PANDOLFO now also favours natural regeneration for the management of the primary forest in Amazonia. Artificial regeneration is only suitable and probably necessary to recuperate devastated areas.

4. CONCLUDING REMARKS

During our visit we got the impression, that up till about 1979 a great part of the silvicultural research efforts in Amazonia was directed into research on artificial regeneration. Around that year a change in research policy took place and more emphasis was given to natural regeneration. Both natural and artificial regeneration can and probably will play an important role in the silviculture in Amazonia (see below). Hence, the research efforts into both should be continued, to clear and brighten important silvicultural aspects of these systems as intensity of the harvest, logging damage, intensity and timing of treatments, growth reaction on the treatment, cutting cycle, choice of species, spacing and thinning regime, etc.

However, it should be kept in mind that silviculturists, just like all the people working in the forest, have to work within the limiting conditions of the natural forest. A step beyond those lines endangeres the productivity and the durability. These conditions can only be found by basic research into the ecology of the forest and be demonstrated to the people working in the forest by a good education. Important research subjects should be:

- the cycling of the nutrients through the natural forest ecosystems and through derived, more or less artificial ecosystems, with special attention for losses of nutrients through leaching and harvesting.
- the role and the functioning of the litter - mycorrhiza - root - soil - complex.
- the dispersion and the germination of seeds of primary forest species in natural regeneration systems.
- the hydrology of natural and artificial regeneration systems.
- the ecological effects of diminishing the richness and diversity of species in natural regeneration systems.
- the autecology of many species, which are important in natural and/or artificial regeneration systems.

The research into these and other ecological aspects by INPA, EMBRAPA/CPATU, SUDAM and other institutes should be continued. Due to the many variations in the Amazonian forests, more than one institute, should participate in this research and, more important, this research should be carried out on more than one location. However a good coordination is recommendable, not only to avoid unnecessary duplications but more to stimulate complementary research and to make results interchangeable.

In this context, the project LH/UvS 01 will keep contact with these research organizations in Amazonia. Hopefully the funding institutes of the project, i.c. the Faculty of Natural Resources of the University of Suriname and the Agricultural University of Wageningen will do the same. The ecological and silvicultural problems are more or less be same.

Natural regeneration. This silvicultural approach has the considerable advantage that its treatments can be very extensive, keeping biomass high and interventions as light as economically feasible. The forest manager needs rigid control over the fellings, especially regarding the volume cut per hectare. It would take us too far to describe here all the advantage and problems with natural regeneration, one should read the publications of Project LH/UvS 01 about some of these subjects. The large areas of uninhabited primary forest on terra firme in Amazonas open wide perspectives of extensive forest management with natural regeneration. Very much has to be learned still of how to handle these forests, but the first lesson is already absorbed: clear-cutting large areas is bad policy on these poor soils.

Artificial regeneration. In terra firme areas where the natural high forest has been cut, a rapid method to get productive forest again is replanting with valuable species. This needs much more manpower and investment per hectare than natural regeneration, and the production goal should be assessed carefully. It is not sound to plant monocultures to be harvested by clearcutting on the chemically very poor soils which are common in the area. Upgrading the secondary forest (capoeira) by planting high valued (cabinet)timber species might be the best choice in the long run. This still means an extensive use of soils compared with agricultural use, and there should be a carefully planned admittance of settlers in such region, after a thorough study of the labour force needed to develop the region under a system of sustained yield.

Forestry Education. People inhabiting the forest districts mostly have a good way of living with and working in the tropical rainforest environment. This is very important for efficiency in forestry operations. University people or people educated otherwise nearly always have grown up in towns, and often have problems to adjust to the life in the forest. The best of them however will learn the things necessary in this respect.
Our experience in Surinam with staff, local or expatriate, was that one's attitude is of extreme importance when things have to be accomplished by hard pioneering fieldwork, as is common in tropical forestry. The best subprofessional staff were recruited from the lower ranks. Such well-motivated people should be allowed, encouraged or even pushed to get further training.

5. LITERATURE

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APPENDIX ONE

Abbreviation of Organizations, Agencies and Institute used in this report.

CFI : Commonwealth Forestry Institute at Oxford.

CNPq : Conselho Nacional de Desenvolvimento Cientifico e Technologico (National Conseil for Scientific and Technological Development) of the Secretaria de Planejomento (Secretary for Planning). Semi-governmental research organization. Brasilia.

CPATU : Centro de Pesquisa Agropecuaria do Tropico Umido (Center for agricultural research in the humid tropics). The division of EMBRAPA responsible for Para (address: EMBRAPA/CPATU, Caixa Postal 48, 66000 Belem-Para Brazil).

CPPF : Centro de Pesquisa Agroproductos Florestas (Centre for Research on Forest Products) of INPA.

CTM : Centro de Technologia Madeireira (Centre of Wood Technology) of SUDAM (address: Trav. Vera Par., Caixa Postal 78 68100 Santarem-Para Brazil).

EEST : Estacao Experimental de Silvicultura Tropical (Experimental Station for Tropical Silviculture) of INPA. Formerly Station at km. 60 along the road BR 174.

EMBRAPA : Embresa Brasileira de Pesquisa Agropecuaria (Brasilian organization for agricultural research). Semi-governmental organization of the Secretary of Agriculture, divided in divisions, each responsible for the agricultural research in their state. CPATU is such a division.

FAO : Food and Agricultural Organization of the United Nation Organization, Rome.

FCAP : Facultia de Ciencias Agropecurios de Para: Faculty of Agricultural Sciences of the University of Para at Belem.

IBDF : Instituto Brasileiro de Desenvolvimento Florestal (Brazilian Institute for Forestry Development). Comparable to a Forest Service. Headquarters in Brazilia, with dependant organizations in every state.

IICA : Instituto Interamericano de Ciencias Agricoles (Interamerican Instituto for Agricultural Sciences).

INPA : Instituto Nacional de Pesquisa da Amazonia (National Research Institute for Amazonia). Semi governmental organization, founded by CNPq, responsible for many fields of research in Amazonia Headquarters in Manaus (Caixa Postal 478, 69000 Manaus, Brazil) and dependences in Belem, Rio Branco and Puerto Velho.

SUDAM : Superintendencia do Desenvolvimento da Amazonia (Overall Organization for the Development of Amazonia). Semi governmental organization (Address: Av. Almirante Barroso 426, 66000 Belem-Para, Brazil).