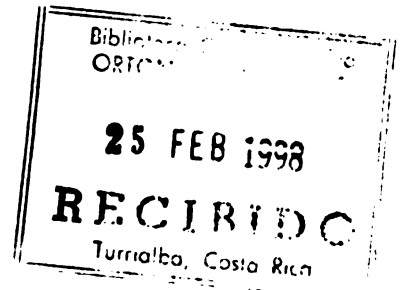


**CENTRO AGRONÓMICO TROPICAL DE INVESTIGACION Y ENSEÑANZA
(CATIE)**

**SWEDISH AUTHORITY FOR RESEARCH COOPERATION WITH
DEVELOPING COUNTRIES
(SAREC)**



**PROJECT WITH NITROGEN - FIXING TREES:
LEUCAENA-CALLIANDRA**

FINAL REPORT

**Centro Agronómico Tropical de Investigación y Enseñanza
Turrialba, Costa Rica
December, 1994**

CONTENT

	Page No.
INTRODUCTION	1
RESEARCH ACTIVITIES	3
1. PERENNIAL CROPS WITH TREES	3
1.1 Effect of fertilization in the production of coffee with and with- out shade of <u>Erythrina poeppigiana</u> . .	3
2. ALLEY CROPPING	3
2.1 Corn-corn crop system using <u>Erythrina</u> <u>poeppigiana</u> planted in four spatial arrangements	3
2.2 Evaluation of loss of soil nutriments by hydric erosion, run-off and leach- ing in hillside farm lands. San Juan, Turrialba	4
2.3 Ñampi (<u>Colocasia esculenta</u> var. <u>antiquorum</u>) and corn (<u>Zea mays</u> L.) production in alley cropping with <u>Erythrina fusca</u> and <u>Calliandra</u> <u>calothyrsus</u>	4
2.4 Growth and production of yam (<u>Dioscorea alata</u>) using live supports of <u>Erythrina berteroa</u> and <u>Gliricidia</u> <u>sepium</u>	5
2.5 Evaluation of the corn-corn (<u>Zea mays</u>) crop system in alley cropping with four tree legumes	6
2.6 Behavior of genotypes of corn (<u>Zea</u> <u>mays</u>) and beans (<u>Phaseolus vulgaris</u>) associated with different tree species in alley cropping	7

2.7	Soil conservation in hillsides with alley cropping, live and dead covers, in the bean-corn crop system	8
3.	SYLVOPASTORAL SYSTEMS	9
3.1	Behavior evaluation of star grass (<u>Cynodon nlemfuensis</u>) associated with <u>Gliricidia sepium</u> and <u>Leucaena leucocephala</u> under grazing conditions in the dry tropics	9
4.	LIVE COLLECTIONS	10
4.1	Collection of <u>Gliricidia sepium</u>	10
4.2	Clonal trial of <u>Erythrina</u> spp.	11
4.3	Evaluation of genotypes of <u>Leucaena</u>	11
5.	SUPPORT TO THE LABORATORIES	12
5.1	Soils Laboratory	12
5.1.1	Soil analysis	12
5.1.2	Plant tissue analysis	13
5.1.3	Institutional supporting unit	13
5.2	Animal Nutrition Laboratory	14
5.2.1	Development of a methodology for the analysis of total alkaloids in the genus <u>Erythrina</u> spp. by means of ultraviolet spectroscopy	14

5.2.2	Development of a methodology for the extraction and quantification of coumarin, o-cumeric acid and melilotic acid in leaves of madero negro (<u>Gliricidia sepium</u>), by high pressure liquid chromatography	15
5.2.3	Support to Research	16
6.	PARTICIPATION IN TECHNICAL MEETINGS AND TRAINING ACTIVITIES	17
6.1	Technical Meetings	17
6.2	Training at CATIE and Nicaragua	17
7.	RESEARCH PROPOSALS PREPARED BY THE PROJECT AND SUBMITTED TO SAREC FOR POSSIBLE FINANCING	18
8.	PUBLICATIONS	18
9.	Videos	18
10.	TECHNICAL ASSISTANCE	18
11.	CAPITAL GOODS BOUGHT WITH SAREC FUNDS AND DONATED TO CATIE	18

FINAL REPORT
OF THE LEUCAENA-CALLIANDRA AGROFORESTRY PROJECT
CATIE-SAREC

INTRODUCTION

The Central American Isthmus is facing a strong destruction of its forest reserve, which is being destroyed at the rate of 400,000 ha per year, especially by the use of the traditional slash and burn system.

The loss of forest resources contributes to the heating of the earth by the accumulation of CO₂ and the loss of the ozone layer in the atmosphere.

The substantial increase of human population in Central America (calculated to be 40 million inhabitants in the year 2000) and the consistent pressure on tenancy and land use, has as a consequence an estimated 35 to 45% of agricultural land of the isthmus in progressive deterioration.

The above mentioned problem together with the unsatisfied demand for food by our population, are some of the reasons that justify the need to search for alternative farming systems, that will contribute to maximize the productive expression of resources, obtaining a higher production of food under a focus that will rehabilitate and conserve natural resources. These were the main reasons to design the Leucaena-Calliandra Project of CATIE-SAREC.

The Leucaena-Calliandra Project had as its main objective, study these genus as to their potentiality to be used in agroforestry systems that will present an alternative for a more sustainable production.

The Leucaena-Calliandra Project began in 1989 with the financial support of the Swedish Agency for Research Cooperation with Developing Countries (SAREC).

Initially the Project planned and executed activities jointly with the Nitrogen Fixing Trees Project, financed by the International Development Research Center (IDRC) of Canada, since 1984.

This period of cooperation lasted until June, 1991 when both projects decided to separate their research trials and

related activities. The activities of the Leucaena-Calliandra Project lasted until December 31, 1994, when financial support terminated.

The experiments included in this report pertains to the years of AFN-CIID cooperation.

From the beginning of the Project, until December 1992, the financial and technical control of the Forestry and Agroforestry Projects financed by SAREC in the Nicaragua institutions, was carried out at CATIE: MARENA (previously called IRENA), Faculty of Natural Resources of the National Agrarian University (UNA), and the Faculties of Zootechny and Ecology of the Central American University (UCA).

The Nicaraguan Projects were responsible for the financial and technical management of their activities from January, 1993. CATIE was responsible for the Technical Advisory activities requested by them, included in the letters of understanding. The SAREC-Nicaragua Projects submitted their technical and financial reports directly to the donor, and CATIE has responsibility only for the Leucaena-Calliandra Project.

Due to the characteristics of this project, the activities carried out corresponded to generation of the technology, so it is important to search for financial support so that the promisory technologies may be validated with the producers and their advantages may be used, through the support to Transfer Institutions of CATIE's member countries and ONG's.

At the conclusion of the Leucaena-Calliandra Project, important information has been obtained on agroforestry systems. Due to its promisory condition it deserves to be considered for its validation and transfer and accumulate the use of alternatives that will stimulate food production and conservation of the environment and biodiversity.

RESEARCH ACTIVITIES

1. PERENNIAL CROPS WITH TREES

1.1 EFFECT OF FERTILIZATION IN THE PRODUCTION OF COFFEE WITH AND WITHOUT SHADE OF Erythrina poeppigiana

This experiment was established with the purpose of obtaining coffee yield under two management systems (with and without shade) and with various levels of fertilization. The Erythrina trees were pruned twice a year and fertilization dosis were: 0, 330, 660, 990 and 1320 kg/ha/year of 20-7-12 with 3 kg of Mg and 1,2 of Bo.

Evaluatory data from a 7 year period (1984-1990), the average production of coffee with shade was 17515 kg/ha/year, which was highly significant at the level of 1% in relation to the coffee production without shade is 15563 kg/ha/year.

When 660 kg/ha of complete fertilizer was used with shade, the same yield was obtained as with 1320 kg/ha without shade. The advantage provided to the system by the contribution of tree biomass, is demonstrated upon making a more efficient use of the fertilizer and by the cherry coffee production of 14960 kg/ha without fertilizer and with the contribution of biomass. To reach this production in the system without shade, a fertilization of approximately 500 kg/ha/year was required.

2. ALLEY CROPPING

2.1 CORN-CORN CROP SYSTEM USING Erythrina poeppigiana PLANTED IN FOUR SPATIAL ARRANGEMENTS

The objective of this work was to study the long-term effects of Erythrina poeppigiana on corn production, planted in four spatial arrangements (6x1, 6x2, 6x3 and 6x4 m).

The combined analysis of 12 harvests did not show significant differences ($P>0.5$) between the treatments with trees and the monoculture with fertilizer (100 kg/ha/year of N and 60 of K). However, a highly significant difference ($P<0.05$) was noted between the treatment without trees and

without fertilization (1390 kg/ha) in relation to the average of the treatments with trees (2325 kg/ha) and the average of fertilized monoculture (2578 kg/ha).

Upon analyzing biomass production of the trees, it was found that upon increasing the spacings from 6x1 to 6x2, there is a lesser production per tree (5097 and 3739 kg/ha, respectively); when going over from 6x3 to 6x4 the production is reduced (3167 and 2198 kg/ha, respectively). The results of this experiment shows that it is possible to maintain an adequate production of corn in alleys of Erythrina poeppigiana for various years, without the application of fertilizers.

2.2 EVALUATION OF LOSS OF SOIL NUTRIMENTS BY HYDRIC EROSION, RUN-OFF AND LEACHING IN HILLSIDE FARM LANDS. SAN JUAN, TURRIALBA

On the hillside/acid soils of CATIE's experimental plots in Turrialba, run-off plots were established, tilled with different treatments: alleys with simple rows of trees spaced at 4 m and 12 m, dead cover of Inga edulis and Erythrina fusca and a control treatment.

Loss of nutrients by leaching, were higher than those found by erosion and run-off. The highest values found of leached elements were: 108, 6, 65, 362 and 29 kg/ha/year of N, P, K, Ca and Mg, respectively. The values of loss of nutrients in the control treatment were higher than those found in the treatments with alley cropping and mulch. The annual balance of the nutrients showed a tendency to decrease in the reserves year after year, P and Ca being the most critical.

The average yields in beans in three years were higher in the treatments with mulch of E. fusca (2007 kg/ha) and I. edulis (1963 kg/ha), statistically surpassing ($P < 0.005$) the others.. The control produced 1337 and the alleys around 1000 kg/ha. A similar behavior was observed in corn production.

2.3 ÑAMPI (Colocasia esculenta var. antiquorum) AND CORN (Zea mays L.) PRODUCTION IN ALLEY CROPPING WITH Erythrina fusca and Calliandra calothyrsus

This study was established in Guápiles, with the purpose of evaluating the performance of ñampí in crop association with trees of Calliandra and Erythrina spaced at 6x0.5, 6x1 and 6x2 m.

The combined analysis of three harvests of ñampí show significant differences ($P < 0.05$) between the production of corms and commercial cormelos (15.52 t/ha) in association with trees, and that of the control without trees (13.60 t/ha). The production of the same variables was higher in the association with Erythrina fusca than with Calliandra calothyrsus (16.71 and 14.33 t/ha), respectively, and both were higher than the control (13.60 t/ha).

The production of grain of corn, combining the three harvests, was higher in association with trees (4.8 t/ha) than that of monoculture (3.4 t/ha); this contrast presented a highly significant difference ($P < 0.01$).

In the third harvest, significant differences were detected ($P < 0.05$) between treatments. A significant difference was found between the monoculture (2142 kg/ha) and the average of the treatments with trees (3874 kg/ha). There was also a significant difference ($P < 0.05$) between the corn yield with Calliandra (3296 kg/ha) and Erythrina (4454 kg/ha).

The production of total biomass (average of five prunings), of the trees was higher in the treatment of Calliandra spaced at 6x0.5 m (7845 kg/ha), higher yield and different ($P < 0.05$) from the rest of the treatments, the production of E. fusca being the lowest planted at 6x0.5 m (1632 kg/ha).

2.4 GROWTH AND PRODUCTION OF YAM (Dioscorea alata) USING LIVE SUPPORTS OF Erythrina berteroa and Gliricidia sepium

The purpose of this work was to evaluate the growth and production of yam by using live supports of G. sepium and E. berteroa, with different pruning managements and by comparing them with the conventional supports.

The contrasts for total yield of tubers indicate significant statistical differences ($P < 0.05$) between E. berteroa (3387 kg/ha) and G. sepium (6427 kg/ha). This last one was different with the treatment with dead supports (12800 kg/ha). The control without support produced 8264 kg/ha.

It is concluded that yam associated with live supports of G. sepium, obtained similar results as that of the control without support and surpassed the growth and yield

of the yam associated with E. berteriana. The use of live supports is feasible, especially with G. sepium. However, more study should be done on the pruning managements, in order to reduce the competence the tree has over the crop.

2.5 EVALUATION OF THE CORN-CORN (Zea mays) CROP SYSTEM IN ALLEY CROPPING WITH FOUR TREE LEGUMES

Using a Complete Randomized Block Design with three replications, an experiment was established to evaluate productive response of the corn-corn crop system, cultivated in alleys of E. berteriana, E. fusca, C. calothyrsus and G. sepium and to determine the agronomic advantages of the system. The treatments were: the different trees planted at 6x1 m and corn monoculture without fertilizer.

The combined analysis of six corn harvests, did not show significant differences between the treatments ($P>0.05$), for the average yield of grain, but for biomass production, the difference was highly significant ($P<0.01$). In grain production, the control was 25% higher than the crop associated with Calliandra. In the stubble production, monoculture surpassed significantly ($P<0.05$) corn associated with trees, except the treatment with E. fusca. The superiority of monoculture for both variables fluctuated between 20 and 30%.

The comparison of the variables per harvest show a superiority of the harvests of May; these come from corn planted in January, date that coincides with the main planting period of the crop in the zone. For corn yield, the averages of the planting during May and January, were 2416 and 4044 kg/ha, respectively, and for stubble it was 2886 and 4832 kg/ha, respectively.

Differences were found between tree species for the different variables of biomass production. The highest productions of total biomass and biomass of leaves were obtained with E. fusca and C. calothyrsus and the lowest in G. sepium and E. berteriana; within these two groups there was no significant difference ($P>0.05$). Biomass production of the December-January pruning, was higher than the May-June prunings (4242 and 2288 kg/ha), respectively.

Biomass produced by the system, the association of corn with E. fusca and C. calothyrsus contributed 8.0 and 7.6 t/ha, respectively. With the other associations, the total

incorporation was 6 t/ha. Biomass production of E. fusca outstands, which is also of easy decomposition.

It is concluded that grain production of corn was not statistically superior to that of monoculture ($P>0.05$), while this one produced a larger quantity of stubble than the treatments with trees.

2.6 BEHAVIOR OF GENOTYPES OF CORN (Zea mays) AND BEANS (Phaseolus vulgaris) ASSOCIATED WITH DIFFERENT TREE SPECIES IN ALLEY CROPPING

The purpose of this work was to evaluate the growth and yield of different genotypes of corn and beans associated with trees. It was established in a Complete Randomized Block Design, with divided plots in three replications. The large plot corresponded to monoculture and to the tree species of: Gliricidia sepium, Calliandra calothyrsus and Erythrina poeppigiana, established at 6 m between rows and 0.5, 1 and 2 m between trees, respectively. The small plot corresponded to the genotype of corn or beans, planted consecutively.

The hybrid genotypes of corn H3 and H5 were superior than cultivars Tuxpeño and Centapasaquina. Grain yield was 4 t/ha for the control, which surpassed significantly ($P<0.05$) the production obtained for corn grain, in the treatments associated with trees (2.5 t/ha).

The association with E. poeppigiana (1.7 t/ha), produced less than the genotypes: H3 (3.42 t/ha), H5 (2.73 t/ha), Centapasaquina (2.86 t/ha) and Tuxpeño (2.54 t/ha).

In the bean crop, a better performance was observed when associated with trees. Total biomass, plant height and foliage area, was significantly higher than that obtained in the control treatment. The genotypes presented some variations during the crop cycle, but at the end of it, Dor 390 had less biomass production than Dor 364, Bat 76 and Negro Huasteco. In grain production and stubble of the bean, no statistical differences were observed ($P>0.05$), although a slight advantage was found in the treatments with trees and that of the control. Grain yield was: 1.47, 1.42, 1.53 and 1.2 t/ha, for bean associated with Calliandra, Gliricidia, Erythrina and the average of control treatment of beans, respectively. Among the genotypes of beans, the yields obtained were: 1.54, 1.50, 1.33 and 1.23 t/ha, for Dor 364, Negro Huasteco, Dor 390 and Bat 76, respectively.

Tree biomass production for Calliandra, Erythrina and Gliricidia was 6.5, 3 and 2.4 t/ha, respectively.

This work shows that the highest corn yields were obtained in the control treatment, while for beans, although the differences were not significant, the best yields were obtained in the treatments with trees.

2.7 SOIL CONSERVATION IN HILLSIDES WITH ALLEY CROPPING, LIVE AND DEAD COVERS, IN THE BEAN-CORN CROP SYSTEM

Seven treatments were compared: traditional cropping with natural vegetation as control, alley cropping with 4 m between rows, alley cropping with 6 m between rows, cropping with cover of Mucuna pruriens, cropping with mulch of Erythrina berteroana, soils without protection and alley croppings with 12 m between double rows.

The objectives of this work were to evaluate soil and nutrient loss caused by superficial run-off, hydric erosion and leaching and their effects on corn and bean production planted in relief.

The results indicate that cropping with mulch of E. berteroana (1694 kg/ha), with Mucuna (1536 kg/ha) and in alleys of 6 m, surpassed the control treatment (1209 kg/ha) in 28, 21 and 9%, respectively.

In the treatments with cover, no important soil losses appeared, as these were less than 100 kg/ha, during the period of 6 months. On the contrary, in the naked soil the loss was higher than 10 t/ha. The lowest soil loss was found in cropping with Mucuna cover, the rest of the treatments behaved statistically the same ($P>0.05$).

The treatments with cropping in alleys of 4 and 6 m, showed the highest run-off values with 2.8 and 2.55%, respectively. The treatments with cover and alley cropping of 12 m, presented the lowest run-off coefficient values. The run-off coefficient fluctuated between 0.85 (Mucuna) and 2.8% of the alley cropping with 4 m spacing.

3. SYLVOPASTORAL SYSTEMS

3.1 BEHAVIOR EVALUATION OF STAR GRASS (Cynodon nlemfuensis) ASSOCIATED WITH Gliricidia sepium AND Leucaena leucocephala UNDER GRAZING CONDITIONS IN THE DRY TROPICS

This experiment was established with the purpose of evaluating the productivity of pasture lands associated with Gliricidia and Leucaena trees. The trial was established in November, 1991, by spacing the trees at 6x5 m. A one-year establishment period for the trees was allowed, meanwhile the pasture was used for producing hay and seed. ✓

The trees were pruned twice a year at the beginning and at the end of the rainy season, biomass was left on the land for its incorporation into the soil. Grazing was done every 28 days with 28 animals during three days. Before and after grazing, production of pasture was determined by sampling.

The combined analysis of 10 grazings taken place during the year, indicate that there was no significant difference ($P > 0.005$) in pasture production before grazing (dry base) (6021, 5943, 5556 kg/ha) for Leucaena, Gliricidia and control, respectively. However, there was a higher pasture production and higher consumption in the treatments with trees than in the control.

No difference was found in the wide-leaf weed population or in the presence of spits (Aeneolamia spp.).

The above indicates that the presence of 320 trees per ha did not affect the production of star grass; on the contrary, it may be expected that at the long-term basis, the incorporation of biomass (litter and faeces) and nitrogen fixation, may significantly increase the production and pasture consumption. To the above advantages we must also add the contribution of the tree in capturing CO_2 . This work ended in June, 1994, due to the lack of funds in the Project, but it is recommended to carry out this type of study at least every 5 years.

4. LIVE COLLECTIONS

4.1 COLLECTION OF Gliricidia sepium

Seeds of 9 provenances from this collection were provided by the Oxford Forestry Institute, containing 167 families. Three more provenances with 10 families were collected by the SAREC-CATIE Project and were evaluated at the nursery and plantation level.

Highly significant differences were found ($P < 0.01$), between provenances and families among provenances, in seed weight. The highest variability from provenances (76%) were greater than those of the families (22%). At the nursery level differences between blocks, provenances and families were found in height and basal diameter at 100 and 240 days after transplanting.

The results of the first evaluation at three months after planting in the field, demonstrated significant differences among provenances and families among the provenances, except in basal diameter. The variability of the tree was higher than 84% in all of the variables studied.

The outstanding provenances in growth and biomass production, were La Garita and Cañas in Costa Rica, followed by Masaguara, Honduras and Vado Hondo in Guatemala.

Biomass production presented highly significant differences within the individuals in the families and the evaluation of the quality of edible biomass showed a great variation among families. Contents of N varied from 30 (San Mateo) to 46 g/kg of dry matter (La Garita).

Consumption trials indicated significant differences in the acceptability, percentage of dry matter, crude protein, crude protein related to acid detergent fiber and cellulose, among provenances, families and individuals.

The Masaguara provenance presented the highest average values of acceptability and the ones from Cañas and La Garita, presented the lowest.

Studies to determine the presence of antinutritional factors demonstrated highly significant differences ($P < 0.01$) among clones, in the concentration of coumarin, ortho-

cumeric acid and melilotic acid, compounds of recognized alelopathic properties and that also cause decreases in consumption and health problems in the animals.

From the above research, 55 clones from 25 families were selected, which were reproduced and planted in a clonal garden in Guápiles, in order to continue the study of their properties for edible biomass production and antiqualitative factors.

4.2 CLONAL TRIAL OF Erythrina spp. ✓

Thirty seven clones were selected from three species of Erythrina: 9 clones of E. poeppigiana, 18 of E. berteroana and 10 of E. fusca.

Clones 2674 and 2667 of E. berteroana showed superiority in most of the growth and biomass production variables, surpassing the viables of total biomass in more than 3.5 kg per harvest. Clone 2674 presented a total biomass production higher than of the best clones of E. poeppigiana and E. fusca.

In E. fusca clones 2701 and 2706 had the highest production of total biomass. Clones 2660, 2700, 2687 and 2661 of E. poeppigiana showed the highest values. Clone 2660 surpasses the general variable per harvest in more than 2.5 kg of total biomass.

4.3 EVALUATION OF GENOTYPES OF Leucaena

The Oxford Forestry Institute provided the Project with 24 genotypes of Leucaena, which were planted at the Jiménez Núñez Experimental Station of the Ministry of Agriculture in Cañas, Guanacaste, Costa Rica. The objective was to identify the promisory species and varieties of Leucaena for their use in agroforestry systems.

Measurements were made of woody biomass production, finding that Leucaena collinsi 4585 and 5688 were superior upon producing 10 and 9.5 kg of dry woody stem per tree. The genotypes presented highly significant differences ($P < 0.05$). There were highly significant differences ($P < 0.01$) in edible biomass production, the Leucaena salvadorensis 1786 outstanding with a production of 2 kg of dry matter per tree.

5. SUPPORT TO THE LABORATORIES

The Leucaena-Calliandra Project gave support to CATIE's Soils and Animal Nutrition Laboratories since 1989 up to the end of 1992. During the period of 1993 and 1994 it was not possible to provide more support, due to the budgetary restrictions from the SAREC.

The objective of the support provided to these laboratories was to consolidate or adapt analytical methodologies for its use in the project's research and of CATIE, in general.

5.1 SOILS LABORATORY

5.1.1 Soil Analysis

The Soils Laboratory carried out phosphorus retention studies on different soils using various methodologies, with the purpose of finding a methodology most appropriate for routine laboratory analyses.

For phosphorus retention, the following methodologies were used: Isotherms, North Carolina and New Zealand. The isotherms methodology was used as control against the other two.

Upon analyzing 22 samples of soils from different areas, a correlation was determined of 0.635 with $R^2=0.403$, among the methodologies of Isotherms and North Carolina, observing that there is not a good correlation among the two methodologies of phosphorus retention. It was observed that the soils that are low fixing presented lower values with the isotherms method than with the North Carolina method. With high fixing values the contrary happens.

The correlation calculated between the isotherms and New Zealand methodologies was 0.933 with $r^2=0.870$, which indicates that there is a good correlation between both methods. The information obtained for this last method are lower than those obtained by the isotherms method. This is explained by the fact that the time of contact or shaking in the New Zealand method is 16 hours, which is a period much less than 6 days needed to reach an equilibrium in the isotherms method.

The New Zealand method is considered to be more viable to use in routine analysis, since it is easier to carry it out, requires less time and a higher number of soil determinations can be done in one run.

5.1.2 PLANT TISSUE ANALYSIS

Three analytical methods were used for the determination of nitrogen, phosphorus and potassium in plant tissue. For nitrogen determination the semimicro Kjeldahl (Kj) method was compared with the Sulfo-Selenic Mixture. This methodology has the advantage that when separating an aliquot, phosphorus and potassium are determined, while in the semimicro Kjeldahl only nitrogen is determined.

For the determination of phosphorus and potassium, a digester mixture composed of nitric acid and perchloric acids in a 5:1 relation is used.

The analysis done in samples of Leucaena leucocephala and Gliricidia sepium were compared, obtaining the following nitrogen correlations: $r=0.993$ and $r^2=0.987$; for phosphorus: $r=0.971$ with $r^2=0.943$ and for potassium: $r=0.976$ with $r^2=0.953$.

Although similar results were obtained, you must be careful with the differences that exist between the digester solutions, especially with phosphorus content, since the small differences of this element, may place a sample in two different categories.

It is recommended to continue with this type of analysis, including other plant tissues and other elements such as Ca, Mg, Cu, Fe, Mn and Zn.

5.1.3 INSTITUTIONAL SUPPORTING UNIT

The Soils Laboratory is an institutional supporting unit, that carried out physical-chemical analyses of soils and chemical analyses of plant tissues, waters, amendments and organic fertilizers as support to research work carried out by technicians from different projects and postgraduate students at CATIE.

The support from the NFT/SAREC Project consisted of reagents, glassware and materials, air conditioning equipment, computer equipment, maintenance of the laboratory building as well as equipment, personnel, field and office materials and transportation.

During 1990 to 1992, 21,516 samples were analyzed, with a total of 129,839 determinations.

5.2 ANIMAL NUTRITION LABORATORY

5.2.1 DEVELOPMENT OF A METHODOLOGY FOR THE ANALYSIS OF TOTAL ALKALOIDS IN THE GENUS ERYTHRINA SPP. BY MEANS OF ULTRAVIOLET SPECTROSCOPY

This work was carried out with the purpose of establishing a methodology for the analysis of total alkaloids, that is simple, rapid and low cost, but as precise as other conventional methods, to be used in clone selection of Erythrina.

Three methods were tested in preparing the samples: dried in oven for 48 hours at 60°C; freeze drying and fresh sample.

The methodology considered the following phases:

1. **Extraction:** variables measured were time of heating in boiling water vat at 50°C, the number of extractions with alkaline chloroform, the concentration of sodium hydroxide and the time of agitating the sample.

2. **Purification:** the extract was purified in order to obtain only the compounds of interest, the alkaloids. A column formed by a filling of silica gel inside the cartridge as support of a 5 ml disposable syringe was used. A series of washes were done with solvents and mixtures of these, until all impurities were eliminated.

3. **Analysis:** the determination was done using the ultraviolet spectroscopy technique; however, to test the efficiency of the column, the use of the high pressure liquid chromatography technique was of great help.

The results indicate that the extraction of the alkaloids improves with heating or when treating the sample with a tissue homogenizer. With the concentration of 0.1% of NaOH, the maximum extraction was obtained of total alkaloids, higher concentrations to this level do not result in increases of the level of extraction. As for the time of heating, it was observed that only after one hour, the quantity of extraction alkaloids were stabilized.

The disposable column of silica gel was used for the purification of the alkaloids, using hexane in order to reduce polarity of the previous extract and permit that the alkaloids remain in the column and so eliminate the impurities with washes.

The selection of the longitud of the wave (245 and 236 nm) in the quantification of alkaloids by ultraviolet spectroscopy and high pressure liquid chromatography methods, were determined by running an ultraviolet spectrum of 200 to 300 nm.

The results indicate that the content of total alkaloids were variable between the clones analyzed. So was the effect of the treatment of the sample, after its collection in the field. The highest values correspond to clone 2652 which is identified as E. berteriana and the lowest was clone 2650 pertaining to E. costarricensis.

Greater quantitative differences are found in the alkaloids, depending on the drying process of the sample. The low concentrations were found when the sample was oven dried and the highest values were determined by the freeze drying method.

The intraclass coefficient correlation was higher in the oven drying method, followed by the freeze drying and last is the fresh method (0.99, 0.98 and 0.93).

5.2.2 DEVELOPMENT OF A METHODOLOGY FOR THE EXTRACTION AND QUANTIFICATION OF COUMARIN, O-CUMERIC ACID AND MELILOTIC ACID IN LEAVES OF MADERO NEGRO (Gliricidia sepium), BY HIGH PRESSURE LIQUID CHROMATOGRAPHY

The objective of this work was to establish a reliable method for the extraction and quantification of coumarin, o-cumeric acid and melilotic acid in madero negro leaves, in order to select the clones with a high potential due to its hig or low content of alelochemicals.

In the extraction phase, tests were made to determine heating time of the sample with HCL in steam bath, number of hydrolysis and the number of extractions with ethylic ether of the free and liberated compounds.

In the analysis phase, the high pressure liquid chromatography method was used for compound determination, with a mixture of a compound of acetonitril and buffer phosphate in a 3 ml/minute flux.

Trees of G. sepium from the project's collection at Guapiles were used. The samples were prepared by using the oven drying method during 48 hours at 60°C, freeze drying and fresh sample.

The evaluation of the results of the treatments was done by using a Complete Randomized Block design, where the individuals were the blocks and the different methods of drying were the treatments. The reliability was evaluated by calculating the coefficient of intraclass correlation.

The results indicated that upon increasing the hydrolysis time of the sample in steam bath from 15 to 30 minutes, the quantity of extracted compounds is substantially increased with ethylic ether; this does not occur if heating of the sample in HCl is prolonged to 45 minutes.

The quantities extracted also vary, depending on the number of extractions, inorganic as well as organic done to the sample, for all the heating times used, with 3 hydrolysis with HCl and/or three extractions with ethylic ether, the percentages of extracted compounds excel 90%. From 4 extractions with HCl for 30 minutes heating period, 97.6% of the metabolites under study are obtained with 3 extractions, while with ethylic ether (with the same amount of extractions) 94% of total metabolites are quantified.

Conclusions of this work indicates that the quantities of coumarin, melilotic and o-cumeric acids in samples of madero negro through high pressure liquid chromatography, vary depending on such factors as the individual to which it belongs, drying treatment applied, hydrolysis time in steam bath and the number of hydrolizations with HCl and organic extractions done. Coumarins present in madero negro are quantified better by using the sample treatment method with liquid nitrogen since it is the most approximate to reality. The fresh sample treatment must be used for coumarin quantification with the high pressure liquid chromatography.

5.2.3 SUPPORT TO RESEARCH

The Animal Nutrition Laboratory has consolidated analytical methodologies to determine coumarin, tanins and alkaloids and through these they give analysis services to all postgraduate students, short course students and in-service training given by CATIE. To the end of 1993, this laboratory trained 90 students at different levels and from CATIE's member countries.

6. PARTICIPATION IN TECHNICAL MEETINGS AND TRAINING ACTIVITIES

The activities carried out from July to December, 1994, are mentioned below. Activities of previous years is enclosed in this report.

6.1 TECHNICAL MEETINGS

1. Lecturer in the Annual Meeting of the Stockbreeding Association of Llano Redondo, Río Hondo, Guatemala. From March 11 and 12, technical practices were presented on: production, conservation and cattle feeding in dry seasons. Simple technical demonstrations were made. Emphasis was made on the advantages of sylvopastoral systems using Leucaena and Gliricidia as an efficient technical way to carry out a sustainable cattle exploitation. Forty producers attended.

2. A theoretical-practical activity was carried out on April 11, on the application of sylvopastoral systems in the Boaco, Nicaragua stockbreeding project. Forteen technicians of the project attended.

3. From May 12 to 14, assistance was given to the PROCAFOR-DIGEBOS Program in Guatemala, by lecturing on agroforestry and giving support to the field work of 22 national technicians that work in this project in different zones of the republic.

4. From June 28 to 30, we participated in the Workshop held at CATIE by ISNAR and CIAT on Planning, Evaluation and Follow-up of Research. Work was given to the Central American group.

5. From August 1 to 6, technical support was given to the preparation of an Agroforestry Proposal of Río Chixoy in Guatemala, and participated as instructor in the Agroforestry and Organic Agriculture Course given at Los Esclavos to 25 technicians of the Mi Cuenca and CARE Project. This collaboration was requested by the Watershed Management Project of CATIE.

6.2 TRAINING AT CATIE AND NICARAGUA

List of training is enclosed.

7. RESEARCH PROPOSALS PREPARED BY THE PROJECT AND SUBMITTED TO SAREC FOR POSSIBLE FINANCING

- Project for Sustainable Agroforestry Systems for Small Farms of Central America.
- Nitrogen Fixing Trees Project: Leucaena-Calliandra. October 28, 1992.
- Nitrogen Fixing Trees Project: Leucaena-Calliandra. May 2, 1994.
- Support to the Agroforestry Area through Core Budget.
- Study of the Forestry and Agroforestry Systems in the Humid Tropics of Nicaragua, for its sustainable use (UCA).
- Use of Agroforestry Systems as Sustainable Production Alternatives in Dry Zones of Nicaragua (MARENA).
- Sustainable Agroforestry & Forestry Production Systems for the Dry Tropics of Nicaragua (UNA).

8. PUBLICATIONS (list enclosed)

9. Two videos were prepared by the project on the research experiences (enclosed):

- Agroforestry in Central America (1991)
- Agroforestry as an alternative for agricultural sustainability in the American tropics (1994)

10. TECHNICAL ASSISTANCE

According to the agreements suscribed between CATIE and each Nicaragua institution: MARENA, UCA and UNA, technical assistance was provided as required by the SAREC-Nicaragua Projects. Calendar of activities and closing financial report are enclosed. (The financial report for December 1994 is pending; will be sent to SAREC as soon as the Administration Office prepares it. It was requested two months ago).

11. CAPITAL GOODS BOUGHT WITH SAREC FUNDS AND DONATED TO CATIE

List enclosed.

The final list will be prepared by Inventory personnel of the institution (as of Dec. 16 our request to officially receive all goods by CATIE was attended). Definite list will be sent when prepared.

CAPITAL GOODS

1 Truck
2 Launches
4 Pathfinder vehicles
1 Pick-up (double cabin)
1 Tractor (Kubota) with full equipment
1 Meteorology Station
1 Motorcycle

Office equipment: 8 desks
8 chairs
3 computer desks

10 Air conditioners
1 Photocopier - Canon
2 Canon typewriters
1 Sprinkler pump with motor
1 Fax - Canon
1 Telephone line (556-1789)

Radios and repeaters, towers (5 Philips bases; 5 bolsters; 5 microphones; 5 loudspeakers. ICOM Base 2: 2 loudspeakers; 2 microphones. ICOM Base 1: 1 bolster; 1 microphone; 2 ICOM repeaters; 11 portable radios; 9 chargers).

Computer equipment:

20 monitors
9 printers
18 keyboards
11 C.P.U.
8 U.P.S.
13 monitor arms
12 Mouse
1 Laptop
5 leads
4 Bata
7 stabilizer lines
7 Computer cards

TRAINING AT CATIE

Personnel of Soils Laboratories of Central America and Caribbean Member Countries: July 1990 - September 1991

Training sessions on Soil and Plant Tissue Chemical Analysis and Evaluation of Fertility under greenhouse conditions, Analysis Methodology, evaluation work on soil fertility under greenhouse conditions (two to six weeks):

Sandra Llanet Najarro	CENTA	El Salvador
Elsy Argentina de Rosales	CENTA	El Salvador
Xiomara Medrano Leonardo	UNA	Nicaragua
Bayardo Alfaro	UCA	Nicaragua
Marta Rodríguez Gutiérrez	Escuela Agrí.	Nicaragua
Norma Navarro	ITCR	Costa Rica
Eliécer Elizondo Mora	FERTICA	Costa Rica
Hugo Méndez Esquivel	FERTICA	Costa Rica
Leonardo Mora	UNA	Nicaragua

Training in: Agroforestry, Data Management, Herbarium:

Eugenia Rojas	UCA	Nicaragua
Nicolás Díaz	IRENA	Nicaragua
Gustavo Sandoval	IRENA	Nicaragua
Alfredo Grijalba	UCA	Nicaragua
Pedro Pablo Moreno	UNA	Nicaragua
Isabelle Marie Lauziere		Canada
Jule Lamontage		Canada
Roger St. Aneault		Canada

The Animal Nutrition Laboratory gave support to thesis work of Master's degree students (6) and Licenciante degree (1):

Suyen González (Nicaragua)	Manuel Márquez (Guat.)
Roldán Corrales (Nicaragua)	Gerardo Rodríguez (C.R.)
Guillermo Jiménez (México)	Alejandro Martínez (Nic.)
Luis Diego Delgado (Costa Rica)	Pedro Altamirano (Nic.)

This laboratory also gave in-service training on the most modern techniques in grass & forage analyses to:

Damaris Mendieta (Nic.)	Uta Stehle (Germany)
Marciane Maia da Silva (Brazil)	Jorg Witte. (Germany)
Genara Batista (Dom. Rep.)	Herberth Rojas (C.R.)
Pedro Alirio (Colombia)	

Graduate Course on "Laboratory Techniques in Animal Nutrition" (July to September, 1992). Graduate students from the Tropical Livestock Area:

Davíd Urriola (Panama)
Gerardo Zenón (México)
Carlos Mercado (Nicaragua)

International Course on Development of Agroforestry Systems (JICA):

Georgina Orozco	UNA	1991
Javier López	UNA	1991
Benigno González	UNA	1991
Nicolás Díaz	IRENA	1992
Glenda Bonilla	UNA	1993
Eugenia Rojas	UCA	1994

Note: Course for 1993 (July 12-Oct. 2) was coordinated by Pedro Oñoro (18 participants); Course for 1994 (July 11-Sept. 30) was coordinated by Edgar Viquez and Jorge Jiménez (21 participants).

Postgraduate Course on Agroforestry Systems (April 6-June 26, 1992) (Edgar Viquez, Coordinator):

Julio Aguilar M.	Luis Meléndez
Jorge Araujo S.	Elías de Melo M.
Jorge Cancino C.	Fernando Muñóz
Ernest Celada	Silvia Rebottaro
María Goncalves	Octavio Sánchez E.
José G. Jiménez	Alex Tineo L.
Arturo Limón L.	David Urriola
Diómedes Londoño M.	Oscar Valenzuela
Lidia Mainardi G.	Gerardo Z. López T.

Postgraduate Course on Agroforestry Systems (July 5-Sept. 24, 1993)

Nelson A. Arriaza V.	Mario R. Paíz G.
Jorge Blanco S.	Carlos R. Paz M.
Jesús A. Caamal M.	Nicolás Pérez R.
Alfredo Castillo V.	Olmedo Romero G.
Mauricio G. Cerda O.	Alberto Sánchez S.
Luis D. Delgado R.	Alma A. Saravia C.
Jean Raoul Dominique	Edna C. Soihet M.
Manuel V. Feliz L.	Mauricio I. Torres M.

Isabel C. Herrera S.
 Francisco S. López F.
 Leoncio N. Madrigal O.
 Silas Mochiutti
 Jorge F. Navia E.
 Francisco Oviedo C.

Héctor M. Valdivia L.
 Miguel Vallejo S.
 Rudolf Van Kantén
 Norma Vera de López
 Vilma Vilchez V.
 Róger Villalobos S.

Postgraduate Course on Agroforestry Systems (July 4-Sept. 23, 1994)

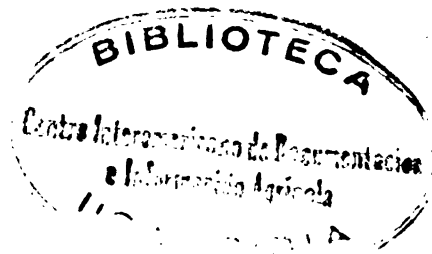
José R. Baidés P.
 Nancy Cadima M.
 Robertomy Camas G.
 Luis F. Castañeda R.
 George Duarte R.
 Aderaldo B. Gazel Filho
 José N. Granados L.
 Oscar R. Hernández G.
 Silvia López O.

Róger B. Mendoza G.
 Luis Mora M.
 Napoleón E. Paz Q.
 Juan R. Quintanilla Q.
 Juan Samaniego P.
 Fernanda Tavares da Costa
 José F. Urgiles C.
 María Yañez K.
 Efraín Zelada S.

Experimental Design (Postgraduate course) (April 5-June 25, 1993)

Nelson A. Arriaza V.
 Oscar M. Barea M.
 Carmen I. Bieberach F.
 Jorge Blanco S.
 Jesús A. Caamal M.
 Alfredo Castillo V.
 Mauricio G. Cerda O.
 Luis D. Delgado R.
 Juan C. Díaz G.
 Jean Raoul Dominique
 Manuel V. Feliz L.
 Mario R. García M.
 Roberto González Q.
 Elmer F. Guillén C.
 Ramón Hernández N.
 Isabel C. Herrera S.
 María del Rosario Jiménez S.
 Francisco S. López F.
 Leoncio N. Madrigal O.
 Silas Mochiutti
 Jorge F. Navia E.

Francisco Oviedo C.
 Mario R. Paíz G.
 Carlos R. Paz M.
 Nicolás Pérez R.
 Rolando Portilla P.
 Lilliam A. Rodríguez O.
 Olmedo Romero G.
 León J. Saborío B.
 Alberto Sánchez S.
 Alma A. Saravia C.
 Edna C. Soihet M.
 Mauricio I. Torres M.
 Héctor M. Valdivia L.
 Miguel Vallejo S.
 Rudolf Van Kantén
 Carlos Vásquez P.
 Norma E. Vera de López
 Héctor E. Vidaurre A.
 Vilma Vilchez V.
 Róger Villalobos S.
 Javier G. Villegas O.



Experimental Design (Postgraduate Course) (April 11-July 1, 1994)

José R. Baidés P.	Napoleón E. Paz Q.
Robertomy Xamas G.	Oswaldo E. Pérez J.
Luis F. Castañeda R.	Jorge A. Pinazo S.
Francisco Paulo Chaimsohn	Juan R. Quintanilla Q.
Lilliana Chávez F.	Juan J. Rodríguez A.
Violeta Colan C.	Carlos A. Ruíz S.
Constantino R. de la Piedra	Fernando Sáenz S.
Yajaira V. Díaz P.	Juan Samaniego P.
George Duarte R.	Mario Sánchez S.
Aderaldo B. Gazel Filho	Henry A. Saravia C.
Jorge M. Goitía A.	Carlos Shiguimi Tawara
Oscar R. Hernández G.	Vanda G. Sousa R.
Bernal Herrera F.	Pilar H. Suazo H.
Jacquelin Francois Herrera	Fernando Tavares da Costa
Silvia López O.	Willmer R. Turcios C.
Juan M. Medina B.	José F. Urgiles C.
Armando Melgar D.	Jorge O. Vásquez M.
Róger B. Mendoza G.	Aida V. Wilches M.
Jorge E. Miranda C.	Marcia Yañez K.
Luis Mora M.	Martha E. Zamora S.
Nancy de Fátima Cadima M.	Efraín Zelada S.
Mario R. Padilla R.	

Master's degree students:

Marcia Mendieta L.	UNA	1989
Emilio Pérez C.	UNA	1990
Raquel Chavarría S.	IRENA	1991
Amelia María Paniagua	Costa Rica	1992
Carlos Ruíz	UCA	1992
María Engracia Detrinidad	IRENA	1993
Georgina Orozco	UNA	1993
Alejandro Mejía	UCA	1994
Roberto Obando	IRENA	incomplete
Claudio Calero	UNA	incomplete

TRAINING ACTIVITIES IN NICARAGUA

Short Course on Tropical Forests and Silviculture Management

Alfonso Castillo (UCA)	René Ayerdis (UNA)
Armando Castañeda (UCA)	Luis Valerio (UNA)
Claudio Calero (UNA)	

Workshop on Analysis of Information

ECFOR and UCA students

Violeta Hallenslevens	Fátima Calero
Rodolfo Ramírez	Pablo Herosliga
Auxiliadora López	Alfonso Castillo
Mario Téllez	Martha Alvarez
Marta Gigliola Tercero	

Workshop on Statistical Analysis of Information (UCA)

Gerardo Martínez	Alfonso Castillo
Manuela González	Pablo Herosliga

Training in Analysis of Information

Students of UNA-SAF

Javier López	Lisette Rodríguez
Georgina Orozco	Nohemi López
Jerónimo Jiménez	Edwin Castillo
Fátima Calero	Jaime Gutiérrez
Martha Alvarez	Masirelly González

Students of UNA-Chacocente

Mariano Ríos	Rodolfo Ramírez
Oscar Zapata	Violeta Hallesleven
Mario Mayorquín	Mario Téllez
Marta Méndez	Rigoberto López
Carmen Carrillo	Pilar Bohorquez
Mayra Chacón	Marta Tercero
Ramón Altamirano	Auxiliadora López
Wilfredo López	Rosa Navarrette
Bladimir Salinas	Gertrudis Urrutia
Jorge Neyra	Helen Pavón
Armando Martínez	

Students of UCA

Alfonso Castillo
 Nohemí Lanuza
 María Isabel
 Cristina Dávila Conrado

Pablo A. Arroliga Pérez
 Iván Gutiérrez
 Leopoldo Rivera

Course on Data Management (1990-91)

Roberto Obando	IRENA
Nicolás Díaz	IRENA
Luis Valerio	UNA
Carmen de la Cruz	UNA
Mario Mayorquín	UNA
Benigno González	UNA
Magdalena González	UCA
Pedro Altamirano	UCA
Alejandro Mejía	UCA
Gustavo Sandoval	IRENA

Course on Development of Agroforestry Systems (1990)

Roberto Obando	DIRENA
Ignacia Quiñónez R.	DIRENA
Bernardo Lanuza R.	DIRENA
Xiomara Medrano	ISCA
Fátima Calero	ISCA
Alejandro Mejía	UCA
Suyen González	UCA
Amilcar Jarquín P.	EAG (Rivas)
Víctor Cáceres	EAG (Estelí)
Susana García	INTECFOR (Estelí)
Lizeida López L.	DIRENA (León)
Felipe Lezama	DIRENA (León)
Jazmín Medina S.	DIRENA (Chontales)
Rafael Martínez G.	Región Esp., Río San Juan
Moisés Solís A.	DIRENA (Rivas)
Leonardo Chávez V.	DIRENA
Gustavo Sandoval P.	DIRENA
David Varela	DGTA
Rafael Galo S.	CARE
Benedicto González	CARE
Efraín Rodríguez	Prog. For. Campesino
Zaida López H.	DIRENA
Maribel Pizzi	UCA
Carolina Martínez	UCA
Nicolás Linarte C.	AGROFOCSA

Course on Biology of Agroforestry Systems (August, 1991)

Yadira Jiménez E.	Francisco Rodríguez P.
Zayda Cerda P.	Mercedes Castillo M.
Francisco Reyes F.	Edwin Padilla M.
Francisco González R.	Daniel Cortéz R.
Glenda Bonilla Z.	Edwin Castillo J.
Matilde Somarriba C.	Edwin Taylor W.
Mercedes Ordoñez H.	Francisco Peña D.
Fernando Ríos B.	Ramiro Picado M.
Lorenzo Vásquez R.	Eugenia Rojas Z.
Miguel Matos L.	

Course on Data Analysis (1991)

Luis Borrell Ch.	Francisco Mayorga
Camilo Galindo	Oscar Miranda
Carlos Gadea A.	Patricia Montenegro
Sonia García	Julio César Palma
Franklin Guillén	Consuelo Ríos
Mario Gutiérrez	Everth Rivas
Carlos Hill	Rosario Rodríguez P.
Cecilia Masís G.	Liliam Torres R.

Course on Technical Writing (Oct. 21--25, 1991)U.C.A.

Leopoldo Rivera T.	Luis Borrell
Luis Herrera W.	Patricia Navarro
Iván Gutiérrez C.	Janneth Moreira R.
Léster A. Corea R.	Zoila Pavón P.
Sonia García V.	Juan Sánchez A.
Willy Flores D.	Natasha Almendárez
Duilio Avellán S.	Oscar Miranda
Aura E. Mendoza	Carlos Hill A.
Xiomara Ibarra H.	María Pérez G.
Marlen Lacayo M.	Martha Cucalón G.
Rosario Rodríguez P.	Aracelly Ruíz G.
Carlos J. Gadea A.	María Silva G.
Francisco Mayorga G.	Jaromin Pastora
Patricia Montenegro J.	Manuel Martínez F.
Consuelo Ríos O.	Marvin Mercado H.
Mario Alvarez	

U.N.A.

Glenda Bonilla
 Ricardo A. Silva
 Javier López
 Gloria Urbina
 Luvy Villalobos
 Benigno González

Francisco Reyes
 Noemí López
 Fátima Calero
 Marta Salgado
 Emilio Pérez

Course on Design & Analysis of Experiments (Aug. 27-Oct. 29, 1991)

Carlos Hill
 Julio César Palma
 Camilo Galindo
 Luis Borrell
 Francisco Mayorga
 Oscar Miranda
 Carlos Gadea
 Patricia Montenegro

Consuelo Ríos
 Lilliam Torres
 Mario Gutiérrez
 Sonia García
 Everth Rivas
 Rosario Rodríguez
 Cecilia Masís
 Franklin Guillén

Course on Management of Natural Resources & Sustainable Agriculture (April, 1991); 1 week of classes each one. (Romeo Solano: Production Systems; Pedro Oñoro: Methodology for Research)

Lesbia Aguilar G.
 Antonio Andino S.
 Gladys Barrios S.
 Martín Brenes S.
 Róger Díaz L.
 Elia Estrada R.
 Anabell García S.
 Laura Gutiérrez G.
 Dennis Larrave Ch.
 Armando Martínez P.
 Yadira Marengo C.

David Payán L.
 Carmen Pong W.
 Norberto Pérez C.
 Mauricio Rodríguez
 Evelin Silva S.
 María Antonia Ubeda
 Carolina Vega J.
 Martiza Vega G.
 José Inés Varela
 Benito Ant. Zeledón
 Teresa Zúñiga R.

Methodology for Rapid Diagnosis (R. Solano)U.N.A.

Emilio Pérez
 Benigno González
 Javier López
 Glenda Bonilla

Francisco Reyes
 Fátima Calero
 Nohemí López

Alejandro Mejía	UCA
Marielos Pérez	UCA
Manuela González	UCA
Nohemí Lanuza	UCA
Juan Chamorro	MAG
Carlos Chamorro	MAG
Gustavo Gross	IRENA
Renato Padilla	IRENA
Eugenia Rojas	UCA

Course on Data Management (July 25-29, 1994)

Professors and students of UNA (16 participants).

PUBLICATIONS

1. **BIBLIOGRAFIA SOBRE los géneros Calliandra-Gliricidia-Inga-Leucaena**. 1991. Turrialba, Costa Rica, CATIE, Proyecto AFN. 142 p.
2. **CAMACHO H., Y; VIQUEZ, E.; PEREZ, E.** 1993. Variación clonal de tres especies del género Erythrina. In: Erythrina in the New and Old Worlds. Ed. by S.B. Westley & M. Powers. NFTA. Nitrogen Fixing Trees Research Reports. Special Issue. pp. 258-273.
3. **CHAVARRIA, R.; JIMENEZ, J.M.; OÑORO, P.** 1993. Evaluation of growth and production of tropical yam (Dioscorea alata L.) using live supports of Erythrina berteroana (Urb.) and Gliricidia sepium (Jacq.) Walp. In: Erythrina in the New and Old Worlds. Ed. by S.B. Westley & M. Powers. NFTA. Nitrogen Fixing Trees Research Reports. Special Issue. pp. 185-191.
4. **EWEL, J.J.; MAZZARINO, M.J.; BERISH, C.W.** 1991. Tropical soil fertility changes under monocultures and successional communities of different structure. *Ecological Applications* 1(3):289-302.
5. **JIMENEZ, J.M.; KASS, D.C.L., D.; OÑORO, P.R.** 1991. Analysis of the growth and phenology of corn (Zea mays L.) associated with mountain immortelle (Erythrina poeppigiana (Walpers) O.F. (Cook)) at different tree densities. In: Proceedings. 3rd International Symposium "Windbreaks and Agroforestry" (2-7 June, 1991, Ontario, Canada). Ridgetown College of Agricultural Technology, Ontario, Canada. pp. 166-169.
6. _____; **VIQUEZ, E.; KASS, D.C.L.; CHAVARRIA, R.** 1991. Use of fast-growing nitrogen-fixing trees as living support for tropical yams (Dioscorea alata L.). In: Proceedings. 3rd International Symposium "Windbreaks and Agroforestry" (2-7 June, 1991, Ontario, Canada). Ridgetown College of Agricultural Technology, Ontario, Canada. p. 251. (Abstract).

7. **JIMENEZ, J.M.; VIQUEZ, E.; KASS, D.L.; CHAVARRIA, R.** 1992. Uso de Erythrina berteroana y Gliricidia sepium como soportes vivos de ñame alado (Dioscorea alata L. cv 6322). El Chasqui (C.R.) no. 29:6-11.

8. _____; **SOLANO, R.; VIQUEZ, E.** 1993. Evaluación del sistema maíz-maíz (Zea mays) cultivado en callejones de cuatro leguminosas arbóreas. In: Memoria. XXXIX Reunión Anual del PCCMCA (Marzo 28-Abril 3, 1993, Guatemala). Investigación aplicada para una agricultura sostenida y competitiva. Resúmenes. Guatemala, ICTA. p. 12.

También en: Memorias de la Semana Científica (8-10 Dic., 1993, Turrialba, C.R.). Turrialba, Costa Rica, CATIE. v.1, pp. 43-45.

9. _____; **OÑORO, P.; VIQUEZ, E.** 1993. Evaluación del sistema maíz (Zea mays)-ñampí (Colocasia esculenta var. antiquorum) en un cultivo en callejones. In: Memoria. XXXIX Reunión Anual del PCCMCA (Marzo 28-Abril 3, 1993, Guatemala). Investigación aplicada para una agricultura sostenida y competitiva. Resúmenes. Guatemala, ICTA. p. 13.

También en: Memorias de la Semana Científica (8-10 Dic., 1993, Turrialba, C.R.). Turrialba, Costa Rica, CATIE. v.1, pp. 47-49.

10. _____; **SOLANO, R.; VIQUEZ, E.** 1994. Evaluación del sistema maíz-maíz (Zea mays) en un cultivo en callejones con cuatro leguminosas arbóreas. Turrialba, Costa Rica, CATIE. 15 p.

11. _____; **OÑORO, P.; VIQUEZ, E.** 1994. Producción de ñampí (Colocasia esculenta var. antiquorum) y maíz (Zea mays L.) en un cultivo en callejones con Erythrina fusca y Calliandra calothyrsus. Turrialba, Costa Rica, CATIE. 15 p.

12. **JON LLAP, R.; CAMACHO H., Y.; VIQUEZ, E.; SANCHEZ, G.** 1990. Comportamiento juvenil de procedencias y familias de Gliricidia sepium de la región de origen. El Chasqui (CATIE) no. 22:7-13.

13. **KASS, D.L.; JIMENEZ B., J.** s.f. Cultivo en callejones - pasado y perspectivas. CATIE, Turrialba, Costa Rica. 19 p.

14. **KASS, D.L.; TINEO, A.; FAUSTINO, J.; ARRIAZA, N.; VIQUEZ, E.; RODRIGUEZ, M.; JIMENEZ, J.** s.f. Performance of Erythrina fusca (Lour.) associated with annual crops following liming of an acid soil with 70% aluminum saturation. Turrialba, Costa Rica, CATIE. 12 p.
15. _____; **JIMENEZ, J.** 1990. Cultivo en callejones con raíces y tubérculos. Agroforestería (C.R.) No. 5. 5 p.
16. _____.; **FASSBENDER, H.; OÑORO, P.; JIMENEZ, J.** 1993. Cambios en propiedades del suelo en experimento agroforestal a largo plazo en el CATIE. In: Memorias de la Semana Científica (8-10 Dic., 1993, Turrialba, C.R.). Turrialba, Costa Rica, CATIE. v.1, pp. 29-31.
17. _____; **JIMENEZ, J.; SANCHEZ O., J.; SOTO P., M.L.; GARZON S., H.** 1993. Erythrina in alley farming. In: Erythrina in the New and Old Worlds. Ed. by S.B. Westley & M. Powers. NFTA. Nitrogen Fixing Trees Research Reports. Special Issue. pp. 129-137.
18. _____; **ROGERS, S.; COOPERBAND, L.; NYGREN, P.** 1993. Trees with annual crops. In: Erythrina, production and use: a field manual. Ed. by M.H. Powell & S.B. Westley. NFTA/CATIE. pp. 12-14.
19. **LASCANO, C.E.; MAASS, B.L.; ARGEL, P.J.; VIQUEZ, E.** 1994. Potential for development and priorities for research into Leucaena in Central and South America. 17 p.

Presentado en: Leucaena R & D Workshop, Bogor, Indonesia (Jan. 24-29, 1994).
20. **LIMON, A.; KASS, D.; OÑORO, P.; JIMENEZ, J.M.** 1993. Comportamiento de genotipos de maíz y frijol en cultivo en callejones con Erythrina poeppigiana, Calliandra calothyrsus y Gliricidia sepium. In: Memorias de la Semana Científica (8-10 Dic., 1993, Turrialba, C.R.). Turrialba, Costa Rica, CATIE. v.1, pp. 37-38.
21. **MAZZARINO, M.J.; CHACON, J.C.** 1990. La enseñanza de la agroforestería. El Chasqui (CATIE) no. 22:4-6.

22. MAZZARINO, M.J.; OLIVA, L.; ABRIL, A.; ACOSTA, M. 1991. Factors affecting nitrogen dynamics in asemiarid woodland (Dry Chaco, Argentina). *Plant & Soil* 138:85-98.
23. _____; OLIVA, L.; NUÑEZ, A.; NUÑEZ, G.; BUFFA, E. 1991. Nitrogen mineralization and soil fertility in the Dry Chaco ecosystem (Argentina). *Soil Science Society of America Journal* 55(2):515-522.
24. _____; SZOTT, L.; JIMENEZ, M. 1993. Dynamics of soil total C and N, microbial biomass and water-soluble C in tropical agroecosystems. *Soil Biology and Biochemistry* 25(2):205-214.
25. NYGREN, P. 1991. Cálculo de la radiación solar en sistemas agroforestales. CATIE, Turrialba, Costa Rica. 15 p.
26. _____; REBOTTARO, S.; CHAVARRIA, R. 1993. Application of the pipe model theory to non-destructive estimation of leaf biomass and leaf area of pruned agroforestry trees. *Agroforestry Systems* 23(1):63-77.
27. _____; RAMIREZ, C.; SANCHEZ, G. 1993. Growth of seedlings of five half-sib families of Erythrina poeppigiana inoculated with a selected strain of Bradyrhizobium. In: Erythrina in the New and Old Worlds. Ed. by S.B. Westley & M. Powers. NFTA. Nitrogen Fixing Trees Research Reports. Special Issue. pp. 278-282.
28. _____. 1993. Manejo de sombras de cacao: consideraciones ecofisiológicas para experimentos con árboles leguminosos. In: Memoria. Seminario Regional "Sombras y Cultivos Asociados con Cacao" (9-11 Oct., 1991, Turrialba, Costa Rica). W. Phillips-Mora, ed. CATIE. Serie Técnica. Informe Técnico no. 206. pp. 131-140.
29. _____. 1993. Un modelo de los patrones de sombra de árboles manejados con podas periódicas en sistemas agroforestales. *Pesquisa Agropecuária Brasileira* 28(2):177-188.
30. _____; RAMIREZ, C. 1993. Phenology of N₂-fixing nodules in pruned clones of Erythrina poeppigiana. In: Erythrina in the New and Old Worlds. Ed. by S.B. Westley & M. Powers. NFTA. Nitrogen Fixing

Trees Research Reports. Special Issue. pp. 297-305.

31. **NYGREN, P.; JIMENEZ, J.** 1993. Radiation regime and nitrogen supply in modelled alley cropping systems of Erythrina poeppigiana with sequential maize-bean cultivation. *Agroforestry Systems* 21(3):271-285.
32. _____ . 1993. Traditional uses and cultural significance of three Erythrina species among the rural population of Tuís District, Turrialba, Costa Rica. *In: Erythrina in the New and Old Worlds.* Ed. by S.B. Westley & M. Powers. NFTA. Nitrogen Fixing Trees Research Reports. Special Issue. pp. 62-67.
33. _____; **MARAUX, F.; SANCHEZ, G.** 1993. Transmisión de la radiación solar en la copa de Erythrina poeppigiana (Walpers) O.F. Cook. *Pesquisa Agropecuária Brasileira* 28(2):167-176.
34. **OÑORO, P.; JIMENEZ, J.; VIQUEZ, E.** 1993. Efecto del espaciamiento entre árboles de Erythrina poeppigiana sobre un cultivo de maíz en callejones. *In: Memoria. XXXIX Reunión Anual del PCCMCA (Marzo 28-Abril 3, 1993, Guatemala).* Investigación aplicada para una agricultura sostenida y competitiva. Resúmenes. Guatemala, ICTA. p. 12.
35. _____; **JIMENEZ, J.; VIQUEZ, E.; SOLANO, R.** 1993. Evaluación de un sistema maíz-maíz en callejones de Erythrina poeppigiana con diferentes espaciamientos. *In: Memorias de la Semana Científica (8-10 Dic., 1993, Turrialba, C.R.).* Turrialba, Costa Rica, CATIE. v.1, pp. 39-41.
36. **OROZCO, G.; ARZE, J.** 1993. Desarrollo de modelos agroforestales para evaluación de tierras en Nicaragua. *In: Memorias de la Semana Científica (8-10 Dic., 1993, Turrialba, C.R.).* Turrialba, Costa Rica, CATIE. v.1, pp. 23-24.
37. **PAYNE, L. D.** 1993. Chemical constituents of Erythrina: historical perspectives and future prospects. *In: Erythrina in the New and Old Worlds.* Ed. by S.B. Westley & M. Powers. NFTA. Nitrogen Fixing Trees Research Reports. Special Issue. pp. 314-321.

38. **PEREZ, E.; VIQUEZ, E.; SANCHEZ, G.A.** 1990. Clonal variation in Erythrina species. In: Proceedings. IUFRO, XIX World Congress (5-11 Aug., 1990, Montreal, Canada). Division 1, vol. 2 p. 480.
39. **RAMIREZ, C.; SANCHEZ, G.; KASS, D.; VIQUEZ, E.; SANCHEZ, J.; VASQUEZ, N.; RAMIREZ, G.** 1990. Advances in Erythrina research at CATIE. In: Fast Growing Trees and Nitrogen Fixing Trees: International Conference (8-12 Oct., 1989, Marburg, Germany). Ed. by D. Werner & P. Müller. Stuttgart, Alemania, Justv Fischer Verlag. pp. 96-105.
40. **REBOTTARO, S.; NYGREN, P.** 1993. Development of the shading pattern of Erythrina poeppigiana during a pruning cycle. In: Erythrina in the New and Old Worlds. Ed. by S.B. Westley & M. Powers. NFTA. Nitrogen Fixing Trees Research Report. Special Issue. pp. 154-168.
41. **SABOGAL, C.** s.f. Management of tropical dry forests: the case of Central America, with particular reference to Nicaragua. Turrialba, Costa Rica, CATIE. 33 p.
42. _____ . 1992. Regeneration of tropical dry forests in Central America, with examples from Nicaragua. Journal of Vegetation Science 3:407-416.
43. **SALICK, J.** 1991. Non-timber forest products in buffer zone management of the Peace Park, Nicaragua. In: Proceedings. The sustainable harvest and marketing of rain forest products (20-21 June, 1991, Panama). Panamá, Asociación Nacional para la Conservación de la Naturaleza (ANCON). 12 p.
44. **SANCHEZ, G.; SANCHEZ, J.; VIQUEZ, E.** 1990. Alley cropping as a sustainable production system in the conditions of Turrialba, Costa Rica. In: Proceedings. IUFRO, XIX World Congress (5-11 Aug., 1990, Montreal, Canada). Division 1, vol. 2 p. 428.
45. **SOLANO, R.; RUANO-VIANA, R.; ZAMORA, R.** 1994. Hornos forrajeros: una tecnología promisoría para pequeñas fincas ganaderas del trópico seco. Aspectos prácticos. Agronomía Mesoamericana (C.R.) v. 5:59-66.

46. Solano, R.; JIMENEZ, J.; OÑORO, P.; VIQUEZ, E. 1994. Proyecto Arboles Fijadores de Nitrógeno: Leucaena-Calliandra. Agroforestería en las Américas (C.R.) Año 1, no. 1. pp. 13-17.
47. SZOTT, L.T.; MAZZARINO, M.J.; JIMENEZ, M.; KASS, D. 1991. Soil microbial biomass dynamics in alley cropping and sole cropping systems in the humid tropics. In: Proceedings. 83rd Annual Meeting ASA-CSSA-SSSA (Oct. 27-Nov.1, 1991).
48. TINEO, A.; FAUSTINO, J.; KASS, D.L.; FERREIRA, P. 1993. Análisis de transferencia de nutrientes en rotación de cultivos frijol-maíz bajo sistemas agroforestales en tierras de ladera, San Juan Sur, Turrialba, Costa Rica. In: Memorias de la Semana Científica (8-10 Dic., 1993, Turrialba, C.R.). Turrialba, Costa Rica, CATIE. v.2, pp. 135-137.
49. _____; FAUSTINO, J.; KASS, D.L.; FERREIRA, P. 1993. Evaluación de la pérdida de nutrimentos del suelo por erosión hídrica, escorrentía y lixiviación en tierras agrícolas de ladera, San Juan Sur, Turrialba, Costa Rica. In: Memorias de la Semana Científica (8-10 Dic., 1993, Turrialba, C.R.). Turrialba, Costa Rica, CATIE. v. 2, pp. 131-133.
50. VIQUEZ, E.; SANCHEZ, G.; CAMACHO, Y.; JON LLAP, R. 1990. Results of a Gliricidia sepium (Walp.) Steud. provenance and family trial in tropical humid forest conditions. In: Proceedings. IUFRO, XIX World Congress (5-11 Aug., 1990, Montreal, Canada). Division 1, vol. 2. p. 437.
51. _____; SOLANO, R. 1993. Avances en la investigación de Gliricidia sepium (Jacq.) Steud. como árbol forrajero. In: Memoria. XXXIX Reunión Anual del PCCMCA (Marzo 28-Abril 3, 1993, Guatemala). Investigación aplicada para una agricultura sostenida y competitiva. Resúmenes. Guatemala, ICTA. p. 52.
- También en: Memorias de la Semana Científica (8-10 Dic., 1993, Turrialba, Costa Rica). Turrialba, Costa Rica, CATIE. v.2, pp. 69-71.
52. _____.; CAMACHO, Y. 1993. Establishment. In: Erythrina, production and use: a field manual. Ed. by M.H. Powell & S.B. Westley. NFTA/CATIE. pp. 7-11.

53. **VIQUEZ, E.; PRADO, A.; OÑORO C., P.; SOLANO A.** 1993. Evaluación del huerto casero "La Asunción", Masatepe, Nicaragua. In: Memorias de la Semana Científica (8-10 Dic., 1993, Turrialba, Costa Rica). Turrialba, Costa Rica, CATIE. v.1, pp. 25-27.
54. _____; **ROMERO, F.; BUDOWSKI, G.** 1993. Live fenceposts. In: Erythrina, production and use: a field manual. Ed. by M.H. Powell & S.B. Westley. NFTA/CATIE. pp. 19-21.
55. _____. 1994. Brief review of Leucaena research in Central America. Turrialba, Costa Rica, CATIE. 11 p.

Presentado en: Leucaena R & D Workshop, Bogor, Indonesia (Jan. 24-29, 1994).
56. _____; **PRADO, A.; OÑORO, P.; SOLANO, R.** 1994. Caracterización del huerto mixto tropical "La Asunción", Masatepe, Nicaragua. Agroforestería en las Américas (C.R.) Año 1, no. 2. pp. 5-9.
57. **ZAMORA, R.; SOLANO, R.** 1994. Evaluación de la sacharina seca (caña enriquecida) como suplemento en la alimentación de vacas lecheras en la época seca. Agronomía Mesoamericana (C.R.) v.5:50-58

THESES

1. **ARRIAZA VALLEJO, N.** 1994. Conservación de suelos en ladera con cultivo en callejones, coberturas vivas y muertas, en el sistema frijol-maíz. Tesis Mag. Sc. Turrialba, Costa Rica, CATIE. (In press).
2. **CAMACHO HERNANDEZ, Y.M.** 1991. Comportamiento de procedencias y familias de Gliricidia sepium (Jacq.) Steud. a los 12 meses de edad en condiciones del trópico húmedo de Costa Rica. Tesis Mag.Sc. Turrialba, Costa Rica, CATIE, Programa de Postgrado. 95 p.
3. **CELADA ROBLES, J.E.** 1993. Desarrollo de modelos para evaluación de tierras en el trópico seco de Jutiapa, Guatemala: aplicación del sistema automatizado ALES. Tesis Mag. Sc. Turrialba, Costa Rica, CATIE, Area de Postgrado. 109 p.
4. **CHACON ESPINOZA, J. C.** 1990. Análisis del crecimiento del follaje en tres especies de Erythrina en Costa Rica. Tesis Mag. Sc. Turrialba, Costa Rica, CATIE. 77 p.
5. **CHAVARRIA SACASA, M. R.** 1991. Evaluación del crecimiento y producción del ñame alado (Dioscorea alata cv "6322") utilizando soportes vivos de poró (Erythrina berteroana Urban) y madero negro (Gliricidia sepium Jacq.) Walp. Tesis Mag. Sc. Turrialba, Costa Rica, CATIE, Programa de Posgrado. 109 p.
6. **CONTRERAS FERNANDEZ, M.** 1991. Efecto de la cobertura muerta de Inga densiflora Benth. e Inga edulis Mart. en el crecimiento inicial de plántulas de cafeto (Coffea arabica cv. Catuai) y maíz (Zea mays) L.), híbrido salvadoreño H-5. Tesis Mag. Sc. Turrialba, Costa Rica, CATIE, Area de Posgrado. 142 p.
7. **DELGADO RODRIGUEZ, L. D.** 1992. Establecimiento de una metodología de extracción y cuantificación de cumarina, ácido orto cumárico (ácido trans-2 hidroxicinámico) y ácido melilótico en hojas de

madero negro (Gliricidia sepium). Tesis Lic. Ing. Agr. San José, Costa Rica, Universidad de Costa Rica, Facultad de Agronomía. 62 p.

8. **DETRINIDAD PRADO, M. E.** 1993. Criterios para la selección de árboles plus y control fenológico de cinco especies nativas, en condiciones de bosque seco tropical en Chacocente, Nicaragua. Tesis Mag.Sc. Turrialba, Costa Rica, CATIE, Programa de Posgrado. 107 p.
9. **DOMINIQUE, J. R.** 1994. Evaluación de la sostenibilidad agronómica financiera y económica de un sistema de cultivo en callejones asociando el maíz (Zea mays L.) con poró (Erythrina poeppigiana (Walpers) O.F. Cook) plantado en diferentes densidades. Tesis Mag. Sc. Turrialba, Costa Rica, Area de Posgrado. (In press).
10. **ESCOBAR MUNERA, M. L.** 1990. Dinámica del nitrógeno en un cultivo en callejones de poró (Erythrina poeppigiana (Walpers) O.F. Cook) y madero negro (Gliricidia sepium (Jack) Steud) con frijol común (Phaseolus vulgaris L.). Tesis Mag. Sc. Turrialba, Costa Rica, CATIE, Programa de Posgrado. 106 p.
11. **GARZON SANCHEZ, H.** 1991. Evaluación de la erosión hídrica y la escorrentía superficial bajo sistemas agroforestales, en tierras de ladera, Turrialba, Costa Rica. Tesis Mag. Sc. Turrialba, Costa Rica, CATIE, Programa de Posgrado. 121 p.
12. **GONZALEZ CHAU, M. S.** 1992. Selectividad y producción de leche en pasturas de estrella (Cynodon nlemfuensis) solo y asociado con las leguminosas forrajeras Arachis pintoi CIAT 17434 y Desmodium ovalifolium CIAT 350. Tesis Mag. Sc. Turrialba, Costa Rica, CATIE, Area de Posgrado. 142 p.
13. **JIMENEZ BONILLA, V. I.** 1990. Establecimiento aséptico y propagación in vitro de Erythrina fusca y Erythrina poeppigiana por micro estacas. Tesis Mag. Sc. Turrialba, Costa Rica, CATIE, Programa de Posgrado. 81 p.
14. **JIMENEZ BURGOS, J. M.** 1990. Análisis del crecimiento y fenología del maíz (Zea mays L. c.v. Tuxpeño) en un cultivo en callejones con poró (Erythrina

- poepigiana (Walpers) O.F. Cook), plantado en cuatro arreglos espaciales. Tesis Mag. Sc. Turrialba, Costa Rica, CATIE. 124 p.
15. **LIMON LIMON, A.** 1993. Comportamiento de genotipos de maíz y frijol en cultivos en callejones con Erythrina poepigiana, Calliandra calothyrsus y Gliricidia sepium. Tesis Mag. Sc. Turrialba, Costa Rica, CATIE, Area de Posgrado. 126 p.
 16. **MEJIA CASCO, A. C.** 1994. Análisis del efecto inicial de un tratamiento de liberación, sobre la regeneración establecida en un bosque húmedo tropical aprovechado en Río San Juan, Nicaragua. Tesis Mag. Sc. Turrialba, Costa Rica, CATIE, Area de Posgrado. 88 p.
 17. **MENDIETA LOPEZ, M.** 1989. Caracterización de la composición química de procedencias y familias de Gliricidia sepium (Jacq.) Walp de México, América Central y Panamá. Tesis Mag. Sc. Turrialba, Costa Rica, CATIE, Programa de Estudios de Posgrado y Capacitación. 75 p.
 18. **NYGREN, P.** 1990. Modelos de patrones de sombra de surcos de Erythrina poepigiana (Walpers) O.F. Cook en sistemas de cultivo en callejones. Tesis Mag. Sc. Turrialba, Costa Rica, CATIE. 143 p.
 19. **OROZCO SEQUEIRA, G.** 1993. Desarrollo de un modelo para evaluación y utilización de tierras de uso agroforestal para la Región IV de Nicaragua, con el Sistema Automatizado de Evaluación de Tierras (ALES). Tesis Mag. Sc. Turrialba, Costa Rica, CATIE, Programa de Posgrado. 127 p.
 20. **PANIAGUA VASQUEZ, A. M.** 1992. Metodología de fraccionamiento de fósforo del suelo, en un sistema de cultivo en callejones, Turrialba, Costa Rica. Tesis Mag. Sc. Turrialba, Costa Rica, CATIE, Programa de Posgrado. 92 p.
 21. **PAYNE, L.D.** 1991. The alkaloids of Erythrina: clonal evaluation and metabolic fats. Ph.D. Thesis. Louisiana State University and Agricultural and Mechanical College, Graduate Faculty. 158 p.
 22. **PEREZ CASTELLON, E. E.** 1990. Evaluación del ensayo clonal de Erythrina spp. en San Juan Sur, Turrialba, Costa Rica. Tesis Mag. Sc. Turrialba,

Costa Rica, CATIE, Programa de Estudios de Posgrado y Capacitación. 111 p.

23. **RUIZ FONSECA, C. J.** 1992. Aceptabilidad por ovinos de la biomasa comestible, de procedencias, familias e individuos de Gliricidia sepium (Jacq.) Walp, Guápiles, Costa Rica. Tesis Mag. Sc. Turrialba, Costa Rica, CATIE, Programa de Posgrado. 99 p.
24. **SANCHEZ OVIEDO, J. F.** 1989. Análisis de la estabilidad y dinámica de sistemas de producción de cultivos en callejones. Tesis Mag. Sc. Turrialba, Costa Rica, CATIE. 174 p.
25. **TINEO BERMUDEZ, A.L.** 1993. Erosión hídrica, lixiviación y balance de N, P, K, Ca y Mg, en una rotación frijol-maíz con prácticas agronómicas de conservación de suelos, en tierras de ladera, Turrialba, Costa Rica. Tesis Mag. Sc. Turrialba, Costa Rica, CATIE, Area de Posgrado. 134 p.

TECHNICAL REPORTS

1. CATIE. 1993. Leucaena-Calliandra Project; **Progress Report 1992-1993**. Turrialba, Costa Rica, Proyecto AFN-SAREC. 18 p.
2. CATIE. 1994. Nitrogen Fixing Trees Project: Leucaena-Calliandra; **Progress Report 1993**. Turrialba, Costa Rica. 6 p.
3. CATIE-SAREC. 1991. Proyecto Arboles Fijadores de Nitrógeno: Leucaena-Calliandra. **Informe Anual 1991**. Turrialba, Costa Rica. 129 p.
También en inglés (127 p.).
4. CATIE-SAREC. 1991. Proyecto Arboles Fijadores de Nitrógeno: Leucaena-Calliandra. **Plan Operativo 1991-1992**. Turrialba, Costa Rica. 111 p.
También en inglés (123 p.).
5. CATIE-SAREC. 1992. Proyecto Arboles Fijadores de Nitrógeno: Leucaena-Calliandra. **Informe Anual 1992**. Turrialba, Costa Rica. 155 p.
También en inglés (152 p.).
6. CATIE-SAREC. 1993. Proyecto Arboles Fijadores de Nitrógeno: Leucaena-Calliandra. **Plan Operativo Enero 1993 - Junio 1994**. Turrialba, Costa Rica. 83 p.
También en inglés (85 p.).
7. IRENA-CATIE. 1991. Investigaciones en sistemas agroforestales como alternativas de uso de la tierra en Nicaragua. **Informe Anual 1991**. Turrialba, Costa Rica, CATIE/SAREC. 54 p.
También en inglés (54 p.).
8. IRENA-CATIE. 1991. Proyecto: Investigaciones en sistemas agroforestales como alternativas de uso de la tierra en Nicaragua. **Plan Operativo 1991-1992**. Turrialba, Costa Rica. 54 p.
También en inglés (46 p.).

9. IRENA-CATIE. 1993. Proyecto: Investigaciones en sistemas agroforestales como alternativas de uso de la tierra en Nicaragua. **Informe Anual 1992**. Turrialba, Costa Rica, CATIE/SAREC. 91 p.

También en inglés (93 p.).
10. UCA-CATIE. 1991. Desarrollo de sistemas de manejo sostenible para el aprovechamiento de los bosques húmedos tropicales de Nicaragua. **Informe Anual 1991**. Turrialba, Costa Rica, CATIE/SAREC. 138 p.

También en inglés (143 p.).
11. UCA-CATIE. 1991. **Plan Operativo** para el desarrollo de sistemas de manejo sostenible para el aprovechamiento de los bosques húmedos tropicales de Nicaragua. Turrialba, Costa Rica, CATIE/SAREC. 94 p.

También en inglés (95 p.).
12. UNA-ECFOR-CATIE. 1991. Estudio de componentes y sistemas agroforestales en Nicaragua. **Informe Anual de 1991**. Turrialba, Costa Rica, CATIE/SAREC. 41 p.

También en inglés (42 p.).
13. UNA-ECFOR-CATIE. 1991. Investigaciones para el manejo del bosque seco en Chacocente, Nicaragua. **Informe Anual 1991**. Turrialba, Costa Rica, CATIE/SAREC. 93 p.

También en inglés (96 p.).
14. UNA-ECFOR-CATIE. 1991. Investigación para el manejo del bosque seco en Chacocente, Nicaragua [**Plan Operativo**]. Turrialba, Costa Rica, CATIE/SAREC. 53 p.

También en inglés (62 p.).
15. UNA-ECFOR-CATIE. 1991. **Plan Operativo** del Proyecto "Estudio de componentes y sistemas agroforestales en Nicaragua". Turrialba, Costa Rica, CATIE/SAREC. 45 p.

También en inglés (49 p.).

FINANCIAL REPORTS

1. CENTRO AGRONOMICO TROPICAL DE INVESTIGACION Y ENSEÑANZA (CATIE). 1991. Financial Report: period Dec. 1, 1989 to April 30, 1991. 10 p.
2. _____. 1991. Financial Report: period December 1, 1989 to June 30, 1991. 10 p.
3. _____. 1992. Financial Report: period July 1, 1989 to Dec. 31, 1991. 10 p.
4. _____. 1992. Financial Report: period July 1, 1989 to June 30, 1992. 10 P.
5. _____. 1992. Financial Report: period Nov. 1, 1989 to Dec. 31, 1992. 19 p.
6. _____. 1993. Financial Report: period Jan. 1 - June 30, 1993. 4 p.
7. _____. 1994. Financial Report: period Jan. 1 - Dec. 31, 1993. 4 p.
8. _____. 1994. Financial Report: period Jan. 1 - June 30, 1994. 4 p.

TECHNICAL ASSISTANCE
1993 - 1994

Advisor	IRENA	UCA	UNA- CHACO	UNA- SAF	TOTAL DAYS
	D A Y S				
Romeo Solano	6	11,5	--	7,5	25
Jorge Jiménez	12,5	12,5	--	7,5	32,5
Pedro Oñoro	25	5	5	10	45
Edgar Víquez	25,5	5	--	2,5	33
César Sabogal	--	9	15	--	24
Eduardo Somarriba	--	--	--	5	5
TOTAL DAYS	69	43	20	32,5	164,5