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Consultant Final Report
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TROPICAL SILVICULTURE

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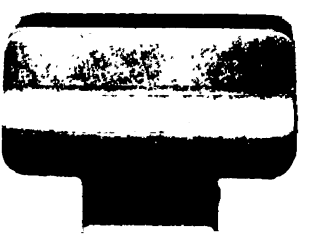

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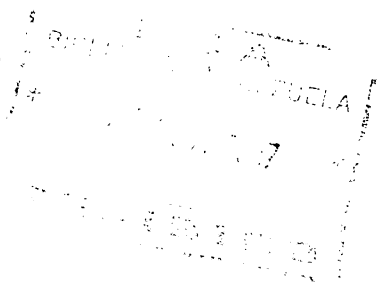

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TROPICAL SILVICULTURE

Consultant Final Report
IICA/EMBRAPA-PROCENSUL II

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Brasília, junho de 1989

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As atividades de consultoria são realizadas no âmbito do Projeto de Desenvolvimento da Pesquisa Agrtopecuária e Difusão de Tecnologia na Região Centro-Sul do Brasil - PROCENSUL II, financiado parcialmente pelo Banco Interamericano de Desenvolvimento - BID e a EMBRAPA conforme os contratos de Empréstimo 139/IC-BR e 760/SF-BR, assinados em 14 de março de 1985 entre o Governo Brasileiro e o BID.

As opiniões dos consultores são inteiramente pessoais e não refletem, necessariamente, o ponto de vista do IICA ou da EMBRAPA.

A coordenação dos Contratos IICA/EMBRAPA agradeceria receber comentários sobre estes relatórios.

Horacio H. Stagno
Coordenador Contratos IICA/EMBRAPA

INTER-AMERICAN INSTITUTE FOR COOPERATION ON AGRICULTURE
IICA/EMBRAPA CONTRACT

CONSULTANT FINAL REPORT

1. Consultant's full name: *Nicolaüs Reitze de Graaf*

2. Specialist in: *Silvicultura Tropical*

3. Title of IICA Project: *2.SB.3*

4. EMBRAPA Program for which consultancy is provided:

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EMBRAPA/CPATU, Belem. Depto. Florestal/Manejo
IBDF (Actually: IBMARNR), Directress of the Floresta Nacional do Tapajos, Santarem.

7. Cooperating staff

EMBRAPA/CPATU:
Engh. Flor. Jose do Carmo Alves Lopes
Engh. Flor. Jorge Alberto Gazel Yared
Engh. Flor. Osmar Jose Romeiro de Aguiar
(All research workers)

IBMARNR
Engh. Flor. Nilma Maria Sarmento Macedo (Directora FloNaTa)

8. Persons interviewed for development of activities

Dr. Emeleocipio Botelho de Andrade (Chefe EMBRAPA/CPATU)

9. Activities developed by the consultant

ITINERARY

April

17 Departure from Schiphol Aiport Amsterdam at about 15.00 h.
18 Arrival in Belem, Brasil, at 04.00 early morning.
First contact with EMBRAPA/CPATU, visit in afternoon to Forest Research Department.
19 Plannning of programme etc, at CPATU, with Engh.For. Jose do Carmo. Contact with Mr. Horacio Stagno of IICA, by phone.
20 Discussions with Srs Jorge Gazel Yared, Jose do Carmo and Osman J.R. de Aguiar, about actual problems in forestry for small enterprises in natural forest exploitation etc.
21 Further discussions and exchange of information with CPATU research people. Meeting with the directress of the Tapajos National Forest, Mrs Nilma Maria Sarmento Macedo.
22 Further exchange of information with Sr. Jose do Carmo.
23 (Sunday) Visit to centre of Belem.
24 Early morning to Santarem, by air. Further travel by car to Belterra guest house. Visit to experimental plantations in the afternoon.
25 Heavy rains, but even so, trip by car to Km 83, Post of Forest Guard, in Tapajos National Forest, with director (Mrs Nilma M. Sarmento Macedo) and Srs Carmo and Erly. Visit on foot to area of 100 ha exploited experimentally under supervision and control of the Forest Service in 1987.
At night intensive discussion about silvicultural treament of exploited forest, use of arboricides, selection of trees, etc. with the persons named above, at the Forest Guard Station.

26 Visit to experimental site Km 114, starting from Forest Guard Station Km 83. Forest stroll of several hours, through plots exploited in 1981/82. Discussion about silviculture was continued in the field. Prints of a jaguar were seen, indicating good control of hunting/poaching.
Return to Belterra and Santarem in afternoon/night, over very bad road Cuiaba-Santarem. Night spent in hotel in Santarem.
27 Back to Belem by air. In afternoon session at CPATU, trying to organize trip to Cia. Florestal Monte Dourado (Jari), to see the experimental plots of CPATU. Flight back not guaranteed, and trip had to be canceled.
During afternoon late: meeting with Mission d'Orientation de FORMAGRO, of the French Ministry of Agriculture, who seek to establish cooperation with brazilian institutes of education and research in agriculture.
28 Gathering information at CPATU, discussions with Srs Jorge Gazel Yared and Jose do Carmo and others about silviculture.
29 Shopping, first stage of report to IICA.
30 (Sunday) continued writing of report.

May

01 (National day of celebration) Writing report.
02 Discussions at CPATU. Critical review of new experiment planned by Sr Jose do Carmo.
03 Discussions at CPATU, and presentation of some elementary thoughts in silviculture in the humid tropics for a small audience of mainly foresters, at the office of IBMARNR.
04 Departure to Rio, at 07.00 h.
05 Arrival in the morning at Schiphol Airport Amsterdam.

Objectives of my visit were (in short):
1/ to give comments or even criticise the ongoing research work.
2/ to help analyse and interprete research data and results.
3/ to make suggestions and recommendations to ameliorate ongoing research, and for setting up new research projects.

My comments on the research and my suggestions are found in section 12, as they turn out quite complex, and mostly on a practical level too.

10. Results of the activities

I consider the consultancy as successful, notwithstanding the failure to visit the experiments on the land of the Companhia Florestal Monte Dourado.

General remarks: Publications by the team since my visit in 1984 have improved quite much, also because more information has become available, and interpretation has become more feasible with this. It is however still quite desirable to stimulate the writing of publications about the results obtained, and this

especially regarding publications in international media.

The team of CPATU, working on management of natural forest, is developing into a group of experienced scientists, that know to plan their further work, and just need comments from, and discussion with, a peer group. A lack of contact with institutes in other countries still is observed. For the other Sout-American countries with tropical rain forest, like Colombia and Peru, such contact should be relatively easy to start. The important international literature on tropical rainforest however is in English mostly, and this is one of the bottle-necks. A good start would be to make more time available to read recent publications of workshops etc. It is suggested to read first the Guri Workshop report (Hadley, Malcolm, 1988).

11. Conclusions

No general conclusions are given here, but see section 12.

12. Suggestions and recommendations for improvement of the research by the Natural Forest Management team at CPATU.

The following comments and recommandations on the ongoing experiments and possible future experiments are made in following order of location, to create more system in the text.

Belterra plantations

The Cordia goeldiana plantation visited looks healthy and well guarded. However, growth seems to slow down, even at this wide spacing, and it is advisable to remeasure this plot every two years. This is a light task, and takes only a few days. If indeed growth has slowed down, crown thinning of the Cordia is advised. This should be combined with planting of a filler species adapted to the conditions (Inga?)or leaving of already established weed species in the gaps from the crown thinning. The reason for this advice is that I suspect increasing root competition between the Cordia trees, and mixing with other species might help. In Ivory Coast the pure plantations already twenty and more years old of various light-demanding species have suffered much mortality, probably due to lack of mixing with other species,

The conversion planting with various species like Bagassa, Cedrela, Swietenia etc., still were in the phase of height growth, not yet developing good crowns. The fat Schizolobium nearby, of the same age, but established naturally and almost twice as thick, shows the advantage of natural establishment compared with planting (apart from the rapid growth of this species).
The Hymenaea courbaril initially had "bad form", but has recovered very well, this being normal for such species with the architectural model of TROLL, and under conditions of side shade.

Regenerating in gaps in natural forest, this species has very good stem form usually.
The Vochysia maxima planted in 1977 still develops very well, and is already forming good crowns, while height development seems to slow down now. Here also a crown thinning might help the best trees to produce good logs in short time. Like with the Cordia this strategy seems better to me than to try to reach more stem length by keeping the stand closed for another five years. The canopy of the Vochysia however is much darker than that of the Cordia, and no need exists for filler trees in the gaps.

With all these results of plantations, it should not be forgotten that Belterra is situated partially on better-than-average soils (Terra mulata), which may make results less representative for the ubiquitous Latossolo amarelho distrofico.

The high mortality in the open plantation of Jacaranda copaia again warns against being too optimistic about pure plantations of light-demanding species. A heavy crown thinning should be tried, reducing BA e.g. to half or less of the original value, and some years later a second thinning, less severe, but just as selective as the first. Better ground cover might install itself or be planted/sown.
The Didymopanax morototoni grows well, but might also profit from a crown thinning now. The characteristic undergrowth of Jacaranda was noted.
Various trees of Acacia mangium, planted along the roads in Belterra only a few years ago, and well grown untill now, suffered mortality or death of main branches, combined with exudations from the stem.

The various types of agroforestry systems already developed in Belterra now should be used in planning overall conversion of the dying Hevea plantations into more useful forms of landuse, supplying e.g. Santarem with agricultural products. The existing infrastructure of Belterra fits quite well to this. The still untouched areas of high forest on the planalto elsewhere then need not be changed into agricultural land but may be reserved for future production of quality timber and secondary forest products.

Km 67

This area was not visited now, but has been seen by me during a visit with the team of the CVRD in 1988. The forest structure, mainly the undergrowth, then had recuperated somewhat from the heavy harvest of timber in 1979. A good publication about this experiment has recently been written by the research team of CPATU, in english (Silva, De Carvalho & Lopes, 1988). I especially noted the much improved drainage of the skid trails, most probably resulting from restructuring activities of roots and soil organisms. The forest is now much more accessible than during my visit in 1983.

Km 67 may be selected as the area for some new experiments, which will be discussed later. Km 67, and Terra Rica, the Forest Guard Station located more to the west, on the edge of the Planalto, is better accessible (more near to Santarem) than Km 83 and Km 114, and this is important for visitors.
The existing experiment at K 67 should not be silviculturally treated in future. Observation alone will already be rewarding.

Km 83

The 100-ha area recently exploited lightly and selectively (40 M3/ha, in 1987, was compared with the untouched forest in the already inventoried blocks nearby, during a forest stroll of several hours. The usual comments on such selective harvesting may be made: damage to the forest is not impressive, but the population of commercial species has been reduced strongly, and thus needs selective silvicultural help. The areas with liane forest (cipoal) probably should be left out of the exploitation scheme, as felling is risky, and silvicultural help for recuperation not effective probably. Planting may be tried, but seems to me not a promising strategy, as liane dominance will remain the problem. Let the cipoal serve as a refuge.

Engh. Florestal Jose do Carmo is planning a new experiment on seedling growth and mortality in managed and untouched forest, which might be executed at Km 83. Indeed a lack of information exists about population dynamics of seedlings and saplings, as in the existing experiments these are not marked individually, but only counted per species and size class.The idea is very worthwile, and should take form as a series of seedling plots under various conditions. Plots preferably should be 4 M2 at each site, subdivided in 4 subplots of 1 M2, to have more seedlings to work with. Important is the grouping of the species and of the conditions which are described for each plot. Of course the description: "exploited forest" would be totally insufficient.

Per (grouped) condition enough seedlings should be available to make sense for analysis. Species may be grouped according to "temperament" or ecological requirements, or survival strategy etc., as individual species data usually are not interpretable for reason of the multitude of species and the scarcity of individuals per species. Fifty or hundred individuals per group may be a reasonal target to calculate mortality, ingrowth and other population dynamics parameters.

Km 114

It was a pleasure to see the guesthouse (Casa da Onca) which was built some years ago, following punctually my design of 1983, and with partial financing by the Forest Department of Wageningen Agricultural University. It should be used more frequently, and

have a water tank, to increase hospitality. Guarding however is a problem, as thieves frequent the Santarem-Cuiaba road. This site is optional for a "demonstration park" with various types of forest treatment, but remoteness and lack of water are actual problems, and probably Km 67 is more serviceable.

Periodic fires, crossing the main road, and coming from the agricultural area at the east side, have further burnt and damaged the regrowth of the regeneration area bordering the location of the Casa da Onca. This again stresses the need to keep the exploitation light and canopy closed as much as possible, to prevent drying out of the managed forest. Forest opened too much, when bordering grassy agricultural areas is very vulnerable to ground fire in dry years in this climatic zone.

The forest was visited making a walk of several kilometres, through the exploited parts and the control plots. Exploitation, in 1982, less than one year after layout of the experiment, has left its traces, but the overall structure of the forest was not changed much by the exploitation damages. Undergrowth already has cleared up in most places, and accessibility on foot is quite good now. Compared with the structure of untouched forest, the exploited forest now seems to have more seedlings up to about 1 m high, and less saplings and small poles. But this might be only an impression. The permanent skidtrails still were largely overgrown with secondary weeds, but in a more open way, and these weeds are expected to dy in the long run, as the canopy is kept closed.

As already advised in 1983, permanent skidroads and log landings should be regarded as permanent infrastructure, be designed as modest as possible, and not be replanted or regenerated into forest. Better is to fashion them a bit before departure, as long as the machines are available, to make next harvest easier.

The experiment at Km 114 should be refined as already planned in 1983 (See my report of 1983 and 1984). Main reason is the fundamental need for information about the reaction of the trees/forest on Basal Area reduction in various grades. This remains interesting, even if refinement will not be applicable in daily forest management in the FloNaTa. The information will help much to define the limits for growth of important species under forest conditions, which information otherwise has to be extracted from vaguely defined situations in only exploited plots, where the extremes reached in refined plots cannot be found.

Probably the use of arboricides, even the quite harmless 2,4-D (agricultural use permitted, and manufactured in Brasil!) will be impossible for reason of bad publicity and unreasonable ecofanatics. In that case deep rings should be made with a small powersaw or with an axe, cutting fully through the sapwood (alburno) and repeated once or twice in case of trees known to be

difficult to kill this way. Trees with fluted stems (fustes sulcadas) should be ringed as good as possible, and a further treatment of such trees should be a liberal application of used motoroil (oleo queimado) in the grooves that could not be reached by the cutting tool. The oil may be thinned with some diesel oil for easier application with a sprayer.

This all is not quite cheap to do, and I estimate the input in labour as four times more than planned in 1983/84, apart from the availability of a powersaw. This last one should be a small one, with a very short blade, as often the ring has to be applied quite high. A short aluminium ladder, so short that the man on it can saw right in front of him, might be helpful for trees with large buttresses (sapopemas). Such physical ringing need not be applied so near to the roots as is advisable for hormonal arboricides. It is possible that methods found less effective in other countries, like in Suriname, will be more effective in Tapajos for reason that on the Planalto the trees cannot reach a phreatic level in most cases, as this lies too deep for their roots. Drought stress thus will be stronger under the relatively quite seasonal climate and low total rainfall in the Tapajos region.

Not only such physical ringing means more handwork, but it also may cause easy and premature breaking of treated trees, increasing the damage to the remaining stand. And labour/visitors should be more careful in such stands when wind gusts are coming with the rain. Arboricide-killed trees give less of such problems.

It should be marked that, even when such physical girdling costs four times as much labour imput as arboricide treatment, the total cost still remains very reasonable per M3. Cost might increase from 0.6 US$ (see Jorge A. Gazel Yared et al., 1988) to three times as much (more labour needed, but no expensive chemical), but remaining below 2 US$ per M3.

The experiment at Km 114 still has the problem, already discussed in my reports of 1983 and 1984, that too few intermediate-size and large trees of commercial species are found in the recording plots to make a good estimate of the reactions of such trees to the treatments. For this reason the plots should of course be remeasured before any treatment to be applied in coming years, as until now the plots form only two groups each with one treatment (level of exploitation) or at least grow under less varied conditions of competition (remaining BA). Thus, grouping trees until now can comprise larger numbers of trees per treatment or BA-level than when refinement has been applied. This even might be a reason to omit refinement completely in this experiment. But I would prefer more information about more extreme BA-levels, and thus application of refinement.

The set-up of the experiment at Km 114 cannot be easily changed,

enlarging the plots to include measurement of more trees of larger size, for reason of the intricate and elaborate method of measuring in the plots, which should not be changed (in my opinion). It remains always possible however to add individual trees, found outside the recording plots, but still inside the treatment plots.

It has to be stressed again that intermediate-sized and large trees are the ones that produce timber in polycyclic systems. Timber growing on small trees only reaches value when these survive long enough to reach mature sizes. Usually many small trees are lost on this road to maturity, and unlike as in plantations, will have no value as thinnings. A new experiment will be discussed below, which will provide more information about reactions of the important classes of intermediate-sized and large trees in polycyclic systems.

Companhia Florestal Monte Dourado (Jari)

This location could not be visited. Some remarks can be made, referring to information from publications (Carvalho et al,1987).

The setup of the large experiment with exploitation and silvicultural treatment on several levels was set up according to what was agreed between me and the research team in 1983/84. I hope it will be possible to use arboricide (2,4-D) in this experiment, which will make it very informative for fundamental studies, also for ecological follow-up on effects of decreased species diversity. (The effect of the arboricide on flora and fauna, other than trees killed by it, most probably cannot be found, and quantities applied are so minimal these will not be found in the hydrological cycle.)

The use of secondary forests for energy wood and pulpwood production is criticised by me as being too optimistic regarding sustainable yield. The harvesting most probably will be done by clearcutting, or nearly so. This means heavy removal of biomass, and this is the wrong road for sustained yield, as here in Amazonas the forest keeps the biggest part of the nutrient capital of the site. One could call this the Biomass-dependent site quality hypothesis.
Moreover, it is not to be expected that after clearcutting the secondary forest, a new forest of the same quality will regenerate. This "tertiary" forest will be even less balanced ecologically, and may contain large spots of grassy vegetation, making it quite vulnerable to forest fires.

It is here the place to elaborate a bit on secondary forest. Many people assume these to be the natural response of the forest ecosystem on clearing etc. This may be only partly true, as the response is natural indeed, but the factor triggering this response is not. Large clearings are not natural in Terra Firme

forests, and destroy much of the nutrient capital, so arduously collected from aerial inputs, and so safely locked away in the primary forest during many ages. Capoeira (secondary forest) over large areas is a human artefact, not a form of forest that has proven stable through long periods. It should only be used as a way to repair of the best and only stable forest ecosystem, the high rainforest. In various places the ultimate degraded forms of vegetations can be seen in the Amazon region, and these are shrubby or grassy vegetations, with only sparse treegrowth.

Amazon soils belong to the chemically poorest soils in the world, and for management this nutrient capital is highly needed, to make good productivity possible in future cycles. Using secondary forest with clearcutting systems for production of bulk products like energy wood or pulpwood seems to me somewhat better than clearing Terra Firme forest for open planting of exotics, but even so it is a downslope road, easy but degrading.

Regarding the occurrence of productive forest on reasonable soils in the Amazon region, one should not be over-optimistic. As already noted by Heinsdijk in 1963, the best stocked forest occurs along the borders with the drier climates. I suppose it is better to reserve these for profitable forestry than for submarginal agriculture. Farming, also agroforestry, on the Planalto of the Polo Tapajos will be problematic forever due to lack of access to good water sources for domestic use.

New Experiments

The first proposal to be made is the setup of a series of plots in which the preliminary chosen exploitation and silvicultural treatment in the FloNaTa managed forest area will be demonstrated to visitors on a smaller scale than in reality. Every few years (two or four or five years) a plot of say 5 ha will be harvested and treated, every time shifting to the next plot. This way a series of forest stands in various conditions over time in the management cycle will be available to show to visitors. These will be able to see in one or a few hours the whole gamut of forest structures and other conditions in the various stages of a polycyclic system. Usually, to show this, one needs days, as the areas normally are large and not easy to visit. Harvesting level and treatment should be as conform to the usual management as possible.

Such a series of demonstration plots is very valuable to convince politicians, ecological activists and other people, usually in a hurry and with no desire to spend long hours on a bad road. Such a series of plots needs to be set up in early years, and the choice of treatment will be a preliminary one, by necessity. A good and wide path along the plots, with a closed, undamaged and original canopy above will improve presentation to the level necessary to convince people that the usual management methods

are not destructive. Having to wrestle first through the usual capoeira bordering exploitation roads is not a good start for such presentation.

The setup of such a series was already advised concisely in my report of 1984. The location of such a series should preferably be near the entrance road at Km 67, or near Terra Rica.

Marking and liberating Reserve Trees

The other new experiment should be one on a more selective system of harvesting trees than is now practised in the FloNaTa, combined with a silvicultural treatment that needs no arboricide.

Refinement usually is an effective way to reduce overall level of competition in a mixed forest. Its use is especialy indicated when remaining trees of commercial species after exploitation are small compared with remaining trees of non-commercial species. This is usually the case in poorly stocked forests, where all commercial volume above the felling diameter limit has to be taken to reach a reasonable volume/ha for contractors. Such was the situation in Suriname, with a forest much poorer than the FloNaTa (see Table 2).

When the use of effective arboricides is blocked, refinement becomes less easy and cheap to apply, and other approaches have to be found. A choice may be the leaving (marking) of Reserve Trees with a dbh below as well as above the felling limit. These trees will produce the next harvest of timber. They should be vital, with a good, or potentially good crown and a good stem form, able to produce well under improved conditions of competition. They should be liberated to reach good increment levels, and this is done individually.

Of course the first condition for this system is that there should be enough stock of timber before harvesting, to permit reservation of such trees. For an estimate of this in the FloNaTa, Table 1 was constructed with data from the 100% inventory done at Km 114 before exploitation (Silva et al.,1985).

The data are used to see how many Reserve Trees (RT, or in portuguese: AR, Arvores Reserves) may be marked, leaving enough commercial volume to be harvested. The volumes per tree have been derived from Heinsdijk & Miranda Bastos, 1963)

Table 1. Diameter and volume distributions in the FloNaTa.
All data per ha, and for commercial spp class I.

Diam. class	N/ha	N/ha cumul	Vol/ tree	Vol/ class	Vol/ha cumul	% RT	N/h RT	Vol RT	VolRT cumul	VolEXPL cumul
15-24	(10)est	(41)	-	-	-	-	-	-	-	-
25-34	(7)est	(31)	(0.8)	(5,6)	(120)	-	-	-	-	-
35-44	(6)est	(24)	(1.5)	(9,0)	(115)	70	(4)	(6)	(25)	(90)
45-54	5.0	17.7	2.4	12.0	105.7	70	3.5	8.8	19.1	87.2
55-64	4.3	12.7	3.4	16.3	93.7	50	2.2	8.2	10.3	83.4
65-74	2.7	8.4	4.7	14.3	77.4	10	0.3	1.4	2.1	75.3
75-84	1.9	5.7	6.2	14.1	63.1	5	0	0.7	0.7	62.4
85-94	1.3	3.8	7.8	12.4	49.0	0	0	0	0	49.0
95-104	0.9	2.5	9.7	10.7	36.6	0	0	0	0	36.6
>105	1.6	1.6	14.3	25.9	25.9	0	0	0	0	25.9

Although these data are preliminary and roughly calculated and estimated, they still indicate that the marking of 10 Reserve Trees does ask for sacrificing only about 20 M3 of commercial volume to be harvested immediately. And these 20 M3 are no losses, but an investment for the next cycle.

At a (pantropically used) conversion factor of 0.5 for standing inventoried timber volume to actually extracted timber, still about 40 M3/ha will be harvestable,on a total of more than 80 M3.

A growth rate of 10% annually of the volume of Reserve Trees may be assumed (See de Graaf, 1986: Table 8.4, and the discussion of Treatment V in Chapter 7, Fig. 7.9). With a standing volume of RT's of 25 M3, annual increment will be 2.5 M3/ha. This most probably will be achieved only when these already vital trees are liberated, by killing neighbouring large and overtopping trees. For small trees this costs too much, as it has to be done quite intensively in that case to be of any use.

Such a system of marking Reserve Trees, and subsequently liberating them individually has been applied in e.g. Serawak, by Hutchinson, under the name of Liberation Thinning.

When quite a number of RTs above the commercial felling limit have to be marked, this reduces the immediate harvest, which is a disadvantage in lowly stocked forests. Furthermore, this Liberation Thinning does not help small regeneration so much as does a refinement. Total increment of commercial timber is less, as only relatively large trees are liberated.

Advantages are that only a restricted number of only large trees are eliminated, saving labour, and making use of arboricides less needed. It is a less intensive system, and thus has less impact

than refinement on the forest ecosystem.

Another aspect is the need for relatively more and better trained labour, especially tree spotters, as more time has to be spent in selecting and marking Reserve Trees. This may be seen as an advantage (more and better jobs) or as a disadvantage (higher cost). I would say that more well-trained people as a result of a system is an advantage for society, and might contribute to the general (public) desire of conservation of the high forest in the Amazon.

The stocking of trees in the FloNaTa may be compared with the one in Suriname. The data for the Mapane region (Suriname) in Table 2 came from De Graaf (1986).

Though the criteria for the commercial species cannot be held the same for Suriname and Tapajos, the diameter distributions show that numbers and thus volume of commercial timber trees are highest in Tapajos. This means that whereas for Mapane it is not well possible to mark Reserve Trees above the exploitation diameter limit witnout big reductions of harvestable volume, this procedure of reserving trees is much better possible in Tapajos.

Table 2. Diameter distributions for various populations in the FloNaTa, and in Suriname (Mapane region). Numbers /ha

Diam. class	100% inv. Km114 Comm.spp1	Rec.Plots Expt Km114 9 ha Comm.spp1	Mapane 2% (de Graaf, 1986) Comm.spp	Mapane2% ditto All spp	Rec.Plots Km114, 9 ha All spp
15-24	(10)est	7.57	n.a.	n.a.	170.67
25-34	(7)est	3.11	9.06	62.0	58.55
35-44	(6)est	2.67	5.72	32.5	27.20
45-54	5.0	3.33	4.14	18.6	16.31
55-64	4.3	2.34	2.56	10.8	9.43
65-74	2.7	1.78	1.67	6.1	5.98
75-84	1.9	0.77	0.90	3.5	3.41
85-94	1.3	1.21	0.54	2.0	2.52
95-104	0.9	0.44 (>95:	0.58) (>95:	2.3	0.98
>105	1.6	0.44			0.78

The data for the 9-ha inventory in the measuring plots only, have been taken from Carvalho et al.,(1986). These are much lower than the 100% inventory had indicated before, and this may be due to the relatively small area inventoried and the rigorous selection applied to the rough data by the authors. Only good trees were accepted in the class reproduced here, and this diameter distribution seems too pessimistic.

Procedures and problems in selecting and liberating Reserve Trees

The following should be seen as a suggestion, to be improved by doing it and testing, rather than as a prescription.

Before exploitation, some 15 trees/ha, with a minimum of 10/ha should be selected and marked as Reserve Trees, adding up to a volume of about 20-30 M3. Diameters should be in the range of 35-65 cm dbh, plus some larger trees when necessary as seed trees for important and scarce species (Cedrela, Cordia). In the table above (Table 1) a reasonable distribution over the diameter classes was used, with not all trees below felling limit reserved, and not all trees above felling limit exploited. With some experience gained, a better, more adapted distribution may be found. It will vary per location.

Only vital trees, with a good, or at least potentially good crown should be selected, and they should have a good or reasonable stem form. preferably the RTs should be well distributed over the area, but this is least of all important. Vitality, which means good potential productivity after full release, is above all important. Crown characteristics, indicating this vitality, of course are specific for the species. The architecture of the tree, especially its crown, gives usually much information on the phase of life the tree is in, and about its vitality. Experienced tree spotters are able to recognize this, and may, if training further, reach high precision in determining potential of a certain individual tree.

If not enough trees can be found that conform to these specifications, the criterium for stem form may be set lower. Vitality remains necessary, always, as it is of no use to maintain and liberate trees that will not grow.

When after more years of research, more is known about the temperament (silvics) of the various important tree species, the RT-system will become even more efficient in use.
Determination of internal rot is difficult when trees should not be damaged. Boring with an auger (hand driven) may be possible, but the pantropical use of sound for tracing may be still the best. The bark is removed over an area of about a fist, with an axe, and the exposed wood is hit with the back of the axe. This produces a sound characteristic for the species, diameter and internal condition (rot). With some training on trees of known internal rot conditions, this may work in many cases.

Loss of RTs by the following exploitation should be avoided as much as possible, but some mortality may be inevitable. Smallest trees will suffer most, with broken stems. Larger RTs may be pushed to a leaning position when not broken, or may lose part of their crown. This last named damage is not the worst. Cutting of lianas before felling is always desirable, especially near RTs.

After exploitation, the RTs should be liberated individually, and immediately after the skidding of the logs, as the forest then still is well accessible. The liberation might even be done just before the harvesting, under even better conditions, but then the harvesting period narrows down quite much, as felling should not be done in stands with many dead trees due to liberation thinning more than a few months ago.

Liberation is done by girdling, or if permitted, poisongirdling, some two or three or more large trees, which are overtopping or menacing the crown of the RT. Because this is less effective in reducing overall competition level than is refinement, the operation is only efficient in helping the RTs, and does not promote regeneration to such an extent. With respect to sustained yield however, this system is still more secure than planting of homogeneous or mixed forest, as the forest ecosystem is largely left intact.

Regarding the setup of an experiment for this RT-system, I suggest measuring plots of 4 ha net, and 6.25 ha gross (250 x 250 m) treatment plots. With testing of one exploitation level (40M3/ha ?) and two levels of intensity of liberation, four replications would result in a 50 ha gross experimental area. Only large trees, say above 25 cm dbh, of commercial species should be measured, with preferably also measurement of trees of non-commercial species, say above 35 cm dbh. This would mean measuring some 70-100 individual trees per ha, in total some 32 x 70 or 100 trees. The time needed to mark the RTs cannot be easily given, and I will not try to do this here.

Quantification of the liberation treatment may be done with the Bitterlich method, registering the BA reduction close around the RT, using a prism with a high factor.

Information on behaviour of the productive trees would be considerable in this experiment. A good location might be Terra Rica, or the entrance of the road at Km 67. Location at the actual exploitation site at Km 83 would make exploitation easier and cheaper.

Further recommendations

Quick-and-dirty calculations of preliminary results from measurements, directly from the field data for a few key species, best known in their behaviour. The computer processing takes unexpectedly much time. For such q-d-c's some five or more common species might be selected. From these, a good number of observations on individuals can be picked from the field sheets and grouped, in various ways. For increment studies, this should be in rather wide diameter classes (15 cm wide e.g.) For mortality studies some hundred individuals should be picked from

the field sheets. Species used for these q-d-c's preferably should be well-known already in their behaviour, from other experiments.

Seeking advice about GIS (Geographic Information Systems) on Personal Computers, applicable in processing the 100% inventory data as collected by the Manager of the FloNaTa. Especially the maps to be produced will be handled very much better by such systems than by hand. Various versions of inventory lists can be produced in a whim, fitted to everyone's need.

To promote the work done on sustained yield in the FloNaTa, a "demonstration park" as suggested several pages before, would be very worthwhile, for education as well as for training purposes. Funds might be raised internationally. Human resources are the most important for a region, as is well known. Especially the training of tree spotters should be started quite soon.

The obligation of sustained yield management in the FloNaTa opens perspectives to promote export of timber from Santarem, produced from areas managed according to law. Ecological and nature conservationist pressure groups agitate for banning of tropical timber imports into Europe, and this sale of guaranteed timber might be an answer. I will try my contacts in The Netherlands for this.

Blocking of use of otherwise quite harmless arboricides in forestry gives an unfair advantage to agriculture which is permitted to use such weedkillers. Land use planners should realize this. Management of natural forest then should get some advantages to overcome this handicap, e.g. taxes on timber from land cleared for agriculture, to be paid to the Forest Service. Or management of natural forest should get tax incentives as has been the case with plantation forestry.

Natural forest management for small areas of a few thousand hectares, often is problematic for the owner. He was recently obliged by law to perform sustained yield management, but usually has no good idea how to do this. A polycyclic system would technically be the easiest to apply, but often the owner wants only a few timber species and would be obliged to sell the other logs to be harvested.
A cooperation of such small forest owners would be the most elegant solution for such management problems. It is not good to try to change the forest deeply, only to fit better to one's (mostly temporary) needs. A stand of only a few species, or even a pure stand, usually is much more vulnerable to fire, pests and diseases.
The preferable silvicultural technique probably is the one described here, with the Reserve Trees, but this is only applicable where enough comercial volume is available.

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Programa II. Geração e Transferência de Tecnologia

O Programa de Geração e Transferência de Tecnologia é a resposta do IICA a dois aspectos fundamentais: (i) o reconhecimento, por parte dos países e da comunidade técnico-financeira internacional, da importância da tecnologia para o desenvolvimento produtivo do setor agropecuário; (ii) a convicção generalizada de que, para aproveitar plenamente o potencial da ciência e da tecnologia, é necessário que existam infra-estruturas institucionais capazes de desenvolver as respostas tecnológicas adequadas às condições específicas de cada país, bem como um lineamento de políticas que promova e possibilite que tais infra-estruturas sejam incorporadas aos processos produtivos.

Nesse contexto, o Programa II visa a promover e apoiar as ações dos Estados membros destinadas a aprimorar a configuração de suas políticas tecnológicas, fortalecer a organização e administração de seus sistemas de geração e transferência de tecnologia e facilitar a transferência tecnológica internacional. Desse modo será possível fazer melhor aproveitamento de todos os recursos disponíveis e uma contribuição mais eficiente e efetiva para a solução dos problemas tecnológicos da produção agropecuária, num âmbito de igualdade na distribuição dos benefícios e de conservação dos recursos naturais.

INSTITUTO INTERAMERICANO DE COOPERAÇÃO PARA A AGRICULTURA

O Instituto Interamericano de Cooperação para a Agricultura (IICA) é o organismo especializado em agricultura do Sistema Interamericano. Suas origens datam de 7 outubro de 1942, quando o Conselho Diretor da União Pan-Americana aprovou a criação do Instituto Interamericano de Ciências Agrícolas.

Fundado como uma instituição de pesquisa agronômica e de ensino, de pós-graduação para os trópicos, o IICA, respondendo às mudanças e novas necessidades do Hemisfério, converteu-se progressivamente em um organismo de cooperação técnica e fortalecimento institucional no campo da agropecuária. Essas transformações foram reconhecidas oficialmente com a ratificação, em 8 de dezembro de 1980, de uma nova convenção, que estabeleceu como fins do IICA estimular, promover e apoiar os laços de cooperação entre seus 31 Estados membros para a obtenção do desenvolvimento agrícola e do bem-estar rural.

Com um mandato amplo e flexível e com uma estrutura que permite a participação direta dos Estados membros na Junta Interamericana de Agricultura e em seu Comitê Executivo, o IICA conta com ampla presença geográfica em todos os países membros para responder a suas necessidades de cooperação técnica.

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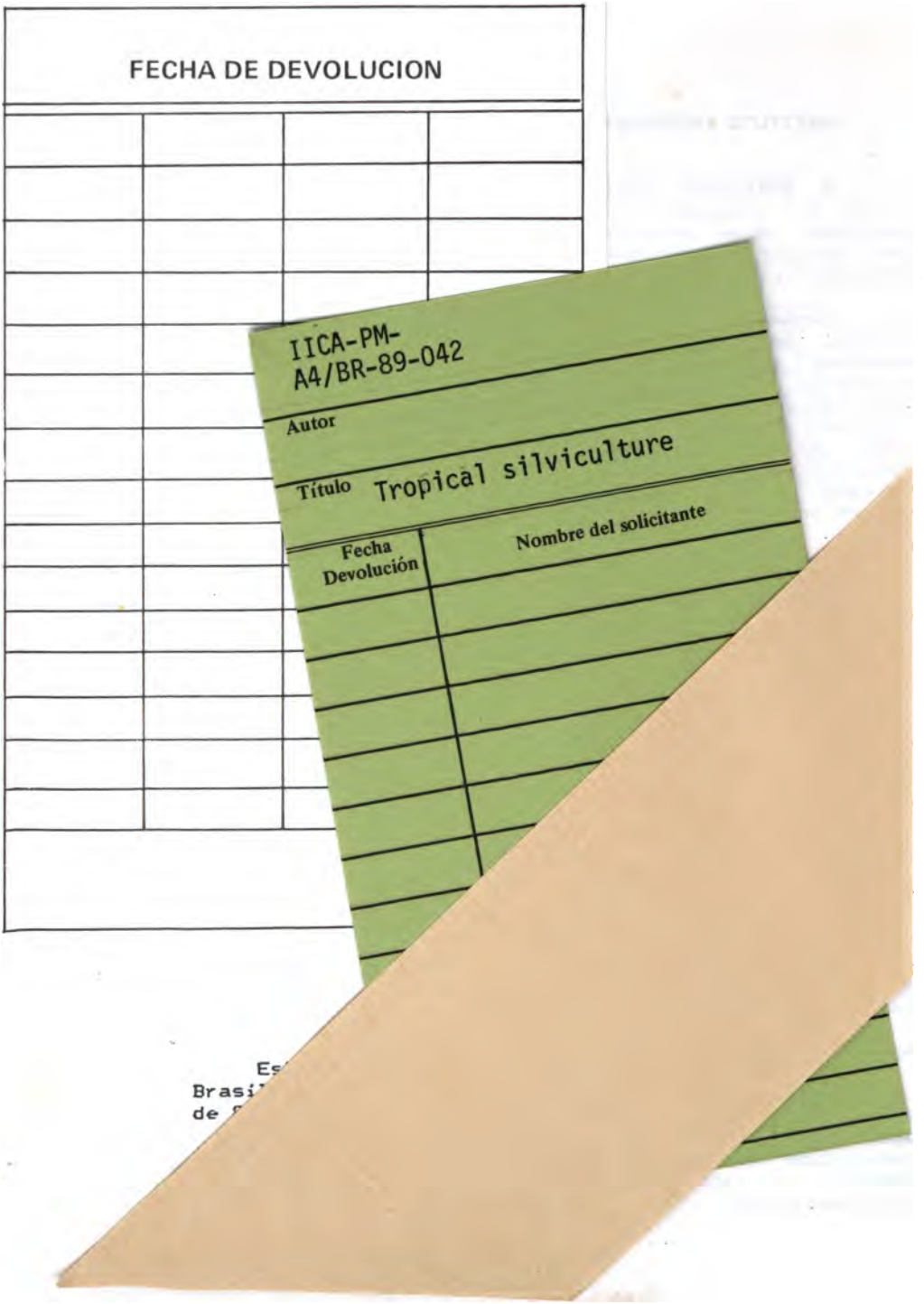
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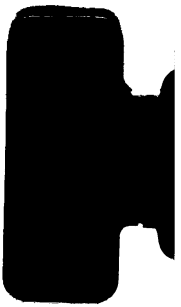

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