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Semi-Annual Administrative Report  
Agronomic-Economic Research on Tropical Soils

AID/csd-2806

North Carolina State University at Raleigh

1 January - 30 June, 1971

Status of Work in Progress

The activities related to the project during the reporting period were in four principal areas: (1) review of the literature on the project subject matter and development of a computer-based information storage-retrieval system, (2) proposals presented to initiate soil fertility studies in South America and Central America, (3) characterization of soil properties from priority areas, and (4) development of models for economic analysis of agronomic data. A brief summary is given of the activity in each area.

Literature Review and Data Storage

The review of literature on fertilizer response on soils of the tropics and chemical and physical properties of these soils that influence fertilizer response was continued. Through an arrangement with the North Carolina Board of Science and Technology, a search was made of Biological Abstracts for relevant work in Central and South America. Approximately 1000 abstracts were obtained on research results published since 1960. These abstracts were coded according to the keyword list previously prepared and entered into the storage-retrieval system. The North Carolina Board of Science and Technology made available their computer-based information storage and retrieval system for use by the project.

A summarization is currently being made of these data on fertilizer response on tropical soils and soil properties affecting fertilizer response. Particular emphasis is being given to the response of food crops to nitrogen, phosphorus, lime, micronutrients, sulfur and potassium. Summarizations to date indicate that most of the tropical soils show a response to nitrogen fertilizers. The highly weathered soils are generally very deficient in phosphorus and in most instances are very acid; aluminum appears to be the predominant exchangeable cation. The volcanic ash soils generally are also deficient in phosphorus and have a high phosphorus fixation capacity.

Arrangements to Initiate Soil Fertility Studies in South America and Central America

The contract specifies that research is to be initiated in certain priority areas to obtain additional information on fertilizer responses and economics of fertilizer use. High priority areas listed are Llanos Orientales of Colombia, the southern Campo Cerrado area of Brazil, and the Central America Highlands.

Colombia. To implement this phase of the work, a trip to Colombia was made by E. J. Kamprath on January 13-21, to discuss the various matters pertaining to initiating cooperative soil fertility studies in the Llanos Orientales. Since Cornell University also has an AID supported project on tropical soils, D. R. Bouldin represented it at the meetings. Discussions were held with officials of ICA, CIAT, and AID/Colombia to discuss the possibility of initiating soil studies in the Llanos. It was recommended by AID/Colombia that North Carolina prepare a Memorandum of

Agreement which would be considered by AID/Colombia and ICA. A proposed Memorandum of Agreement was sent to AID/Colombia on April 1, 1971, a copy of which is attached to this report. No response has been received concerning this proposal.

Brazil A request was received from AID/Brazil for representatives from North Carolina and Cornell to visit Brazil to discuss possible research work at Brasilia in cooperation with the Ministry of Agriculture. E. J. Kamprath from North Carolina State and D. R. Bouldin from Cornell made a visit to Brasilia, April 20 - May 3 and conferred with officials of AID/Brazil and the Ministry of Agriculture. A report of this trip is attached. While in Brazil a proposal for cooperative research by North Carolina and Cornell was developed with the assistance of AID/Brazil and R. B. Gate, Jr. who is associated with the AID sponsored North Carolina Soil Fertility Evaluation and Improvement Project. On May 21, a meeting was held in Washington with officials of AID/Washington to discuss the proposed work in Brazil. This meeting was attended by C. B. McCants and E. J. Kamprath from North Carolina State and M. J. Wright and Matt Drosdoff from Cornell. Formal approval has been received from AID/Brazil to locate a full-time research leader in Brasilia under the sponsorship of the Cornell contract. North Carolina State University will work cooperatively with this individual through short-term consultants.

Central America. At the meeting in Washington it was suggested that the Ag and Food Officers of AID in Central America be contacted about their interest in participating in soil fertility studies in Central America. A proposal was developed and sent to them for their consideration. At the present time no formal response has been received

concerning their interest in this proposal.

#### Characterization of Soil Properties of Certain Tropical Soils

Laboratory studies have been completed on phosphorus fixation by volcanic ash and highly weathered soils typical of those in Central America and South America. Determinations also were made on the amount of fertilizer phosphorus required to raise the available soil phosphorus to levels optimum for crop production.

Clay mineral determinations and characterizations of chemical and physical properties of representative soils from the Llanos of Colombia have been conducted. These data will provide the information to plan soil fertility studies and also provide the basis for the applying the results of previous work in other regions.

#### Economic Analyses of Agronomic Data

Activities by R. K. Perrin, J. G. Ryan and V. E. Ball during this period were directed towards (a) completion of the review of literature on economic analysis of crop response to applied nutrients and soil characteristics, and (b) detailed analysis of an extensive set of potato response data in Peru to determine the effects of weather and such soil characteristics as soil nutrient level, pH and organic matter content on the optimum level of fertilizer application. Several suitable studies of wheat and corn response have been located in Brazil and Colombia and preliminary contacts with economists and agronomists there indicate that the data can be made available to us for a similar type of analysis.

Collection of such data, however, is contingent upon memoranda of understanding between North Carolina State University, USAID offices and government agencies in these countries.

Research personnel involved with contract activity. June 30, 1971

<u>Soil Science</u>		<u>Service Obligations to csd-2806</u>
W.V. Barthelomew	Professor	2 months per year
S.W. Buol	Professor	2 months per year
F.R. Cox	Associate Professor	2 months per year
G.A. Cummings	Associate Professor	1 month per year
E.J. Kamprath	Professor	2 5 months per year
J.F. Lutz	Professor	1 month per year
O.D. Philen	Research Assistant	2 months per year
Patricia Patrick	Research Technician	Full time
Faye Stadler	Typist	Full time
 <u>Economics</u>		
J.G. Ryan	Research Assistant	Full time
R.K. Perrin	Assistant Professor	2 months per year
V.E. Ball	Graduate Research Assistant	6 months per year
Sue Gardner	Statistical Aide	Full time
 <u>Statistics</u>		
L.A. Nelson	Associate Professor	1.2 months per year

Expenditures for Period 1 January - 30 June, 1971

<u>Category</u>	<u>Expenditures</u>
Salaries & Wages	\$ 31,872.09
Fringe Benefits	3,459.17
Consulting	. 0 .
Travel	2,814.94
Other Direct Costs	1,039.92
Out of Pocket	3,789.20
Overhead	14,983.02
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Total	\$ 57,958.34

Appendix 1. Proposal submitted to AID/Colombia, April 1, 1971

General Agreement to Enable the Performance of Agronomic and Economic  
Research on Tropical Soils in Colombia Under Contract AID/csd-2806

I. Introduction

Pursuant to the principles set forth in the Act of Bogota, the Charter of Punta del Este and the General Agreement for Economic, Technical and Related Assistance signed July 23, 1962, this Project Agreement to provide technical assistance as further defined here-under is entered into between the Colombian Agricultural and Livestock Institute (hereinafter called "ICA") as represented by the Director General, the National Department of Planning, as represented by the Director, and the Agency for International Development (hereinafter called "AID"), as represented by the Director of the Agency's Mission in Colombia.

II Current Situation

Future large scale expansion of agricultural production in Colombia will necessitate development in the Llanos Orientales. This region contains the largest single contiguous area of undeveloped soils which are ideally suited for agricultural production taking into account topography, rainfall, and temperature. Estimates are that 3 million hectares of well-drained savannah are available for cropping. One of the main factors limiting crop growth in this region is the naturally infertile status of the soils. They are very acid, very low in phosphorus, nitrogen and potassium and indications of deficiency of micronutrients, particularly boron and zinc. The development of a research station at Carimauga provides opportunities to determine the lime and fertility requirements of

these soils for crop production. Also, these experiments will provide data to determine the economic returns that could be expected from inputs of fertilizer.

### III. Specific Objectives of the Project

This project provides for technical assistance to ICA by North Carolina State University, in cooperation with Cornell University, in planning and conducting soil fertility studies on the well-drained soils of the Llanos Orientales and in obtaining basic soils information to enable the application of the results to other areas with similar soils. The information obtained on characterization of the soils also will be of special interest to the Instituto Geográfico.

A significant part of the project will be concerned with the collection and analysis of data on yield response to fertilizers. The data will be used to develop methodology for making economically sound fertilizer recommendations for tropical soils.

### IV. Scope of Work of Technical Services

The work to be done on this project is divided into two parts, agronomic and economic. The main effort of the agronomic work would be at the Carimagua Research Station in the Llanos Orientales, though activities would not be confined necessarily to this area. Research activities could be conducted in other areas of Colombia as mutually agreed upon.

The economic studies would be based on existing data of yield response to fertilizer plus that which may be generated from the agronomic phase. The development of the appropriate analytical models and economic

evaluation of the results would be done by North Carolina State University economists and ICA personnel.

A. Agronomic Studies

The agronomic studies performed under this Agreement will be conducted by North Carolina State University and ICA in consultation and cooperation with Cornell University and CIAT. Field sites will be selected so that the results maybe applicable to other areas containing acid weathered soils and having distinct dry seasons.

1. Field studies would be conducted at Carimauga in cooperation with ICA and CIAT. Following are examples of studies that would be performed:

a. Nitrogen studies to determine the rates, time and methods of application for corn and/or grain sorghum. Measurements will be made of total nitrogen uptake, grain yield, and movement of ammonium and nitrate in the soil.

b. Liming studies to determine the minimum amounts of lime required to give optimum yields. Lime rates will be based initially on the amount of exchangeable aluminum in the soil. Other methods will be considered. Measurements will be made of crop yields, amounts of exchangeable aluminum, calcium, magnesium and the concentration of calcium and magnesium in the plant tissue.

c. Phosphorus studies will be initiated to determine the response to rates and methods of phosphorus applications. Measurements will be made on the fixation capacity of selected soils and the effects of wet and dry cycles on the fixation of phosphorus and residual availability of soil phosphorus.

2. Micronutrient survey. Plant and soil samples from the field experiments will be collected and analyzed for their micronutrient content and their concentrations related to existing information on levels of adequacy.

3. Characterization, classification and correlation of soil types will be made on the research and sampling sites. This will require measurements of chemical and physical properties of the soils and clay mineral identification.

#### B. Economic Studies

The objectives of the economic studies is to develop methodology for an economically sound system of making fertilizer recommendations based on information gained from soil analysis and fertilizer response data. Data will be obtained from existing experiments on fertilizer response and supplemented by those originating from research performed under this agreement. The analysis and evaluation will be done by economists and other appropriate personnel from ICA and North Carolina State University.

Personnel from North Carolina State University will make short term visits to Colombia to meet with appropriate persons of ICA to discuss and evaluate the economic analyses of fertilizer response data; and to review the progress of the research.

#### V. Purpose of this Agreement

The purpose of this agreement is to establish an arrangement for North Carolina State University to provide the technical services of long-term and short-term consultants, the funds to hire an Ingeniero Agronomo, and to provide the allied support necessary to accomplish the research

objectives set forth.

## VI. Responsibilities

A. North Carolina State University agrees to the following responsibilities and commitments to conduct the agronomic and economic research:

1. To furnish one full-time specialist who will coordinate the agronomic studies to be conducted under this agreement. Funds will be provided for his salary, per diem, travel and housing allowance. This individual will be stationed at Tibaitata.

2. To provide short-term consultants not to exceed 6 man months per year. Funds will be provided for salaries, per diem and travel.

3. To provide funds for ICA to hire an Ingeniero Agronomo and for his per diem and travel. This individual will be stationed at Carimauga and will be assigned to ICA to work on this project.

4. To provide funds for ICA to hire a half time bilingual secretary.

5. To provide one vehicle and funds for operation and maintenance.

6. To provide funds for certain supplies and equipment needed to conduct the research.

7. To consult with soils personnel of ICA on matters pertaining to soil and plant analyses and to pay ICA for such analyses as mutually agreed upon.

8. To perform specialized soil and plant analyses at North Carolina State University.

9. To consult and cooperate with soil scientists from Cornell University on matters of mutual interest and responsibilities and through

the full-time specialist to act as liaison between the Cornell soil scientists and ICA, AID, and CIAT and to aid in programing their work and in arranging visits to Colombia.

B. ICA agrees to the following responsibilities and commitments:

1. To provide office space at Tibaitata for the full-time specialist. Laboratory and greenhouse facilities of ICA will also be available for his use.
2. To recruit an Ingeniero Agronomo specified in the agreement, who is also qualified for graduate work. Housing for him will be provided at Carimauga by ICA.
3. To recruit a bilingual secretary and provide office space.
4. To provide land at Carimauga, farm machinery and other equipment and labor as needed for the field work.
5. To perform the soil and plant analyses previously discussed under Section A.
6. To work with North Carolina State University specialists in collecting and evaluating existing data for economic analysis of crop response to fertilizer.

C. Responsibilities of AID-Colombia:

AID-Colombia would handle the obtaining of visas, importation of equipment, supplies, vehicles and personal effects; and the initial contract negotiations.

## VII. General

The activities outlined in this agreement relate to the North Carolina Contract, AID/csd-2806 and the Cornell Contract, AID/csd-2490.

This agreement will be for one year and may be renewed on an annual basis.

North Carolina State University will submit to USAID and ICA for approval the curriculum vitae of full-time and short-term specialists assigned to the project.

The North Carolina State University staff as well as ICA staff may use data from these studies for thesis or dissertations for graduate degrees.

Upon termination of the agreement, vehicles and equipment purchased by North Carolina State University will be assigned to the Soils Section of ICA.

Proposed Budget for Work in Colombia

1. Salaries	
(a) Visiting Assistant Professor	\$16,500
(b) Ingeniero Agronomo (money to be paid ICA) 4200 pesos/month X 16 = \$225/month X 16	3,600
(c) Bilingual Secretary 1/2 time 2500 pesos/month X 8 = \$135/month X 8	<u>1,080</u>
	\$21,180
2. Fringe benefits 14% X Salary in la	\$ 2,310
3. Overhead 19,680 X 23.5%	4,978
4. Travel and Transportation	
(a) <u>Travel</u>	
Travel in country	2,000
International travel	1,000
Travel for home leave	<u>2,100</u>
	\$ 5,100
(b) <u>Transportation</u>	
Household goods	\$ 3,000
Car	800
Unaccompanied baggage	400
Material for project	<u>500</u>
	\$ 4,700
5. Allowances	
(a) Housing allowance for Assistant Professor	\$ 4,200
(b) Housing for Ing. Agronomo at Carimauga (to be pd. ICA)	840
(c) Travel for Ing. Agronomo (to be pd. ICA)	1,000
(d) Per diem for Assistant Professor	<u>2,400</u>
	\$ 8,440

6. Equipment and supplies	
(a) Ford pick-up 250, limited slip differential	\$ 3,000
(b) Equipment	2,000
(c) Supplies	<u>1,000</u>
	\$ 6,000
7. Other direct costs	
Workman's compensation (1.25% X salary in 1a)	<u>\$ 207</u>
	TOTAL
	\$52,915

Report on Trip to Brazil, April 26 - May 5, 1971

E. J. Kamprath

North Carolina State University

A request was made by the Brazilian Ministry of Agriculture to Robert Cate of the NCSU project, AID/1a-646, in Brazil that North Carolina and Cornell consider the possibility of starting research at Brasilia. As a result of this contact, a visit to Brazil was made during the period April 26 to May 5, 1971 by Dr. D. R. Bouldin of Cornell and myself to investigate the possibility of initiating research at Brasilia under the respective research contracts.

1. Discussions were held at Brasilia with the following individuals:

Dr. Roberto Meirellis, Director de Escritorio de Pesquisase e Experimentacao (EPE), Ministerio de Agricultura.

Mr. Nathaniel Bloomfield, Chief de Equipe de Pedologia e Fertilidade do Solo (EPFS), EPE.

Wilson Soares, Agronomist with EPFS/EPE.

Edson Lobato, Agronomist with EPFS/EPE, stationed at the Federal Experiment Station at Brasilia.

Dr. Robert Cate, Soil Fertility Evaluation and Improvement Program, LA-646.

Mr. Elbert Bowen, Assistant Agricultural Officer, USAID/Brazil.

2. Nature of the request by the Brazilian Ministry of Agriculture.

With the movement of the Brazilian government to Brasilia there has been an influx of people onto the Campo Cerrado soils in the area surrounding Brasilia. Dr. Meirellis stated that they are being asked for information on the fertilization and management practices needed for the soils of the Campo Cerrado to

produce optimum yields. In addition, they would like to know what are the economically optimum rates of fertilization and liming.

3. Proposed location of the soils research.

The Ministry has an experiment station located in the Federal District about 25 kilometers northeast of Brasilia. The area of the station is approximately 1,600 ha and it contains the principal soils found in the Campo Cerrado. A soils survey of the station has been made and published. A modern laboratory and office building has just been completed. In addition, they have some excellent greenhouses and also equipment is available for field work.

Dr. Cate indicated that there are plans to establish a soil testing laboratory at the station. This laboratory would test farmer samples from the Campo Cerrado, would be used by the research workers and would serve as a control lab.

4. Nature of the present work conducted at the experiment station.

Three days were spent at the experiment station examining the research in progress and discussing the results obtained.

A factorial experiment with lime and phosphorus was started in 1966 using corn as the test crop. Lime rates of 0, 5 and 10 tons/ha and  $P_2O_5$  rates of 0, 150, 300 and 450 kg/ha had been applied. This experiment had been abandoned but would lend itself to a sampling study on the effect of lime and phosphate on the chemical properties of the soil. A similar study was started in 1967 with a legume, *stylosanthes gracilis*. It also was abandoned.

Another factorial experiment with lime and phosphorus was started with soybeans in the fall of 1969. The phosphate was applied in bands. One treatment included addition of zinc, boron, and molybdenum. A large increase was obtained with the micronutrients, probably due to molybdenum. Rates of lime were 0, 1.5, 3, 4.5 and 6 tons/ha and rates of  $P_2O_5$  were 0, 80, 160, 240 and 320 kg/ha.

A study with rock phosphate and concentrated superphosphate at two lime levels was initiated in the fall of 1967. This study also includes row application of phosphate. A rotation of corn and soybeans is being used.

Another experiment has been started involving three variables - lime, P and K. No factorial combinations are involved. Nutrients other than the one being studied are added in adequate amounts. The rates are as follows: 0, 50, 100, 200, 300 and 400 kg  $P_2O_5$ /ha, applied in bands; 0, 30, 60, 90, 120 and 150 kg  $K_2O$ /ha, applied as broadcast treatments; lime rates applied at 0, 0.5, 1, 2, 3 and 4 times the chemically equivalent amount of exchangeable aluminum. The test crop is *stylosanthes gracilis*.

Studies also have been started on the need of various nutrients for upland rice production. Yields of upland rice to complete fertilizer were 2,760 kg/ha. This was considered by Dr. Bouldin to be a very good yield for upland rice.

The experimental data have not been summarized or evaluated as to their significance. This needs to be done.

The following conclusions about the data can probably be made:

- a. Without lime and phosphorus, the growth of corn and soybeans is essentially zero. The principal exchange cation is aluminum which accounts for 70 percent of the exchangeable cations
- b. Phosphorus fixation is apt to be a problem in these soils because of their high iron oxide content.
- c. Micronutrient deficiencies will be very likely.

Indications are that molybdenum, boron and zinc will have to be applied for optimum yields.

5. Meetings to discuss proposed agreement for research at Brasilia.

After the initial meetings with the individuals from the Ministry of Agriculture, a proposed agreement for conducting soil fertility research was prepared by Dr Bouldin, Dr. Cate and myself. This was discuss with Mr. Bowen, USAID/Brazil and he made a number of very helpful suggestions. The proposed agreement was then given to the officials of the Ministry for their comments and suggestions. A copy was also sent to Mr. Rodgers, Agricultural Officer USAID/Brazil in Rio. He telephoned and indicate he agreed in principle with the proposal and gave us his specific suggestions. A final draft was prepared incorporating the suggestions of the Ministry and USAID/Brazil. It was the opinion of all concerned that this work was of vital importance and should be initiated as soon as possible.

6. Meetings with other individuals.

A meeting was held with Dr. Robert Goodland of the Instituto

de Biologia, Universidade de Brasilia. He is doing considerable work on some of the ecological-soil relationships in the Campo Cerrado.

Dr. Joseph Varvra, Soils Advisor with the IRI met us at the Rio airport on our way back to the United States. We discussed the proposed work with him