Soil science in Costa Rica. Classification, fertility and conservation

ANEXO 18

CATIE
TURRIALBA, COSTA RICA

1978

CATIE

CENTRO AGRONOMICO TROPICAL DE INVESTIGACION Y ENSEÑANZA

SOIL SCIENCE IN COSTA RICA

CLASSIFICATION, FERTILITY AND CONSERVATION

Compiled by:

P. C. Dulsberg
H.P. Newton

Preliminary document for discussion prepared for the "Reunión Técnica Regional sobre Fertilidad y Análogos de Suelos", in San Salvador, El Salvador, March 13-18, 1978.

For review and completion by the Costa Rican soil scientists.

Turrialba, Costa Rica
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Acknowledgement

The authors appreciate the many Costa Rican soils men and others who gave the information which made this report possible. They especially wish to thank Dr. Elemer Bornemisza and Ing. Agr. Alfredo Alvarado of the University of Costa Rica, and Ing. Agr. Alexis Vásquez of MAG for their suggestions and corrections and their helpfulness.

Abstract

The status of soil science in the fields of classification, fertility and conservation is reviewed. The history of these fields is briefly discussed. The existing agencies, and groups and their work in soils are described in some detail. Agencies which provide services and products used in soils work, such as maps, and institutions which supply supplementary information from other natural resources fields important to understanding and using soils information in context with the total environment, are treated in less detail.

A summary table is presented making it possible to compare soils agencies on a number of points. An incomplete section of soils references and maps is included to stress the importance of completing this work. Details on the status of soil classification work is presented in the appendix and on a separate map.

A section of conclusions and suggestions represents an attempt to evaluate the meaning of the information in the report with respect to making suggestions as to needs for studies and policies for improving the organization and use of soil science and soils scientists in Costa Rica. This section represents values judgements by the authors. It is particularly important that it be recognized as an imperfect analysis which should be deepened and revised by other soil scientists.

SOIL SCIENCE IN COSTA RICA*

CLASSIFICATION, FERTILITY AND CONSERVATION

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I. INTRODUCTION

This is one of six reports on the state of soils work in the countries of the Central American Isthmus. A similar outline and pattern is presented in each, in order to make the country reports as comparable as possible. Reports are based on interviews by members of the "Soil Analog Project" plus published information and reports available. However, no claim to completeness or full accuracy can be made. In Costa Rica the the report was prepared with some participation by national soil scientists. In other countries time did not permit even this. It is hoped that these imperfect reports will serve as a basis for discussion during the first regional soils meeting at San Salvador, El Salvador from March 13 to March 18, 1978, and that soils scientists from the different countries present will improve and complete the documents for their countries. The Costa Rican report is the best but still should be thoroughly revised and improved by national and other soils men.

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* Preliminary document for discussion prepared for the "Reunión Técnica Regional sobre Fertilidad y Análogos de Suelos", in San Salvador, El Salvador, March 13-18, 1978.

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If all countries produce quality documents they can be used as the basis for a comprehensive document on the state of soils work in Central America and a realistic assessment of the weaknesses and needs for strengthening the field. The field of soil science in Central America cannot serve as a basis for improving soil analogs and overall development unless it can be considerably strengthened. The similar soils which have been identified through the soil analog subproject of CATIE/ROCAP for the Pacific area of Nicaragua, Honduras and El Salvador represent only a first step. If basic knowledge of soils and climate can be improved, the quality of analogs will also improve. The potential economic and social savings of identifying soils requiring very similar management, fertilization and conservation practices is enormous.

II. CONCLUSIONS AND SUGGESTIONS FOR THE FIELDS OF CLASSIFICATION, FERTILITY AND CONSERVATION

Costa Rican soil science has produced more advanced and sophisticated soil research than any other country in Central America. On the other hand it has lagged behind in coordinating its efforts and in obtaining some of the simpler and more basic information needed for classifyng soils and making fertilizer recommendations. It would appear that if the Costa Rican soil scientists could coordinate their present capability more efficiently they could have considerably greater effect on agricultural improvement. Nevertheless, a larger cadre of soil scientists is needed. Since the calibre and interest of agronomy students is high and the university training adequate, Costa Rica should be able to produce the Agronomists needed. Those capable and interested in soils could receive further specialized training needed in a very few years.

Perhaps the most glaring weakness in Costa Rica lies in the field of soils classification. However, since 1971 several promising soil scientists have begun to provide leadership. With minimal support they have ingeniously reviewed fragmented theses and work of the past and translated it into the new taxonomy. The most recent result has been a general soils map of the nation with a fair degree of reliability to the level of suborders. Many of the major agriculturally significant soil series have already been described. However, there are also many gaps and inconsistencies. In addition, many soil problems due to poor land use are beginning to become apparent. What is needed is a project using air photography or photomosaics to a level of detail of the major AID projects carried out in recent years in Nicaragua.

Panamá, Honduras and El Salvador. This could now be carried out with available Central American and Costa Rican leadership at lower cost.

An asset for this work is the existence of ample laboratory facilities and laboratory direction at the University of Costa Rica, CATIE and the Ministry of Agriculture and Animal Husbandry. With some increases in and training of laboratory personnel, it should be possible to meet laboratory needs. At the same time these laboratories might better coordinate their efforts, increase their production and increase their capacities for routine and research analysis. CATIE (formerly IICA) could participate in this Costa Rican coordination while also providing leadership in improving and standardizing methodology and laboratory operation over the entire Central American isthmus. There would not seem to be much need for additional laboratory space for the next few years, since there is still underused capacity.

Costa Rica has a small number of men doing detailed soil survey and mapping for irrigation in the soils section of the Direction of Irrigation and Drainage. This group could benefit from technical assistance in the form of an outstanding advisor. It could be equipped to carry on detailed studies for dry land farm lands of high potential as well as irrigation. A nucleous could be developed to train others needed. One inexpensive way of obtaining this training might be to obtain help from specialists from other Central American countries. Some have several exceptionally experienced and qualified men. There is also a need to bring soil survey in many areas to the level of capability units and relating them to crop response.

In the field of soil chemistry research, Costa Rica has been more fortunate than its neighbours. The Interamerican Institute of Agricultural Sciences now called CATIE at Turrialba has had a series of projects and outstanding internationally known soil scientists over a thirty-year period. This has resulted in important research in past years. In addition, the Univeristy of Costa Rica Center of Research has had a vigorous program in soils and plant chemistry for years.

Research is especially dependent on good library facilities.

Costa Rica has been fortunate in that during the 50's and 60's the IICA library in Turrialba was considered by many as the outstanding library in Tropical agriculture and in soils in Latin America. Recently the library has suffered from the effects of a reorganization and a lack of funds. Every effort should be made to help it regain its excellency not only in the interests of Costa Rica but for the whole Central American region. Meanwhile the University of Costa Rica has been improving its library.

Possibly the biggest weakness in research in Costa Rica lies in the dissemination and use of results. Soil scientists should devise ways of overcoming this deficiency in their field.

The situation with respect to fertilizer trials is spotty. Coffee has been given special attention and support by the government. Coffee trials have been widespread with notable effects on production and more efficient fertilizer use. Other crops have not fared so well except perhaps rice and bananas.

At present there is a fair amount of effort being devoted to fertilizer trials. However, for various reasons many are lost, do not yield

significant results or are not transferred to the farmers. The recent CIMMYT program in wheat and corn has resulted in cooperation between the University of Costa Rica agronomists and those from the regional centers of the Ministry of Agriculture, and involves the application of a methodology designed to demonstrate successful results to the farmer. It is too early to say how successful this approach will be, but it appears promising. However, a main problem, adequate supervision of the plots, may remain. There is also duplication and lack of effective coordination in the present fertility trial program.

Routine analytical laboratory data, research data and soil classification information should all be used more in selecting sites for fertilizer trials. A decision to obtain soil profiles for characterization and classification at each fertilizer trial site might help solve the weakness in the soil classification field as well as increase the meaning of the trial results.

Although the government is at last actively trying to keep lands in national forest reserves and national parks from being overrun, deforested and eroded, the results to date leave much to be desired. There is little or no control over private lands and soil erosion from this source is considerable. The government is now greatly expanding its staff of forest guards and this should help.

However, there are still no technicians working in the field of soil conservation in spite of the increased recognition of the importance of the field to the future of the country.

A project of law has been proposed for a National Resources Institute (INDERENA). If INDERENA is formed, one of its stated responsibiliti

will be for the field of soil conservation. Even if INDERENA is not formed, the official program of the Unity Party which will be in power from 1978 until 1982 states that numerous offices related with Natural Resources and the environemnt are dispersed and inefficient and there is no "solid public institution dedicated to the problem of conservation and good use of Natural Resources and Enviromnetnal Protection". Therefore, if the soil scientists and others interested in the conservation of the environment will take the time to make specific practical proposals it is likely that their ideas will receive serious consideration.

In conclusion, there is a great deal that Costa Rica could do by using the present cadre more efficiently and by improving the ways in which soils information reaches the planning office and OPSA and is used by them and in agriculture. However, in addition comprehensive programs are needed and training opportunities should be increased, which would require higher levels of support.

III. SUMMARY TABLE OF SOILS AGENCIES IN COSTA RICA

Table I in the back envelope of this report compares some basic information for each of the entities in the field of soils in Costa Rica.

The information on budget is quite rough in some cases but probably represents a fair estimate of the total spent and the relative parts of the total spent by government agencies, the university, etc. An attempt was made to confirm these estimates with persons within the entity concerned. In a few cases estimates were made on the basis of the number of employees, estimated salaries and other costs without cross checking.

It is recommended that this table be expanded and made more accurate by the Costa Rican soil scientists. It will provide a rapid means to determine where efficiencies could be effected and where possible duplications exist and where additional funding should be sought. In addition, when compared with similar Tables from the other five countries of the Isthmus, it will tell much about where Costa Rica stands and what the regional picture looks like.

IV. EARLY PERIOD OF SOIL SCIENCE

A. Soil Classification

Initial attempts at soil clasiification began with the United Fruit Company about 1918. In 1924 H.H. Bennett, founder of the U.S. Soil Conservation Service, made a very general survey as part of a program to find areas suited for rubber production in tropical America. Although the United Fruit Company produced a large number of soil maps, these seem to have been largely limited to determining texture along grid lines.

In the early 1950's the field received a stimulus because of the search for areas suitable for abaca production (Robinson and H. Stryker, 1951) the surveys of the Standard Fruit Company and work at the Interamerican Institute of Agricultural Sciences at Turrialba (IICA and now CATIE). Standard Fruit systematically mapped areas at the series level on the Atlantic coast of interest for growing the Panama disease-resistant variety Cavendish. Standard Fruit subsequently established fertilizer experiments to determine potential productivity and nutrient needs of the important soil series.

In the late 1950's, a number of areas were mapped by the Ministry of Agriculture and Industries. Dondoli and Torres (1954) studied the Eastern part of the Meseta Central and Vargas (1958) studied the Pacific side. Leitón and Sáenz (1958) studied part of the Pacific Coast and Vargas (1959) the Tempisque Valley. Soil mapping during this period was influenced by geologists who felt that a study of soil minerals was of special value.

Soil surveys work never received substancial assistance from international organizations such as the US Point 4 program and FAO, although more general soils advisors, including one of the writers, H. Newton, were furnished by STICA (Point 4). Some soil classification was done by students and

professors at IICA in Turrialba. In 1958 the small soils section originally under Ing. Torres was divided between the geology and rural engineering departments of the Ministry.

Also in the 60's, the Institute for Land and Colonization (ITCO) made several regional studies of natural resources, including soils at a reconaissance level, in the North. During this period, also Plath published a technical map using his land use potential method at 1:1'000,000 and some of his students at IICA in Turrialba applied it at larger scales in Guanacaste.

Coto and Torres in 1970 dropped some of the climatic parameters of Plath's system in producing a national map with his four classes at 1:750,000. In addition, other technical type maps using the land capability system of the U.S. Soil Conservation Service and the irrigation classes of the U.S. Bureau of Reclamation have been produced for specific purposes and limited areas over the years.

The present period began about 1971 with the formation of a soils Department within the new Direction of Irrigation and Drainage. This Department began by making technical maps for irrigation potential and detailed surveys of irrigation projects. It now provides a more scientific foundation for such technical maps based on use of the new taxonomy of the U.S. Soil Conservation Service. During the same period Ing. A. Alvarado stimulated interest and initiated modern teaching in soil classification at the University of Costa Rica. His compilation "Evaluación sobre clasificación de suelos en Costa Rica" (appendix A) summarizes what has been done in soil classification. In addition, this technical bulletin includes two small scale maps showing the areas covered by soil surveys of diverse kinds both

nationally and for the Meseta Central. This national map has been updated for this report (see map 1). In addition, Alvarado has classified soil profiles according to the new taxonomy . These, as well as others collected for this report from theses, are included in Table 2.

Three national maps have been published over the years. The first in 1965 by the AID Resources Inventory Center and ROCAP as part of an Atlas. The map was at the level of great Soils groups at the small scale of 1:1'750,000. The second was the 1:5'000,000 soil map of Mexico and Central America prepared by FAO-UNESCO and published in 1975 using their new classification. The FAO-UNESCO map is useful in showing general relationships between soils of the countries of the Central American Isthmus. However, the scale is too small to be of much use nationally. The AID/ROCAP map is part of an Atlas containing some 30 other subjects. The soils map at a scale of 1·750,000 uses the superceded great soil group nomenclature. It also has the deficiency in that it draws conclusions and extrapolates from limited information of uncertain reliability.

In 1978, Alvarado and Perez prepared a soils map at 1:200,000 for OPSA using the new taxonomy to the level of sub-groups. This map is based on all the information presently available on profiles, series and from less precise information. Many soil unit limits are drawn by making inferences from topographic and ecological maps and using climate information. It is a major step forward but preliminary until it can be thoroughly field checked and revised. The information for the OPSA map is already sufficient to revise and improve and modernize the AID/ROCAP map with little additional effort. Present Costa Rican knowledge is more than adequate for a map with a fair level of accuracy at this small scale.

It would appear that after many years of lagging behind in soil classification, Costa Rica is now well prepared and has leaders for an imaginative and creative program to fill in the many gaps in knowledge.

B. Soil Fertility

Initial interest in fertilizer use began with the main crops of coffee and bananas. In the case of coffee, field experiments were set up on an extensive scale, beginning in the 1950's by the Coffee Department of STICA under the advice of Dr. H. Mowry. Dr. Mowry also helped negotiate a contract with the University of Florida which resulted in substantial accomplishments in plant and soil science.

During this period investigations included foliar testing with field sites for both major nutrients and trace elements. This fertilizer-trace element program, along with other aspects of coffee improvement by STICA and IICA in Turrialba, helped Costa Rica almost double its coffee production from one half million bags to 900,000 in about 5 years without any appreciable increase in the area cultivated (Rice was also studied and later the country was converted from an importer to an exporter of a small excess). W.G. Blue did pioneer work on pasture fertilization with important findings, and laid the basis for a continuing effort.

Export of bananas was first largely under control of the United Fruit Company and later Standard Fruit Company. United Fruit limited its fertilization program primarily to urea. However, Standard Fruit based its recommendations on more scientific soil surveys and laboratory testing and had a much more varied and effective program.

This may have been partly a necessity, since their soils were are often poorer quality and more highly leached and mostly on the Atlantic side. Both companies also engaged in cacao and oil palm production to some extent.

During the 60's fertilization trials were extended to corn and other basic crops for the major elements as part of the international FAO-Freedom from Hunger Program. While some dramatic results were obtained, much of the data of this program have apparently been lost with little benefit. Same were rescued by J. Walker and the results are being recalcuated and archived under the present CATIE/ROCAP soil analog subproject.

At present fertilizer trial work has been carried out by the Department of Coffee investigations of the Ministry of Agriculture for coffee and the Department of Agronomy for all other crops. The University of Costa Rica also has a separate rpogram.

Routine laboratory analyses of farm soil and leaf samples received a strong stimulus from the North Carolina State-USAID project which began in Costa Rica in 1964. This project included all of Latin America and has resulted in adoption of similar methods by all the countries of the Central American Isthmus. In Costa Rica laboratory facilities have been improved and expanded quarters were opened in 1972. The North Carolina project was terminated in 1976 but J. Walker remained to transfer its regional functions to CATIE until 1978.

From the 1950's on, Costa Rica has been the most advanced country in Central America with respect to soil and plant chemistry research. This is partly due to the highly trained scientists from many countries who have done research or advised graduate students at the International Institute,

IICA in Turrialba (now CATIE). In addition to research on soils as such, considerable work was done in connection with research on such crops as cocoa and coffee and pastures. During the 60's and early 70's the Institute at Turrialba carried out an extensive program involving radioactive isotopes under grants from the U.S. Atomic Energy Comission. This program did not survive the termination of grant funding except for tracer projects from time to time conducted at the University of Costa Rica.

At present CATIE is doing very little soils research since it has changed its orientation toward interdisciplinary projects related to systems of agriculture and identification of Soil Analogs. Almost all soil and plant chemistry research is now being done at the Center of Investigations of the University of Costa Rica. This laboratory dates from the time of STICA and has retained a vigorous and active program.

The department of the Ministry of Agriculture and the experiment station of the Univeristy of Costa Rica carry out fertility trials. The regional centers of the extension service have also carried out some independently and some cooperatively. Careful consideration ought to be given to the efficiency and degree to which the results of fertilizer trials, routine laboratory analysis and research data are used to supplement each other and are archived, disseminated and applied at the farm level and for regional characterization.

C. Soil Conservation

An article appeared in the magazine of the coffee growers, pointing out the importance of soil conservation on steep cultivated lands as early as 1935. There were a few additional articles and graduate theses at IICA in

Turrialba through the 50's. Although little was accomplished in a practical way in the field, the soils section of the Ministry was officially called the Soil Conservation Department in the mid '50's.

During the 60's when ITCA was doing its studies, the emphasis was on opening new lands for forestry and colonization and harnessing rivers for hydroelectric power, rather than concern for conservation.

CATIE acquired a Soil Physicist who became interested and guided three practically oriented graduate theses in the mid 70's and constructed erosion control demonstration plots at low cost. However, following his departure, no plans were made to try to replace his skills on the staff. Almost simultaneously, however, the effect of deforestation, poor land use and soil erosion on dependable public water supply, loss of storage capacity in hydroelectric dams from sedimentation and the cost of fertility loss to marginal farm families began to cause concern at high political levels. A proposal for a law to establish a Natural Resources Institute has been drafted. Therefore, it appears that the time is appropriate for the proposal of a well-reasoned farsighted program related to soil conservation in Costa Rica.

There are not any persons employed in the field at this time and few soil specialists have taken public positions expressing the need and apparently none participated in the planning for the Natural Resources Institute.

V. PRESENT SOILS ENTITIES AND LABORATORIES

Introduction

The soils work in Costa Rica involves an annual expenditure of about six hundred thousand dollars, as indicated in Table 1. This is divided among three major institutions: the Ministry of Agriculture with almost half of the budget, the University of Costa Rica more than one quarter and CATIE almost one sixth. ITCO and private business make up the remainder. While CATIE is a regional institution, the fact that its most highly trained personnel, its laboratories and the major part of its research and graduate theses are done in Costa Rica, gives it a special significance to Costa Rican soil science. It is to be hoped that its present ROCAP funded regional Soil Fertility Project may establish the need for it to play a continuing coordinating roele betweer Central American countries. Costa Rica would automatically become a principal beneficiaty because of the physical location of CATIE within the country.

A. Ministerio de Agricultura y Ganadería

1. Dirección General de Investigaciones Agrícolas

This office is responsible for the research program of the Ministry and maintains the experiment stations "Los Diamantes" on the Atlantic; El Alto on the Meseta Central; and Estación Experimental Enrique Jiménez Núñez, in Guanacaste.

It also carries out considerable experimental work in cooperation with the Regional Centers of the Extension Service and on private haciendas and fincas.

The subprojects programmed for 1976 illustrate the fields of interest and relative distribution of effort as shown in Table 2, for 1976. Some 50 subprojects are listed under Fertilization. The number actually successfully carried to completion, analysed and archived is generally considerably less than programmed due to unforeseen climatic and biological, human, economic and logistical problems.

The Direction is organized as follows:

Dirección General de Investigaciones Agrícolas; Ing. Agr. Carmona, Jefe.

Ing. Agr. A. Vargas, Sub-Jefe.

Departamento de Investigaciones en Café, Ing. Agr. Juan Pérez.

Departamento de Entomología, Ing. Agr. E. Morales.

Departamento de Fitopatología, Ing. Agr. Bianchini.

Departamento de Agronomía, Ing. Agr. Carlos Ramírez, Jefe.

- Sección de Fertilidad de Suelos y Nutrición de Plantas.
- Sección de Arroz.
- Sección de Caña.
- Sección de Semillas.
- Sección de Maíz/Sorgo.
- Sección de Leguminosas de Grano.
- Sección de Laboratorio de Suelos.

Departamento de Biometría.

Fertility trials involving specific crops by sections of the Agronomy Department and the Coffee Research Department constitute much of the effort in soils. The principal group in the Agronomy Department involved in the planning, execution, analysis and interpretation of these trials is the three man section of Soil Fertility and Plant Nutrition, often with the cooperation of the section responsible for the crop involved and at times with the regional center in whose area the trial is carried out.

Tabla 2. Dirección General de Investigaciones Agrícolas
Ministerio de Agricultura y Ganadería
Subproyectos Programados para 1976.

	Mejoramiento Genético	Fertilización	Prácticas Culturales	Entomología	Fitopatología	Estudios Económicos	Industrialización	Total
Arroz	6	3	6	6	4	--	--	25
Banano	-	-	-	-	2	--	--	2
Café	6	14	25	1	19	--	--	65
Caña de azúcar	6	4	2	1	6	--	--	19
Control biológico	-	-	-	3	-	--	--	3
Cultivos varios	3	-	-	-	2	--	--	5
Fruticultura	13	2	-	2	6	4	--	27
Horticultura	4	11	-	7	1	--	--	23
Leguminosas de Grano	13	1	9	1	3	--	--	27
Maíz	18	3	4	12	1	--	--	38
Tecnología de Alimentos	-	-	-	-	-	--	7	7
Tubérculos y raíces	7	8	6	6	17	--	--	44
Sorgo	4	1	-	2	3	--	--	10
Fertilidad y fertilización de suelos	-	3	-	-	-	--	--	3
Semilla mejorada	3	-	-	-	-	--	--	3
TOTAL	83	50	62	41	64	4	7	301

The Coffee Research Department has a section on mineral nutrition about twice the size of that of the Agronomy Department.

The other major source of soils work in the Dirección is the soils laboratory which does routine fertility analyses on farm soil samples for fertilizer recommendations and makes certain soil, foliar and greenhouse tests for other units of the government, particularly those within the Ministry of Agriculture and private agricultural firms.

a. Department of Agronomy

i. Section on Soil Fertility and Plant Nutrition

The Soil Fertility and Plant Nutrition section of the Department of Agronomy carries out independent soil fertility trials. They also plan trials for some of the other sections related to specific crops - i.e. sugar cane section. They are located in the same building as the MAG soils laboratory which makes it convenient to share results and exchange ideas.

The unit is headed by Dr Alvaro Cordero, who recently received his Ph.D. from North Carolina State University. Dr. G. Ramírez is working with Dr. Cordero, but is on loan from the Soils Section of the Department of Irrigation and Drainage. Ing. P. Guzmán is studying in Spain. There is one sub-professional helper and two vehicles.

Corn and bean trials are set up in various parts of the country, cotton in Guanacaste, rice on the Southern Pacific coast and middle Pacific coast, sorghum in the drier areas of the Pacific coast, vegetables in the zone of San Carlos and at the University of Costa Rica experiment station near

Alajuela, bananas at the experiment station "Los Diamantes" on the Atlantic sode and sugarcane at various locations sometimes in cooperation with the Liga de la Caña. Various experiments are located at experiment stations and others on farms.

Care of the trials is a problem in view of their distribution throughout the country, limited personnel and vehicles. Therefore, assistance from regional extension service centers could be critical. The section plans and coordinates trials through these centers and receives varying amounts of cooperation in their care, but it was our impression that this is a weak point. Formerly, Peace Corps volunteers were a valuable form of additional assistance, but this source seems to have diminished. Some farm cooperators are very helpful in maintaining the scientific integrity of the trials and others less so. In a recent period about 10 of 30 trials were lost because of drought and other causes. The total number planned for 1978 involving the section is over 30.

Fertilizer applications are usually of varying amounts of N, P, and K, the combination and quantities depending on the region where experiments are conducted. Other elements included are mostly sulfur and zinc, with some work on copper toxicity on the rice growing on formerly banana growing soils in the South.

In the past the fertility section also carried out fertilizer field trials on African oil palm. However, the experiments, due to size (large plots) and fertilizer consumption, turned out too costly and were given up.

Identification of the soils on which fertilizer field experiments were conducted has been variable. In past years Dr. G. Miner and Dr. S. W. Buol of N. C. State University have identified and classified a number of

soils on which experiments were located, but the practice has not been continued even though Costa Rican classifiers are competent to do it.

Dr. Perrin, also of N. C. State University, has collected considerable data on soil fertility and experiments from Costa Rica. Dr. Miner participated in rice fertility research. This was quite successful in solving problems and was a factor in converting Costa Rica into a new exporter in rice.

Soil fertility work by MAG is directly supported by the soil laboratory of MAG in the same building. It would appear logical to combine the two sections, without the laboratory losing its responsibility for serving national needs.

II. Section of Soils Laboratory - MAG (Laboratorio de Suelos y Foliares, MAG)

This laboratory has existed since 1962. It received technical assistance from a series of advisors from North Carolina State University starting in 1964. The North Carolina analytical methods and procedures for rapid fertility analysis of routine soil samples and for foliar analyses and greenhouse testing were largely accepted (as they also were in other Central American countries). In 1974, it was moved to a fair sized building located in Guadalupe designed for the government as a laboratory. There seems to be more than adequate space at present for the laboratories. Additional work benches could be installed if the volume or nature of the services were expanded. The conference room designed for transfer of information to farmers and technicians has been taken over by the library of MAG. The conference room could be an important aid in reaching and

transferring knowledge if it were restored and well used. The library appears small, poorly organized, out of date and already overcrowded in the space provided. In addition, its distance from the main offices of MAG in San José makes it less convenient to use.

The Ministry of Agriculture has several greenhouses in the area behind the building. These are in urgent need of repair and are assigned to various sections of the Ministry. At present there would be more greenhouse space available than needed if they could be properly reconditioned.

The laboratory is directed by Ing. Agr. Raymundo Amerling. He is assisted by one other Ingeniero Agrónomo and a chemist and relies on two student subprofessionals and two non-technical helpers. One secretarial position is allotted for sharing with the Section on Soil Fertility and Plant Nutrition.

The production of the Laboratory is as follows:

1970	4255 soil samples
1971	4520 soil samples
1972	5706 soil samples
1973	8607 soil samples
1974	8509 soil samples
1975	11361 soil samples
1976	13496 soil samples

The increase in the number of samples probably is the result of increased fertilizer prices, and due to the fact that in 1974 the laboratory started to give fertilizer recommendations, while prior to this they had only reported the analytical results, which do not mean as much to many people. The routine analysis includes. pH, P, K, Ca, Mg, Al, Fe, Cu, Zn, Mn. If P, K, Fe, are high in research samples,a more exact analysis follows the routine analysis.

High results for Cu are frequent in the south where banana lands have been converted to rice and corn lands. The frequent application of Bordeaux mixture on bananas has produced levels of 1000 ppm of Cu on some soils. This causes problems with rice and corn. The laboratory also analyses foliar samples, which are usually research samples, although some come from fertilizer companies and some from the banana companies.

The distribution of analyses in 1974 was as follows:

57.0%	routine (service samples)
38.8%	research
4.2%	Physical analysis

Since then, there has been an increased proportion of service samples and fewer research samples.

The following foliar samples were analysed:

1972	668
1973	2317
1974	1173
1975	4423
1976	2202

FERTICA, the biggest fertilizer company in Costa Rica, has not equipped its own laboratory, and relies on the MAG laboratory. Abonos Superior did have its own laboratory but gave it up and uses MAG.

The physical analyses are done by an Ing. Agr. and one sub-professional (student) who are part of the "Dirección de Riego y Drenaje, MAG" and therefore are under the direction of Ing. Vásquez of the Department of Soils of that division. There is naturally considerable interchange and cooperation since they occupy the same facility. Nevertheless, it would appear to be desirable to fully integrate the laboratory, something successive foreign advisors in MAG, including one of the writers (H. Newton) have advocated.

The routine physical determinations are Retention of Moisture (1/3 and 15 atmospheres); texture, bulk density, and real density. Also, in many samples the cation exchange capacity (CEC) is determined by the chemical laboratory.

Since 1974 the laboratory has filed analytical data on the basis of political subdivisions, i.e. provinces, cantons and municipios. Since four of the seven provinces reach all the way from high mountain tops to the low level tropics, it would be desirable to tie the data to soil s ries and climate. However, since only a limited number of soil series have been mapped and identified in Costa Rica, this is not entirely practical for the near future. Meanwhile, the results could be stored in such a way that the soils classification could be added at a later date for each farmer's name. At present fertilizer recommendations are quite general and for each of nine agricultural regions, and leave ample opportunities for the laboratory to improve their precision. Table 3 for sugarcane is an example.

It is said that the banana growers asociacion, BANDECO has a laboratory at Hacienda Carmen near Siquirres and that the Liga de la Caña has or had one but time did not permit further investigation.

b. Departamento de Investigaciones de Café

Costa Rica was one of the first Central American countries to produce coffee as an important export beginning about the 1840's. It has ever since been the principal crop although others like bananas have exceeded it in value at various times.

TABLE 3. MINISTERIO DE AGRICULTURA Y GANADERIA
DIRECCION DE INVESTIGACIONES AGRICOLAS
DEPARTAMENTO DE AGRONOMIA
LABORATORIO DE SUELOS

RECOMENDACIONES PARA FERTILIZACION DE CAÑA DE AZUCAR

Sugerencias de $N-P_2O_5$ y K_2O en Kg/Ha. (SIEMBRA)

85-200-150	85-200-110	85-200-70
Nº1 A) 0-200- 0 B) 40- 0 -75 C) 45- 0 -75	Nº2 A) 0-200- 0 B) 40- 0 -55 C) 45- 0 -55	Nº3 A) 0-200- 0 B) 40- 0 -35 C) 45- 0 -35
85-100-150	85-100-110	85-100-70
Nº4 A) 0-100- 0 B) 40- 0 -75 C) 45- 0 -75	Nº5 A) 0-100- 0 B) 40- 0 -55 C) 45- 0 -55	Nº6 A) 0-100- 0 B) 40- 0 -35 C) 45- 0 -35
85- 80-150	85- 80-110	85- 80-70
Nº7 A) 0- 80- 0 B) 40- 0 -75 C) 45- 0 -75	Nº8 A) 0- 80- 0 B) 40- 0 -55 C) 45- 0 -55	Nº9 A) 0- 80- 0 B) 40- 0 -35 C) 45- 0 -35

El nivel de NITROGENO se calcula de acuerdo a la producción y se estima en 1 Kg. por Tonelada de caña, por corte.

A) A la siembra en el fondo del surco
B) A los dos meses de la siembra; en bandas, sólo la macolla
C) A los cuatro meses de la siembra, en bandas.

En suelos de características ácida, es recomendable el uso de SULFATO DE - POTASIO en fórmula. Lo mismo que FOSFORO a base de superfosfato sencillo.

En suelos con pH menor de 5.2, es necesario efectuar encalado durante la preparación del terreno, usando 800 Kgs carbonato de CALCIO por Ha. Luego se harán aplicaciones con la misma cantidad de carbonato de calcio, corte de por medio.

CAÑA DE AZUCAR - RETOÑO

85-100-150	85-100-110	85-100-70
Nº1 A) 40-100- 75 B) 45- 0 - 75	Nº2 A) 40-100- 55 B) 45- 0 - 55	Nº3 A) 40-100- 35 B) 45- 0 - 35
85- 50-150	85- 50-110	85- 50- 70
Nº4 A) 40- 50- 75 B) 45- 0 - 75	Nº5 A) 40- 50- 55 B) 45- 0 - 55	Nº6 A) 40- 50- 35 B) 45- 0 - 35
85- 40-150	85- 40-110	85-40 - 70
Nº7 A) 40- 40- 75 B) 45- 0 - 75	Nº8 A) 40- 40- 55 B) 45- 0 -,55	Nº9 A) 40-40 - 35 B) 45- 0 - 35

El NITROGENO se aplicará de acuerdo a la producción y se estima en 1 kg. por tonelada de caña, por corte.

A) Se aplica 1 o 2 meses después del corte.

B) Se aplica 4 meses después del corte.

En suelos de característica ácida, es recomendable el uso de SULFATO DE - POTASIO en la fórmula. Lo mismo que FOSFORO a base de superfosfato sencillo.

En suelos con pH menor de 5.2 es necesario efectuar encalado corte de por medio, a razón de 800 Kgs. de carbonato de CALCIO por Ha.

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Coffee is the only crop in the Dirección de Investigaciones Agrícolas to have a special department. The other crops are treated as sections within the Department of Agronomy. In 1976 the area planted to coffee was 83.406 hectareas employing over 200,000 in the harvest. In the Agricultural Census of 1973, 32,358 fincas are listed most of which do not exceed 10 hectares in size. The department claims that yields have increased from 7.87 fanegas/ha in 1950/57 to 20.26 in 1976/77, a gain of almost 300 percent. Specialists from around the world have come to observe Costa Rican practices since yields are among the highest in the world. In the last three years yields have declined for various reasons including lower fertilizer use due to high cost.

A cooperative program on coffee between the Ministry of Agriculture and the Office of Coffee began in 1962. The Office of Coffee is governed by representatives of the Ministry of Economics, Industry and commerce, two producer members, one representative of the "Beneficios" and one representative of the exporters. The program is supported by an ad-valorem tax on coffee.

In the 1950's considerable pioneer research was done under the STICA-University of Florida Contract. Since, then the Department has carried out numerous fertilizer trials. Partly as a result of these two efforts fertilizer consumption for coffee is among the highest in the world and includes minor element supplements in areas where deficiencies were discovered.

The organization of the Department is as follows:

Sección de Nutrición Mineral
Sección de Mejoramiento Genético
Sección de Modalidades de Cultivo

Control of weeds work is done by the entire staff. Technical assistance to farmers is done by the entire staff in the form of technical services, short courses, technical and other publications. Seed and nursery plants are distributed. The department also maintains 50 demonstration areas to show and teach cultural practices.

From the point of view of soils and soil plant relationships, the section of primary importance is the Sección de Nutrición Mineral.

The emphases of this section are the following:

1. Nutritional needs of coffee
2. Sources of nutritive elements on fertilizers
3. Time and methods of application of fertilizers
4. Levels and quantities of fertilizer elements needed.
5. Effects of fertilization on the yield and quality

The department is under the supervision of Ing. Juan Pérez G. The staff includes about 20 technicians of whom about half are Ingenieros Agrónomos and some have not quite finished their agronomy degrees.

In 1976, the Sección de Nutrición Mineral consisted of three Ingenieros Agrónomos, three Ingenieros Agrónomos who are in process of receiving degrees and one technical assistant. They have 18-20 trials per year carried out in different coffee farms throughout the country.

These trials mostly test the effect on yield of the major elements. Increases averaged up to 40% in 1976 compared to controls.

Since the coffee program is largely financed by a fee on the crop it would probably not be popular to combine all fertilizer trial work in the Ministry. However, since diversification has been important to maintaining income for coffee growers it may not be impossible.

Since the University of Costa Rica also carries out such trials, it should be considered in any plans for more coordination or partial or total consolidation.

2. Dirección de Riego y Drenaje, MAG

a. Departamento de Suelos

This office is under the supervision of Ing. Agr. J. Mannix. It is housed near the hospital Calderón Guardia in San José, i.e. well away from the main Ministry building, where it shares the premises with the National Park Service and the Meteorological Service. The "Dirección de Riego y Drenaje" consists of the Department of Rural Engineering, under Guillermo Cabrera, concerned with direct assistance to the extension service, Departament of Engineering under Ing. F. Picado, concerned with the design of irrigation and drainage projects, and Department of Soils under Ing. Agr. Alexis Vásquez. It began its work in 1971.

The Soils Department has completed considerable soil survey in the central valley including 20,000 ha at a detailed level. It has classified the area according to irrigation capability. This work has been in connection with the "Distrito de Riego Río Itiquís", near Alajuela, the main work of the entire irrigation and drainage office. A map with soils classified according to irrigation classes covers about 15,000 ha.

There are 600 families in this project with average sized holdings of about five hectares. It includes two or three owners with as much as 50 ha. The office maintains a local branch and gives technical services to this district.

At present the principal work of the soils department is mapping the planned "Distrito de Riego de Moracia" in Guanacaste. This project includes the area of the Tempisque River Valley project which has been studied several times since the early fifties, but never before found feasible. However now, with ICE contributing water from the Arenal Project, it has become a much bigger project and has been approved as feasible as some of the costs can be written off against power production. Engineering aspects are being studied by a consortium of BEL, a local engineering firm, and Backman-Edmonston, a Glendale, California engineering firm.

The "Distrito de Moracia" covers a total of 184,000 ha of which about 100,000 ha seem suitable for irrigation. A soil reconaissance study on a 1:100,000 map was completed in 1974 ("Estudio del Suelo a Nivel de Reconocimiento: Proyecto de Riego mediante el Aprovechamiento de las Aguas de la Laguna de Arenal", por el Ing. Agr. A. Vásquez M., 1974). While the soils are classified according to the U.S. taxonomy, the report contains no detailed soil profile description.

A total of 60-70,000 ha within the district (in two sections, one on the N.W. and one at the S.E. end) have been mapped at a semi-detailed level on 1:25,000 maps. The report will contain detailed profile descriptions. In addition, four pilot areas adding up to 4 - 5,000 ha has been mapped in a detailed way on 1:10,000 maps.

Other projects of the soils section have been a reconaissance study of 30,000 ha at reconaissance level of the Parrita area in cooperation with the University of Costa Rica and an on-going project to prepare a potential land use map of the Central Valley covering about 193,000 ha at

a scale of 1:100,000. This potential land use map is being done for a joint comission of INVU, MAG, ICE and SNAA. The area has also just been covered by the National OPSA map from the stand-point of suborders of soil at a 1:200,000 scale.

There is a "Comisión de Riego" in Costa Rica consisting of representatives of ICE, ITCO, MAG, Servicio Nacional de Electricidad, CNP, OPSA and the Servicio Nacional de Aguas Subterráneas. It is working on a master plan for irrigation of the country.

The Department of Soils has only three professionals but appears to have dynamic leadership. In addition to survey, it operates a small part of the MAG laboratory facility for physical testing. If an expanded program to map the country at series level was initiated, the fertility and physical laboratories could probably be expanded in personnel and used to characterize the soils under the new taxonomy. The Department is limited in office space and cartographic capacity. The present staff is just about able to keep in the field using one additional car provided by the Irrigation Comission, in addition to its own.

A. Instituto de Tierras y Colonización (ITCO)

The Institute of Land and Colonization was created in the early 60's as part of a major national effort to obtain lands for the landless by the establishment of "asentamientos". Some of these settlements came about as the result of resettling uprooted people such as those displaced by the eruption of the Volcano Irazu or by the necessity of stabilizing settlements on lands occupied by squatters without titles.

In addition general natural resources surveys were made in relatively unoccupied forested areas on the theory that large areas of agricultural lands could be found and developed into colonies. This proved overoptimistic.

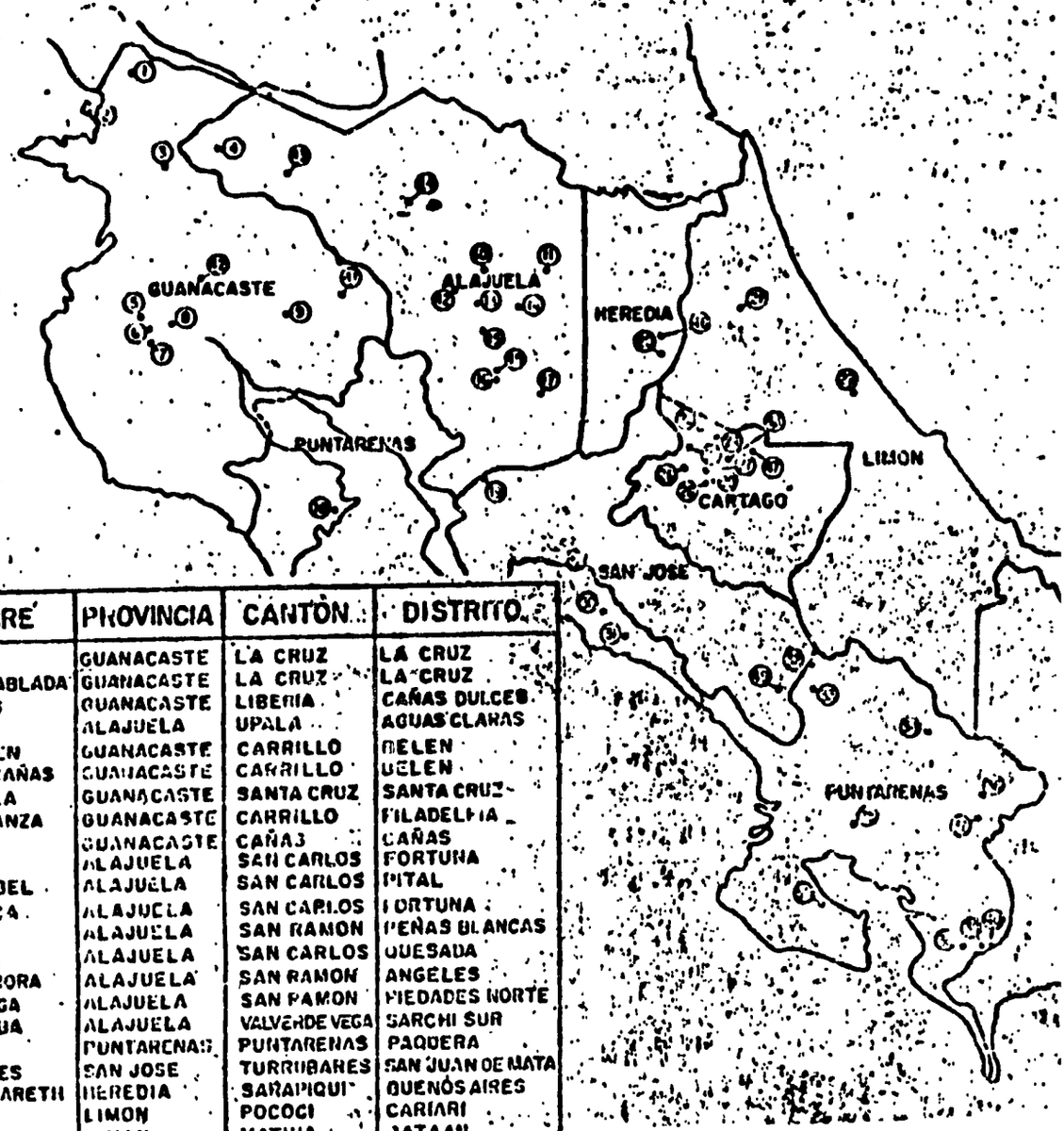
During the 60's four of these general resources studies were made in the Northern frontier areas. These studies were Upala (app. 1700 km^2), Zona Norte (app. 8500 km^2), Sarapiqui (app. 3000 km^2), Estudio Atlántico Norte (app. 5000 km^2). Other smaller studies such as the Estudio Bataan were also carried out. The map of these studies received technical assistance of the German Geographers H. Nuhn and G. Sandner. Natural resources such as climate, soils, vegetation and water resources and human sociological aspects were covered. Soils were classified by the seventh approximation (now new taxonomy) but only on the basis of a few sampling sites and mostly by visual inspection with very little laboratory data. Although other areas, notably the Southeast, are in need of such reconnaissance studies, the approach was not continued after the advisors left in the early 1970's.

At present soils is included in a section of the Planning Department of ITCO.

1. Departamento de Planificación

This department consists of a section on Basic Investigation which primarily does soil survey, a section on Evaluation and Statistics and one on Plans and Projects.

Mapa Nº2. Ubicación de los Asentamientos Campesinos



Nº	NOMBRE	PROVINCIA	CANTÓN	DISTRITO
(1)	SAN DIMAS	GUANACASTE	LA CRUZ	LA CRUZ
(2)	COOPEGILTABLADA	GUANACASTE	LA CRUZ	LA CRUZ
(3)	LAS LILAS	GUANACASTE	LIBERIA	CAÑAS DULCES
(4)	LIBERTAD	ALAJUELA	UPALA	AGUAS CLARAS
(5)	COOPE BELEN	GUANACASTE	CARRILLO	BELEN
(6)	COOPERUCAÑAS	GUANACASTE	CARRILLO	BELEN
(7)	BERNABELA	GUANACASTE	SANTA CRUZ	SANTA CRUZ
(8)	LA ESPERANZA	GUANACASTE	CARRILLO	FILADELFIA
(9)	SAN LUIS	GUANACASTE	CAÑAS	CAÑAS
(10)	AGUILA	ALAJUELA	SAN CARLOS	FORTUNA
(11)	COOPEISABEL	ALAJUELA	SAN CARLOS	PITAL
(12)	SOMAFLUCA	ALAJUELA	SAN CARLOS	FORTUNA
(13)	TRINIDAD	ALAJUELA	SAN RAMON	PEÑAS BLANCAS
(14)	TESALIA	ALAJUELA	SAN CARLOS	QUESADA
(15)	COOPEZAMORA	ALAJUELA	SAN RAMON	ANGELES
(16)	COOPETULGA	ALAJUELA	SAN RAMON	PIEDADES NORTE
(17)	COOPEUTAUA	ALAJUELA	VALVERDE VEGA	SARCHI SUR
(18)	CURU	PUNTARENAS	PUNTARENAS	PAQUERA
(19)	PASO AGRES	SAN JOSE	TURRUBARES	SAN JUAN DE MATA
(20)	COOPENAZARETH	HEREDIA	SARAPIQUI	BUENOS AIRES
(21)	CARIARI	LIMON	POCOCI	CARIARI
(22)	BATAAN	LIMON	MATINA	BATAAN
(23)	LAS VIRTUDES	CARTAGO	TURRIALBA	SANTA CRUZ
(24)	GUAYABO	CARTAGO	TURRIALBA	SANTA TERESITA
(25)	BUENOS AIRES	CARTAGO	ALVARADO	PACAYAS
(26)	PARRUAS	CARTAGO	PARAISO	PARAISO
(27)	LAS VUELTAS	CARTAGO	JIMENEZ	TUCURRIQUE
(28)	COOPEHUMO	CARTAGO	JIMENEZ	PEJIBAYE
(29)	PEJIBAYE	CARTAGO	JIMENEZ	PEJIBAYE
(30)	COOPELERRITOS	PUNTARENAS	AGUIRRE	QUEPOS
(31)	COOPESILENCIO	PUNTARENAS	AGUIRRE	SAVEGRE
(32)	COOPELIBERACION	SAN JOSE	P. ZELEDON	SAN PEDRO
(33)	COOPEUTRAPEZ	PUNTARENAS	BUENOS AIRES	VOLCAN
(34)	COLINAS	PUNTARENAS	BUENOS AIRES	COLINAS
(35)	ALIANZA	PUNTARENAS	OSA	PALMAR
(36)	COTO BRUS	PUNTARENAS	COTO BRUS	SAN VITO
(37)	COOPESOLIDARIDAD	PUNTARENAS	COTO BRUS	SAN VITO
(38)	COTO SUR	PUNTARENAS	CORREDORES	LA CUESTA-OTROS
(39)	COOPEVAQUITA	PUNTARENAS	CORREDORES	LA CUESTA
(40)	EL CONTROL	PUNTARENAS	CORREDORES	LA CUESTA
(41)	COLORADO AZUL	GUANACASTE	TILARAN	SANTA ROSA
(42)	FINCA WILSON	GUANACASTE	BAGACES	BAGACES
(43)	LAS ARMONIAS	ALAJUELA	UPALA	AGUAS CLARAS
(44)	HNOS. JENKINS	ALAJUELA	GUATUSO	BUENAVISTA
(45)	LOS CHILES	ALAJUELA	SAN RAMON	ANGELES
(46)	RIO FRIO	HEREDIA	SARAPIQUI	HORQUETAS
(47)	STA. TERESITA	CARTAGO	TURRIALBA	STA. TERESITA
(48)	JUAN VIÑAS	CARTAGO	JIMENEZ	JUAN VIÑAS
(49)	ALEGRIA	SAN JOSE NORTE	P.ZELEDON-OSA	VARIOS
(50)	CABUYA	PUNTARENAS	OSA	PUERTO

a. Sección de Investigaciones Básicas

In recent years this four man section has concentrated its efforts on more detailed mapping of areas suitable for colonization which have mostly been obtained by purchase. They are receiving technical assistance from A. Vásquez, head of the Soils Section of the Dirección de Riego y Drenaje, especially with regard to their largest project, a part of the Finca Palo Verde near Bagaces, Guanacaste. This project covers about 18,000 hectares, and a part is being mapped at a detailed level which consists mainly of alluvial soils and vertisols. The Israeli government has a technical assistance mission to plan and assist with the subsequent phases necessary to complete the project.

The ITCO soils group is small, under equipped and are not trained in the new taxonomy. From a standpoint of efficiency it would appear logical to combine this group under Ing. Vásquez and form a single soils group to serve national institutions like the Office of Irrigation and Drainage and ITCO.

As of the end of 1976, ITCO is said to have helped over 22,000 families and affected land use over some 750,000 hectares or about 15% of Costa Rica. Map 2 indicates the location of ITCO asentamientos which are spread throughout every province. ITCO is under considerable criticism and the "Programa de Gobierno 1978-82" of the victorious Partido Unidad, singles it out for reorganization. This will probably result in changes in the structure, support, type of work and quantity of work it does in soils.

C. Universidad de Costa Rica

1. Facultad de Agronomía

The faculty consists of three divisions, namely:

- Fitotecnia (Plant Sciences)
- Zootecnia (Animal Sciences)
- Economía Agrícola (Agricultural Economics)

a. Departamento de Fitotecnia (Soils Part)

There is no separate soils department.

The staff concerned with soils consists of three full-time professors (Elemer Bornemisza, Alfredo Alvarado and Alberto Sáenz who carry most of the course load. Carlos López and Miguel González teach part time but are mostly engaged in research at the Center of Agricultural Research. In addition, there are three other part-time professors (Santiago Flores Bernardo Chaverri and Carlos Chavez.

The standard courses given are the following:

- General Soils	thrice a year
- Soil Fertility	twice a year
- Soil Conservation	twice a year
- Soil Genesis and classification	once a year
- Soil-Plant relationships (for Animal Science students)	once a year
- Agricultural Production I (for Agricultural Economics Students)	thrice a year
- Irrigation	once a year

All courses are one-semester courses.

The total number of students enrolled in the Faculty of Agronomy is approximately 2000. Of these, about 105 received their degree in 1977. A similar number received their degree each year for the past 4-5 years, indicating a fairly high drop-out rate among the students. Of the approximately

105 Ingenieros Agrónomos graduating, 12-15 generally write their theses on investigations connected with a soil problem. There is demand for more thesis work on soils by the students, but the capacity of the faculty to give support to soil research projects by students is limited.

In a cooperative program between CATIE and the UCR there are about 50 graduate students who present their thesis each year. Three or four are written about soils problems.

There is a student-teaching laboratory for soils and two laboratories for research in soils. The smaller of the research laboratories is mostly devoted to work on trace elements.

The library of the University is improving in the field of soils. However, it does not appear to meet the needs for good theses without being supplemented by the private collections of the professors and the library of CATIE at Turrialba.

The University soils staff seems quite capable of giving students a good background in soils and stimulating better students to consider careers in those parts of soils science in which the country is weak.

In addition to teaching, the professors also do individual research in soil formation and mapping, chemistry and fertility or do it in part by guiding student theses. Some of the projects are in cooperation with the F. Baudrit Exp. Station and some field work is carried out on farmer's fields.

Characterization and classification of soils derived from volcanic ash in different parts of the country is one of the main projects. The influence of different soil forming factors under the conditions of Costa Rica are also studied.

The soil chemistry work is mainly oriented towards micronutrient problems. There is also work in cooperation with the university herbicide specialist in studying the behaviour of these chemicals in Costa Rican soils.

About half dozen papers are published each year mostly in national and local level scientific publications.

2. Centro de Investigaciones Agronómicas

This laboratory is the former STICA soils laboratory. It has been part of the UCR since 1960. It is located on the University campus. The laboratory is devoted to research in soils and plant relations, soil chemistry and fertility.

Ing. Agr. José Francisco Carvajal Castro has been in charge of the laboratory since 1958. The center received help from the University of Florida contract in past years. Its present personnel consists of (including the Director):

- Six professionals (including one D.Sc. in Plant Physiology, two M.Sc., two Ing. Agr., one Chemist) (C. A. López and M.A. González carry out much of the soils research).
- Five laboratory assistants.
- One Secretary.

The present budget is in excess of US$100,000 per year and comes entirely from the UCR. The laboratory has published numerous studies and bulletins. It is rather well equipped and is adding major peices of equipment, according to the following list:

Already on hand:

- One emission spectrometer for N 15 analysis (only one in Central America).

- One atomic absorption spectrometer.
- One beta-counting unit, completely automatic with printer.
- One scintellation counter, fully automatic, for 300 samples.

On order:

- Complete unit of gas chromatograph, fully equipped to work on pollution of agricultural environment (with this unit the laboratory will need two more Ph.Ds. who will transfer from other divisions of the University).

Equipment planned for next year:

- One differential thermal analysis unit.
- X-ray diffraction equipment for soil clay mineralogy.
  If this equipment is obtained it will give Costa Rica a capacity to classify soils to the family level unique in Central America. This capacity might be considered for sharing with other countries.

The building is fair sized and has two floors for laboratories and office space and a small greenhouse for pot tests and similar work. The Director informed us that plans are advanced for a new building about double the capacity.

In January 1975 the Center published a small volume "Contribuciones 1955-1974" which lists all the work done by this laboratory since it was started in 1955. It includes publications either in bulletins or in various technical journals, technical books, papers prepared for meetings and student theses done under the supervision of the Center. Work covers chemical and physical characterization of soils, nutritional aspects of many crops including responses to trace elements, with a special interest in coffee and development of foliar analysis.

The work program for the 1976-1980 period plans the following:

a. Uso y componentes del nitrógeno en suelos de Costa Rica.
b. Estudio y corrección de la fertilidad de suelos ácidos de Costa Rica.
c. Toxicidad de aluminio.
d. Estudio de las propiedades físicas de los suelos que influyan en su riego y drenaje.
e. Determinación de niveles críticos (de elementos nutritivos) en los cultivos de mayor importancia.económica.
f. Investigaciones de métodos bioquímicos de diagnóstico del estado de nutrición de las plantas.
g. Reguladores del crecimiento.
h. Nutrimentos requeridos por las plantas cultivadas en suelos de fertilidad variable.
i. Génesis de los suelos de Costa Rica.

Some of these projects are to be cooperative with members of the faculty not on the Center's staff.

With the shift in research emphasis at CATIE; the UCR has become the only major source of soil chemistry research in Costa Rica and probably the best in Central America. Many of its more basic studies should have application throughout the Central American region.

Perhaps it is time to think of a network of regional research laboratories for Central America in soil and plant chemistry, soil physics, soil mineralogy and soil microbiology, in which case the center and the faculty probably qualify for soil and plant chemistry.

The significance of the problems selected and the dissemination and practical application of results is critical in evaluating the importance of research of this kind. The center certainly brings its work to the attention of national agronomists. At the second biennial agronomy congress in Costa Rica in 1976, the center was responsible for 22 of the 37 studies presented in the sections of plant physiology, soil and fertilizer and annual plants. Since this laboratory has now been operating under the University for more than 15 years, it would be of value to analyse

the impact of its research on agricultural concepts and practice in Costa Rica. It is probable that fundamental research in soils and plants should be considerably increased in Central America, if it can be shown that the mechanism for translating results into practical use can be made efficient. This could be a case study.

3. Experiment Station Fabio Baudrit Moreno

This experiment station of the University was established on the Central Plateau near Alajuela in 1955. It contains about 120 hectares and is used for conventional experimentation and thesis work. The Director is Ing. Agr. W. Lorfa. The 14 man technical staff specialize from specific crops such as corn, legumes, etc. to such fields as crop diversification, weed control, fish culture and rabbit raising. They have cooperative projects with the Ministry of Agriculture in such items as coffee, horticulture and minor fruits. There is a question in our mind as to the efficiency of the Ministry of Agriculture and the University having separate experiment stations and experimental programs. In spite of the fact that there are cooperative projects one gets the impression that considerably more cooperation could be achieved in the field of soil fertility.

The Ministry of Agriculture has the important advantage of a number of experimental stations and regional extension centers for testing and disseminating. The University partially overcomes this by having a Coordinator, Ing. Agr. Ernesto Araya, to relate the research to the extension service of the Ministry of Agriculture. There are some 40 students theses per year carried out at the experiment station or on projects

throughout the country, partly supervised by the staff of the experiment station.

There are no specialists or specific projects strictly related to soils. The staff depends upon the trained University professors for their needs and to give guidance to students on the soils aspects of their problems.

Perhaps, the most interesting project at present in soils is a project introduced by CIMMYT for testing of corn and wheat. Some 25 parcels of wheat representing 29 varieties and 118 parcels of corn have been planted around the country from sea level to 800 meters elevation. These are planted and cared for with the cooperation of the regional center personnel and individual farmers.

CIMMYT has introduced a methodology for comparing the farmer's traditional practice with a complete technical package including variety fertilizer need and disease control and with a minimum cost intermediate technology. The results are biometrically analysed for significance. Those practices which prove superior over a sufficient time period are then tested in demonstration plots on farms and shown and recommended to others in the area. The program is only in its second year. The methods and results seem to have impressed the experiment station staff enough to induce them to apply the technique to trials of zuchini squash, cucumber and beans.

It would appear that these trials would suffer from many of the same problems which result in loss of fertilizer trials conducted by the workers of MAG. The aspect of following through promising results through demonstration and other means of gaining acceptance within the community

appear to be important ingredients which receive less emphasis in the fertilizer trials of MAG.

The soil/climate analogs which CATIE/ROCAP are developing with the assistance of the soil scientists fo Central America could be of value in the selection of sites for these trials, based on more exact knowledge of soils series and capability units and climate.

D. Oficina de Planeamiento Agropecuario (OPSA)

OPSA was organized under the Consejo Agrícola Nacional (CAN) in order to coordinate planning in the field of Agriculture. CAN is under the chairmanship of the Minister of Agriculture and Livestock and includes representatives from the Ministry of Industries and Commerce, the Central Bank, the National Production Council and the Institute for Land and Colonization (ITCO).

OPSA has a high level technical committee which includes directors of planning offices in different institutions. At present work is concentrated on a national plan under a contract with IICA which hires the technicians producing it. It is uncertain what permanent structure OPSA will finally have or what its role will be in planning policy affecting the field of soil science or whether it will have a technical staff with specialists in the field.

OPSA recognized the lack of any satisfactory general map of soils even for macro-planning. Therefore, it set up technical section under S. Pérez and contracted A. Alvarado of the University of Costa Rica. Together they quickly produced a national map at 1:200,000 using Alvarado's complete bibliography of random soil studies carried out over the years,

and supplementary information from topography maps, and information about life zones, climate, land use, forestry, etc. A manual which will explain the map has been prepared by A. Alvarado and E. Knox, consultant for the AID/CRIES project who also needed such a map for his work. The map has a total of 56 soil associations. The first part of the manual will describe each of these morphologically and also describe agricultural aspects of the Soil Association. A second part will give all available chemical and physical data.

To obtain additional data in the future it is suggested that about 10 UCR students each year, could prepare their theses for graduation studying and classifying soils in the field under the direction of Ing. Alvarado. It is expected that each student will be able to produce data for 6-10 profiles and obtain valuable experience in soil science. If Alvarado leaves for additional graduate work this plan would have to be abandoned temporarily.

The map is the best which can be made at this time. It is recognized that it should be field tested and continuously improved in the geographic accuracy of the soil units and by the identification and better characterization of soil series and phases.

E. Commercial Companies

1. Fertica S.A.

Fertica S.A. is the principal fertilizer company in Central America. It started as a subsidiary of Granos y Fertilizantes S.A., México. The latter company still has a major interest in Fertica, which is organized regionally as Fertica - Centro América and in several Central American

sountries as a national company, like Fertica - Costa Rica. Fifty percent of the shares of the latter company were recently acquired by the Costa Rican government.

Fertica - Centro América has a Technical Agriculture Department whose main office is near San José, Costa Rica. The department was started about four years ago and consists of two Agronomist Engineers (Ing. Rodolfo Acosta, Jefe and Ing. Jorge Bonilla, Sub-Jefe) and two additional Agronomist Engineers each in Costa Rica, Guatemala, El Salvador, and one each in Nicaragua and Panama. No one is based in Honduras.

This group carries out field experiments with the following crops in all six countries: sugar cane, corn and sorghum. In addition, field trials are done with cotton in Guatemala, Nicaragua and El Salvador, horticultural crops (mostly potatoes, tomatoes and cabbage) in Panama, and rice and African oil palm (the latter in cooperation with the United Fruit Company) in Costa Rica. There are also some small trials with coffee. Necessary greenhouse studies are done through the cooperation of CATIE and statistical analyses at IICA. The total annual program covers about 35 field experiments.

In setting up field experiments soils are identified thorugh soil survey information, if such exists. Otherwise, soil samples are taken and sent for analysis. In Costa Rica, the MAG and CATIE soil laboratories are available to Fertica at limited cost. The Fertica building has space for a laboratory, but none has been installed for a number of reasons, one being that Fertica feels that if they analyse soil samples for their customers, these might distrust the results since Fertica's business is selling fertilzers. However, Fertica does operate one laboratory in El Salvador.

Field trials generally involve rates of N, P, K alone and in combinations and also often rates of Mg and S. Fertilizers used to set up experiments are mostly combination of single element fertilizers like NH_4SO_4, NH_4 NO_3 and triple superphosphate. Most experiments are set up on collaborating farmer's fields with Fertica supplying fertilizer and pesticides for the field trials.

Fertilizers produced and sold are many mixtures of N P K, often with the addition of other elements like Mg, S, Zn, Fe and B. Costa Rica's fertilizer use is high being up to two thirds the average European country and second highest in Central America. Fertica maintains factories at Puntarenas, Costa Rica; Acajutla, El Salvador, and Tecun Uman, Guatemala. Fertica also sells a complete line of pesticides and is the exclusive representative in Central America for Meshenev, an Israeli company producing pesticides.

Fertica has a program of assistance to students (two students in each C. A. country are supported each year with a U.S.$1500 scholarship).

The effect of higher prices for petroleum were noted by Fertica through a 30% drop in consumption. Prices of fertilizer have doubled since 1974-75.

2. Other companies

Other fertilizer companies in Costa Rica and Central America that compete with Fertica, Abonos Agro and Abonos Superiores, merely mix fertilizers. Abonos Superiores conducts some simple fertilizer trials. Nitrophoska (B.A.S.F., Germany), Albatros (Holland) and Rustica (Holland) import mixed fertilizers.

F. Centro Agronómico Tropical de Investigación y Enseñanza (CATIE)

1. Research and Teaching

IICA at Turrialba (now CATIE) has made important contributions to soil science in Latin America since its organization in the 1940's. A considerable part of the work has been in support of tropical crop studies such as cacao, coffee, beans, pasture, etc., or as student theses. An extensive program involving use of radioactive atomic tracers for soil and plant research was carried out from 1957 to 1970. This work was supported by the U.S. Atomic Energy Commission.

From 1956 - 1968 Dr. F. Hardy was a member of CATIE's staff. He had long been with the Imperial College of Agriculture (now University of the West Indies) in Trinidad, and was one of the world's authorities on tropical soils. While at CATIE he worked closely with the cacao program. Other notable soil scientists at CATIE, including several supported by FAO were Drs. J. Martini and H. Fassbender and E. Bornemisza in soil chemistry, L. Muller in plant nutrition including demonstrating trace element deficiencies on tropical crops, E. Besoin in Soil Mineralogy, S. A. Gavande and W. Forsythe in soil physics and E. Knox and F. Maldonado in volcanic soils. Much of the work involved soils of the Turrialba area or Costa Rica. Some soil survey work was done on the Atlantic coast in the early 50's and later in other areas as student theses to characterize soils by series.

The soils staff at CATIE has produced important books in Spanish oriented toward tropical soils and the needs of Latin American students and soil scientists.

These include two books on Tropical Soils by Hardy and single

volumes on Soil Chemistry by Fassbender, Soil Physics by Gavande, a Laboratory Manual for Soil Physics by Forsythe and a Laboratory Manual for Soil Chemistry by J. Saiz del Río and E. Bornemisza. A volume on Soil Mineralogy by E. Besoin is still in press.

The permanent soil scientist staff at CATIE now consists of Dr. R. Bazán who originally worked closely with Dr. Hardy and Ing. R. Díaz-Romeu, Chief of the Soils Laboratory. In addition, from mid 1976 and terminating in early 1978, CATIE has received support from ROCAP for a soil fertility project under the direction of Dr. J. Walker. One of the objectives of this project has been to encourage CATIE to assume the role in soil fertility which North Carolina State Univeristy has relinquished. Another has been to stimulate a regional effort to identify similar soils or soil analogs and help develop a methodology.

Drs. R. Bazan, H. Newton, P. Duisberg, J. Walker and Ing. Agr. W. Bejarano have participated with national cooperating soil scientists including Ing. Agr. E. Marin and E. Sequeira of Nicaragua, M. Rico and E. Denys of El Salvador, H. Yuksel and J. Díaz of Honduras, and Dr. F. Calhoun of the University of Florida in the analog project.

2. Soils Laboratory - CATIE

The soils laboratories at CATIE were started about 1958 and primarily served thesis and research needs. In 1976 additional support was provided by ROCAP with the idea that the laboratory under R. Díaz-Romeu might come to serve as a control laboratory and innovator of methodology for the rest of the Central American Isthmus.

The laboratory performs physical and chemical analyses of soils and also does plant tissue analysis. Water and fertilizer samples can be analysed, if necessary. During 1977 approximately 2000 samples were analysed for chemical analysis, for physical analysis or for foliar analysis.

The estimated maximum capacity of the laboratory is (if needed and assuming additional assistants) 25,000 samples per year. Chemical analyses normally made are the following: pH, extractable acidity, Ca, Mg, K, S; also B, total exchange capacity, organic matter, total nitrogen, electric conductivity. Physical determinations which are made are: moisture content, specific gravity, bulk density, texture, consistency, moisture curves, infiltration rates, field capacity, hydraulic conductivity.

Recently a system was devised to record data on type-written forms, filed by countries. Within each country they are to be subdivided according to political administrative units, and soil suborders and series. Until now only Costa Rica samples and a small number from Honduras have been submitted for analysis by the CATIE research staff and students.

Major pieces of laboratory equipment are: one atomic absorption spectrophotometer (PE 370 A) with double beam and digital reading. The laboratory has a modern "reverse osmosis" apparatus to make distilled water.

The laboratory has the use of CATIE's greenhouse to make pot tests on soils and for preliminary fertilizer trials. From October 1976 until December 1977, 55 pot test studies were carried out. The space available for this work measures about 315 m^2.

The annual budget requested for the laboratory and its staff is about US$80,000 from April 1, 1978 when CATIE assumes full responsibility again. From mid-1976 through March 1978 it has largely been financed by ROCAP funds.

The present personnel consists of Ing. R. Díaz-Romeu, Head of the Laboratory, assisted by four field and laboratory assistants. It may be necessary to contract one more professional (Ing. Agr. or Chemist) in the future.

VI. RELATION OF SOILS TO OTHER NATURAL RESOURCES AGENCIES AND FIELDS

A. Present Organization of the Natural Resources Fields and INDERENA

The term natural resources is generally considered to include atmospheric, natural vegetation and forests, soils, water and mineral and wildlife resources. These include such fields as meteorology, geology, soils, hydrology, wildlife, natural vegetation, forestry and geology.

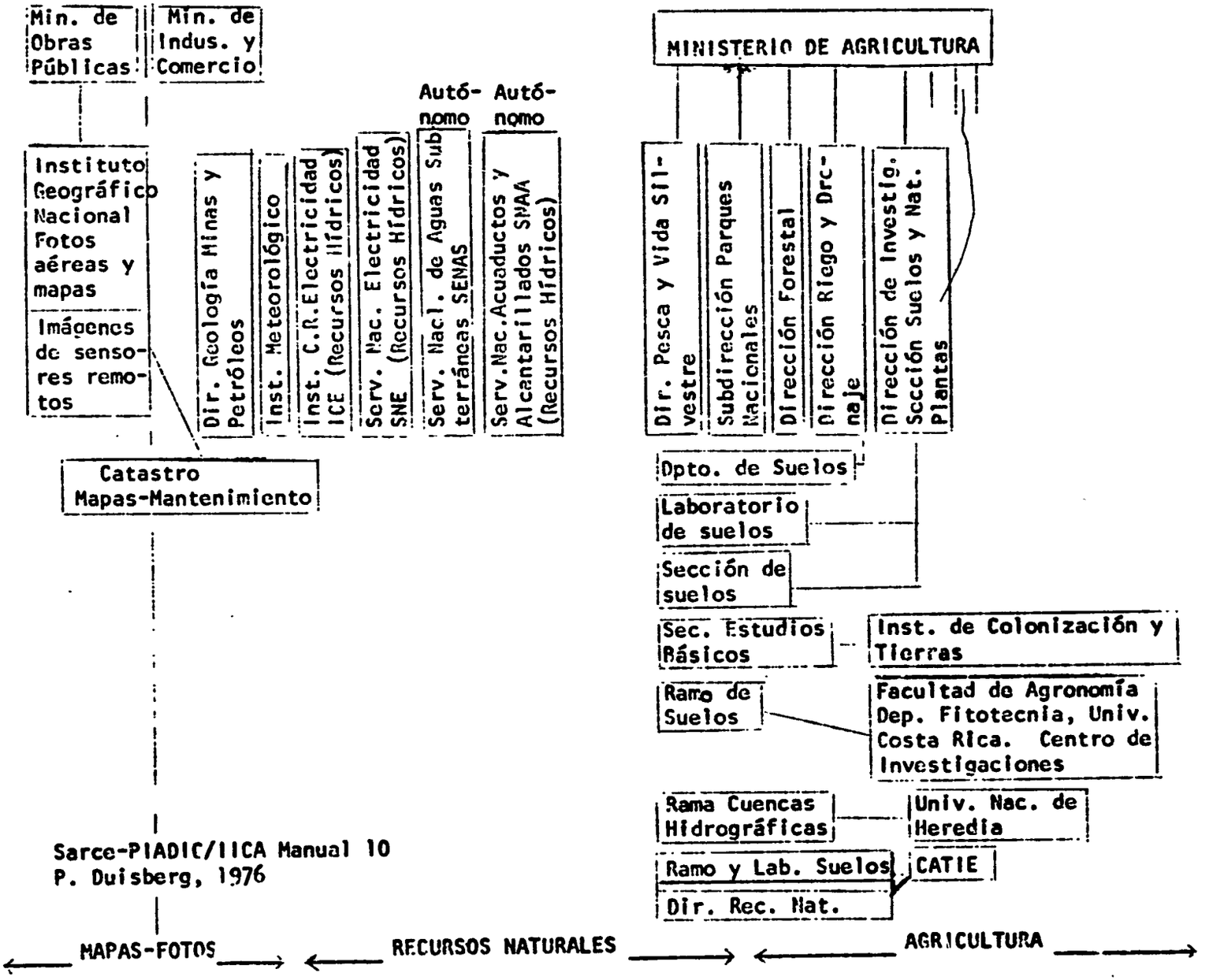
The institutional situation with respect to these fields in Costa Rica is confusing. A number of natural resources components are divided between agencies on the basis of function or neglected entirely. There is often little interchange between these agencies which could contribute much to each other. Soils itself is a fragmented field because by its very nature it must be considered both a natural resource field and an essential field for agriculture.

Figure 2 is a diagram which shows the relationship of soils agencies to the other agencies involved with natural resources. Most of the soils fields are not even linked to the same parent agency and cooperative relationships between them are informal at best.

This plus the rapid deterioration of the nation's natural resources heritage through deforestation, soil erosion, sedimentation, and water pollution as well as water shortage have caused a dramatic recent change from thinking in terms of rapid development and exploitation of resources to emphasis on devising means for more rational use and conservation. This shift in thinking extends from the president, cabinet ministers, officials, scientists and technicians to the new public conservation group, ASCONA.

COSTA RICA

Organigrama para Recursos Naturales



Sarce-PIADIC/IICA Manual 10
P. Duisberg, 1976

In view of the special division of soils between natural resources and agriculture, it is very important that soil scientists rethink the suitability of the present institutional situation within their field and advise the planners in OPSA, OFIPLAN and other national policy makers before irrevocable decisions are made.

One idea already well advanced without marked participation of soils scientists is the proposal for the creation of an Institute of Natural Resources and Conservation (INDERENA). According to the proposal, INDERENA would incorporate the Dirección de Riego y Drenaje of MAG including its soils section, be responsible for defining and applying policy relative to potential use of soil, carry out or cooperate in programs and studies in classification and conservation of soils, inventory soils and other natural resources and attempt to protect and conserve the soil and control pollutants and contaminants. The controlling body of INDERENA would include four officials of ministerial level and three professioanl specialists in Natural Resources, Ecology or Conservation of the Environme The future of soil science in Costa Rica could well depend on the way the field is reorganized as the government tries to overcome critical problems by creating new institutions.

While the program of the Partido Unidad, which will govern from 1978-82 does not mention INDERENA, it clearly puts very strong emphasis on the need for better coordination of resources agencies and protection of the environment.

B. Some Natural Resources Agencies

Regardless of whether or not the natural resources agencies are reorganized under INDERENA or in some other way, many will continue performing almost exactly the same kind of tasks. A brief description of some major agencies which produce products which support soils studies or are complementary natural resources agencies follows:

1. Instituto Geográfico Nacional (IGN)

The Director is Ing. Fernando Mauro Rudín and the sub-director ing. Claudio Vieto. The IGN is the source of topographic maps, aerial photography and remote sensing imagry. These tools are vital in soil and land survey and classification and important in planning agricultural use and conservation of the soil from the level of the region to that of the farm.

It would be helpful if a national planning group could coordinat needs for map and photoproducts on an annual basis. At present the IGN is a part of the Ministry of Public Works. If the proposed legislation is adopted the IGN would become a part of INDERENA.

The IGN is custodian for satellite imagery and receives references on remote sensing and its applications from NASA.

Costa Ricans have received training in remote sensing interpretation as well as aspects of cartography and photogrammetry at the Cartographic School of the Inter American Geodetic Survey in the Canal Zone of Panama. Recently two technicians from the IGN and Ing. Agr. A. Vásquez of the Soils Department of MAG were sent to the United States to receive special training under the sponsorship of BID.

Under a recent AID project a strip of multiband spectral imagery will be flown by IGN across Costa Rica and used along with landset imagry to develop methods for vegetation and tropical forest identification.

The IGN is the custodian and sales agent for maps, air photography and imagry and some geographic works and publishes a semiannual report.

In the 60's, Costa Rica began a Cadastral program under an AID loan. Certain parts of the country were covered, as for instance, Pérez Zeledón but the project failed of completion. The director of IGN has jurisdiction over the Cadastral office. The area covered is available on chronoflex transparencies at 1:25,000 which can be used for making maps with properties delineated and lists of owners. The Cadastral office is charged to maintain the cadaster.

Principal products of interest for soils work include:

Aerial Photographs

Area	Year	Scale
Costa Rica	56-60	1:60,000
Valle Central to Dominical and almost to Guanacaste (some photos on the Northern border missing)	64-65	1:20,000
Valle Central	56-57	1:16,000
Valle Central	45	1:32,000
Guanacaste, Nicoya	52	1:20,000
Guanacaste Provincia Puntarenas (to Quepos)	44-45	1:40,000
Costa Atlántica and Pacífico and Cordillera de Tilarán	58	1:32,000

Area	Year	Scale
Pacífico Sur border with Panama	48	1:40,000
Costa Atlántica	53	1:40,000
Costa Pacífico Sur	53	1:40,000
Costa Atlántica y Pacífico	53-54	1:40,000
Península de Nicoya	55-56	1:32,000
Costa Atlántica (ocho líneas)	48-51	1:40,000
Guanacaste (not complete)	70-76	1:20,000
Valle General - Coto Brus	70-76	1:20,000
Costa Atlántica (prop. JAPDEVA)	74-76	1:30,000
Valle Central	70-77 (each year)	1:50,000

MAPS OF INTEREST

Area	Scale	Type
Costa Rica (one sheet)	1:750,000	Vegetation
Costa Rica "	1:750,000	Climate-Rainf
Costa Rica "	1:750,000	Surface Water Resources
Costa Rica "	1:750,000	Geology
Costa Rica "	1:750,000	Rock Types
Costa Rica "	1:750,000	Ground Water Resources
Costa Rica "	1:750,000	Uso Potencial Tierra
Región Central "	1:200,000	Uso actual d Tierra
Valle Central "	1:150,000	Geology

Area	Scale	Type
Guanacaste (one sheet)	1:150,000 (?)	Geology
Costa Rica (nine sheets)	1:200,000	Topographic-complete for country
Costa Rica (135 sheets)	1:50,000	Topographic-complete for country
Costa Rica (obsolete, not complete)	1:25,000	"
Costa Rica (one sheet)	1:1'000,000	"

2. Instituto Meteorológico

The meteorological institute is under the direction of Lic. Norman Vega G. The meteorological service has been greatly benefitted and the network improved and expanded as a result of the 11 year hydrometeorological program of the World Meteorological Organization of the UN which terminated in 1977.

Distribution of meteorological stations in Costa Rica can be seen on Map 3. These are maintained by the Instituto Meteorológico de Costa Rica and the Instituto Costarricense de Elecrricidad. According to a 1976 U.N. document Costa Rica had 12 stations of Class A type (complete installations) or one every 4200 km^2, 59 type B (temperature and rain) and 310 type C stations (rain only).

A tabulation of climatic data for agricultural use done by L. Vives (Tabulación para uso Agrícola de los Datos Climáticos de Costa Rica, Universidad de Costa Rica, Facultad de Agronomía, 1971) and members of Utah State University (A.J. Pate, 'Validity of Evapotranspiration Prediction in Costa Rica", U.S.U., 1967, George H. Hargreaves, "Climate and Moisture Availability in Costa Rica", U.S.U. 197[illegible], George H. Hargreaves "Monthly

Precipitation and Moisture Availability for Costa Rica", U.S.U. 1976, J. Karl Hancock y George H. Hargreaves "Precipitación, Clima y Potencial para Producción Agrícola en Costa Rica", U.S.U., 1977).

It is recognized that soil analogs can only be meaningful when the climate can be taken into account. Trials are in process to test out the utility of the Holdridge Life Zone transitions as indicated on maps at 1:50,000 in parts of three countries. Costa Rica does not have life zone maps at this scale. If the life zone transitions at 1:50,000 prove valuable in making the first approximation soil analog for parts of Nicaragua, El Salvador and Honduras, Costa Rica should consider contracting the needed work. A later possible refinement would be the addition of numerical meteorological averages or moisture availability indices for meteorological stations within delineated life zone transitions.

3. Servicio Nacional de Aguas Subterráneas

This agency is autonomous within the government. Its Director, Ing. Alvarado Suárez used to work in the Rural Engineering Department, MAG, where he was in charge of all water gauging stations along rivers and streams. The agency has existed for about ten years, and originated as an UNDP project, which lasted for seven years. Its task, as the name indicates is to locate subterranean water supplies and prepare studies on the subject. Its past work has concentrated in the Río Tempisque area, Río Virilla basin, and Río Barranca area.

Presently it works mostly in the Península de Nicoya. The agency also drills wells, under contract with local communities and farmers.

Analytical work on water is carried out for them by the SNAA laboratory in Tres Ríos.

4. Dirección Forestal

The "Dirección Forestal" has sections on investigations, reserves, operations and reforestation.

There is also a subdirection on National Parks. To strengthen the forestry organization in the country various measures are in progress. The section of Forest Reserves is being combined with the National Parks Service under Ing. Alvaro Ugalde, the Parks Service will be headed by Raúl Solórzano and Forest Reserves by Luis Méndez. A section on watersheds and one on forest industries will be organized. The total budget will jump from about ₡4'000,000 to ₡26'000,000 according to latest information available.

A map showing forested areas was prepared about 1966 and again in 1977. This is valuable as a measure of the rate of deforestation and new areas open to potential soil conservation hazard. The maps were created with help of the FAO at the small scale of 1:1'000,000. There are preparations to obtain more detailed information.

VII. COMPILATIONS OF SOILS REFERENCES AND MAPS

A. Bibliografías Agrícolas de América Central - Costa Rica, Bibliografía, número 8. Centro Interamericano de Documentación Información Agrícola, IICA-CIDIA, Turrialba, Costa Rica.

Approximately 350 soils references included.

B. Indice de Mapas de América Latina y el Caribe existentes en el IICA-CIDIA. IICA-CIDIA, Turrialba, 1975, lists of maps which appear useful for soils. Includes type of map, scale and year. About 100 pertinent maps listed.

C. A separate appendix listing specific soils reports and maps is being prepared for the conference on soil analogs. It will be quite incomplete but provide a base from which Costa Rican soils scientists should work following the conference. It is hoped that eventually each country will have a very complete listing and that copies can be transmitted to CATIE so that it can maintain a file for the region.

D. The following references in the text of this report should be completed later by Costa Rican soil scientists. There was insufficient time to do this before the regional conference

Literature Cited or Recommended (to be completed by Costa Rican soil scicentists using standard reference format for missing data)

1. United Fruit Company Records - 1918 and on.
2. H.M. Bennett, General Survey of Costa Rica, 1924.
3. Robinson and M. Stryker. Survey for abaca areas, 1951.
4. Standard Fruit Company, Records, 1950 and on.
5. IICA - Turrialba - Student theses.
6. Journal "Turrialba". Review of Articles.
7. AGRINTER - Quarterly references from about 1974 by IICA/CIDIA.
8. Dóndoli and J. Torres. Soil survey, part of Meseta Central, about 1954.
9. Vargas, Soil Survey, Part of Meseta Central, about 1958.
10. Coast and Vargas, Soil survey, Tempisque Valley, about 1959.
11. Leitón and Sáenz, Soil Survey, Part of Pacific Coast, about 1958.
12. C. V. Plath, Land use potential bulletins and map, FAO, about 1966.
13. Coto and Torres - 1:750,000 land use potential map, 1970.
14. A. Alvarado, Evaluación sobre clasificación de suelos en Costa Rica, Bol. Tec., Vol. 5, Fac. Agronomía, U. de Costa Rica, 1972.
15. General inventory of physical resources, Costa Rica, U.S. Resources Inventory Center, about 1965.
16. Index of maps of Costa Rica, OAS, about 1965.
17. Soils of Mexico and Central America, text and map at 1:5'000,000, 1975. FAO.
18. A. Alvarado and S. Pérez. Soils map of Costa Rica at 1:200,000 with booklet, 1978.

19. H. Mowry, Fertility publications, 1950's.

20. Research papers from the Atomic Energy Program at CATIE during the 60's.

21. Coffee Growers Magazine, Article on Soil Conservation, 1935.

22. Three theses on soil conservation under Dr. W. Forsythe, CATIE, 1970's.

23. Creación del Instituto de Recursos Naturales y Conservación Ambiental (INDERENA) y del Organismo Regulador de Servicios Públicos, Proposal of law, 1977.

24. Ley de reforestación, Dictamen afirmativo de mayoría de la Comisión Permanente de Asuntos Económicos, Expediente 7616, 1976.

25. Documents on soils and fertility trial data from Department of Agronomy, MAG.

26. Publications and data from N. Carolina State professors.

27. Documents on Soils and Fertility trial data from the Department of Coffee Research, MAG.

28. Documents and theses on fertility trails from the University of Costa Rica.

29. Aleger, Editor. Friendly land and friendly people. Reports from staff of the University of Florida Contract, early '60's.

30. Reports and maps by A. Vásquez and soil department of MAG, 1970's.

31. A. Vásquez. Estudio del suelo a nivel de reconocimiento, Proyecto de riego mediante el aprovechamiento de las aguas de la laguna de Arenal. 1974.

32. H. Nuhn and G. Sandner and ITCO studies on Upala, Zona Norte, Sarapiquí, Estudio Atlántico Norte and Bataan. 1960's.

33. Soils articles in Agronomia Costarricense, 1977.

34. Soils and Fertilizer trial papers delivered at the Biennial National Agronomy Congresses, 1974 and 1976.

35. Bulletins on Soils from the Centro de Investigaciones Agronómicas.

36. Carvajal, J. Centro de Investigaciones Agronómicas, contribuciones. 1955-1974. 1975.

EVALUACION SOBRE CLASIFICACION DE SUELOS EN COSTA RICA

Alfredo Alvarado H.*

Introducción

Al igual que en otras partes del mundo, en Costa Rica han sido las necesidades agrícolas las que originaron el primer sistema de clasificación de suelos. El agricultor se ubicó en aquellas áreas en las cuales la "tierra" le "dio más" y las separó en malas y buenas.

El uso posterior de los terrenos adquiridos, factor determinante en la ganancia o pérdida del potencial agrícola del suelo, define en parte el que algunos de ellos clasificados dentro de una de las dos categorías, pasasen a la otra al perder sus horizontes superiores o al sufrir cambios en sí debidos al laboreo.

Dentro de este marco se desenvuelve el país durante todo el período colonial y aún durante bastantes años de la época republicana. Con la creación de la Escuela Nacional de Agricultura (1926) y anteriormente de dependencias gubernamentales como el Departamento de Agricultura (1912) la situación cambia poco a poco, hasta que en dichas instituciones se comienzan a realizar estudios de clasificación.

En la actualidad, además de los trabajos realizados por la empresa privada, las instituciones oficiales que más han laborado en este sentido han sido el Instituto de Tierras y Colonización (ITCO), el Ministerio de Agricultura y Ganadería (MAG), la Universidad de Costa Rica (UCR) y el Instituto Interamericano de Ciencias Agrícolas de la OEA (IICA).

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Materiales y métodos

La clasificación de suelos en Costa Rica ha sido efectuada por diferentes investigadores, bajo diferentes sistemas, en diferentes épocas y a diferentes escalas. Se pretende reunir esta información y presentarla en forma de mapas para el Valle Central (Mapa 1) y para el país en general (Mapa 2), haciendo grupos de acuerdo a la escala en que se efectuaron los trabajos y explicando algunas de sus características.

Escala 1:1.000 a 1:10.000

Se incluyen en este grupo los estudios de 1) tesis efectuadas en la Universidad de Costa Rica y 2) empresas agrícolas y algunos investigadores presentados o no a los bancos para la obtención de créditos.

1) Entre los primeros, las escalas varían mucho y la calidad de los mismos es de regular a aceptable. Su mayor mérito es el proporcionar una idea bastante acertada acerca de la composición mineralógica, química y física, a veces, del área que cubren. Puede decirse que son un buen trabajo preliminar pero su grado de interés decrece conforme se trate de ahondar en aspectos pedogeneticos. Por otro lado, siempre se adjunta al mapa de Clasificación del Suelo otro de Uso Potencial o Actual o Erosion que permite algunas interpretaciones más o menos generales.

   Los trabajos de este tipo varían en sus sistemas de clasificación y ocupan en su mayoría secciones localizadas dentro del Valle Central, en tierras de café, cultivos de subsistencia y ganadería. Se incluyen en su mayoría en el Mapa 1 y su calidad mejora conforme nos acercamos al presente (1, 5, 7, 10, 13

51, 52, 58, 63, 72, 73, 78, 79, 81, 94, 95, 99, 116, 121, 133, 139).

2) Entre los segundos se encuentran todos aquellos trabajos que la agricultura del banano, hule y cacao ha requerido para su desarrollo. Presentan en su mayoría mapas de Capacidad de Uso y están ubicados en las costas Atlántica y Pacífica del país. Su calidad es aceptable y algunos han sido elaborados con ayuda de laboratorios extranjeros (8, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 45, 46, 49, 55, 56, 60, 61, 62, 64, 65, 70, 80, 89, 91, 97, 98, 102, 105, 107, 108, 109, 110 111, 117, 118, 119, 120, 122, 123, 125, 126, 127, 128, 129, 130, 131, 132, 136, 137, 138).

Escala 1:1.000.000 a 1:1.000.000

A esta categoría pertenecen los estudios 1) a escala regional y 2) a escala nacional. Se incluyen en su mayoría en el Mapa 2.

1) Estos trabajos han sido realizados por dos instituciones principalmente; el Instituto de Tierras y Colonización (ITCO) y el Ministerio de Agricultura y Ganadería MAG).

El área cubierta por el ITCO abarca la mayor parte del total mapeado en el país. Se basa en la fotointerpretacion y su posterior estudio de campo con algunos análisis de laboratorio (11, 30, 32, 33, 40, 42, 43, 46 104, 124).

2) A escala nacional encontramos estudios que cronológicamente no distan mucho (1954 a 1971), aunque sin son bastante

diferentes en su contenido y en su manera de representar las categorías en que se subdividen. Están basados en informaciones anteriores a su publicación y en pocos casos en datos de laboratorio propios (2, 9, 59, 66, 92, 101, 103, 106).

Varios

Obras de índole diferente a las anteriores han sido efectuados por el Instituto Interamericano de Ciencias Agrícolas (IICA) y la Organización de Estudios Tropicales (OTS), cuya información es importante de considerar dentro de la clasificación de suelos del país.

Estos trabajos están basados en la fotointerpretación, estudios previos y análisis de laboratorio. Sus escalas así como su presentación son variables y no ocupan, salvo algunas excepciones, áreas bien definidas (3, 4, 8, 66, 68, 69, 71, 74, 75, 82, 83, 92, 93, 96, 100, 105, 134, 142).

Discusión

Al presente, la división del país en zonas de suelos similares ha sido hecha en una forma tal que representa la realidad del sustratato clasificado. En un principio se identificaron las áreas de mayor auge económico y más accesibles para luego iniciar el mapeo de aquellas otras de potencial agrícola de reserva. Queda aún una amplia región comprendida por la Cordillera de Talamanca cuya situación es incierta, lo que se desprende de los trabajos de AID (2), Harris (66) y Pérez (103), quienes la clasifican en un período de seis años en tres categorías diferentes.

La zona central (Valle Central), a pesar de contar con bastantes estudios amerita una reclasificación total. En la actualidad, Pérez (103) es el que lu clasifica mejor, pero a escalas mayores será necesario efectuar nuevos trabajos de reconocimiento para sustituir los ya existentes (50, 52).

En la región de Guanacaste, el mapeo necesariamente deberá corregirse, quizá no tanto a escalas pequeñas como a escalas grandes, en las cuales el detalle es imperfecto o casi nulo.

La zona norte del país está cubierta acertadamente por las investigaciones del ITCO (30, 32, 33, 43, 104). Solamente será necesario en lo descrito efectuar el análisis de laboratorio para completarlo.

Debe hacerse notar que mapas sobre otros temas (geología, ecología y Uso Potencial) han sido confeccionados con anterioridad al mapa de suelos y han sido base de algunos de los trabajos de clasificación edáfica.

Resumen

En total se recopilaron 142 estudios de clasificación de suelos, de los cuales 79 fueron hechos a escala 1:1.000 a 1:10.000 y casi todos diferentes entre sí. A escala 1:11.000 a 1:1.000.00 se encontraron 28 y otros trabajos sumaron 35.

Se confeccionaron dos mapas de áreas estudiadas para facilitar cualquier estudio posterior, uno para el Valle Central (Mapa 1) y otro a nivel nacional (Mapa 2).

Bibliografía

1- ACOSTA, R. y ESCALANTE, E. Estudio agrológico preliminar de la región de San Rafael de Vara Blanca. Tesis Ing. Agr. San José, Universidad de Costa Rica, Facultad de Agronomía. 1949. 56 p. (mapa 1:2.000). (mecanografiado).

2- AGENCY FOR INTERNATIONAL DEVELOPMENT. Mapa de suelos agrícolas de Costa Rica. Resources Inventory Center Corps of Engineers, U.S. Army. Washington, D.C. 1965. 1 p. (1:750.000).

3- AGUIRRE, V. Estudio de los suelos del área del Centro Tropical de Enseñanza e Investigación, IICA-Turrialba, Costa Rica. Tesis Mg. Sc. Turrialba, IICA, 1971. 139 p.

4- AGUIRRE, V. y SILVA, L. Estudio de seis perfiles en las zonas de colonia Guayabo y San Antonio, Cantón de Turrialba, Costa Rica. Turrialba, IICA, 1968. 42 p.

5- ALVARADO, A. Estudio edafológico y agrológico de las sabanas de Buenos Aires de Puntarenas, Tesis Ing. Agr. San José, Universidad de Costa Rica, Facultad de Agronomía 1970. 116 p. (mapa 1:13.000). (mimeografiado).

6- ASOCACION REGIONAL PARA EL DESARROLLO DE LA PENINSULA DE NICOYA AGENCIA PARA EL DESARROLLO INTERNACIONAL. Datos generales. Introducción a los inventarios e inventario de los recursos naturales de la Península de Nicoya. Nicoya, Guanacaste, Costa Rica, 1965. pp: 65-70.

7- AVILA, O. y GRANT, F. Estudio agrológico de las Fincas La Guaria y La Trinidad en el Cantón Central de la Provincia de Alajuela. Tesis Ing. Agr. San José, Universidad de Costa Rica, Facultad de Agronomía, 1950. 78 p. (mapa 1:5.000) (mecanografiado).

8- BAZAN-SILVA, R. Soil survey of La Lola cacao farm. Tesis Mag. Agr. Turrialba, IICA, 1963. 127 p. (mapa 1:50.000) (mimeografiado).

9- BENNETT, H.H. (1924) General soil regions of eastern and northern Costa Rica. In. Treadwell, Jh. Cl. Posibilities for para ruber production in northern tropical America. Washington, U.S. Bureau of Foreign and Domestic Commerce, 1026. facing p. 24 (mapa 1:2.000.000).

10- BONILLA, R. y DELGADO, C. Estudio agrológico de la Finca El Alto. Tesis Ing. Agr. San José, Universiad de Costa Rica, Facultad de Agronomía, 1952. 127 p. (mapa 1:4.000) (mecanografiado).

11- CALVO, J. Suelos. In Nuhn, H. et al. Estudio geográfico regional de la Zona Atlántica Norte de Costa Rica. San José, ITCO, 1967. pp. 68-117.

12- CAROLINA TICA, S.A. Estudio económico-financieron para solicitud de crédito aplicable a la explotación de 210 Has. de banano. San José, Costa Rica, 1969. p. irr. (mecanografiado).

13- CARVAJAL, J.F. y VARGAS, A. Estudio agrológico de la Hacienda la Lindora. Tesis Ing. Agr. San José, Universidad de Costa Rica, Facultad de Agronomía, 1952. 130 p. (mapa 1:4.000). (mecanografiado).

14- CONSULTORA AGROPECUARIA EIRL. Compañía Bananera Anita Grande S.A. Proyecto de solicitud de crédito para la explotación de 120 Has. de banano. San José, Costa Rica, 1968. 85 p. (mapa 1:5.000). (mimeografiado).

15- _____. Productores Unidos de Banano S.A. Proyecto y solicitud de crédito para la explotación de 150 Has. de banano. San José, Costa Rica, 1967. 61 p. (mapa 1:5.000) (mimeografiado).

16- _____. Proyecto de explotación y solicitud de crédito para 250 Has. de banano. La Perla S.A. San José, Costa Rica, 1967. p. irr (mimeografiado).

17- _____. Proyecto de solicitud de crédito para la explotación de 170 Has. de banano en Monte Líbano. San José, Costa Rica, 1966. 56 p. (mapa 1:5.000). (mimeografiado).

18- CONSULTORA AGROPECUARIA, S.A. Banawaldeck S.A. Proyecto y solicitud para la explotación de 250 Has. de banano. San José, Costa Rica, 1968. 66 p. (mimeografiado).

19- _____. Compañía agrícola de Parismina S.A. "Finca modelo". Proyecto bananero 205 Has. San José, Costa Rica, 1969. p. irr. (mapa 1:5.000). (mimeografiado).

20- _____. Compañía Agrícola La Guadalupe, S.A. Proyecto y solicitud de crédito para la explotación de 200 Has. de banano. San José, Costa Rica, 1968. 64 p. (mimeografiado).

21- _____. Compañía Bananera Tel Aviv S.A. Proyecto y solicitud de crédito para la explotación de 115 Has. de banano. San José, Costa Rica, 1969. 72 p. (mimeografiado).

22- _____. Cooperativa de Asociación Bananera de Cariari R.L. Proyecto de crédito para la explotación de 200 Has. de banano. San José, Costa Rica, 1968. 65 p. (mapa 1:5.000). (mimeografiado).

23- _____. El Jardín de Cariari S.A. Proyecto y solicitud de crédito para la explotación de 200 Has. de banano. San José, Costa Rica, 1969. 73 p. (mapa 1:5.000). mimeografiado).

24- _____. Empresas de Banano Oro S.A. Solicitud de crédito para el cultivo de 250 Has. San José, Costa Rica, 1969. p. irr. (mapa 1:5.000). (mimeografiado).

25- _____. Finca el Jordán. Proyecto para el cultivo de 50 Has. de banano. San José, Costa Rica, 1967. 54 p. (mapa 1:5.000). (mimeografiado).

26- _____. Hacienda La Miluca S.A. Proyecto y solicitud de crédito para la explotación de 150 Has. de banano. San José, Costa Rica, 1968. 42 p. (mimeografiado).

27- _____. Hacienda La Miluca S.A. Proyecto y solicitud de crédito para ampliar en 50 Has. la explotación de banano ya existente. San José, Costa Rica, 1969. 59 p. (mapa 1:4.000). (mimeografiado).

28- _____. Reporte de suelos de la finca bananera Oro S.A. San José, Costa Rica, 1967. 23 p. (mimeografiado).

29- COSTA RICA. INSTITUTO DE TIERRAS Y COLONIZACION. Asociación Bananera de Cariari. Sociedad Cooperativa de Responsabilidad Limitada. Proyecto para el cultivo de 200 Has. de banano. San José, Costa Rica, 1967. 72 p. (mapa) (mimeografiado).

30- _____. Estudio de la región de Upala. San José, Costa Rica. 1964. 153 p. (mapa 1:60.000).

31- _____. Estudio finca Villa Marta. San José, Costa Rica, 1970. 32 p. (mapa 1:25.000). (mimeografiado).

32- _____. Estudio geográfico regional de la zona norte de Costa Rica. San José, Costa Rica. 1966. 308 p. (mapa 1:2.400.000).

33- _____. Estudio regional de la zona norte de Heredia. San José, Costa Rica, 1964. 205 p. (mimeografiado).

34- _____. Estudio regional zona de Paraíso-Ujarrás-Urasca. San José, Costa Rica, 1970. 37 p.

35- _____. Fraccionamiento finca El Control. San José, Costa Rica, 1971. 78 p. (mapa 1:15.000), (mimeografiado).

36- _____. Fraccionamiento La Thesalia. San José, Costa Rica, 1969. 127 p. (mapa 1:20.000). (mimeografiado).

37- _____. Fraccionamiento Paso Agres. Alternativa de 32 manzanas. San José, Costa Rica, 1971. 178 p. (mapa 1:25.000 . (mimeografiado).

38- _____. Fraccionamiento San Luis. San José, Costa Rica, 1970. 156 p. (mapa 1:10.000). (mimeografiado).

39- _____. Mapa de suelos finca Srs. Pinto Echeverría. San Isidro Peñas Blancas. San José, Costa Rica, 1963. 1 p. (mapa 1:10.000).

40- _____. Mapa de suelos y capacidad de uso. Finca Santa Rosa. San José, Costa Rica, 1966. 1 p. (mapa 1:63.000).

41- _____. Plan de desarrollo para la colonia de Pejiballe. San José, Costa Rica, 1966. 51 p. (mapa 1:15.000). (mimeografiado).

42- _____. Plan para el asentamiento de familias en la zona de Astúa Pirie. San José, Costa Rica, 1964, 71 p. (mimeografiado).

43- _____. Estudio geográfico nacional. Zona Atlántica Norte de Costa Rica. San José, Costa Rica, 1967. 360 p. (mapa 1:250.000).

44- _____. Proyecto de colonización Alfredo González Flores. San José, Costa Rica, 1966. 97 p. (mimeografiado).

45- _____. Proyecto de colonización de Bataán. San José, Costa Rica, 1963. p. irr. (mapa) (mimeografiado).

46- _____. Proyecto de colonización de Cariari. Mapa de suelos. San José, Costa Rica, 1968. 1 p. (mapa . 1:40.000).

47- _____. Programa de colonización para damificados por la actividad volcánica del Irazú. San José, Costa Rica, 1964. p. irr (mimeografiado).

48- _____. Proyecto para el asentamiento de 75 familias en la zona de Guayabo. San José, Costa Rica, 1964. 40 p. anexo (mapa 1:30.000). (mimeografiado).

49- _____. Soil Map. Lands between Parismina and Matina Rivers. Fincas El Carmen, Truque y Suerre, Goschen Nº 2. San José, Costa Rica, 1958. 1 p. (mapa (1:20.000).

50- COSTA RICA. MINISTERIO DE AGRICULTURA E INDUSTRIAS. Estudio preliminar de suelos de la región occidental de la Meseta Central. San José, Costa Rica. Bol. Téc. Nº 22, 64 p. 1958. (mapa 1:100.000).

51- CHIRRINOS, H.A. Levantamiento agrológico de la Estación Experimental de la Universidad de Costa Rica. Tesis Ing. Agr. San José, Universidad de Costa Rica, Facultad de Agronomía, 1957, 111 p. (mapa 1:1.000). (mecanografiado).

52- DELGADO, J.M., RAMIREZ, C.A. y UREÑA, R.A. Levantamiento agrológico de la zona de Paraíso. Tesis. Ing. Agr. San José, Universidad de Costa Rica, Facultad de Agronomía, 1955. 94 p. (mapa 1:4.902). (mecanografiado).

53- DONDOLI, C. Los suelos de Palmares. Suelo Tico 4 (21-22): 260-262. 1950.

54- _____ y TORRES, J.A. Estudio geoagronómico de la región oriental de la Meseta Central. San José, Costa Rica, Ministerio de Agricultura e Industria, 1954. 180 p. (mapa).

55- FLORES, S. y LEITON, J.S. Estudio agrológico detallado finca propiedad de Compañía Bananera Atlántica Ltda. (cobal). San José, Costa Rica, S.A. ESPROAGRO, 1970. 45 p. Anexo. (mapa 1:2.000). (mecanografiado).

56- _____ y LEITON, J.S. Estudio agrológico detallado Hacienda Speedway S.A. San José, Costa Rica, S.A. ESPROAGRO, 1969. 43 p. Anexo. (mapa 1:10.000). (mecanografiado).

57- _____ y LEITON, J.S. Estudio y clasificación detallada de tierras con fines de riego, zona San Antonio-San Rafael. San José, Costa Rica, S.A. ESPROAGRO, 1970. 63 p. (mapa 1:2.5000). (mecanografiado).

58- FLORES, O. y LEIVA, C. Estudio agrológico de las fincas San Bosco y Coris. Tesis Ing. Agr. San José, Universidad de Costa Rica, Facultad de Agronomía, 1949. 106 p. (mapa 1:4.000). (mecanografiado).

59- FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS. Proyecto de mapa de suelos de Centroamérica. Santiago, Chile, FAO/UNESCO, 1968. p. irr.

60- FUSSELL, K.E. Detail soil survey of the Freeman área-Costa Rica. IAIAS. Abaca Research Report Nº 18. 1952. 2 p.

61- _____. General soil survey reconnissance in Costa Rica of Potencial lands for the production of abaca. IAIAS. Abaca Research Report. Nº 13. 1951. 5 p.

62- GODEFROY, J. Etude agro-pedologique des sols de la Ticaban au Costa Rica. Institud Francais de Recherches Fruitiers Outre-Mer. Tica Bananera, Limón, Costa Rica, 1970. 34 p.

63- GONZALEZ, M.A. y TERAN, F.R. Estudio agrológico detallado de la región central de Curridabat-La Unión. Tesis Ing. Agr. San José, Universidad de Costa Rica, Facultad de Agronomía, 1961. 156 p. (mapa 1:5.000). (mecanografiado).

64- HARDY, F. The soils of the I.A.I.A.S. area. Cacao Center. Turrialba, Costa Rica, IICA, 1961. 75 p. (mapa 1 pulg: 5 millas). (mimeografiado).

65- _____ y BAZAN, R. Studies on Costa Rica soils. I-VII. Informes mimeografiados. Turrialba, IICA, 1963-1966. p. irr. (La Francia, La Lola y Colorado).

66- HARRIS, S.A. et al. The major soil zones of Costa Rica. In. Congreso Latinoamericano de Química, 10º, 1969. 11 p. (mapa). (mimeografiado).

67- HENNINGSEN, D. Notas sobre los tipos de suelos a uno y otro lado de la Cordillera Costeña, Zona Sur-Este de Costa Rica. Tierras Agrícolas del Valle del General. Inst. Geográfico de Costa Rica, Informe Semestral, 1963. 116 p.

68- INSTITUTO INTERAMERICANO DE CIENCIAS AGRICOLAS. Inventario de los recursos de los cantones Atenas, Orotina, Esparta y San Mateo, Costa Rica. Parte: Suelos; preparado por estudiantes año académico 1968-1969. Turrialba, 1969. 17 p. (mimeografiado).

69- JARAMILLO, L.R. Caracterización de algunos "latosoles" de Mesoamérica. Tesis Mg. Sc. Turrialba, IICA, 1969. 233 p. (mimeografiado).

70- _____, Estudio detallado de los suelos del Proyecto La Curia, Guápiles, Pococí, Prov. de Limón. Informe de Progreso. San José, Sociedad Agrícola San Cristobal, S.A., Dept. de Investigaciones, 1970. 97 p. (mimeografiado).

71- _____ y GOMEZ, M.T. Inventario de recursos del área laboratorio Nº 4: Río Barranca-Río Tárcoles, Costa Rica. Parte: Suelos. Turrialba, IICA, 1967. 55 p. (mimeografiado).

72- JIMENEZ, A. Estudio agrológico de la parte norte del Distrito Central de Turrialba. Tesis Ing. Agr. San José, Universidad de Costa Rica, Facultad de Agronomía, 1951. 78 p. (mapa 1:250.000). (mecanografiado).

73- JIMENEZ, M.F. y JIMENEZ, M. Estudio agrológico de La Hacienda de Verbena S.A. Tesis Ing. Agr. San José, Universidad de Costa Rica, Facultad de Agronomía, 1952. 107 p. (mapa 1:4000). (mecanografiado).

74- KESEL, R. et al. Soils report. In. Organization for Tropical Studies. Geography Course. July-August, 1967. pp: 42-49.

75- KNOX, E.G. y MALDONADO, F. Suelos de cenizas volcánicas; excursión al Volcán Irazú. In. Panel sobre suelos derivados de cenizas volcánicas de América Latina, Turrialba, IICA, 1969. 12 p.

76- LARA, M. Ingeniero Consultor: Informe al Ing. Carlos Ulate, Jefe División de Desarrollo del I.C.E., en relación con los estudios de suelos de la cuenca del Río Reventado. San José, Costa Rica, 25 mayo 1965.

77- LEITON, J.S. y SAENZ, R. Estudio semidetallado de suelos de la región comprendida entre los ríos Barranca y Lagarto. San José, Costa Rica, Ministerio de Agricultura e Industrias. Depto. de Conservación de Suelos, 1958. 70 p. (mapa 1:50.000).

78- _____ y VILLALOBOS, E. Estudio agrológico de la zona cafetalera de Lagunilla de Heredia. Tesis Ing. Agr. San José, Universidad de Costa Rica, Facultad de Agronomía, 1952. 106 p. (mapa 1:2.500). (mecanografiado).

79- LIZANO, C.L. y LOPEZ, M. Estudio agrológico de las fincas Carrillo-Davidson y Sección Giustiniani. Tesis Ing. Agr. San José, Universidad de Costa Rica, Facultad de Agronomía, 1954. 106 p. (mapa 1:2.000). (mecanografiado).

80- LORIO, P.L. y MUERY, H.O. Reconnissance soil survey of The Estrella Valley, Costa Rica. Limón, Costa Rica, Standard Fruit Co., Costa Rica División, Research Dept., 1956. p. irr.

81- LORZ, A. y RAMIREZ, M.T. Estudio sobre la erosión de los suelos en relación con las condiciones de uso de la Tierra que prevalecen en las fincas "Los Cuadros", región de Ipís, Cantón de Goigoechea. Tesis Ing. Agr. San José, Universidad de Costa Rica, Facultad de Agronomía, 1967. 97 p. (mapa 1:2.500). (mecanografiado).

82- LUZURIAGA, C. Propiedades morfológicas, físicas y químicas y clasificación de seis andosoles de Costa Rica. Tesis Ng. Sci. Turrialba, IICA, 1970. 159 p. (mimeografiado).

83- MACIAS, M. Propiedades morfológicas, físicas, químicas, y clasificación de ocho "Latosoles" de Costa Rica. Tesis Mag. Sc. Turrialba, IICA, 1969. 193 p. (mimeografiado).

84- MANNIX, J. Estudio agrológico de la Península de Nicoya, Provincia de Guanacaste. San José, Costa Rica, Ministerio de Agricultura y Ganadería, 1964. 2 p. (mapa 1:500.000). (mecanografiado).

85- _____. Estudio de suelos finca del Consejo Nacional de Producción, Liberia. San José, Costa Rica, Ministerio de Agricultura y Ganadería, 1967. 14 p. (mapa 1:2.000). (mecanografiado).

86- _____. Reconocimiento de suelos, finca Isla Grande, Las Horquetas. San José, Costa Rica, Ministerio de Agricultura y Ganadería, 1969. 13 p. (mapa) (mecanografiado).

87- _____. Reconocimiento del Valle del Ceibo. San José, Costa Rica, Ministerio de Agricultura y Ganadería, 1966. 7 p. (mecanografiado).

88- _____. Redescripción preliminar de suelos volcánicos del macizo del Irazú. San José, Costa Rica, Ministerio de Agricultura y Ganadería, 1966. 8 p. (mecanografiado).

89- _____. Estudio de suelos de la Estación Experimental Los Diamantes. San José, Costa Rica, Ministerio de Agricultura y Ganadería, 1967. 6 p. (mapa 1:2.000). (mecanografiado).

90- _____. Plano preliminar de suelos. In. Wydler, R.E. Asistencia técnica en riego al Gobierno de Costa Rica. San José, Costa Rica, Ministerio de Agricultura y Ganadería. Resumen de los trabajos realizado Noviembre 1967-1969, 1970. 61 p. (mapa 1:20.000).

91- MARTIN, R. y SOTO, M. Remapeo de suelos de la zona Nº 1, Unidades 2 y 5, Distrito Estrella. Limón, Costa Rica, Standar Fruit and Steamship Co., Tropical Research Dept., 1958. p. irr.

92- MARTINI, J.A. Principales grandes grupos de suelos de América Central y México. Fitotecnia Latinoamericana 4(1): 57-79. 1967.

93- _____. Algunas consideraciones sobre los suelos de América Central con referencia especial al desarrollo del trópico húmedo. Fitotecnia Latinoamericana 6 (1): 127-147. 1969.

94- MORALES, E. y TORRES J.A. Estudios preliminares del mapeo y reconocimiento geológico y de suelos de la parte sur y sur-este de la Meseta Central Occidental. Tesis Ing. Agr. San José, Universidad de Costa Rica, Facultad de Agronomía, 1965. 77 p. (mecanografiado).

95- MORERA, M. y MORALES, A. Estudio agrológico de la finca Luis Montenegro. Tesis Ing. Agr. San José, Universidad de Costa Rica, Facultad de Agronomía, 1954. 118 p. (mapa 1:2.000). (mecanografiado).

96- MOSQUERA, L. Génesis y propiedades de los suelos de una secuencia topográfica en el trópico húmedo cálido. Tesis Mg. Sc. Turrialba, IICA, 1967. 141 p. (mimeografiado).

97- MUERY, H.O. Estrella Valley soil survey Fortuna, Aurora, Fortuna, Limón, Costa Rica, Standard Fruit Co., 1967. p. irr.

98- _____ y LORIO, P.L. Reconnissance soil survey of The Old Line District. Limón, Costa Rica, Standard Fruit Co., Research Dept., 1956. 9 p. apéndice. (mecanografiado).

99- ORTEGA, F.M. y CARVAJAL, M. Estudio agrológico de la finca La Esperanza. Tesis Ing. Agr. San José, Universidad de Costa Rica, Facultad de Agronomía, 1951. 53 p. (mapa 1:2.000). (mecanografiado).

100- PALENCIA, J. Caracterización de algunos suelos derivados de cenizas volcánicas en Centroamérica. Tesis Mg. Sc. Turrialba, IICA, 1969. 168 p.

101- PAN AMERICAN INSTITUTE OF GEOGRAPHY AND HISTORY. Costa Rica. Investigación de suelos In. Los estudios sobre recursos naturales en las Américas. México, 1953. v. 1 (mapa 1:2.000.000).

102- PEREZ, S. Compañía Bananera El Jardín S.A. Estudio económico. Proyecto bananero 250 Has. San José, Costa Rica, 1970. p. irr. (mapa) (Mimeografiado).

103- _____. Mapa de clasificación de suelos de Costa Rica. San José, Costa Rica, Oficina de Planificación, 1971. 1 p. (mapa 1:1.000.000).

104- _____. Reporte de suelos de la zona norte de Guanacaste-Costa Rica, San José, Proyecto de Desarrollo Forestal de Zonas Selectivas ITCO-FAO. Informe Nº 4. 1967. 40 p.

105- PROCTOR, J. Soil type and vegetation in the area around finca Taboga. In. Organization for Tropical Studies. Tropical biology. Informe de curso. San Pedro de Montes de Oca. San José, Costa Rica, Julio-Agosto. 1970, pp: 127-129.

106- QUIROS, T. Geografía de Costa Rica. San José, Costa Rica, Ministerio de Obras Públicas, Instituto Geográfico de Costa Rica, 1954. 191 p. (mapa 1:1.000.000).

107- ROBINSON, G.H. y STRIKER, M.M. Soils of the Colina-Pacuare area, Costa Rica, I.A.I.A.S. Abaca Research Report Nº 12 1951. 15 p.

108- _____ y STRIKER, M.M. Soils of the Estrella area, Costa Rica, I.A.I.A.S. Abaca Research Report Nº 11. 1951. 18 p.

109- _____ y STRIKER, M.M. Soils of the Good Hope area Costa Rica, I.A.I.A.S. Abaca Research Report Nº 9. 1951 22 p.

110- _____ y STRIKER, M.M. Soils of the Margarita Goschen-Woldeck areas, Limon Pronvicó, Costa Rica, I.A.I.A.S. Abaca Research Report Nº 8. 1951. 17 p.

111- _____ y STRIKER, M.M. Soils of the Monte Verde area, Costa Rica, I.A.I.A.S., Abaca Research Report Nº 10. 1951. 17 p.

112- SAENZ, A. Anotaciones sobre el orígen de formación y desarrollo de los suelos de la región de Palmares y sus alrededores. Revista Universidad de Costa Rica 4: 187-296 1949.

113- _____. Bosquejo Geoedafológico de Costa Rica y el Instituto Interamericano de Ciencias Agrícolas. 3a. Conferencia Latinoamericana de Agricultura. Caracas, Venezuela, 1945. p. irr. (mimeografiado).

114- _____. Geoedafología costarricense. San José, Costa Rica, Universidad de Costa Rica, Facultad de Agronomía, 1967. 29 p.

115- _____. Suelos volcánicos cafeteros de Costa Rica. Universidad de Costa Rica, Serie Agronómica, Nº 6. 1969. v. 1, 356 p.

116- SANCHEZ, A. y SAENZ, J. Estudio agrológico de una finca en San Antonio de Belén. Tesis Ing. Agr. San José, Universidad de Costa Rica, Facultad de Agronomía, 1952. 150 p. (mapa 1:3.000). (mecanografiado).

117- SCHROEDER, N. Proyecto para el cultivo de 60 Has. de banano. San José, Costa Rica, 1968. 29 p. (mimeografiado).

118- SEGARS, C.B. Some soils and fertilizer relationships of the Cavendish banana (Musa cavendishii Lambert) on three different soils in Costa Rica. Ph. D. Diss. Abstr. 23: 4055-6. 1963. Order Nº 63-3664

119- SOTO, J. Estudio de suelos del Valle de Estrella. Limón, Costa Rica, Standar Fruit Co., Costa Rica Division Research Dept., 1963. 29 p. (mecanografiado).

120- _____. Estudio químico de los suelos de las Unidades Nos. 1, 2 y 5, Zona Nº 1, Distrito Estrella. Limón, Costa Rica, Standard Fruit and Steamship Co., Tropical Research Dept., 1959.

121- _____. y GONZALEZ, R. Estudio geo-químico y geoagronómico de dos suelos de Costa Rica. Tesis Ing. Agr. San José, Universidad de Costa Rica, Facultad de Agronomía, 1956. 131 p. (mapa 1:2.000). (mimeografiado).

122- _____, y MARTIN, R. Estudio de suelos de la región sur del Valle de Estrella. Limón, Costa Rica, Standard Fruit and Steamship Co., Tropical Research Dept. 1958. 34 p. (mecanografiado).

123- _____, y SAENZ, J. Estudio de suelos de Sasso-Pirie. Limón, Costa Rica, Standar Fruit Co., Research Dept., 1960. 34 p. (mecanografiado).

124- _____ GONZALEZ, M.A. y CHACON, A. Estudio de los recursos agrícolas de la finca Santa Rosa-Puriscal. San José, Costa Rica, Instituto de Tierras y Colonización, 1963. 27 p. (mapa 1:50.000). (mimeografiado).

125- STANDAR FRUIT AND STEAMSHP CO. Mapa de suelos Valle la Estrella (Atalanta-Alsacia y Lorena-Talía). Limón, Costa Rica, Tropical Research Dept., s.f. 1 p. (mapa 1:10.000)

126- STANDAR FRUIT COMPANY. Reconocimiento de suelos Río Sucio-Tortuguero. Limón, Costa Rica, s.f. 1 p. (mapa 1:10.000)

127- _____. Mapa de suelos, Colombiana-Williamsburg. Limón, Costa Rica, 1956. 1 p. (mapa 1:10.000).

128- SUAREZ, A. y VARGAS, O. Proyecto para el cultivo de 250 Has. de banano. San José, Costa Rica, Empresa Santa María S.A., 1967. 55 p. (mimeografiado).

129- _____ y VARGAS, O. Estudio agrológico para el cultivo del banano en la finca del Sr. Hernán Araya Madrigal. Pococí, Provincia de Limón. San José, Costa Rica, 1968. 8 p. (mapa 1:5 000). (mecanografiado).

130- _____ y VARGAS, O. Finca Castillo y Azofeifa. Proyecto para el cultivo de 100 Has. de banano. San José, Costa Rica, 1967. 51 p. (mapa 1:5.000). (mimeografiado).

131- _____ y VARGAS, O. Proyecto para el cultivo de 100 Has de banano. San José, Costa Rica, Freehold, S.A., 1967. 45 p. (mapa 1:5.000). (mimeografiado).

132- _____ y VARGAS, O. Proyecto para el cultivo de 250 Has. de banano. San José, Costa Rica, Sociedad Ganadera Río Jiménez, Ltda., 1967. 55 p. (mimeografiado).

133- TERAN, F.F. y GONZALEZ, M.A. Estudio agrológico detallado de la región central de Curridabat-La Unión. Tesis Ing. Agr. San José, Universidad de Costa Rica, Facultad de Agronomía, 1961. 156 p. (mapa 1:5.000). (mecanografiado).

134- TORRES, R. Foto-interpretación, su aplicación en la clasificación y cartografía de los suelos de un área de la Península de Nicoya, Guanacaste, Costa Rica. Tesis Mag. Sc. Turrialba, IICA 1967. 135 p. (mimeografiado).

135- TOSI, J.A., Jr. y MASIS, J.A. Mapa Nº 3. Unidades de Tierra. In. Centro Científico Tropical. Informe sobre investigación preliminar de la Zona Norte de la Provincia de Alajuela y Heredia, Costa Rica, San José. 1968. 1 p. (mapa 1:200.000).

136- UNITED FRUIT COMPANY. Mapa de suelos, zonas entre Río Parismina y Río Matina. Limón, Costa Rica, 1958. 1 p. (mapa 1:5.000).

137- UNITED STATES DEPARTMENT OF AGRICULTURE. Mapa de suelos, zona Freeman. Limón, Costa Rica. 1951. 1 p. (mapa 1:10.000).

138- _____. BUREAU OF PLANT INDUSTRY. Mapa de suelos, fincas La Margarita y Goschen. Limón, Costa Rica, 1951. 1 p. (mapa 1:10.000).

139- URBINA, O. Estudio agrológico de las fincas San Rafael. Tesis Ing. Agr. San José, Universidad de Costa Rica, Facultad de Agronomía, 1951. s.p. (mapa 1:2.000). (mecanografiado).

140- VARGAS, C. Estudio preliminar de suelos. Proyecto de riego Río Tempisque. San José, Costa Rica, Ministerio de Agricultura e Industrias. Boletín Técnico Nº 30, 1959. 48 p. (mapa 1:50.000).

141- _____. Mapa de suelos Finca La Perla. San José, Costa Rica, Ministerio de Agricultura y Ganadería, 1962. 1 p. (mapa 1:20.000).

142- VAZ - CABEDA, M. Génesis comparativa de los suelos desarrollados sobre una secuencia cronológica de terrazas aluviales. Tesis Mag. Sc. Turrialba, IICA, 1970. 56 p. (mimeografiado).

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Table 1. Chapter III. Soils of Costa Rica

ENTITY	SOILS	Major Soils Emphasis	1977 - 1978 Budget* Dollars (Local Salaries)	Staffing Patterns Prof.	Sub. Prof.	Clerical	Office	Library (Books and periodicals)	Access to Laboratory	Green house	Soil Lab. Equipment	Analytical services
I. MINISTERIO DE AGRICULTURA Y GANADERIA												
A. Dirección General de Investigaciones Agrícolas												
1. Departamento de Agronomía												
a. Sección de Fertilidad de Suelos y Nutrición de Plantas	Fertility	50,000 10,000 (Travel)	3 (2 Ph.D.)	1	1/2	Adequate	Poor (Not current and small)	Use NAS Lab.	Poor condition	-	-	
b. Laboratorio de Suelos y Análisis Foliares	Fertility Lab.	50,000	3	4	1/2	Adequate	Use PAS and staff books	PAS Lab. Adequate	Can share NAS	2 steel; Ab. Spectrophot.	-	
c. Departamento de Investigaciones de Café	Fertility trials	50,000 (Est. of soils section)	6	-	-	A.T. SS	Use NAS and staff books	Use NAS Lab.	Can share NAS	-	-	
d. Departamento de Mecanización	Fertility trial analyses	15,000 (calculations for trials)	1/2	1/2	1/2	N.T. SS	Use PAS	Not needed	Not needed	Use of computer	-	
B. Dirección de Riego y Drenaje												
1. Departamento de Suelos	Classification (New taxonomy) (Land use pot.)	40,000	3 1 Lab.	5 (Incl. cartographer)	Pool (Equip. 1)	Small	Use PAS	Share NAS Lab. (No physical testing)	Can share NAS	2 mirror stereoscopes physical soils lab. Photometer	-	
C. Dirección de Extensión												
1. Centro Regionales	Fertility (Field trials support)	25,000 (in support of trials)	Not determined.	Not Det.	Not Det.	Adequate	Weak	Use NAS Lab. None		-	-	
II. INSTITUTO DE TIERRAS Y COLONIZACION (ITCO)												
A. Departamento de Planificación	Classification (Practical)	40,000	4	2 (1 photo) (1 cart.)	1	Small	Small	Use NAS Lab.	None	Mirror stereoscope	-	
1. Sección de Estudios Básicos												
III. UNIVERSIDAD DE COSTA RICA												
A. Departamento de Fitotecnia y Suelos	Teaching and Research	40,000	3 + 6 part time (1 Ph.D.)	1	1/2	Adequate	U. of C.R. (Fair) (Professors have many books)	Use U. of C.R. Lab.	Small	-	-	
B. Centro de Investigaciones Agronómicas (Lab.)	Fertility Lab.	100,000	6 (1 Dr. Sci.)	6	1	Ample	Same as above	U. of C.R. Lab. Adequate	Can share above	Atomic absorb. U.V. spect. scintillation counter	Use chrom. X-ray diff. Therm. Diff.	
C. Estación Experimental Pablo Sandrit	Fertility (trials)	25,000	NOT DETERMINED			Adequate	Use U. of C.R.	Not def. as yet.				
IV. OFICINA SECTORIAL DE PLANEAMIENTO AGROPECUARIO (OSPA)	Classification (New taxonomy)	30,000	2 1/2	1/2	1/2	Adequate	WEAK	Do not use Lab.	No need	-		
V. COMPAÑIAS PARTICULARES												
A. Fertilizantes de Centroamérica (Costa Rica) S.A.	Fertility	30,000	2 1/2	—	1/2	Very sm	Weak	Use NAS Lab. (have unused lab.)	None	-		Will open lat
B. Abonos Superior	About 6 exploratory Fertilizer trials/year											
VI. CENTRO AGRONOMICO TROPICAL DE INVESTIGACION Y ENSEÑANZA (CATIE)												
A. Dirección de Enseñanza	Teaching	(Included in 2)	1 (1 Ph.D.)	—	—	Ample	CATIE (Largest but prof. have books)	Use CATIE Lab.	No need	-		
B. Laboratorio de Suelos	Fertility Lab.	100,000	2 (1 Ph.D.)	4	1	Ample	Same as above	CATIE Labs. adequate	Ample	Atomic Abs. spectrophotometer		

Soils [illegible]	1977 - 1978 Budget* Dollars (Estimated)	Staffing Patterns: Prof.	Sub. Prof.	Clerical	Offices	Library (Books documents and maps)	Access to laboratory	Green house	[illegible]	[illegible]	Other collaborators (Major)	Mobility and transport	Major Outputs	Principal users of information
…ity	50,000 10,000* (coffee)	3 (2 Ph.D.)	1	1/2	Adequate	MAG Library (Not current and small)	Use MAG Lab.	Poor condition	–	–	MAG, Crop Offices	2 MAG Cars (Periodic scarcity)	1978, 30 Crops	MAG Offices
…ility	50,000	3	4	1/2	Adequate	Use FAG and staff books	MAG Lab. Adequate	Can share MAG	2 atomic Ab. Spectrophot.	–	Dir. Riego	Private car	Soil Analyses	Farmers MAG Offices
…ility …	50,000 (Est. of value pe- ties)	6	–	–	NOT DE[T.]	Use MAG and staff books	Use MAG Lab.	Can share MAG	–	–	Oficina del Café	Adequate	Foliar analyses	Private firms
…ility …anal-	15,000 (calculations for trials)	1/2	1/2	1/2	NOT DE[T.]	Use MAG	Not needed	Not needed	Use of computer	–	Support role fertility trials	None needed	Statistical anal. fertilizer trials	MAG Offices
…ifica- (New …vey) … use	40,000	3 1 Lab.	5 (Incl. cartographer)	Pool (Equip. 1)	Small	Use FAG	Share MAG Lab. (Do physical testing)	Can share MAG	2 mirror stereoscopes physical soils lab. Sketchmaster	–	MAG Lab.	MAG Car 1 Loan car (periodic scarcity)	Soil mapping Physical soils Lab.	Dir. de Riego
…ility …ld … …rt)	29,000 (in support of trials)	Not determined.	Not. Det.	Not Det.	Adequate	Weak	Use MAG Lab.	None →	–	–	Support role to fert. trials	Adequate	[illegible]	[illegible]
…ifica- (Prec- …)	40,000	4	2 (1 photo) (2 cart.)	1	Small	Small	Use MAG Lab.	None	Mirror stereoscope	–	Dir. Riego	Pool (periodic scarcity)	Soil maps on small areas	ITCO
…ing and …rch	40,000	3 + 6 part time (1 Ph.D.)	1	1/2	Adequate	U. of C.R. (Fair) (Professors have many books)	Use U. of CR Labs.	Small	–	–	Centro de Investigaciones U DE C.R.	Pool Adequate	12-15 thesis/year Technical Publ.	Agronomist Students
…ility	[illegible],000	6 (1 Sr. Sci.)	6	1	Ample	Same as above	U. of C.R. Lab. Adequate	Can share above	Atomic spect. N^{15} spect scintillation counter	Gas chrom. X-ray diff. Thermal Diff	Dept. Phytotecnia UCR	Univ. Pool Adequate	Technical publ.	Agronomist
…ility …ls)	25,000	NOT DETERMINED			Adequate	Use U. of C.R.	NOT DET. [illegible]				Regional Centers CIMMYT	Adequate	Corn and wheat and other trials	Farmers Agronomists
…ifica- (…)	30,000	2 1/2	1/2	1/2	Adequate	WEAK	Do not use Lab.	No need	–	–	Minor		(1978) general Soils Map 1:200.000	Planning Office
…ility	30,000	2 1/2	—	1/2	Very [illegible]	Weak	Use MAG Lab. (Have unused lab.)	None	–	Will may open Lab. later	Farm cooperators	Private ample	Support 2 theses 6 fertility trials	Salesmen
About 6 exploratory Fertilizer trials/year														
…ing	(included in [illegible])	1 (1 Ph.D.)	—	—	Ample	CATIE (Largest but prof. have books)	Use CATIE Lab.	No need	–	–	Minor	None needed	2-3 theses/year (MS)	Agronomist students
…ility	100,000	2 (1 Ph.D.)	4	1	Ample	Same as above	CATIE Labs. adequate	Ample	Atomic. Abs. spectrophotometer	–	Minor	Adequate	Soil Analyses Foliar Analyses Greenhouse tests	CATIE Researchers

…ent 310,000, Univ. 163,000, CATIE 100,000, Business 30,000) (Total Laboratories $290,000)

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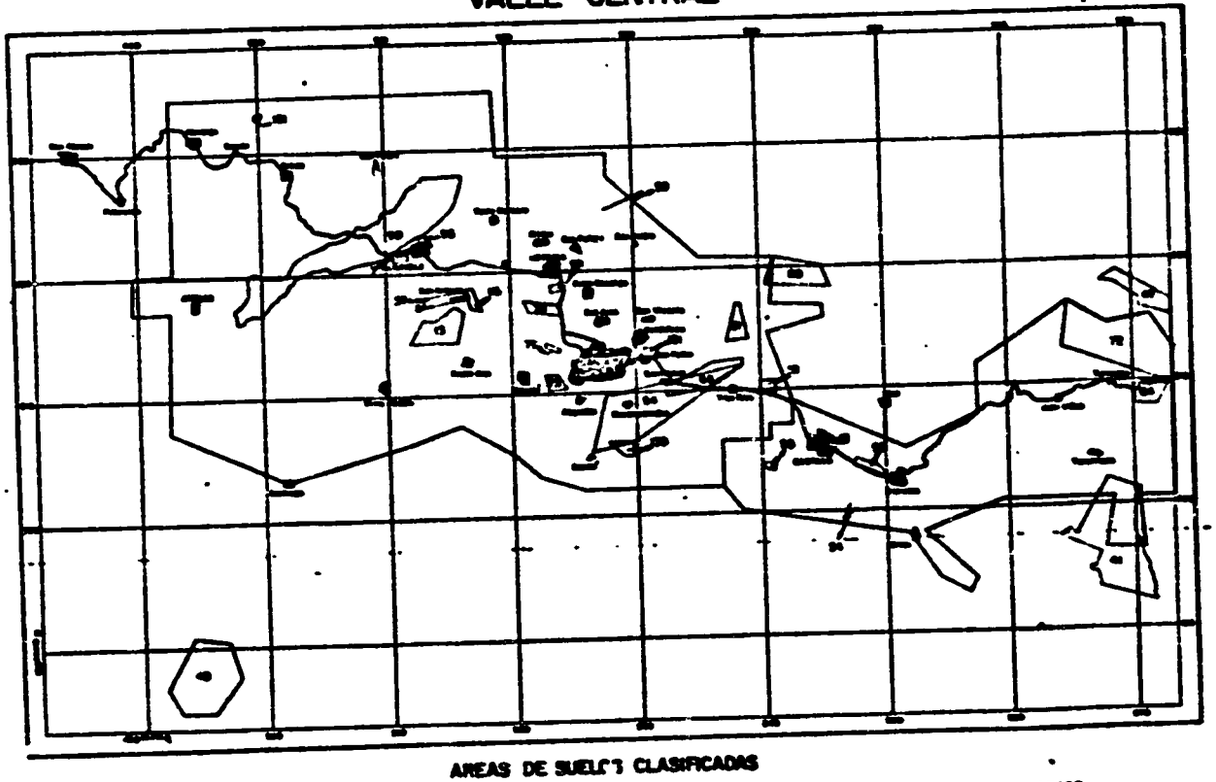
VALLE CENTRAL



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AREAS DE SUELOS CLASIFICADAS

Esc. 1:600.000

AUTOR A. ALVARADO
DIBUJO LUIS FCO SANCHEZ
FECHA 15-9-72

NOTA:
LOS NUMEROS INCLUIDOS EN EL MAPA CORRESPONDEN A LA NUMERACION DE LA BIBLIOGRAFIA.

Appendix B. Table 2. Soil Profiles for map 1.

Algunos suelos de Costa Rica identificados y clasificados según la taxonomía de U.S.D.A.

Perfil No.	Lugar y/o serie	Altitud m	Orden	Sub-orden	Grupo-grande	Sub-grupo	Familia	Clima	Autor
1 (CR-55)	San José de Arenal 34 km N.E. Ciudad Quesada 10°34', 84°17'O Series (?) San Carlos	306	Ultisols	Humult	Palehumult	Typical	Arcilloso mixto isohipertérmico	Tropical Húmedo 3383 mm 26.02°C	Nuñez (1969)
2 (CR-47)	20 km N.E. de Turrialba 9°58' N, 83°35' O	530	Inceptisols	Tropepts	Dystropepts	Typic	Muy fino mixto isohipertérmico	Tropical Húmedo 4266 mm 25.0°C	"
3	2 km oeste de Turrialba 7°54' N, 83°43' O Series: Colorado	780	"	"	"	"	"	Tropical Húmedo 2436 mm 22.2 °C	"
4 (CR-32)	2 km antes Birrisito vía a Paraíso 9°51' N, 83°51' O	1300	"	"	Humitropepts	"	"	Tropical Húmedo 2033 mm 21.8°C	"
5 (CR-46)	15 Km antes Buenos Aires 9°03' N, 83°17' O	400	Ultisols	Humults	Palehumults	Ustic	Arcilloso Mixto Isohipertérmico	Tropical Húmedo 2648 mm 24.2°C	"
6 (#9)	Buenos Aires Compañía La Pinera Series: Tembleroso	350	Ultisols	Aquult	Tropaquults	Aeric Humbric	Arcilloso mezclado ácido isotérmico	Tropical Húmedo 3078 mm 23°C	Alvarado (1970)

Continuación Cuadro 2, Apéndice B.

Perfil No.	Lugar y/o serie	Altitud m	Orden	Sub-orden	Grupo-grande	Sub-grupo	Familia	Clima	Autor
7 (CR-12)	Buenos Aires 9°9' N, 83° 20' O Series Volcán (?)	500	Ultisols	Humult	Palehumult	Orthoxic	Arcilloso kaolintic isohipertérmico	Tropical húmedo 3296 mm 25.7°C	Mata Dias (1969)
8 (CR-17)	18 km sur de San Isidro de El General 9° 16' N, 83° 37' O	750	Ultisols	Humults	Palehumult	Orthoxic	"	"	"
9 (CR-20)	2 km antes de San Isidro de El General, Carretera Panamericana 9° 24' N, 83° 44' O	900	Ultisols	Humult	Palehumult	Typic	Arcilloso mezclado isohipertérmico	Tropical húmedo 2648 mm 24.2 °C	"
10 (CR-56)	5 km de Turrialba hacia Juan Viñas 9° 53' N, 83° 48' O Series: Birrisito	1000	Inceptisols	Andept	Dystroandept	Hydric	Thixotropic, isohipertérmico	Muy húmedo Premontano 2218 mm 22° C	Luzuriaga (1970)
11 (CR-30)	2 km de Cervantes hacia Cartago 9° 52' N, 83° 48' O	1600	Inceptisols	Andept	Dystrandept	Typic	Medial, isotermic	Muy húmedo premontano 2800 mm 19° C	"
12 (CR-67)	2 km de Tapesco hacia La Laguna 10° 13' N, 84° 24' O	1600	Inceptisols	Andept	Dystrandept	Typic	Medial, isotermic	Muy húmedo montano bajo 3534 mm 17.5 C	"
13 (CR-57)	8 km de Cartago hacia el Irazú 9° 54' N, 83° 54' O	1700	"	"	"	"	"	Húmedo montano 1179 mm 17.0 °C	"

Continuación Cuadro 2, Apéndice B.

Perfil No.	Lugar y/o serie	Altitud m	Orden	Sub-orden	Grupo-grande	Sub-grupo	Familia	Clima	Autor
14 (CR-65)	3 km de San José de la Montaña 10° 7' N, 84° 10' O	1800	Inceptisols	Andept	Dystrandept	Typic	Medial, isotermic	Muy húmedo montano bajo 2800 mm - 16° C	Luzurriaga (1970)
15 (CR-35)	Finca La Suiza 1 km antes de Vara Blanca 10° 9' N, 84° 12' O	1900	"	"	"	"	"	Muy húmedo Montano bajo 3534 mm - 15°C	"
16	CATIE Series: Reventazón	±600	"	Tropept	Dystropept	"	Franco fino Mixta Isohipertérmico	2682 mm 22.3 °C	Aguirre (1971)
17	CATIE Series: Juray	±600	"	Tropept	Dystropept	Typic	Fino mixto Isohipertérmico	2682 mm 22.3°C	"
18 (#11, #12)	CATIE Series: Instituto (Normal)	±600	"	"	"	"	Fino francoso mixto Isohipertérmico	"	"
19 (#26)	CATEI Series: Instituto (Fase pantanosa)	±600	"	Aquept	Tropaquept	Fluventic	"	"	"
20 (#10)	CATIE Series: La Margot	±600	"	Tropept	Dystropept	Typic	Fino mixto Isohipertérmico	"	"
21 (#28)	CATIE Series: Colorado	620-990	"	"	"	"	"	"	"
22	Bagaces 1 B		Entisols	Orthent	Ustorthent	"			Moldridge et al. (1971)

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Continuación Cuadro 2. Apéndice B.

Perfil No.	Lugar y/o serie	Altitud m	Orden	Sub-orden	Grupo-grande	Sub-grupo	Familia	Clima	Autor
23	Bagaces 1 D		Vertisols	Ustert	Pellustert	Upic			Aldridge et al.[a] (1971)
24	Bagaces 1 E		Entisols	Fluvent	Ustifluvent	Ustic			"
25	Bagaces 1 F		Inceptisols	Tropept	Ustropept	Ustic			"
26	Taboga 1 G		Entisols	Fluvent	Ustifluvent	Typic			"
27	Barranca 2A		Inceptisol	Tropept	Ustropept	Typic			"
28	Turrialba Siquirres 3		"	"	Eutropept	"			"
29	Los Inocentes 20 A		"	"	Dystropept	Ustic			"
30	Los Inocentes 20 D		Alfisol	Ustalf	Tropudalf	Ultic			"
31	Osa 8 A		Ultisol	Usult	Tropudult	Typic			"
32	Osa 8 D 2		Entisol	Fluvent	Tropofluvent	Typic			"
33	OSA 8 F		Inceptisol	Tropept	Eutropept	Typic			"
34	Alajuela 18		Alfisol	Ustalf	Haplustalf	Udic			"
35	Volcán 7, Sarapiquí 11		Ultisol	Humult	Tropohumult	Typic			"
36	Volcán Orosi 16		Alfisol	Ustalf	Haplustalf	Ultic			"
37	Sanatorio Durán 17		Inceptisol	Andept	Eutrandept	Typic			"
38	Birrisito		Inceptisol	Andept	Dystrandept	Typic			Knox & Valverde (1969)

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Continuación Cuadro 2. Apéndice B.

Perfil No.	Lugar y/o serie	Altitud m	Orden	Sub-orden	Grupo-grande	Sub-grupo	familia	Clima	Autor
39	Cervantes		Ince; tisol	Andept	Vitrandept	Umbric			Knox & Maldonado (1969)
40	Birrisito		Ince; tisol	Andept	Dystrandept	Oxic			"
41	Irazú		Ince; tisol	Andept	Vitrandept	Umbric			"
42	Buenos Aires Compañía La Piñera 450 Series La Piñera **	450	Ultisols	Humults	Palehumults	Orthoxic	Arcillo, muy fino mezclado ácido isohipertérmico	Tropical húmedo	Alvarado (1970)
43	Buenos Aires Compañía La Piñera Series: Salitre **	450	"	Udults	Tropudults	Oxic	Arcilloso, mezclado, ácido isohipertérmico		"
44	Buenos Aires Compañía La Piñera Series: Buenos Aires**	450	"	Humults	Tropohumults	Orthoxic	Arcillo, muy fino, mezclado ácido isohipertérmico		"
45	"	"	"	"	"	Typic	Arcilloso mezclado ácido isohipertérmico		"
46	"	"	"	"	"	"	"		"
47									
48								.....	

Continuación Cuadro 2. Apéndice B.

Perfil No.	Lugar y/o serie	Altitud m	Orden	Sub-orden	Grupo-grande	Sub-grupo	Familia	Clima	Autor
49									
50									
51									
52									
53									
54 (#8)	150 m. E carretera San Isidro-Dominical entre El Alto y La Alfombra Series: La División	1050	Ultisol	Humult	Tropohumult			Bosque muy húmedo pre-montano tropical lluvioso	Portillo (1974)
55 (#9)	1 km S caserío San Cristóbal y 150 m O de carretera San Isidro-Dominical Series: San Cristóbal	740	"	"	"			Bosque pluvial pre-montano	"
56 57	Cerca Carretera Cartago-Volcán Irazú Series: Irazú	2500-2900				Umbric Vitrandept	Ashy Isotermic	2000 mm 9°C	González (1972)
57	Corte camino Cervantes Paraíso (3 km después de Cervantes) Series: Cervantes	1500				Umbric Vitrandept	Ashy o skeletal Isotermic	2000 mm 19°C	"
58	Serie Birrisito Finca Victoria camino Turrialba-Juan Viñas (lava 2000 años)	1200				Oxic Dystrandept	Ash Isohipertérmico	3000 mm 21°C	"

Continuación Cuadro 2. Apéndice B.

Perfil No.	Lugar y/o serie	Altitud m	Orden	Sub-orden	Grupo-grande	Sub-grupo	Familia	Clima	Autor
59	Series: Alajuela O. Carretera Alajuela - San Isidro. 1/2 vía	850	No	se	han	clasificado		1500 mm (8 meses) 20°C	
60	3245 I, Barranca Camino San Mateo - Esparta, 1 km E. de Jesús María	220			Tropostults			Aw'i Koppen trop. lluvioso seco Ave. Min. 18°C	Iporre (1970)
61	3245-I. Finca del Sr. Luis Sánchez, en Zopilota - Cascajal	190			Tropostults			isotermo Bosque Trop. Seco (Hold.) 2073-2163 mm 27°C	"
62	Series: Colorado 2 km antes de Turrialba cerca carretera	780	Inceptisol					Bosque húmedo tropical	Ríos (1969)
63	Series: Paraíso 2 km después Birrisito en vía a Cervantes	1300	Inceptisol					Bosque húmedo premontano	"
64	Series: Buenos Aires cerca Buenos Aires Valle de El General	400	Ultisol					Bosque húmedo tropical (4-5 meses seco)	"
65	Series: San José del Arenal 34 km NE Ciudad Quesada	300	Ultisol					Bosque húmedo tropical	"

Continuación Cuadro 2. Apéndice B.

Perfil No.	Lugar y/o serie	Altitud m	Orden	Sub-orden	Grupo-grande	Sub-grupo	Familia	Clima	Autor
66	Estrella. S.E. de Bataan R. Matina	Cerca nivel Mar	Entisols	Psamments	Udipsamments	Alfic Udipsamments	Loam limoso, mezclado, no ácido, isohy-pertermic	Tropical húmedo (Costa Atlántica)	Jiménez (1972)
67	Pacuare N. Bataan Finca Waldeck	"	Entisols	Fluvent	Tropofluvents	Antic Tropofluvents	Loam mezclado no ácido isohypertérmic	"	"
68	Manila N. Bataan Finca Waldeck	"	Entisols	Aquents	Hydraquents	No hay sub-grupo desa-rrollado	Loam limoso mezclado no ácido isohipertérmic	"	"
69	Celina E. Bataan Finca Monte Líbano	"	Inceptisol	Tropepts	Eutropepts	Vertic Eutropepts	Loam arcilloso mezclado no ácido isohypertérmic	"	"
70	Old Vega (Aluvial) Cariari. Fca. Frutera Atlántica	"	Entisols	Fluvents	Tropofluvents	Vertic Tropofluvents	Loam arenoso mezclado no ácido isohypertermic	"	"
71	Guápiles (Aluvial) Est. Exp. Los Diamantes	"	Entisols	Orthents	Troporthents	Vertic Troporthents	Loam arenoso fino cenizas volcánicas no ácido, isohy-pertermic	"	"
72	La Curia (Planosol) Cariari - Fca. Formosa	"	Ultisols	Aquults	Fragiaquults	Typic Fragiaquults	Arcilloso, mezcla-do, no ácido isohypertermic	"	"

.....

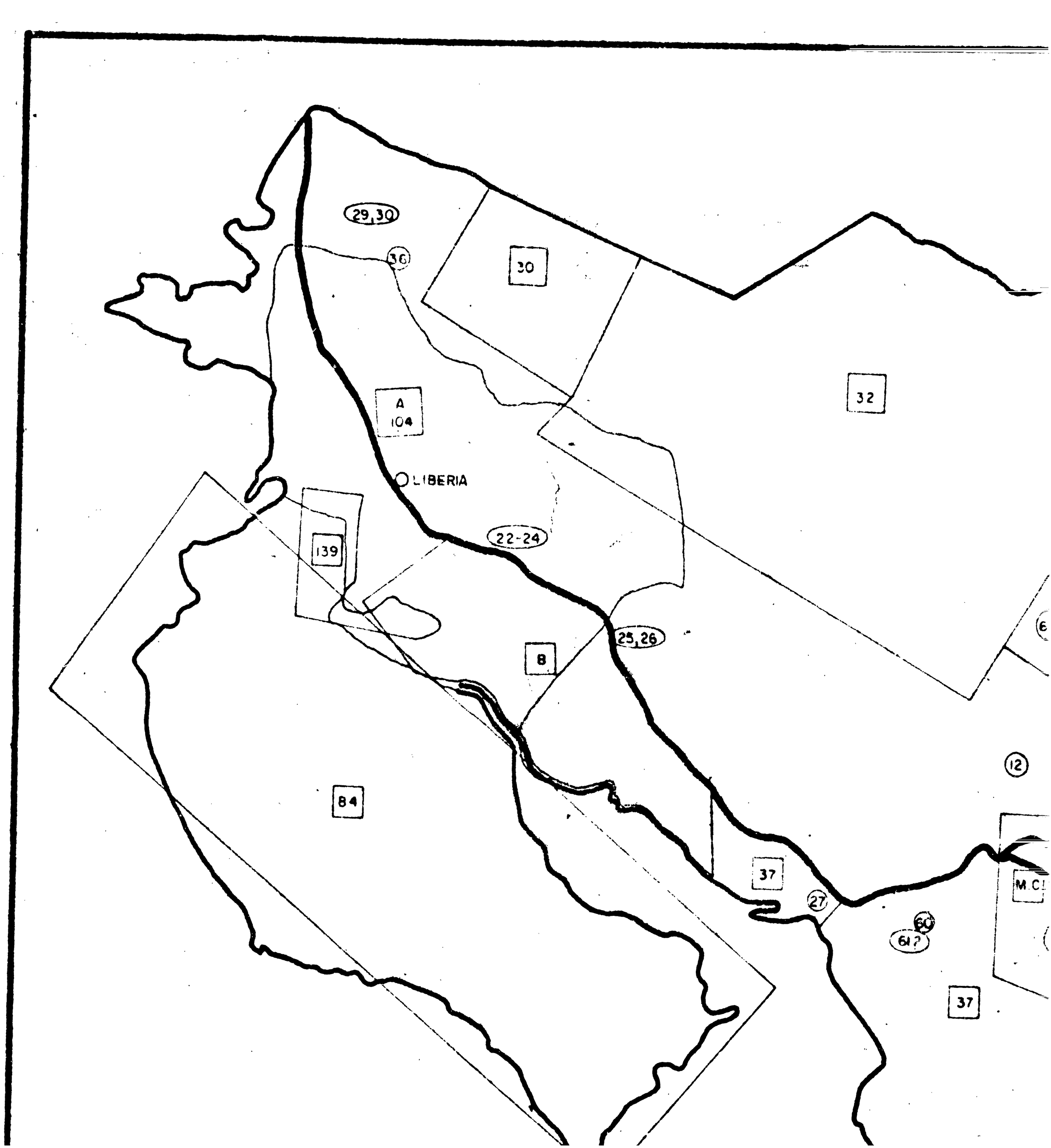
Continuación Cuadro 2. Apéndice B.

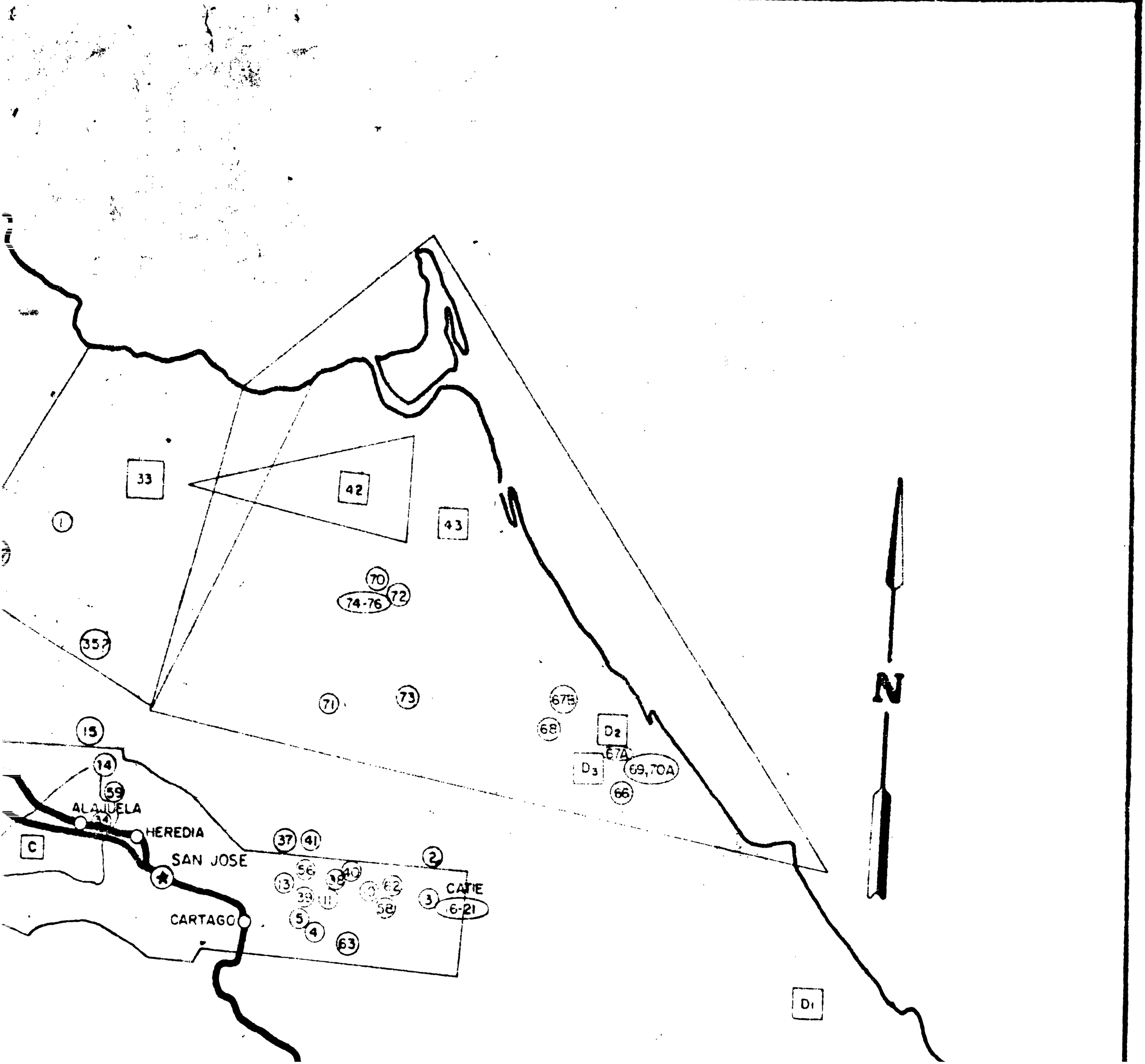
Perfil No.	Lugar y/o serie	Altitud m	Orden	Sub-orden	Grupo-grande	Sub-grupo	Familia	Clima	Autor
73	Colombiana (Latosol) Guácimo - Fca. Louisiana	Cerca nivel mar	Oxisols	Orthox	Haplorthox	Tropeptic Haplorthox	Arcilloso muy fino, caolinita mezclada?,ácido Isohypertermic	Trop. Húmedo (Costa Atlántica)	Jiménez (1972)
74	Ridge Hill (latosols)	"	Oxisols	Orthox	Umbriorthox	Typic Umbriorthox	Loam arcilloso arenoso, arcilla caolinita? ácido Isohipertérmico	"	"
75	Cariari (Latosol hydromorfico) Cariari - Finca San Pedro.	"	Ultisols	Aquults	Plinthaquults	Typic Plintaquults	Arcilloso muy fino, mezclado ácido Isohypertermic	"	"
76	Formosa (Gley húmico e hidromórfico) Cariari - Finca Formosa	"	Histosols	Saprists	Troposaprists	Hydric Troposaprists	Arcilloso mezclado ácido Isohyperthermic	"	"

* Esta clasificación se ha hecho con datos de Holdridge et al.

** Los nombres de las series son provisionales.

Fuente: Datos del Ing. Agr. A. Alvarado M., sin publicar, y tesis de estudiantes y de otros autores tal como se indica.


29,30
36
30
A
104
LIBERIA
139
22-24
25,26
B
32
84
37
27
60
61?
37
12
M.C.


33
42
43
1
70
74-76
72
35?
71
73
67B
68
D2
67A
D3
69,70A
66
15
14
59
ALAJUELA
34
HEREDIA
C
37
41
2
SAN JOSE
56
40
13
39
11
62
58
3
CATIE
6-21
CARTAGO
5
4
63
N
D1

COSTA RICA

TRABAJOS EN LEVANTAMIENTO DE SUELOS HECHO EN COSTA RICA

[A] Mapa de suelos Norte de Guanacaste 1:180.000 – ITCO

[B] Zona del Distrito de Riego "Moracia" – MAG

[C] Proyecto de Riego "Itiquis" – MAG

[D] Abaco Research Reports Nº 9, 11, 12, 13, IAIAS

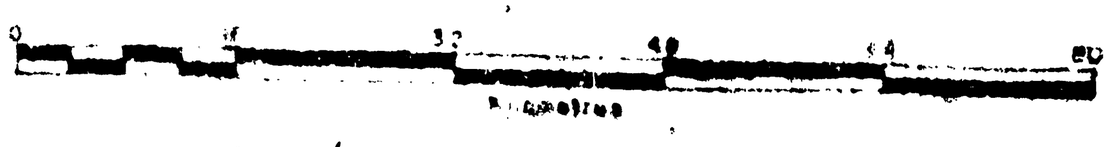
(Informes de Abaco - IICA)

[84] El número refiere al número en la bibliografía de A Alvarado H "Evaluación sobre clasificación de suelos en Costa Rica", Boletín Técnico, Vol 5, Nº 4, Julio 1972, Facultad de Agronomía, Universidad de Costa Rica

[MC] Meseta Central. Corresponde a la referencia arriba a los siguientes números 10, 13, 41, 47 52, 53, 54, 57, 63, 64, 72, 73, 78, 79, 81, 88, 90, 94, 95, 99, 116, 121, 139

(3) Numero de perfiles de suelos estudiados y descritos en tesis estudiantiles (IICA y UCR) enumeradas en el Cuadro Nº

Fuente : Como queda indicado arriba



Dibujó - Emilio Ortiz Cordero


67
33
32
3
5
64
42-46
6
7
5
8
47-55
9