AGROFORESTRY SYSTEMS FOR INCREASING WOOD AND AGRICULTURAL PRODUCTION IN THE HUMID AMAZON REGION OF BRAZIL

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AN AGROFORESTRY RESEARCH PROJECT DOCUMENT

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AGROFORESTRY SYSTEMS FOR INTEGRATING WOOD AND AGRICULTURAL PRODUCTION IN THE HUMID AMAZON REGION

SUMMARY

The vast humid Amazon, totalling 490 million ha, typified by high temperatures, rainfall (over 2,500 mm) and humidity, and by high forest throughout the plateau (Planalto) and on the flanks of the Amazon river (Flanco), has great potential for significantly increasing food and wood production in Brazil. Now covering 80% of the area, the forest contributes only 10% of Brazil's industrial roundwood production and accounts for only 3% of the world's tropical hardwood trade. Because of the low levels of annual removals and lack of management, the forest has a high preponderance of over-mature trees, a waste of valuable resources.

Because of a rapid growth of population in the area, an increasingly significant proportion of the Amazon is being cleared for agricultural production. In this process there is indiscriminate cutting of the forest and in most instances the result has been a rapid deterioration of soil quality with a consequent reduction in productivity and ecosystem degradation.

Increased food and wood production in the Amazonian ecosystem is considered to be technically possible and economically feasible if suitable scientific management systems are employed. Agroforestry systems which combine forest and agricultural crops, and thus emulate the forest in terms of ecosystem protection while also permitting food production, seem to offer a potentially viable and convenient method for managing much of the Amazon. Agroforestry also appears to be more economically and culturally suited to the Brazilian situation.

The EMBRAPA/IBDF Cooperative Forest Research Programme recognizes the scope and need for intensive investigations of agroforestry systems for improving the ecological conditions of the degraded forest areas of the Amazon and for more rational exploitation of the land and human resources of the area. The project proposed here is the outcome of a joint EMBRAPA/IBDF/ICRAF initiative, and the document has been prepared by ICRAF and EMBRAPA.

The specific objectives of the proposed study are:

(i) to ascertain the compatibility of particular tree and herbaceous species;

(ii) to determine the optimum espacements of both the forest tree and agricultural species;

(iii) to establish the best arrangement and admixture of species;

(iv) to determine the cultural practices to be followed during the growing periods of both the forestry and agricultural species;

(v) to evolve appropriate management practices for the forestry species; and

(vi) to assess the input requirements and the socio-economic attributes of the agroforestry systems and to compare these with sole crop systems.

The project headquarters will be in Brasilia. Field work will be based in Rondonia region (near Porto Velho) and Belterra region (near Santarem).

The project period is three years initially. The anticipated donor assistance to the project's budget is US $ 788,000 or approximately US $ 263, p.a. This amount includes a capital budget of US $ 41,000 and US $ 67,000 for education and training programmes. The Brazilian Government contribution for the same period is US $ 696,000 or US $ 232,000 p.a., of which US $ 258,000 is for local staff costs.

AGROFORESTRY SYSTEMS FOR INCREASING WOOD AND AGRICULTURAL PRODUCTION IN THE HUMID AMAZON REGION

INTRODUCTION

The humid Amazon of Brazil is located in the northern part of the country. At present, forests cover about 80% of the area. However, an increasingly significant proportion of the area is being cleared and converted to agricultural use and there is evidence that this process is being accelerated. In general, the areas so cleared are either subsequently abandoned, or are very poorly managed. The ecological consequences are adverse and productivity is considerably reduced.

In order to minimize the hazards of defective land management and possibly to avoid further destruction and degradation of the forest areas, it is important to develop sound land management systems. Agroforestry systems, which combine forest and agricultural crops and thus take advantage of the perennial growth habits of trees, the multi-storeyed physiognomy of forests and at the same time produce food, seem to offer a potentially valuable and convenient method for managing much of the Amazon.

Intensive investigation of agroforestry systems in improving the ecological conditions of the degraded forests of Amazonia region has been recognized as one of the major areas of research of the EMBRAPA/IBDF cooperative Forest Research Program, and such studies for improvement of land management systems in the lowland, high rainfall tropical forest zones of the world form one of the major activities and founding reasons of ICRAF. The project proposed here is the outcome of a joint EMBRAPA/IBDF/ICRAF initiative, and the document has been prepared by ICRAF and EMBRAPA.

BACKGROUND

The humid Amazon region covers the States of Acre, Pará, and Amazonas, and the Federal Territories of Amapá, Roraima, and Rondonia, together with the northern parts of the States of Matto Grosso, Goiás and Maranhão. The total area is approximately 4.9 million km^2.

Physical Factors

The region is composed of an extensive and slightly undulating plateau

(Planalto) at low elevations with no pronounced mountain ranges or peaks. The Amazon river system cuts through the plateau, leaving the lower strata exposed as a sloping dissected escarpment (Flanco), on both sides of the river. At river level, new soils are created from river sediments, and these are seasonally flooded as the river rises during the rainy season (Varzea).

Soils

The soils of the Amazon Region, though varied, are relatively uniform over large areas. The greatest proportion are lateritic, although they vary in texture and colour from place to place. The most common is the yellow laterite soil (Latossolo Amarelo) with textures ranging from very heavy to light sand. These soils are generally deep, very acid and well drained, and of low fertility. The different soil types and their distribution in the Amazon Region are given in Appendix II.

Climate

The climate of the humid Amazon region is typified by high temperatures and humidity and a large excess of precipitation over evapotranspiration during the first half of the year followed by a deficit lasting from 1 to 4 months during the second half. On the basis of the length and intensity of the dry season, the region falls within three of the climatic zones defined by Koppen:

Af - no distinct dry season, with precipitation greater than 58 mm in the driest month - 17% of the area.

Am - a short dry season with rainfall in the driest month more than 1/20th of the annual rainfall deficit below 2,600 mm - 34% of the area.

Aw - a distinct dry season with rainfall in the driest month less than 1/20th of the annual rainfall deficit below 2,600 mm - 45% of the area.

A diagram of the area showing the different climatic zones is given in Appendix III.

Vegetation:

The climax vegetation throughout the Planalto and the Flanco, with the

exception of a few areas of excessively drained soils, is high forest. The forest generally attains a height of about 40 - 45 m and is composed of several hundred tree species, together with many other plants which inhabit ecological niches in the plant-soil-climate system.

The total biomass per unit area is very high, typically around 300 tonnes per hectare, but because the majority of this biomass is concentrated in relatively few large mature trees, the net primary production tends to be small.

Where the forest is cleared and then left, secondary forest (Capoeira) quickly regrows and attains a height of 10 - 12 m after 4 - 5 years. The species composition of the Capoeira is different from that of the high forest and only a few species have any commercial value and reach a merchantable size.

Ecological zones

A number of ecological zones can be distinguished. Despite the very large extent of Amazonia, the total number of the zones is limited, due to the relative uniformity of soils and climate over large areas. Forests are clearly the dominant vegetation type. Appendix IV gives the distribution of different ecological zones.

Social and Economic Factors

The population of the Brazilian Amazon Region is approximately 10 million.

About 90% of the land in Amazonia is vested in the State, but Government manpower resources are insufficient to regulate the movement of small farmers and settlers, who appear to clear tracts of forest where and when they wish. The indiscriminate cutting of the forest without regard to soil and climatic conditions has resulted in an unnecessarily large amount of forest being cleared, and consequently abandoned after only a few years. Moreover, the system of agriculture that is practised does not make full use of the land and is wasteful, and on-farm attention to crop requirements is less than desirable. The sole reliance that is placed upon the temporary fertility that is available immediately after the forest is cleared, means that each family uses an enormous tract of forest over a 20 year period.

The low yields obtained have meant that food production in the region has not been able to keep pace with population growth, and increasing amounts of food must be imported into the region at high cost. The excessive forest clearance has also brought about a shortage of timber within economic transportation distance of the main population centres, so that wood products are also highly priced. The combined effect of all these developments necessitates the urgent improvement of land management systems, which will restore the fertility of both the cut over high forest and the abandoned agricultural land, and at the same time produce timber and food crops. It is also essential that the system be compatible with the needs of the small farmer who requires a regular income and cannot wait for a timber crop to mature. The system must therefore combine the production of food for their own consumption with early maturing crops producing cash income, and longer term forest tree crops for timber and general soil improvement.

JUSTIFICATION

Despite the vast potential of its forests, Amazonia contributes only about 10 per cent of Brazil's industrial roundwood production and has a small share of only 3 per cent of the world's tropical hardwood trade. The forests are therefore not being utilized at present for the benefit of the people of the country. Nor are the forests managed. A major consequence of this lack of management, combined with the low levels of removals that are made, is that there is a high preponderance of over-mature trees in Amazonia, of which no economic use is made. This is, of course, a waste of a valuable resource.

Moreover, Brazil suffers from an overall balance of payments deficit, and has also a balance of trade deficit with respect to wood and wood products. The Food and Agriculture Organisation of the U.N. has forecast that this deficit will increase in the future (for demand will rise) unless more wood is produced in Brazil, mainly from the Amazon.

A recent (1978) FAO team to Brazil made an appraisal of the forests in order to ascertain the feasibility of establishing a permanent forest in industry. The report of the team concluded that "it is technically possible, environmentally sound, and economically viable to manage Amazonian forests

for their industrial utilization. Compared with the prevailing general practice of Amazon occupation which results in the dissipation of the nation's forest wealth and the often irreversible destruction of ecosystems, the developmental benefits and environmental advantages of forest management are enormous.

"With quite conservative estimates of benefits and liberal estimates of costs, an integrated forestry and forest industries enterprise would yield a rate of return of 20 per cent. This includes adequate provision for ensuring rational ecological care, safe silvicultural practices and scientific management of the forests. At the same time an appreciable number of permanent jobs (would be) created in a logging area, regional development accelerated, wood and wood products made available for other sectors of the economy, and foreign exchange earned through exports."

Be that as it may, is would be naive to ignore the possible deleterious effects of farming in some of the areas which could be opened up for forest management. There is already evidence in Brazil that where there is forest exploitation, "spontaneous colonisers" follow the forest roads and clear large areas for food production and animal husbandry. Unfortunately, the evidence also exists that many sites quickly deteriorate, productivity drops, lateritic soils develop, erosion occurs, and the ecosystem in general deteriorates.

Given, therefore, the necessity for and advantages of forest industries development in the area, and given also the possible harmful effects of the farming that is associated with forestry development, it seems advisable to undertake research in agroforestry, in order to ascertain whether the system could conserve the ecosystem in the Amazon and still satisfy the farmers' demand for food.

THE PROJECT

OBJECTIVE

The general objective of the project will be to develop economically viable and sound land management systems using combinations of forest and agricultural species. In order to attain this general objective, a number of experiments, each with specific objectives, will be conducted. The specific

objectives of each of these experiments will be stated separately.

METHODOLOGY

Areas of Research and Treatment Variables

Information is urgently needed on the following aspects of agroforestry systems; if the project's objectives are to be met:-

(a) compatibility of forestry and agricultural species;

(b) the optimum espacements of both the tree and agricultural species;

(c) the arrangement and admixture of species;

(d) the methods of establishing agroforestry systems in recently cleared forest areas, or on forest land in various successional stages;

(e) the arrangement and admixture of the agricultural and forestry species; and

(f) the cultural practices to be followed during the gestation period of both the agricultural and forestry species.

The variables that are involved in these experiments are many. The most important are:

(a) the species (forest crops, perennial agricultural crops, annual and biennual agricultural crops etc.);

(b) the spatial distribution of the plants (rectangular, quincunx, in rows, etc.);

(c) admixture of species (sole crop stands, mixtures by rows, mixtures in strips, sequential arrangements, rotation etc.); and

(d) cultural methods (site preparation, planting methods, pruning, thinning staggered harvesting of forest species, etc.).

It will be evident that it will be difficult to incorporate all these variables into a simple experiment. Moreover it may not be practical to conduct many experiments and to study all these aspects simultaneously. Therefore it seems necessary to establish criteria in the choice of treatments.

Considerations in the choice of treatments

(a) Research priority should be for developing land use systems consisting of timber species and perennial agricultural species which will minmize the indiscriminate destruction of forests. The agricultural crops (perennial as well as annuals) that are chosen should provide an inducement to farmers to take up the systems.

(b) Such information that is available and based on the experience of the farmers of the locality should be made use of while planning the experiment.

(c) The results of experiments are already in progress at different research stations, e.g. CPATU I and CPATU II at Capitao Poco; crop combinations with rubber at CNP Seringueira, Manaus., etc.) should be noted, and care taken to avoid duplicating the treatments, but to complement the information available from the existing trials.

(d) The treatments selected should be practicable and feasible and in accordance with the general practice of the farmers of the locality, and governmental policies.

The Strategy

In view of these considerations, it seems desirable to have simple experiments with a few treatments, to gather information on specific points in as short a time as possible, rather than to aim at complex experiments with many treatments. The simple experiments conducted at different locations within a broad project framework could be analysed together by the technique of analysis of a group of experiments. Based on these trials, detailed information on any aspect could be gathered by future experiments designed specifically for that purpose. Experiments aimed at deriving multifactor interactions do not seem desirable at this stage. However, the project should be able to compare the agroforestry systems in relation to pure agricultural and forestry systems.

The strategy to be adopted in the project will, therefore, be the adoption of a model experimental design which will be used to study a limited number of important interactions. The same design will be repeated in different

ecological zones, with different combinations of factors, so that groups of experiments may be analyzed together, to measure other treatment effects.

The basic experimental design to be used is the Split Plot with the forest tree crop generally composing the Main plots, and the Sub-Plots being used to measure the agricultural crop's response. There will normally be 4 main plots and 4 - 6 sub-plots with 3 to 4 replications. This should enable significant differences to be detected in most cases. Plots of sole crop stands of the component species will also be included as 'control' plots for comparative purposes.

Priorities

It has already been explained that the main components of the agroforestry systems which will be investigated are: the species, their espacements, the pattern of admixture and the cultural and management techniques to be employed.

Information, based on the experience of the farmers and on trials which have been conducted in Brazil, is already available on the species which may be employed in agroforestry systems. Moreover, the experiments CPATU I and CPATU II, which have been conducted at Capitao Poco by CPTATU (agricultural research station for the humid tropics), aim at screening some potential combination systems. Therefore, these species will merely be tested, and the top priority of the proposed ICRAF/EMBRAPA/IBDF project will be to find out the population density (spacing) of the tree and agricultural species. Second priority will be the evolution of optimum admixtures, and the third will be the study of cultural techniques and management (such as land preparation, planting methods, pruning, thinning method and time of final harvest) of the perennial component.

Suitable species

The following species have been identified for the project:

Forest (Timber) species

Freijó (*Cordia goeldiana*)
Brazil nut (*Bertholletia excelsa*)
Inga (*Inga alba*)
Quaruba (*Vochysia maxima*)

Bacuri (Platonia insignis)
(Gmelina arborea)
Marupa (Simaruba amera)
Para para (Jacaranda copaia)
Leucaena (Leucaena leucocephala)
Andiroba (Carapa guianensis)

Perennial agricultural species

Cacao (Theobroma cacao)
Cupuacu (Theobroma grandiflora)
Coffee (Coffee arabica, C. robusta)
Guarana (Paullinia cupana)
Black pepper (Piper nigrum)
Pupunha (Guillielma gasipaes)
Bananas (Musa spp)
Rubber (Hevea brasiliensis)

Annual agricultural species

Upland rice (Oryza sativa)
Maize (Zea mays)
Cassava (Manihot esculenta)
Cowpea (Vigna unguiculata)
Soyabean (Glycine max)

Considering a) that the number of species included in the study has to be limited to a minimum because of experimental convenience and b) that other experiments are in progress, the following forest species will be the main ones in the proposed experiment: Cordia goeldiana, Inga alba, Leucaena leucocephala, and Jacaranda copaia.

The annual agricultural crops will be maize and cowpea (grown together) in accordance with the general practice of the locality. Cacao, coffee and black pepper will be the perennial agricultural species.

The strategy of the experiment and the model experimental framework permit any number of species to be included in separate experiments, depending upon the facilities, requirements and resources for research.

PROPOSED EXPERIMENTS

Title: Optimum spacing for the forest species and perennial agricultural crops in combination culture.

Objectives:

(i) To find out a suitable spacing for the selected forest species when they are grown as overstorey crops in combination systems.

(ii) To evaluate the performance of growth of perennial agricultural species when grown in combination with the selected forest species.

(iii) To assess the production potential of, and economic returns from, the combination systems.

(iv) To study the effect of combination systems on soil fertility.

(v) To compare the agroforestry systems of land use with sole crop systems of agricultural and forestry species.

Design: Split - Plot Design with spacings of forest species in main (whole) plots and spacings for agricultural crops in sub-plots.

Treatments:

Whole plots - 4 spacings for each forestry species (each species to be examined separately).

3.5 x 3.0 m
3.5 x 4.5 m
3.5 x 6.0 m
3.5 x 7.5 m

Sub-plots - 6 treatments

3 perennial agricultural species; each at two spacings

Cacao: a) 3.5 x 2.25 m
b) 3.5 x 3.00 m

Coffee: a) 3.5 x 3.0 m
b) 3.5 x 4.0 m

Black pepper:

a) 2.0 x 2.5 m
b) 2.5 x 2.5 m

The experiment will be repeated using each of the four selected tree species adopting the same experimental design. If two forest species are included in the same experiment, there will be 8 treatments in the whole plots, and the number of replications will be reduced to 3.

There will be replicated plots of the selected forest species, and selected agricultural perennial and annual species, grown as sole crops. The minimum number of replications for each species will be four.

Time of Planting

The annual agricultural crops and the forest tree species will be planted in the first year (i.e. the year of felling the primary and/or secondary forests); the perennial agricultural crops will be planted in the following year.

Uniform treatments

All the basic cultural operations (e.g. weeding and clearing) will be conducted in a uniform manner in all the plots.

Thinning and Pruning

In order to ascertain how long agricultural crops may be continued to be produced from the land in combination with forest tree crops, a series of thinning and pruning trials will be undertaken. At the time of the closing of the canopy of the tree crops a mechanical, systematic thinning will be carried out. Alternate rows of trees, will be removed in half of each of a number of plots in the experiment, the remaining half plot being considered as controls. These thinnings will be repeated, again in a systematic mechanical manner, as and when the canopies again close.

In other plots, again on a half-plot basis, pruning trials will be performed. These pruning intensities, (i.e. removals of $\frac{1}{4}$, $\frac{1}{2}$ and $\frac{3}{4}$ of crown length) will be tried.

It is emphasized that these thinning and pruning trials are essentially observation exercises. The treatments may therefore be modified from time to time. More important, the results of the observations may be used as a basis for the conducting of more sophisticated research programmes on thinning and pruning regimes at a later date.

Location of the experiments

Because a number of trials using different tree species, though all within a common experimental framework, are contemplated, the experiments are proposed to be located at different places. From the point of view of carrying out the experiment efficiently, it is important that the experiments be located at suitable and easily accessible places where laboratory and other facilities exist. It is also important that the localities chosen for such field trials be representative of the areas for which the experiment is ultimately intended.

It is proposed that the project be implemented in two regions, one in the Rondonia region (near Porto Velho) and the other in the Belterra region (near Santarem). These regions have similar ecological and socio-economic conditions.

Human pressure on land is rather high in the Rondonia region, where about 5,000 families are being settled every month. They plant perennial species such as coffee, cacao, and rubber. The area is under the direct administrative control of the Federal Government. Moreover, EMBRAPA has an experimental station in the area, and it is proposed that one part of the project be attached to that station.

Belterra is also a settlement region, where settlement takes place along the Santarem - Cuiaba road. There is a field research unit of the Ministry of Agriculture in the region, which would be the nucleus for the proposed experiment.

Ancillary Studies

- The initial fertility status of the soil: pH, organic carbon, C/N ratio, N, P, K, Ca, Mg status of representative soil samples to be recorded before the commencement of the experiment. The analysis to be repeated at least once in a year after the annual agricultural crop is harvested.
- Physical properties of soil such as bulk density, infiltration rate, moisture characteristics, etc., also to be studied before the commencement of experiment and at annual intervals.

- Nutrient changes and cycling in the soil-plant system.
  A systematic and continuous monitoring of the changes in nutrient content, and the input, output and turn over (litter fall, root decomposition) of nutrients in the soil-plant system for determining the fertilizer requirements and ensuring nutrient economy.

- Root distribution pattern of the timber species and of the agricultural (perennial) species under the different planting densities.

- Light distribution and radiant energy profile within the plant canopies for assessing the competition and interaction for light under different plant densities and the effect on lower storey crops.

- Microbiological investigations to study effect of planting systems on rhizosphere and root surface mocroflora.

- Economic considerations of land equivalent ratio, income equivalent ratio, cost/benefit analysis, etc., of different planting patterns.

IMPLEMENTATION OF PROJECT

Brazilian Organizations

The research will be carried out by the Brazilian Agricultural Research Enterprise (Empresa Brasiliera de Pesquisa Agropecuaria (EMBRAPA). EMBRAPA, which was established by law in 1972, began operating in 1973, and is responsible in Brazil for the coordination and advancement of agricultural research.

With the establishment of EMBRAPA a new institutional and operational research model was created. The basic idea behind the model is that of cooperation and integration between the states, universities, technical advisory agencies and the private sector. Direct research is undertaken by EMBRAPA through the National Centres which are principally concerned with the development of crops, natural resources and agricultural production systems for the humid, semi-arid and cerrado areas; through anciliary services; and through the State and/or Territory Research Units. EMBRAPA, therefore, by its very structure and modus operandi is able to draw upon scientists and facilities throughout Brazil.

EMBRAPA is adequately staffed, and the project will therefore require only a minimum of external professional staff inputs.

Only one externally recruited scientist will be involved in this project. The job description is given in Appendix VI. He will perform the duties of co-manager of the project, and will provide the essential link between the project and ICRAF.

Local Staff

The local staff, both support and professional, their salaries and other benefits will be paid by the Government of Brazil. A detailed list of staff and costs is presented in Appendix I.

The Government of Brazil will provide the co-manager with secretarial and support services. The type of secretarial and support services will be included in the protocol to be signed between ICRAF and the Government of Brazil.

The custody of project funds released by ICRAF for disbursement in Brazil will be vested in the EMBRAPA Chief Accountant. EMBRAPA will designate an Assistant Accountant/Accounts Assistant who will be directly resposible for the project funds under the Chief Accountant.

The estimated local staff costs for three years are US $ 258,000.

ICRAF INVOLVEMENT

Recruitment

The recruitment of the co-manager and the consultants indicated in Appendix I will be carried out by ICRAF in consultation with EMBRAPA. ICRAF will also be responsible for paying their salaries, relocation costs, and allowances.

Project Monitoring

ICRAF's core staff, located in Nairobi will provide technical and scientific advice and support to all the field staff. Visits of ICRAF core staff will be made periodically, and as occasion warrants, to the field sites. In addition monitoring and evaluation exercises will be undertaken by ICRAF,

in collaboration with EMBRAPA, at six monthly intervals in the first 18 months of the project. Thereafter, evaluation and monitoring will be undertaken at yearly intervals, in conjunction with project planning exercises.

Proposals for Project Revision and Forward Planning

ICRAF will organize teams to examine project progress at one-yearly intervals. These teams will advise on the future of the project, and on the necessity or desirability of modifying or extending it.

Education and Training

ICRAF will arrange the holding of seminars and workshops in order to train project staff and other Brazilian and Latin American scientists in agroforestry project methodology, and in order to disseminate the results obtained in the project. Two are planned: one in the first year, which will be concerned mainly with the methods and techniques to be employed in agroforestry research; the other, to be held in the third year, will concentrate on the dissemination of research results.

PROPOSED BUDGET

Donor Contribution

The external funding needed for the project is US $ 788,700 or an average of US $ 263,000 annually over a three year period. This amount includes a standard service charge for ICRAF of 14 per cent.

External personnel costs amount to US $ 240,000 for the period. The capital budget is US $ 41,400. Provision amounting to US $ 67,000 is also made in the budget for a donor contribution towards the education and training programme.

Brazilian Contribution

In addition to contributing in kind (office space, land, etc.), the Government of Brazil will, inter alia: provide all but one of the professional and scientific staff etc. at a cost of US $ 258,000 over the three year period; will construct such buildings as are necessary for the project at a cost of US $ 35,000; and will cover all internal travel costs amounting to US $ 133,000.

The total Brazilian contribution will be US $ 696,000 or US $ 232,000 annually over three years.

PROPOSED BUDGET

ICRAF CONTRIBUTION

OPERATIONAL BUDGET

	YEAR 1	YEAR 2	YEAR 3	TOTAL
Salaries, Relocation Allowances	US $	US $	US $	US $
- 1 Project co-manager	75,000	80,000	85,000	240,000
- 3 x 2 months consultancies for project advice, follow-up, review etc.	63,000	68,000	75,000	206,000
	138,000	148,000	160,000	446,000
Research Expenses				
Cultural practices (cultivation, planting out, harvesting etc.)	8,500	9,400	10,400	28,300
Vehicle maintenance	2,500	2,800	3,100	8,400
	11,000	12,200	13,500	36,700
Transport and Travel				
International (visits to projects, meetings etc.)	13,000	14,000	15,000	42,000
Training (including travel)				
- 2 x 2 week seminars for local and other Latin America researchers	28,000	-	28,000	56,000
- 2 Publications	-	5,000	6,000	11,000
	28,000	5,000	34,000	67,000
	190,000	179,200	222,500	591,700
Contingencies (10%)	19,000	17,900	22,200	59,100
Total Operational Budget	209,000	197,100	244,700	650,800

CAPITAL BUDGET

	YEAR 1	YEAR 2	YEAR 3	TOTAL
	US $	US $	US $	US $
Field Equipment	8,000	5,000	3,000	16,000
Vehicles (1 tractor and 1 wooden wagon)	12,000	-	-	12,000
Lab. equipment	7,000	4,000	2,000	13,000
Total Capital Budget	27,000	9,000	5,000	41,000

ICRAF BUDGET SUMMARY

Operational	209,000	197,100	244,700	650,800
Capital	27,000	9,000	5,000	41,000
	236,000	206,100	249,700	691,800
ICRAF servicing charge (14%)	33,000	28,900	35,000	96,900
	269,000	235,000	284,700	788,700

PROPOSED BUDGET

EMBRAPA CONTRIBUTION

OPERATIONAL BUDGET

	YEAR 1	YEAR 2	YEAR 3	TOTAL
Salaries and Allowances	US $	US $	US $	US $
1 Agronomist (50% time)	10,000	10,000	10,000	30,000
1 Forester (50% time)	10,000	10,000	10,000	30,000
1 Accountant (25% time)	4,500	4,500	4,500	13,500
1 Accts. Asst. (50% time)	2,500	2,500	2,500	7,500
2 Technicians, Agr.	12,000	12,000	12,000	36,000
2 Technicians, Fr.	12,000	12,000	12,000	36,000
1 Senior Technician	9,000	9,000	9,000	27,000
2 Secretaries/Typists	12,000	12,000	12,000	36,000
2 Clerks/Typists	8,000	8,000	8,000	24,000
2 Messengers/Cleaners	6,000	6,000	6,000	18,000
	86,000	86,000	86,000	258,000
Research Expenses				
Survey and mapping	75,000	60,000	-	135,000
Nursery costs	10,000	6,000	3,000	19,000
Cultural practicrs	8,500	9,500	10,000	28,000
Office supplies	15,000	10,000	2,000	27,000
	108,500	85,500	15,000	209,000
Transport and Travel				
Internal travel for project personnel	40,000	44,000	49,000	133,000
Publications				
Reports etc.	1,500	2,500	4,000	8,000
Total Operational Budget	236,000	218,000	154,000	608,000

CAPITAL BUDGET

	YEAR 1	YEAR 2	YEAR 3	TOTAL
	US $	US $	US $	US $
Field Equipment	9,000	6,000	4,000	19,000
Construction (shed, office, laboratory)	35,000	-	-	35,000
Lab. Equipment	10,000	7,000	3,000	20,000
Office Equipment & furniture	8,000	4,000	2,000	14,000
Total Capital Budget	62,000	17,000	9,000	88,000

EMBRAPA BUDGET SUMMARY

Operational	236,000	218,000	154,000	608,000
Capital	62,000	17,000	9,000	88,000
	298,000	235,000	163,000	696,000

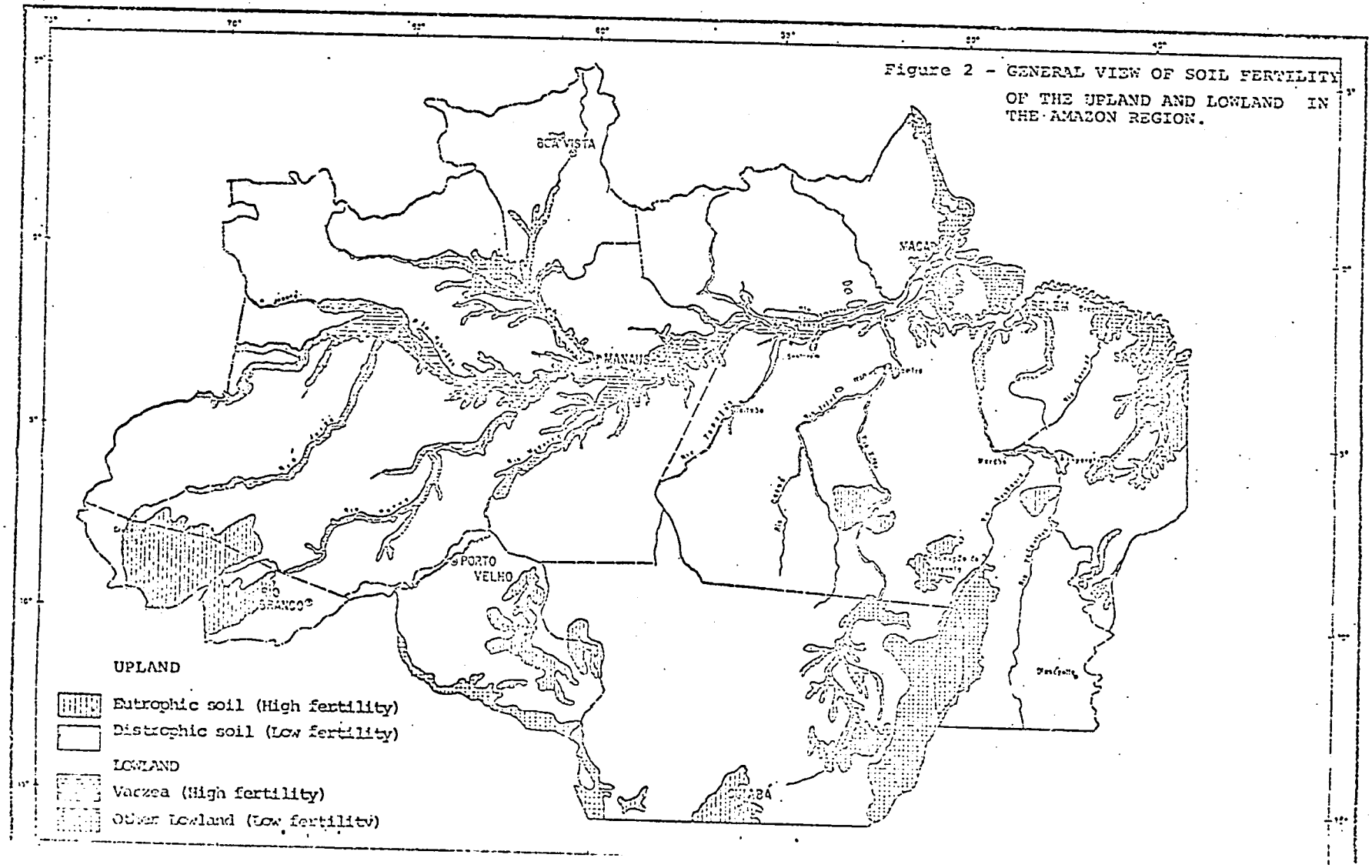


Figure 2 - GENERAL VIEW OF SOIL FERTILITY OF THE UPLAND AND LOWLAND IN THE AMAZON REGION.

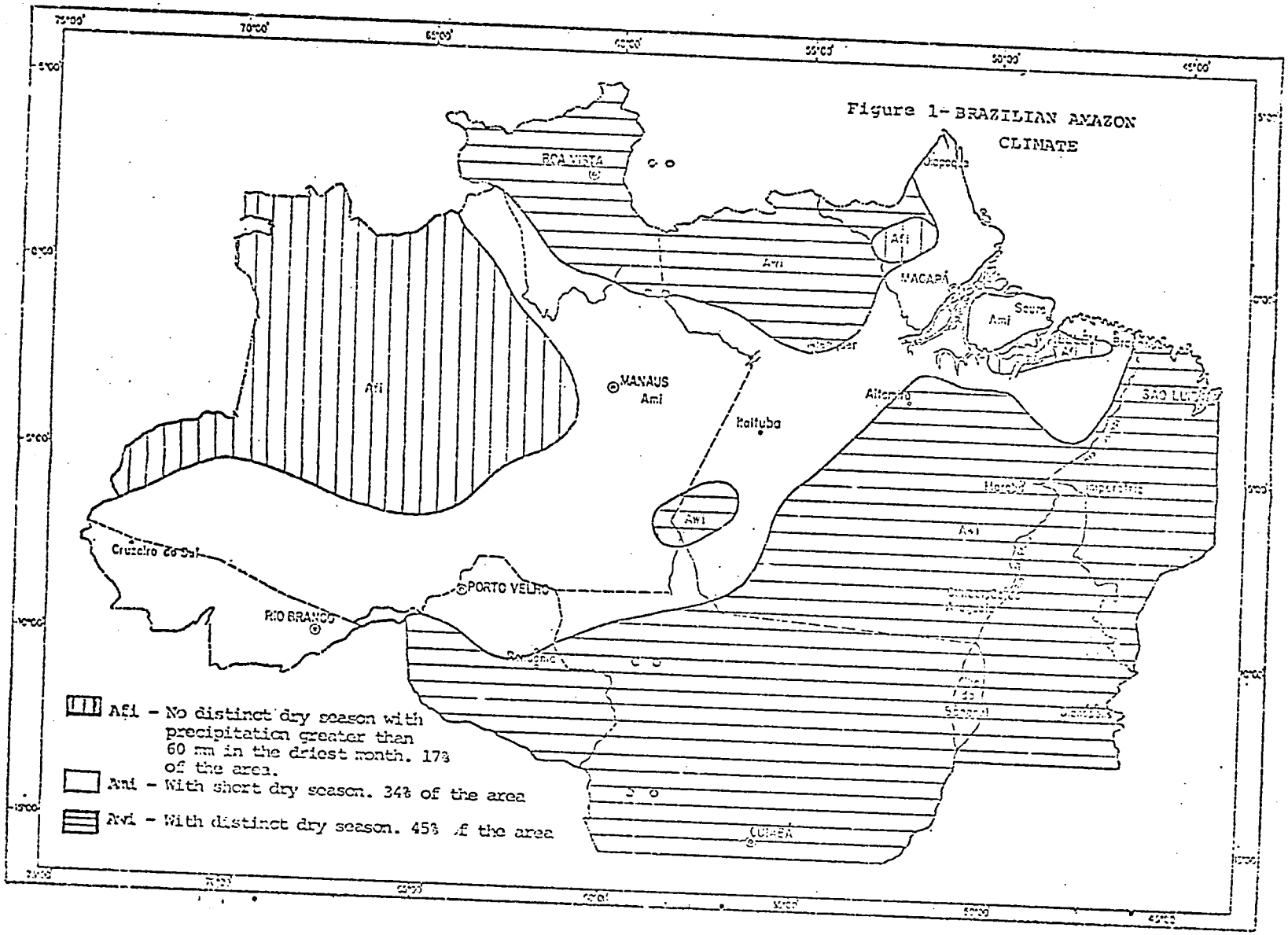
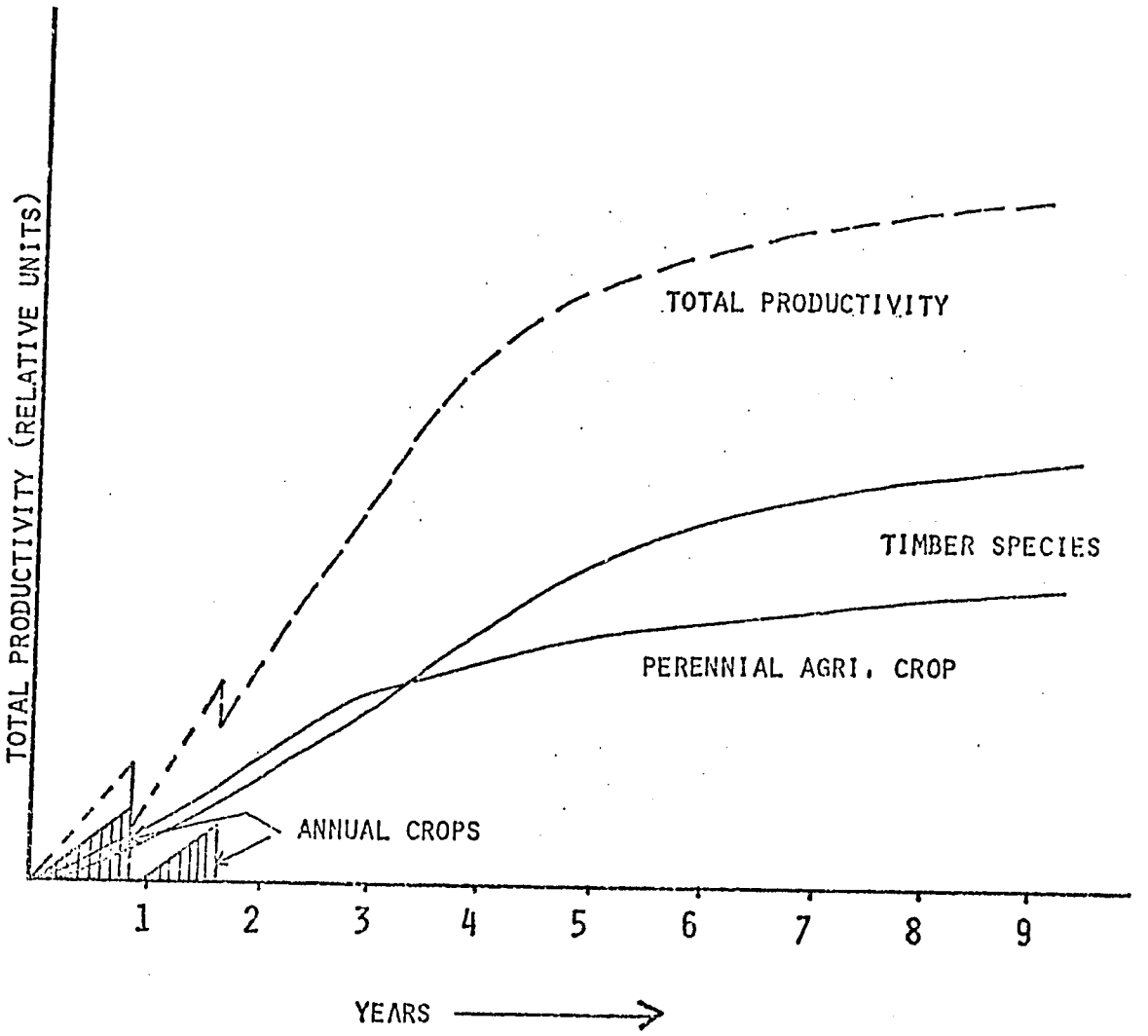


Figure 1- BRAZILIAN AMAZON CLIMATE

Table I - FREQUENCY AND AREA OF THE MACROECOLOGICAL UNITIES OF LEGAL AMAZON REGION

CLIMATE	VEGETATION	SOIL	FREQUENCY	AREA - Km^2	% IN RELATION TO AMAZONIA
Afi	FOREST	DISTROPHIC UPLAND	3	707 991,19	14,05
		EUTROPHIC LOWLAND	5	93 726,96	1,86
		DISTROPHIC LOWLAND	6	36 281,40	0,72
	SAVANNA	DISTROPHIC UPLAND	4	5 542,99	0,11
		EUTROPHIC LOWLAND	1	2 015,63	0,04
		DISTROPHIC LOWLAND	.	503,91	0,01
	GRASSLAND	EUTROPHIC LOWLAND	1	30 234,50	0,60
Ami	FOREST	EUTROPHIC UPLAND	7	127 992,72	2,54
		DISTROPHIC UPLAND	5	1 237 598,81	24,56
		EUTROPHIC LOWLAND	6	92 215,23	1,83
		DISTROPHIC LOWLAND	11	62 484,64	1,24
	SAVANNA	DISTROPHIC UPLAND	16	93 726,95	1,86
		EUTROPHIC LOWLAND	1	4 535,17	0,09
		EUTROPHIC LOWLAND	3	13 101,62	0,26
	GRASSLAND	EUTROPHIC LOWLAND	2	65 004,18	1,29
		DISTROPHIC LOWLAND	3	15 117,25	0,30
Awi	FOREST	EUTROPHIC LOWLAND	10	76 090,16	1,51
		DISTROPHIC UPLAND	14	1 322 255,41	26,24
		EUTROPHIC LOWLAND	1	1 007,82	0,02
		DISTROPHIC LOWLAND	14	120 434,07	2,39
	SAVANNA	EUTROPHIC LOWLAND	14	74 578,44	1,48
		DISTROPHIC UPLAND	34	718 069,36	14,25
		DISTROPHIC LOWLAND	15	138 574,79	2,75
T O T A L				5 039 083,20	100,00



SCHEMATIC PRESENTATION OF TOTAL PRODUCTIVITY FROM A PROPOSED AGROFORESTRY SYSTEM FOR LOWLAND HUMID TROPICS

JOB DESCRIPTION
PROJECT CO-MANAGER

Duties and Responsibilities

The Project Co-Manager, working under the general direction of the Director-General of ICRAF and the Director-General of EMBRAPA, will assist in the implementation of the cooperative agroforestry research programme of the Government of Brazil and ICRAF. His responsibilities will *inter alia* include the following:

(i) administration of the project, including the overall coordination of the planning and implementation activities of the project;

(ii) procurement of materials, equipment and supplies for the project under donor contribution funds;

(iii) accountability for all matters pertaining to fund disbursement, the custody of the funds however being with the EMBRAPA or ICRAF management, as appropriate;

(iv) preparation of detailed programmes of work and budget, within budgetary limits in the project agreement, and clearing the plans with ICRAF and EMBRAPA prior to implementation;

(v) preparation and submission of quarterly and annual scientific progress reports on the project;

(vi) co-ordination of the on-the-job training programmes for Brazilian cooperating scientists and support technical staff so that these effectively impart the concepts, principles and practices of agroforestry and the research methodology appropriate to the different fields of work;

(vii) advising the Government of Brazil (through EMBRAPA) and ICRAF on all matters pertaining to the project;

(viii) advising on reviews for the project and on the need for consultancies for the project; and

(ix) participating in the research activities of the project in the area of his professional competence.

Qualifications

The Project Co-Manager should have at least a Ph.D. in agriculture, forestry, horticulture or animal production.

He should have at least 10 years of professional experience in the development, conduct, and administration of research work at research institute or university level. A significant proportion of his research experience should have been gained in the tropics or subtropics and should have involved multiple cropping systems, with or without the integration of a woody species component.

The Project Co-Manager should have the ability to write clear and concise analytical reports.

He should have full working knowledge of English (UN level 6) and Portuguese (UN level 4).

He should also have the ability to establish and maintain effective working relationships with persons of different national and cultural background.

Duty Station

Brasilia, Brazil.

Assignment Period

3 years.