

UNU PROPOSAL

TRADITIONAL AGRO-FORESTRY
PRACTICES IN THE WET TROPICS;
THE "LA SUIZA", COSTA RICA
CASE STUDY

CATIE



CENTRO AGRONÓMICO TROPICAL DE INVESTIGACION Y ENSEÑANZA
TURRIALBA, COSTA RICA

1979



APPLIED RESEARCH GRANT APPLICATION
UNITED NATIONS UNIVERSITY

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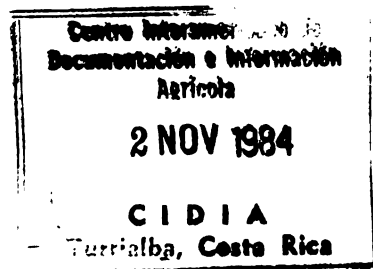
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ABSTRACT

Two adjoining watersheds, north of the town La Suiza, Costa Rica, are suggested as a site for a comprehensive study of traditional agro-forestry practices in the wet tropical zone of Central America. A number of excellent opportunities for research and demonstration purposes are to be found within this area because of the present contiguous use of many common agro-forestry associations.

The first years work which is designed to provide a foundation for the continuing development of this study site, will concentrate upon the following subprojects:

- i) A general survey
- ii) Three studies that will focus on particularly interesting types of tree - crop combinations.
- iii) A detailed survey to delineate critical erosion areas.
- iv) A species trial for the reforestation of degraded pasture land.

These investigations will:

- i) Supply the socio-economic and land use background to the area.
- ii) Foster the development of a methodology for the study of agro-forestry systems.
- iii) Provide demonstration sites to illustrate some of the benefits and limitations associated with agro-forestry practices.
- iv) Generate information of value to scholars and small farmers.

First year results will include a guide to the area, quantitative descriptions of examples of 3 particular agro-forestry practices and the provision of extension agent assistance to the farmers who fear declining productivity as a consequence of soil erosion.

A. INTRODUCTION

A common sight in the developing tropical countries of the world is the destruction of the natural forest on marginal lands which are being converted into agricultural areas (9). The detrimental effects of this thoughtless development have been extensively studied and described (10) yet the damage continues to be wrought on an ever increasing scale. The inefficiency of the scientific community in alerting and convincing the rural populace of the danger to their livelihood can be attributed to many reasons but a few stand out:

- i) Attempts to apply technology from different ecological life zones (e.g. temperate to tropical, tropical dry to tropical wet, tropical highland to tropical lowland) whilst disregarding local traditional techniques, has often resulted in disastrous land management schemes.
- ii) The failure to relate research objectives to the immediate needs of farmers has often lead to impractical techniques being recommended to a sceptical misinformed community.

Most tropical cultivation patterns do permit a stable production system when the soil can be regularly left under fallow. However, population increases have necessitated an intensification of land use and if productivity is to be maintained modifications of local farming methods are urgently needed.

The motivation for this project is to study, in co-operation with small farmers, the little known agro-forestry systems (5), which exist in the wet tropical zone of Costa Rica. Agro-forestry is defined as the combination of trees in space or time with either crops or animal husbandry -- or both -- in order to achieve a stable production system for the benefit of rural populations(4).

The experiments described in this proposal will increase our knowledge of the inherent advantages and disadvantages of some Costa Rican practices, and of the possibilities for integrating these traditional methods with other techniques to provide stable agricultural resource systems for mountainous areas in the wet tropics.

A1. General and Long Term Objectives

I. To analyse the scientific basis of the traditional agro-forestry techniques that form a resource system which has been developed in the humid tropical wet environment exemplified by the proposed study area in La Suiza, Costa Rica. The beneficial and/or detrimental influences resulting from these practices will be assessed in relation to ecological, economic and social considerations such as soil stability, productivity and acceptability to farmers.

II. To test technologies, practiced in other regions and countries, which can be transferred and eventually combined with the traditional land use methods so that the productivity of the land can be maintained and, if possible enhanced.

III. To utilize the various pilot studies, which will be situated in two well defined watersheds, as a teaching and demonstration area that will facilitate the exchange of knowledge between scholars from other institutions, graduate students, interested specialists and others seeking to develop stable land-use systems for tropical wet environments.

A2. Specific First Year Objectives for the Delimited Study Area

I. To carry out various surveys in order to:

- i) provide general information about the socio-economic restraints which apply to small farms so that future recommendations will be within their capabilities,
- ii) determine the details of the specific land use practices employed in our study area,
- iii) define the critical areas where rapid erosion is occurring.

II. To set up permanent plots in areas currently managed with and without a protective tree canopy cover so that the benefits and limitations of some specific agro-forestry techniques can be quantified by measuring yields (tree products and associated crops), soil erosion rates and any other relevant factors.

III. To establish new plots that will permit the assessment of various promising tree species as a means to reduce erosion, and provide more organic matter to the soil.

IV. To produce, in combination with local authorities, simple recommendations for the farmers, a series of publications, audiovisual aids and ongoing evaluations of future research needs based on the data gathered during the 1st. year.

A3. Background

Publications on agro-forestry practices, apart from those concerned with the relatively well known "Taungya" method (8), have usually only contained descriptions of existing traditional systems. Notable exceptions are a report concerned with the yield of cacao in relation to the extent of forest cover used to provide shade (13), and papers discussing the influence of various tree species on pasture forage (1). Thus quantitative studies to assess the benefits and limitations that result from the inclusion of a forest component in a variety of agricultural systems have yet to be carried out (2).

Two adjacent watersheds, north of the town La Suiza, Costa Rica (fig. 1) have been selected as a potential area for studies which will provide some of this missing information for tropical wet environments. The area is particularly suitable for the following reasons:

- i) It contains a range of environments, between 650 and 1200 m. elevation, normally found in the tropical wet middle elevation zone and offers a variety of terrains which are typical of small watersheds in this region.
- ii) It is largely occupied by farms with an average size of 5 ha.
- iii) Examples of most of the agro-forestry combinations used in this region exist in the research area.
- iv) Erosion problems, attributable to inappropriate land use, are common and their correction would provide excellent demonstration models of particular value for the education of the farming community.

- v) The progressive attitude of many of the farm owners involved, illustrated by their independent adoption of grazing rotation schemes, and the presence of a large agricultural vocational training school (Colegio Agropecuario de La Suiza) mean that it will be easier to implement the necessary innovations in farm management in the La Suiza region than it would be in other parts of the country.
- vi) The people of La Suiza are eager to support this project since among other reasons, it should lead to a reduction of the flood damage they have suffered in the past.
- vii) It will be a readily accessible demonstration/teaching facility for students and visiting scholars since the chosen area is only 8 km., by an all weather road, from CATIE.
- viii) Previous projects (7, 11, 12) carried out in the Turrialba and La Suiza region provide a valuable source of general information related to local small farm management.

A4. Rationale

The studies outlined in this document have been designed within the constraints of the tentative budget. Furthermore, the ultimate goal of providing specific recommendations for low cost, low technology methods, which the local farmers could rapidly adopt, was also borne in mind whilst planning the first years work. Hence, the experimental plots will be selected to produce quantitative data and to serve as visual aids for the education of a diverse group of visitors.

Complex expensive techniques are not being proposed or studied and 6 simple sub-projects, that will provide a foundation for future work, are described in the following pages. These are:

- i) The initial survey, which will provide essential background information and give the farmers an opportunity to express their views.
- ii) Investigations of three particular agro-forestry practices which will concentrate upon what presently appears to be the most beneficial or detrimental consequences of each technique. It is intended that these sub-projects will eventually be expanded to include, for example, other properties of the specified tree-crop combinations.
- iii) The definition of critical erosion areas and the evaluation of their relative importance is the goal of the fifth sub-project. This work is linked to the final sub-project which is to demonstrate how reforestation of degraded hillside pastures can reduce the frequency of landslides.

Two of these sub-projects are specifically designed to increase background knowledge of the La Suiza area. This information will be valuable when assessing any quantitative results and may reveal other worthwhile agro-forestry topics which can be included in the expanded programme anticipated for the second year. The remaining sub-projects although only detailed for 1 year are ongoing studies which can be modified as data is collected. Budget estimates for the second year are therefore very approximate and can only be clarified when analysis of the first year's results indicates future research priorities.

B. SPECIFIC AIMS

B1. General Survey of the Research Zone

Farmers in the tropical countries possess a huge heritage of experience, knowledge and superstition that has led to the development of traditional agricultural resource systems. Change can only be initiated when the basis for these local techniques, and the constraints influencing the farmers ability to adopt improved land use methods, are fully considered. However, most of this information has never been recorded and even less carefully quantified to determine its true value. Thus, an essential prerequisite for this project is the compilation of background information for the La Suiza area, on the following inter-related topics:

- i) Socio-economic influences.
- ii) Fallow, secondary forests and other non-agricultural land uses.
- iii) Agro-forestry and agricultural (including grazing) practices.
- iv) Soil erosion and hydrological patterns.

This survey will also seek to record the farmer's justifications for the adoption of particular agricultural methods and their willingness to co-operate with the implementation of any future land use management plans.

B2. Benefits and Limitations of Guava (Psidium guajava) as a Pasture Shade Tree

Guava, a pioneer tree species of world wide distribution in the tropics and subtropics, is found in nearly all the pastures that are located within the delimited watersheds. It is naturally spread, by the seed passing through the

alimentary tract of cattle, and it is tolerated because it provides excellent firewood, shade and edible fruit for farm animals. The local people also use the fruit to prepare guava jams and jellies. Furthermore the trees provide small amounts of a hard fine-grained wood which can be used to make the handles of agricultural tools.

The shade provided by open grown stands of this species does not appear to influence forage yields but this factor should be rigorously examined. The influence of the tree on species composition in unimproved pastures and its ability to protect and stabilise the soil surface in poor pastures situated on steep slopes are further worthwhile study areas. Coppice cutting of guava provides a highly valued firewood and more information is needed on the tree's ability to resprout, and on the subsequent growth rates of these stump sprouts. Determination of the average quantity of fuelwood produced by regrowth will give a measure of the continuous wood production capacity and an indication of the speed, under specified conditions, with which an arboreal protective cover is renewed. These and the other consequences of permitting guava to grow in pastures should be quantified so that the advantages of replacing it with other shade/firewood trees, such as a nitrogen fixing species, can be readily assessed.

B3. Relative Soil Stabilisation Provided by 3 Living Fence Post Species

One of the most striking features of Costa Rican farms is the variety of woody plants employed as living fence posts. Despite the widespread occurrence of this practice, which predates the use of barbed wire, no research has been carried out on the benefits and limitations of the most commonly employed species. The farmers purposes in using living fence posts include the provision

of shade around pastures, the culture of edible foliage for animals, and the production of wood or other products such as fruits and flowers for human consumption. Although aware of the potential benefits to soil, such as the augmentation of available nitrogen, and the stabilisation of erodible soil banks, few people in the La Suiza area offer these reasons when explaining why they prefer living to dead fence posts.

Possibly the most valuable unacknowledged property of living fences is their ability to retard soil erosion with a fine mat of surface roots. The initial aim of a continuing study on living fence post species is to measure the relative soil stabilising properties of 3 varieties frequently encountered in the La Suiza area.

B4. Culture of *Cordia alliodora* with Perennial Crops

Laurel (*Cordia alliodora*) is a native pioneer tree species which is frequently encountered in all parts of the study area below 800 m. The apparent abundance of this species is a consequence of the local habit of leaving existing trees untouched when clearing secondary forest for agricultural uses. This is a successful method for producing saw logs because laurel grows very quickly, prunes itself and naturally develops a straight unforked trunk. The technique is feasible because this species has a remarkably small deciduous crown which intercepts little of the light which the farmers would rather make available to the associated crop. The value of the wood when the trees mature is the benefit which encourages this practice. However, the other benefits, such as soil protection and the recycling of nutrients by the tree component in these forest-crop and forest-pasture combinations have not been determined.

Similarly the actual wood yields and the trees influence on the productive capacity of the associated pasture or crop have yet to be carefully quantified.

A set of permanent plots will be installed in appropriate sites to evaluate these important factors and hence to permit rational assessment of this rapidly spreading agro-forestry practice. CATIE's perennial crops and animal husbandry departments will be consulted during the design and execution of these trials.

B5. Delineation of Critical Erosion Zones

A detailed examination of potentially unstable slopes will be carried out so that a map delineating critical erosion zones can be drawn. This will facilitate the preparation of land use advice for the farmers and will help in the planning of future research.

On the western slopes of the west fork of Quebrada Leona (fig. 2) a large soil slump occurred following heavy rain in April 1970. Since soil creep is continuing on this hillside measurements of the rate of movement and the size of the affected area must be taken. At the same time the beneficial and detrimental effects of local agricultural practices, employed on or around the slope, will be assessed. This information together with the location of all farm houses, facilities and animals endangered by a sudden slippage will be marked on a small scale map.

B6. Reforestation of Degraded Pastures on Hillsides

The secondary forest, which covers the hills surrounding the sources of the two streams included in the research zone, has been partially cleared for

sugar cane plantations and pastures. Erosion damage, usually in the form of small soil slumps, is much more common in the pastures than in the cane fields because the grass is less efficient at intercepting rainfall, produces much less litter material than sugar cane hence providing less protection of the soil surface, and most importantly because of the destructive activities of the grazing animals (primarily soil compaction and devegetation). This problem is most serious on steep hillsides where the cattle produce numerous denuded paths following the contours. In such areas productivity is very low and there are good economic arguments as well as ecological reasons for converting precipitous pastures into forest plantations (3).

The relative abilities of Pinus caribaea, Pinus oocarpa, Cupressus lusitanica, and Erythrina poeppigiana to survive on these poor sites, and to retard further erosion, will be tested by planting monocultural blocks of each species. Although E. poeppigiana will not produce a useable timber the following benefits should balance this drawback:

- i) Foliage for animal fodder.
- ii) Increased soil surface protection through the profuse production of litter material.
- iii) Improved soil structure, fertility and hence stability as a consequence of a higher level of organic material in the soil and nitrogen fixation by the root nodules.
- iv) More rapid establishment by vegetative propagation.

Estimates of the value of all these factors together with survival and growth data, costs, and the reoccurrence of soil slumps following planting will be recorded so that provisional recommendations for converting marginal

pastures into valuable plantations can be made by the end of the first year. The costs to the farmer, including the loss of agricultural production from this land, will also be calculated.

C. METHODS

C1. General Survey of the Research Zone

A standard questionnaire, designed to provide information about the 4 subject areas (socio-economic, secondary forests and other land uses, agro-forestry and agriculture, soil erosion and hydrological patterns) is already being prepared by graduate students and staff of CATIE. These students will be paired with staff of the Colegio Agropecuario, La Suiza, or residents of the town, who have agreed to co-operate and are familiar with the projects objectives. All farmers managing 3 ha. or more will be approached, the replies being noted by the investigating team. Some owners of smaller plots will also be included in the survey but it would not be reasonable to bias the results by including socio-economic data on all the small lot holders, most of whom live in La Suiza, and place little, if any, reliance on their land for an income.

Survey results will be compiled for an illustrated publication that will serve as an introductory guide for visitors to the research zone. This booklet will describe the agricultural systems in use, their approximate yields and potential for sustained productivity assuming low cost inputs, constraints to innovations, the areas of critical soil erosion together with practices which have influenced these areas, and other salient points that emerge from this exercise.

C2. Benefits and Limitations of Guava as a Pasture Shade Tree

I. The frequency of occurrence (trees/ha), and estimated average crown projection on the soil, of mature guava will be recorded in 3 or more pastures.

II. Annual volume increments of the trunks will be determined from a sample of trees which will be permanently marked.

III. In a sparse pasture, which is located on a steep slope, permanent 20 x 2.5 m runoff plots (6) will be installed beneath stands of guava and in the open.

IV. Biomass yield and species composition will be investigated in 3 different pastures where permanent plots can be marked out. Samples will be taken from beneath the trees, and from randomly chosen nearby points that are not shaded.

V. In each of these pastures mature guava will be felled, after recording their breast height diameters and total heights. One year later any new sprouts will be removed from the stumps of half of these cut trees so that a relationship between the original size and sprouting vigour can be calculated. The remaining resprouting trees will be retained for demonstration, and for future measurements that will increase our knowledge of the results of coppicing guava.

C3. Relative Soil Stabilisation Provided by 3 Living Fence Post Species

Within the project area there are many examples of exposed eroding soil banks either alongside roads or around coffee plantations which are kept denuded of all weed growth. The location of the 3 proposed trial plantings will be determined after a preliminary assessment of soil homogeneity (structure and texture) within promising road or field side sections. Open roadside concrete drains will then be built along the base of the chosen strips to ensure constant downslope support and to eliminate the possibility of road surface runoff undercutting the earth bank. Only species which regenerate from large cuttings, will be considered since they will rapidly provide trees of a size that will measurably influence bankside cohesion. Itabo (Yucca elephantipes) madero negro (Gliricidia sepium) and poro (Erythrina berteroana) will be used since they are 3 of the most common fence post species reproduced in this fashion.

Cuttings (2 m.) will be planted in both monocultural and intimately mixed lines. Control plots, which will be left to revegetate naturally or which will be kept plant free are going to be included in each repetition of this design. The plots planted with one or all of the 3 fence post species will also be selectively weeded to eliminate the complicating factor resulting from the mechanical root support of other plants.

Soil erosion will be measured by the extent of collapse with time of a smooth soil face which will be prepared by manually cutting the bank to a constant angle and height. Bench mark stakes at the ends of the test strips, inclined at the same angle as the bank, will provide references for regularly measuring soil loss.

C4. Culture of *Cordia alliodora* with Perennial Crops

A group of permanent plots will be installed in areas containing multistrata coffee-poro-laurel (*Coffea-Erythrina-Cordia*), sugar cane-laurel and pasture-laurel combinations. Control plots, of the same sizes will be situated in nearby sites that only differ through the absence of the forest overstory. Logistics demand that measurements be taken from plots of varying sizes dependent upon the factor to be evaluated and the species involved.

I. Growth increments and hence wood yields will initially be based upon a series of 0.1 ha plots.

II. Within these experimental areas random sampling techniques will be used to determine the crop yield per unit of surface, or in the case of coffee plantations per plant, with and without a laurel overstory.

In pastures random sampling techniques will be regularly used to determine plant species and total biomass per unit of surface. Seasonal variations will thus be investigated.

In cane fields the total wet weight of usable stalk will be recorded from a series of plots (5 x 5 m.) circumjacent to a laurel. Equivalent plots (5 x 5 m.), in nearby sites that are not influenced by a tree, will be harvested as a control.

In coffee plantations comparisons of the crop yield will be complicated by such variables as the plant ages, varieties, management intensity and spacing which are rarely constant even within a small plantation.

In as far as it is possible 5 plots, each containing 20 similar plants, will be delimited in both control and test areas so that the average bean yield per bush can be measured for each environment.

III. Measurements of erosion will also be taken beneath the laurel-crop and the laurel-pasture combinations together with the appropriate controls. In each site a 20 x 2.5 m. runoff plot (6) will be installed so that annual soil losses can be recorded.

C5. Delineation of Critical Erosion Zones

The results of the general survey will be used as a guide for the preparation of a specific questionnaire related to soil deterioration and erosion. Such an investigation will involve a small fraction of the land inside the research area but will necessitate detailed on the ground surveying in the presence of the farm owners.

On the hillside west of Quebrada Leona (fig. 2) the area of land which is gradually slipping will be determined. A large scale map of this section will be prepared with all land use activities marked. The existence of deep rooting species, extent of soil cover provided by crop and/or forest combinations, activities which increase or decrease run-off towards the upper margin of the critical zone and any other obvious influences will be used to qualitatively judge existing land use practices in this unstable area. Buildings and the location of farm animals which would be endangered by sudden failure will also be marked. Horizontal lines of stakes, starting and finishing on solid ground, will provide a reference for regular theodolite measurements that will indicate the annual rate of movement.

C6. Reforestation of Degraded Pastures on Hillsides

Various areas of pasture land, that have previously experienced soil slumps, will be selected and carefully delimited as permanent reforestation plots. In each replication one plot will be left under the present grazing system and another will be fenced to exclude foraging animals so that it can revegetate naturally. The other four plots will be planted with one of the following species --Pinus caribaea, P. oocarpa, Cupressus lusitanica and Erythrina poeppigiana.

Seedlings will be established on a 2.5 m. x 2.5 m. spacing and all plantations will be fenced from the surrounding pastures to minimize animal damage to the young trees. Weed control may be required for satisfactory survival and growth rates. Initially, to avoid worsening the present erosion problem, this would be accomplished by manual cutting of the competing plants in a 1 x 1 m. area around each seedling. However, spot herbicide treatments may be employed if the competition resulting from the existing grass cover is significantly affecting the success of the plantation.

A detailed accounting of all labour and material costs (including fencing) incurred during the establishment of these trials will permit a rapid calculation of the initial financial burden that would be borne by farmers who are willing to undertake reforestation. This calculation will have to take into account the present output of the fenced areas. The information from the survey will provide a basis for a more detailed enquiry into the finances of the co-operating finca so that this factor can be evaluated. Accurate records of the continuing management costs for these plantations will eventually permit a reckoning of the complete cost involved in reforesting degraded hillside pastures.

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E. SIGNIFICANCE TO U.N.U. PROGRAM

The study area and investigations outlined in this proposal have a dual purpose. Experiments that will provide permanent demonstration plots as well as immediate quantitative results have been selected. Thus, the La Suiza research area will also serve as a visual teaching aid to facilitate the exchange of knowledge between farmers, scholars from other institutions, graduate students and the staff of CATIE.

A study of traditional agro-forestry resource systems is unavoidably an interdisciplinary effort and hence all people associated with the project will benefit by being exposed to different viewpoints. CATIE is well suited for the execution of such a broadly based study since it can provide expertise, in 4 essential subject areas, through its major departments (Natural Renewable Resources, Perennial Crops, Annual Crops and Animal Husbandry).

Although the results of the first years work will largely be descriptive the ultimate purpose is to provide a scientific explanation for the successes and failures of agro-forestry techniques in the wet tropics, and then to disseminate, as widely as possible, the knowledge so gained. In order to achieve this goal workshops for scholars from the developing countries, field days for the local farmers and field trips for the Central and South American graduate students at CATIE will be organised to inform and educate people on the advantages of including trees within an agricultural framework. These training programs also have a dual purpose as they will provide opportunities for the participants to influence future work by expressing their views on the practicality and value of each sub-project.

A workshop has already been planned for the end of March 1979 when a group of experts who are presently, or will be, studying agro-forestry in the American tropics will have an opportunity to gain first hand knowledge of Costa Rican practices when they visit the La Suiza zone. This workshop, which is supported by the U.N.U. will be the first of its kind. The proposed research may be modified, within the budget constraints, at this time.

It is hoped that approximately one year later a second workshop can be set up around the central theme "Agro-forestry practices: a case study in La Suiza, Costa Rica". This meeting would give equal emphasis to formal presentations of the first year results and field trips to particular demonstration/experimental areas for detailed explanations of specific techniques.

F. FACILITIES

CATIE's main physical facilities are located at its central headquarters in Turrialba, Costa Rica. However, regional activities are carried out through co-operative programs with national institutions in each country. CATIE also has about 1,100 hectares of land, located in the Atlantic lowlands of Costa Rica.

In Turrialba the main centre includes four buildings for offices, conference halls, seminar rooms, classrooms, and teaching laboratories. There are also research laboratories and installations for the study of soils, plant physiology, entomology, phytopathology, animal nutrition, animal physiology and wood technology. Other facilities are a computer centre, language laboratory, 13 greenhouses, herbarium, cold rooms, arboretum, nurseries and a meteorological station. Moreover, one of the best agricultural libraries in Latin America, is maintained by IICA on the Turrialba campus.

G. COLLABORATIVE ARRANGEMENTS

Assistance with the practical field work has been pledged by the Colegio Agropecuario, La Suiza.

There is a strong possibility that the International Development Research Centre (Canada) will financially support a related agro-forestry proposal.

Another proposal, to study the culture of valuable timber species such as Cedrela odorata intermixed with coffee-poro plantations and pastures, is being submitted to the Consejo Nacional de Investigaciones Científicas y Tecnológicas, a Costa Rican funding agency. If supported some of these trials would be established in the La Suiza research zone.

One of the objectives of the March 1979 U.N.U./C.A.T.I.E. workshop is to co-ordinate Latin American studies on agro-forestry techniques and further collaborative arrangements are anticipated following this meeting.

The U.S. Peace Corps has provisionally agreed to supply 3 volunteers (for 1979-1981) to work as field assistants on agro-forestry and watershed management projects, subject to the submission of an official request by CATIE. One of these volunteers would be placed in La Suiza to provide a permanent contact with the local people.

Two forestry graduate students from CATIE (Walter Apolo from Ecuador and Carlos Figueroa from Guatemala) intend to carry out their thesis research work in the La Suiza study area. Their involvement will be a valuable asset for the execution of this proposal.

H. HUMAN USE APPROVAL

The final product of the work described herein, and that anticipated in future years, will be a set of simple recommendations for small farmers. This information, in the form of booklets, distributed by the Ministry of Agriculture and such local organizations as the Cooperativa de Caficultores y Servicios Múltiples R.L. de La Suiza, will help the rural people to utilize traditional agro-forestry and multiple cropping techniques for the maintenance and, if possible, enhancement of the productivity of mountainous land with poor soils in the wet tropical zone of Costa Rica.

In the La Suiza area more immediate benefits will result from this project. The farmers will be helped and encouraged to safeguard their livelihood by utilizing new and traditional techniques to stabilise the soil. The people of the town will welcome a reduction in the number of landslides which continuously threaten their water supply and which lead to a serious flooding hazard.

Some of the Latin American graduate students from CATIE will also gain especial benefits from the existence of a well defined nearby agriculturae community where they can carry out their special project or thesis research.

I. TIMETABLE

The estimated timing for the execution of the work detailed in this proposal is given in Fig. 3. This schedule is subject to the availability of sufficient skilled and unskilled labour during the demanding initial months of the year when a large variety of trials should be set up. If logistics problems arise the installation of the runoff plots will be postponed until June when the assistance of a Peace Corps volunteer should be available.

The six subprojects have, where appropriate, been broken down into their component parts. Subheading characters used in the table correspond to those in the text and one or two key words have been used to label each specific assignment. The work for every subproject or assignment has been divided amongst 3 activities:

Preparation and Installation (P.I.)

Data Collection (D.C.)

Analysis and Compilation (A.C.)

Figure 1
MAP OF COSTA RICA



Fig. 2. Map of the proposed study area. (-----; limit of zone where soil slump and numerous small landslides have occurred).

Scale
1:25,000

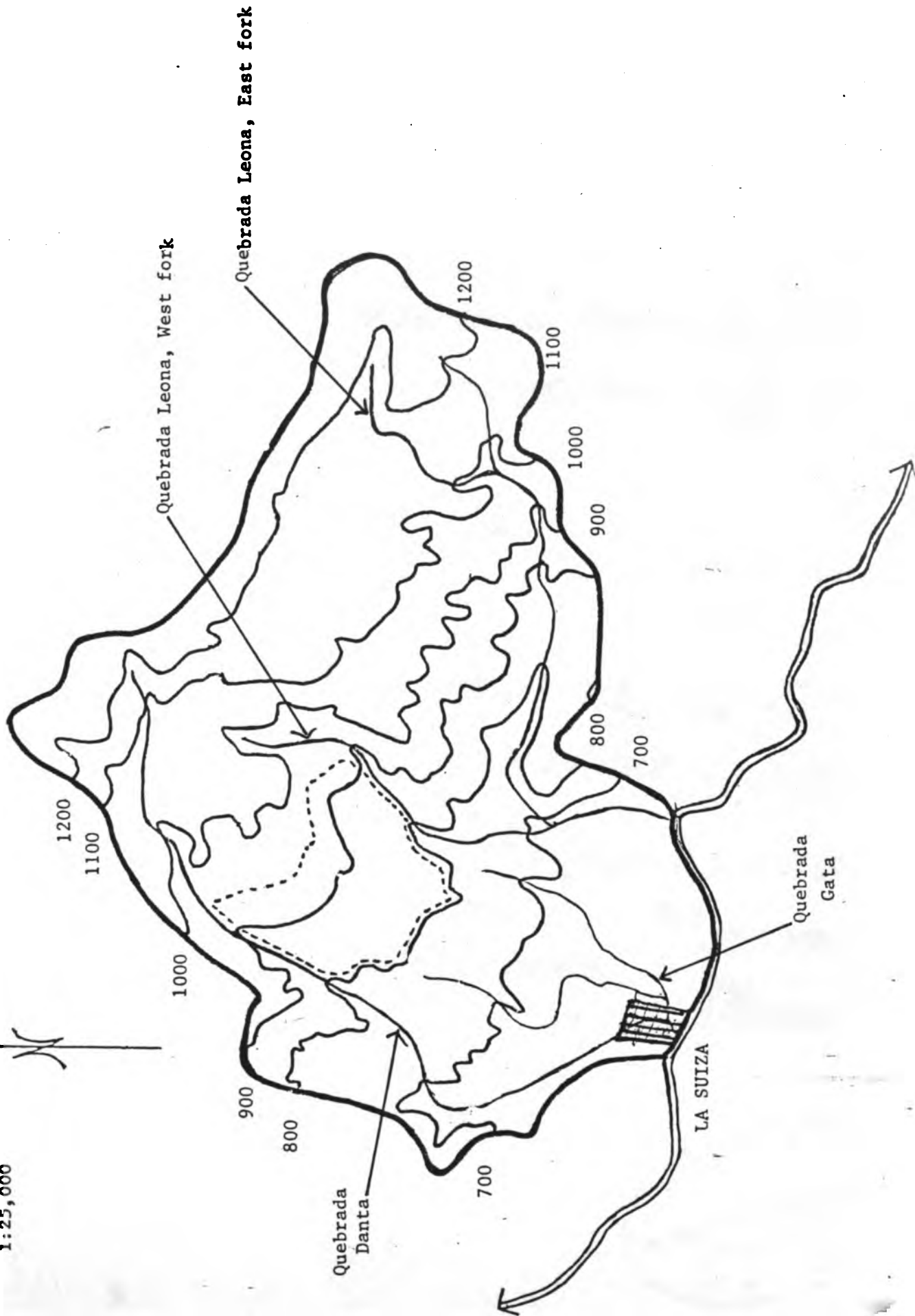


Figure 3. TIMETABLE FOR 1979

			JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
(i) GENERAL SURVEY	P.I.													
	D.C.													
	A.C.													
(ii) GUAVA	a) Occurrence	P.I.												
		D.C.												
		A.C.												
	b) Trunk increment	P.I.												
		D.C.												
		A.C.												
	c) Pasture biomass	P.I.												
		D.C.												
		A.C.												
	d) Runoff	P.I.												
		D.C.												
		A.C.												
	e) Firewood	P.I.												
		D.C.												
		A.C.												
(iii) FENCE POSTS	P.I.													
	D.C.													
	A.C.													
(iv) LAUREL	a) Trunk increment	P.I.												
		D.C.												
		A.C.												
	b) Crop Yield	P.I.												
		D.C.												
		A.C.												
c) Runoff	P.I.													
	D.C.													
	A.C.													
(v) EROSION	a) Occurrence	P.I.												
		D.C.												
		A.C.												
	b) Creep Assessment	P.I.												
		D.C.												
		A.C.												
(vi) REFORESTATION	P.I.													
	D.C.													
	A.C.													

P.I. ; Preparation and/or installation
 D.C. ; Data collection
 A.C. ; Analysis and compilation



DETAILED BUDGET FOR FIRST 12-MONTH PERIOD

PERSONNEL		DESCRIPTION (Itemize)	TIME OR EFFORT %/HRS	AMOUNT REQUESTED (Omit cents)		
NAME	TITLE OF POSITION		SALARY	FRINGE BENEFITS IF ANY	TOTAL	
G. Budowski	PRINCIPAL INVESTIGATOR					
G. De las Salas	Project Director					
J. Combe	Coordinator					
P. Rosero	Advisor					
F. Zadroga	Advisor					
J. Beer	Consultant (9 mo.)					
	Field assistants (130 days)		1,300			1,300
	Field labourers (100 days)		500			500

EQUIPMENT A simple collector and storage system for surface runoff experiments will be constructed from aluminium sheeting and old oil drums by artisans in the CATIE workshops.

Total estimated cost

\$ 400

SUPPLIES	Fence posts treated with preservative (510 at \$1)	510
	Barbed wire (5500 m. at \$0.12 per m.)	660
	Films and processing (including enlargements for exhibitions)	150
	Cuttings	250
	Miscellaneous	200

TRAVEL	Field subsistence (\$10/day, 110 days)	1,100
	Vehicle rental (\$15/day, 120 days)	1,800

OTHER EXPENSES (Itemize)	Publication costs	1,000
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TOTAL COSTS 18,670

BUDGET ESTIMATES FOR ALL YEARS OF SUPPORT REQUESTED**COUNTERPART CONTRIBUTION FROM CATTLE**

DESCRIPTION	1st year	2nd year	3rd year	TOTAL
PERSONNEL COSTS	12,500	19,500		
EQUIPMENT	400	400		
SUPPLIES	760	1,200		
TRAVEL	900	1,400		
OTHER EXPENSES	1,000	1,500		
Total Costs	15,560	23,950		
TOTAL FOR ENTIRE PROPOSED PROJECT PERIOD				39,510

REMARKS: Justify all costs for the first year for which the need may not be obvious. For future years, justify equipment costs, as well as any significant increases in any other category. If a recurring annual increase in personnel costs is requested, give percentage. (Use continuation page if needed.)

BIOGRAPHICAL SKETCH

(Give the following information for all professional personnel beginning with the Principal Investigator.
Use continuation pages and follow the same general format for each person.)

NAME JOHN WILLIAM BEER	TITLE M.S.	BIRTHDATE (Mo., Day, Yr.) 11/6/51
PLACE OF BIRTH (City, State, Country) BIRKENHEAD, ENGLAND	PRESENT NATIONALITY ENGLISH	SEX <input checked="" type="checkbox"/> Male <input type="checkbox"/> Female

EDUCATION (Begin with baccalaureate training and include postdoctoral)

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	SCIENTIFIC FIELD
University of Sheffield, England	B. Sc.	1973	Chemistry
University of Washington, Seattle, U.S.A.	M. S.	1978	Reforestation

HONORS

MAJOR RESEARCH INTEREST Reforestation Agro-forestry	ROLE IN PROPOSED PROJECT Consultant for the establishment and the monitoring of the field trials.
-----------------------------------------------------------	------------------------------------------------------------------------------------------------------

RESEARCH SUPPORT (from other sources national and/or international)

RESEARCH AND/OR PROFESSIONAL EXPERIENCE (Starting with present position, list training and experience relevant to area of project. List all or most representative publications. Do not exceed 2 pages for each individual.)

1. November 1978- To date. Consultant charged with writing the attached proposal and implementing the work described therein.
2. July 1978 - November 1978. Consultant for the University of Washington, Seattle, U.S.A. contracted to instal and monitor a variety of agricultural field trials in Costa Rica.
3. May 1977 - July 1978. Research assistant; Advisor to the manager of the University of Washington experimental forest on problems related to pest control in reforestation areas.
4. Publications:

Wood chemistry and forest biology: partners in more effective reforestation. Tappi. 61(1): 33-35. 1978.

Controlled release herbicides for reforestation. M.S. thesis. Seattle, U.S.A. University of Washington. 1978. 140 p.

BIOGRAPHICAL SKETCH

(Give the following information for all professional personnel beginning with the Principal Investigator.
Use continuation pages and follow the same general format for each person.)

NAME ERARDO BUDOWSKI	TITLE Ph.D.	BIRTHDATE (Mo., Day, Yr.) 6/10/25
PLACE OF BIRTH (City, State, Country) BERLIN; GERMANY	PRESENT NATIONALITY VENEZUELAN	SEX <input checked="" type="checkbox"/> Male <input type="checkbox"/> Female

EDUCATION (Begin with baccalaureate training and include postdoctoral)

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	SCIENTIFIC FIELD
Central University, Caracas, Venezuela	B.Sc.	1948	Agronomy
Inter-American Institute of Agricultural Sciences, Turrialba, Costa Rica.	M.S.	1954	Tropical dendrology
Yale University, New Haven, U.S.A.	Ph.D.	1962	Forest ecology

HONORS

MAJOR RESEARCH INTEREST Tropical Forestry, Agro-forestry, Conservation of natural resources.	ROLE IN PROPOSED PROJECT Principal investigator
-------------------------------------------------------------------------------------------------	----------------------------------------------------

RESEARCH SUPPORT (from other sources national and/or international)

Natural Renewable Resources Program, CATIE.

RESEARCH AND/OR PROFESSIONAL EXPERIENCE (Starting with present position. list training and experience relevant to area of project. List all or most representative publications. Do not exceed 2 pages for each individual.)

1. March 1976-To date. Head of the Natural Renewable Resources Program, CATIE.
2. 1970-1976. Director General of the International Union for Conservation of Nature and Natural Resources.
3. 1967-1970. Programme Specialist for Ecology and Conservation, UNESCO.
4. Publications: 120 papers on ecology, conservation, tropical forestry, agro-forestry and related subjects.

BIOGRAPHICAL SKETCH

(Give the following information for all professional personnel beginning with the Principal Investigator. Use continuation pages and follow the same general format for each person.)

NAME JEAN COMBE	TITLE ING. FOR.	BIRTHDATE (Mo., Day, Yr.) 12/18/45
PLACE OF BIRTH (City, State, Country) BERNE, SWITZERLAND	PRESENT NATIONALITY SWISS	SEX <input checked="" type="checkbox"/> Male <input type="checkbox"/> Female

EDUCATION (Begin with baccalaureate training and include postdoctoral)

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	SCIENTIFIC FIELD
Inst. Technology, Zurich, Switzerland	Ing. For.	1970	Silviculture
Inst. Univ. H.E.I., Geneva, Switzerland			
African Institut, Geneva, Switzerland	Dipl.	1972	Silviculture

HONORS

MAJOR RESEARCH INTEREST Soil-plant interactions in agro-forestry systems	ROLE IN PROPOSED PROJECT Coordinator of this and other investigations on agro-forestry systems.
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RESEARCH SUPPORT (from other sources national and/or international)

The Cooperation for Development Program of the Swiss Government.



RESEARCH AND/OR PROFESSIONAL EXPERIENCE (Starting with present position, list training and experience relevant to area of project. List all or most representative publications. Do not exceed 2 pages for each individual.)

1. 1977-To date. Resident scientist at CATIE working on the identification of stable agro-forestry systems; project description for investigation of soil-plant interactions in agro-forestry systems.
2. 1972-1977. Responsible for research and documentation activities in a bilateral (Swiss) forestry project in Rwanda (E.-Africa).
3. Publications:
 - Classification des techniques agro-forestieres. Turrialba, Costa Rica, CATIE. 1978. 62 p. (Mimeo.).
 - Creation et conduite d'une pépinière forestière. 1976. 33 p. (mimeo.)
 - Etude, construction et entretien de routes forestieres. 1975. 22 p. (mimeo.).
 - Principales essences de reboisement et méthodes de reboisement en milieu rural. 1977. 53 p. (mimeo.).
 - Travaux d'entretien de boisements artificiels. 1977. 26 p. (mimeo.).

BIOGRAPHICAL SKETCH

*(Give the following information for all professional personnel beginning with the Principal Investigator.
Use continuation pages and follow the same general format for each person.)*

NAME JEAN COMBE	TITLE	BIRTHDATE (Mo., Day, Yr.)
PLACE OF BIRTH (City, State, Country)	PRESENT NATIONALITY	SEX <input type="checkbox"/> Male <input type="checkbox"/> Female

EDUCATION (Begin with baccalaureate training and include postdoctoral)

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	SCIENTIFIC FIELD

HONORS

MAJOR RESEARCH INTEREST	ROLE IN PROPOSED PROJECT
-------------------------	--------------------------

RESEARCH SUPPORT (from other sources national and/or international)

RESEARCH AND/OR PROFESSIONAL EXPERIENCE (Starting with present position, list training and experience relevant to area of project. List most representative publications. Do not exceed 2 pages for each individual.)

- Germination de semences forestières autochtones. 1977. 19 p. (mimeo.).
- Determination de l'age des arbres de la foret naturelle. 1976. 14 p. (mimeo.).
- Mycorrhization de Pinus sp. en pépinière. 1976. 11 p. (mimeo.)
- Inventaire de foret naturelle à Gisovu. 1976. 23 p. (mimeo.)
- Essai comparatif de trois méthodes de plantation à Gisovu. 1975. 14 p. (mimeo.)
- Guide des principales essences de la foret de montagne du Rwanda. Kibuye, Rwanda. Project Pilote Forestier. 1977. 241 p.

BIOGRAPHICAL SKETCH

(Give the following information for all professional personnel beginning with the Principal Investigator.
Use continuation pages and follow the same general format for each person.)

NAME GONZALO DE LAS SALAS	TITLE Ph.D.	BIRTHDATE (Mo., Day, Yr.) 1/10/41
PLACE OF BIRTH (City, State, Country) BOGOTA, COLOMBIA	PRESENT NATIONALITY COLOMBIANO	SEX <input checked="" type="checkbox"/> Male <input type="checkbox"/> Female

EDUCATION (Begin with baccalaureate training and include postdoctoral)

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	SCIENTIFIC FIELD
Universidad Distrital "F.J.C." Bogotá, Colom.	Ing. For.	1963	Forestry
University of Goettingen, Federal Republic of Germany	Ph.D.	1973	Forest ecology

HONORS

MAJOR RESEARCH INTEREST Forest soils	ROLE IN PROPOSED PROJECT Project director
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RESEARCH SUPPORT (from other sources national and/or international)

Natural Renewable Resources Program, CATIE

RESEARCH AND/OR PROFESSIONAL EXPERIENCE (Starting with present position. List training and experience relevant to area of project. List all or most representative publications. Do not exceed 2 pages for each individual.)

1. July 1973 - To date. Professor of Forest Soils, Universidad Distrital, Bogotá.
2. 1977 - 1978. Consultant to the Corporación Nacional de Investigaciones Forestales (CONIF)
3. Feb. 1968-Sept. 1971. Assistant professor of forest soils, Universidad Distrital, Bogotá.
4. Publications:
 - Características, importancia y ocurrencia de algunos suelos forestales en Colombia.
 - Tesis Ing. For. Universidad Distrital F.J.C., Bogotá. 1965.
 - Factores edáficos y climáticos en la clasificación de sitios forestales. Bosques de Colombia (1):15-30. 1974.
 - La colonización y el uso de la selva tropical. In 6 aportes para el estudio de la colonización en Colombia. Bogotá. Centro de Investigaciones para el Desarrollo (CID). Universidad Nacional. 1974. 35-55 p.
 - La investigación sobre la delimitación de áreas forestales en Colombia. In Memorias IV Congreso Forestal Nacional. Bogotá. 1973.
 - Características y dinámica del ecosistema forestal Carare-Opón. Tesis doctoral (original in German) In: Goettinger bodenkundliche Berichte, 27: 1-206. 1973.

BIOGRAPHICAL SKETCH

(Give the following information for all professional personnel beginning with the Principal Investigator.
Use continuation pages and follow the same general format for each person.)

NAME GONZALO DE LAS SALAS	TITLE	BIRTHDATE (Mo., Day, Yr.)
PLACE OF BIRTH (City, State, Country)	PRESENT NATIONALITY	SEX <input type="checkbox"/> Male <input type="checkbox"/> Female

EDUCATION (Begin with baccalaureate training and include postdoctoral)

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	SCIENTIFIC FIELD

ADDITIONAL COMMENTS

MAJOR RESEARCH INTEREST	ROLE IN PROPOSED PROJECT
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RESEARCH SUPPORT (from other sources national and/or international)

RESEARCH AND/OR PROFESSIONAL EXPERIENCE (Starting with present position, list training and experience relevant to area of project. List or most representative publications. Do not exceed 2 pages for each individual.)

ases ecológicas para el uso de los suelos en América tropical. V Congreso Latinoamericano de Suelos. Medellín, Colombia. 1975. 22 p.

Fluencia del factor edáfico en el crecimiento inicial de especies tropicales en el bosque húmedo tropical del Carare. Bogotá. Universidad Distrital. 1975. 5 p. (mimeo.)

asser als Minimumfaktor im Regenwald. (Coautor: H. Foelster) Mittl.d. Deutsch. Bodenkl. Ges. D: 233-238. 1974.

BIOGRAPHICAL SKETCH

(Give the following information for all professional personnel beginning with the Principal Investigator. Use continuation pages and follow the same general format for each person.)

NAME PABLO ROSERO	TITLE DASONOMO - FORESTRY	BIRTHDATE (Mo., Day, Yr.) 5/12/ 31
PLACE OF BIRTH (City, State, Country) QUITO, ECUADOR	PRESENT NATIONALITY ECUATORIANO	SEX <input checked="" type="checkbox"/> Male <input type="checkbox"/> Female

EDUCATION (Begin with baccalaureate training and include postdoctoral)

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	SCIENTIFIC FIELD
Universidad Central de Quito, Ecuador	Ing. Agr.	1957	Forestry
CATIE, Turrialba, Costa Rica	Mag. Agr.	1961	Forest management

HONORS

MAJOR RESEARCH INTEREST The management of native species and secondary forest.	ROLE IN PROPOSED PROJECT Advisor for reforestation and secondary forest investigations.
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RESEARCH SUPPORT (from other sources national and/or international)

Natural Renewable Resources Program, CATIE

RESEARCH AND/OR PROFESSIONAL EXPERIENCE (Starting with present position, list training and experience relevant to area of project. List all or most representative publications. Do not exceed 2 pages for each individual.)

1. 1971 - To date. Professor of Forest Management, CATIE.
2. 1957-1970. Forest technician at various levels up to the position of Director of the Forestry Service, Ecuador.
3. Publications:
 - Selección de algunas especies forestales a base de su crecimiento y regeneración natural. Tesis Mag. Agr. Turrialba, IICA, 1960. 59 p.
 - Relaciones hombre-tierra-recursos forestales en América Latina y algunas consideraciones sobre el Ecuador. Quito, Instituto Ecuatoriano de Reforma Agraria y Colonización. 1965. 13 p.
 - La Conservación de la Naturaleza en Ecuador. In Mesa Redonda de Información sobre Conservación de la Naturaleza, Lima, 1968. La conservación de la naturaleza y la prensa en la América Latina. Washington, Unión Panamericana, Departamento de Asuntos Científicos. 1969. pp. 21-43.
 - Metodología sobre ensayo de especies forestales. I Reunión del Grupo de trabajo sobre introducción de especies forestales. Ministerio de Agricultura y Ganadería. Ecuador, 1973.

BIOGRAPHICAL SKETCH

(Give the following information for all professional personnel beginning with the Principal Investigator.
Use continuation pages and follow the same general format for each person.)

NAME PABLO ROSERO	TITLE	BIRTHDATE (Mo., Day, Yr.)
PLACE OF BIRTH (City, State, Country)	PRESENT NATIONALITY	SEX <input type="checkbox"/> Male <input type="checkbox"/> Female

EDUCATION (Begin with baccalaureate training and include postdoctoral)

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	SCIENTIFIC FIELD

HONORS

MAJOR RESEARCH INTEREST	ROLE IN PROPOSED PROJECT
-------------------------	--------------------------

RESEARCH SUPPORT (from other sources national and/or international)

RESEARCH AND/OR PROFESSIONAL EXPERIENCE (Starting with present position. list training and experience relevant to area of project. List all or most representative publications. Do not exceed 2 pages for each individual.)

.. Resultados de tratamientos silviculturales en un bosque de Turrialba. Reunión Internacional sobre Silvicultura de Bosques Tropicales. IICA-INDERENA, Cali, Colombia. 1974.

Situación actual del Manejo y Aprovechamiento de bosques tropicales. Reunión Internacional sobre Manejo de Bosques Tropicales. IICA-INDERENA, Medellín, Colombia. 1972.

BIOGRAPHICAL SKETCH

(Give the following information for all professional personnel beginning with the Principal Investigator.
Use continuation pages and follow the same general format for each person.)

NAME FRANK ZADROGA	TITLE FOREST HYDROLOGIST	BIRTHDATE (Mo., Day, Yr.) 6/30/46
PLACE OF BIRTH (City, State, Country) SYRACUSE, N.Y. U.S.A.	PRESENT NATIONALITY NORTH AMERICAN	SEX <input checked="" type="checkbox"/> Male <input type="checkbox"/> Female

EDUCATION (Begin with baccalaureate training and include postdoctoral)

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	SCIENTIFIC FIELD
Cornell University, Ithaca, U.S.A.	B.S.	1969	Natural Resources Conservation
University of Washington, Seattle, U.S.A.	M.S.	1974	Watershed Management

HONORS

MAJOR RESEARCH INTEREST Land use management Watershed management	ROLE IN PROPOSED PROJECT Advisor on land use practices and erosion control.
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RESEARCH SUPPORT (from other sources national and/or international)

Consultant to CATIE

RESEARCH AND/OR PROFESSIONAL EXPERIENCE (Starting with present position. list training and experience relevant to area of project. List all or most representative publications. Do not exceed 2 pages for each individual.)

1. January 1975. To date. Private consultant, on forest hydrology and the management of natural resources, to the "Tropical Science Center", San José.
2. April 1975-July 1975. Private consultant to the F.A.O. (Food and Agricultural Organization of the United Nations). Duties as (1).
3. Publications:
 - Plan de Manejo y Ordenación de la Cuenca Hidrográfica del Río Frío. Colombia. INCORA. 1971. 178 p.
 - Estudio Básico de la Cuenca Hidrográfica del Río Ariguani. Elmec Engineering Co. e INCORA, Colombia. 1971. 175 p.
 - Some Observations on Man's Impact on Some Natural and Man-made Bogs in the Area of El Empalme, Talamanca Range, Costa Rica. In: Organization for Tropical Studies Geography Course #72-4, 1972. 21 p.
 - Infiltration Considerations for Environmental Impact Statements. College of Forest Resources Library, University of Washington. December 1973.
 - Effects of Forest Felling and Grazing on Surface Soil Characteristics Influencing Surface Runoff in the Headwaters of the Reventazon River Basin, Costa Rica. Master of Science Thesis, University of Washington: 1974.

BIOGRAPHICAL SKETCH

(Give the following information for all professional personnel beginning with the Principal Investigator.
Use continuation pages and follow the same general format for each person.)

NAME FRANK ZADROGA	TITLE	BIRTHDATE (Mo., Day, Yr.)
PLACE OF BIRTH (City, State, Country)	PRESENT NATIONALITY	SEX <input type="checkbox"/> Male <input type="checkbox"/> Female

EDUCATION (Begin with baccalaureate training and include postdoctoral)

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	SCIENTIFIC FIELD

HONORS

MAJOR RESEARCH INTEREST	ROLE IN PROPOSED PROJECT
-------------------------	--------------------------

RESEARCH SUPPORT (from other sources national and/or international)**RESEARCH AND/OR PROFESSIONAL EXPERIENCE (Starting with present position, list training and experience relevant to area of project. List all or most representative publications. Do not exceed 2 pages for each individual.)**

3).. El Proyecto Boruca: Futuro Impacto Ecológico sobre el Hombre y la Naturaleza en el Sureste de Costa Rica y Medidas para su Mitigación y Control, Centro Científico Tropical, San José, Costa Rica, 1975.

Estudio del Medio Ambiente Físico-Natural de la Zona Costañera Comprendida entre Punta Centinela y Punta Carrillo, Provincia de Guanacaste, Costa Rica: su relación a la capacidad de uso, uso actual y uso recomendado de las tierras con fines agrarios y turísticos-recreativos. Centro Científico Tropical, San José, Costa Rica. 1975.