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REVIEW AND EVALUATION
OF THE
INTERNATIONAL SOIL FERTILITY
EVALUATION & IMPROVEMENT PROGRAM

17?

CONTRACT AID 1a-646
NORTH CAROLINA STATE UNIVERSITY
AT
RALEIGH

598-13-120-001

A.I.D.
Reference Center
Washington, DC

LATIN AMERICAN BUREAU, AID, WASHINGTON, D.C.
APRIL 6, 1973

The Rural Development Division, Latin America Bureau, requested that a review and evaluation of the regional contract la-646, North Carolina State University, be carried out. To accomplish this the undersigned team was constituted.

During the period 5 - 26 February 1973, the team visited North Carolina State University at Raleigh, North Carolina, Guatemala, Costa Rica, El Salvador, Ecuador and Brazil. In each country the team met with scientists of the North Carolina State contract, AID officials, officials of cooperating government agencies, persons in private industry, and farmers who were cooperating in field trials. Laboratories and field experiments were observed.

The team is prepared to discuss this report or to provide additional information.

Alvin D. Ayers, Chief
Soil & Water Management Division
Office of Agriculture
Bureau for Technical Assistance
Agency for International Development

Russell Desrosiers
Specialist Crop Production
Office of Agriculture
Bureau for Technical Assistance
Agency for International Development

John O. Kling
Development Officer, Asia Region
Economic Research Service
Foreign Development Division
U. S. Department of Agriculture

I. Introduction

The International Soil Fertility Evaluation and Improvement Program, Contract AID la-646 with North Carolina State University, is designed to develop competence in the evaluation of soil fertility problems through soil analysis and fertility trials. The ultimate aim is to provide farmers with reliable and economic recommendations for the use of fertilizer. This contract is now operating directly in eight countries: Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica, Panama, Ecuador, and Brazil; and has four full time technicians working in these eight countries. Services have also been provided to a half-dozen other countries through visits by specialists from the Raleigh campus and have influenced soil fertility programs in countries not directly associated with the program.

Normal operating procedure is for the contract technician to advise and assist the local personnel in the organization of a soil-test laboratory in a soil sampling program, and in the proper development of fertilizer recommendations. Basic, high-speed, laboratory equipment is provided, which usually amounts to an initial investment of about \$5,000. This, plus the services and support of the contract technician, are the only major inputs provided by the contract. A seven-weeks training seminar is held annually in Raleigh, and this is well attended by Latin American technicians. The expense of bringing participants to the seminar is not, however, borne by the contract.

The level of development in soil fertility work varies widely from country to country, so that the approach to the problems and level of sophistication of the work is very different in the several countries.

The countries in which the project operates are organized into "regions", each in the charge of a technician who resides in one of the countries of his region. At present the organization of the regions is as follows:

Guatemala)	Dr. James L. Walker, resident in Guatemala
El Salvador)	
Honduras)	
Costa Rica)	Dr. Gordon Miner, resident in Costa Rica
Nicaragua)	
Panama)	Dr. Sam Portch, resident in Panama
Ecuador)	
Brazil)	Dr. Robert Gate, resident in Brazil

II. Project Observations

An in-house field evaluation of the North Carolina State University soil fertility project was made by a team consisting of Russell Desrosiers, Alvin D. Ayers and John O. Kling. During a period of three weeks, this team traveled and observed project operations in 5 countries: Guatemala, El Salvador, Costa Rica, Ecuador, and Brazil. In each country, visits were made to the soil testing laboratories, greenhouses, field demonstrations and experimental plots. Also, discussions were held with appropriate officials in the concerned ministries, semi-autonomous agencies, AID, and international agencies.

team

A. Guatemala:

The project is well established and making excellent progress in Guatemala where it has operated since 1966. It is an integral part of the agricultural development program. The new semi-autonomous Instituto de Ciencias y Tecnologia Agricola (ICTA) considers the project an essential part of its structure. The ICTA officials and the Rockefeller CIAT personnel who are advising them, speak of the soil fertility project as that facet of agricultural technology which is farthest advanced in Guatemala; whereas, in other fields, notably plant pathology and entomology, progress is less satisfactory.

Since the inception of the project in Guatemala a thoroughly modern laboratory has been installed and personnel trained to operate it. Eight Guatemalan technicians have attended the seven-weeks soil fertility seminars at Raleigh; two of them for two sessions. The work of correlating laboratory analyses with fertilizer response by means of pot tests and field trials is well advanced (Table 1). This very successful program has enabled the project to play a leading role in the agricultural development scheme financed by the AID loan.

The program of field trials and demonstrations was greatly expanded in 1972 (Table 1) and will be still further expanded in 1973. The money budgeted by the Guatemalan government for these activities has risen sharply (Table 2), making possible a substantial expansion of field activity. Cooperation of the Peace Corps has also been secured and 12 specially trained volunteers worked effectively in the supervision of field trials in 1972; 26 will do so in 1973.

Seventy-six field trials and demonstrations were carried out in 1972. Most of these were highly successful and have had a major impact on the small farmer.

Table 1. Selected Activities, Soils Department, Agricultural Research Division, Ministry of Agriculture, Guatemala, 1970 - 1972.

	1970	1971	1972
Soil samples tested for farmers	13,130	16,372	22,445
Correlation trials (potted plants)	20	40	83
Correlation trials (field)	20	35	76
Training sessions, agricultural personnel	10	12	20
Fertilizer credit covered by soils analyses (%)	60*	70	90*

*New law requires that fertilizer credit be issued only on the basis of soil analysis.

Table 2. Comparison of Budgets of Ministry of Agriculture and its Soils Department, Guatemala 1971 - 1973.

Year	Ministry of Agriculture		Soils Department	
	Budget	Increase from 1971	Budget	Increase from 1971
	(Quetzales)	(%)	(Quetzales)	(%)
1971	19,400,000	-	36,382	-
1972	19,700,000	1.5	113,246	211
1973	24,000,000	21.8	149,196	300

B. El Salvador:

Although the soil fertility program is not as advanced in El Salvador as it is in Guatemala, it is making fairly good progress (Table 3) and there is a strong request on the part of both the USAID Mission and the government of El Salvador for the project technician to devote more of his time to that country. El Salvador has suffered, and continues to suffer to some extent, from the common ills of inadequate financing of the Ministry programs, frequent Ministry re-organization, an unfavorable salary scale, inadequate travel facilities for technicians, and a weak training program. This situation seems to be improving, however, and the establishment of the new semiautonomous agency Centro Nacional de Tecnologia Agricola (CENTA) is expected to improve greatly the efficiency of agricultural research and development operations. This agency has not yet been formally established, however, and there may be considerable delay before it is accomplished. As it is, the soils department is very strong at Santa Tecla experiment Station, the national soils program headquarters. Soils and parasitology are said to be the two strongest departments. The personnel appear to be enthusiastic about their program. Eleven Salvadorian technicians have attended the soil fertility seminars at Raleigh since 1966 and all have returned to continue working in their profession. A recent law makes soil analysis a prerequisite for the obtaining of fertilizer credit.

Table 3. Selected Activities, Soils Department, Agricultural Research Division, Ministry of Agriculture, El Salvador

	1972	1973 (expected)
Soil samples tested for farmers	8,505	10,000
Correlation trials (potted plants)	30	42
Correlation trials (field)	15	19

C. Honduras:

The project has been able to generate very little activity in Honduras. Soils personnel in that country are severely limited and the Ministry seems to suffer to an unusual degree from the common ailments of scarce funds, poor salaries, and lack of travel facilities. Upon occasion when the project technician has visited Honduras for the purpose of establishing field experiments, he has found it necessary to bring all of the required materials and equipment with him from Guatemala because nothing would be available in Honduras.

D. Costa Rica:

Here again the soil fertility project is considered by both the USAID Mission and the local government as an indispensable part of the agricultural development effort. The project has suffered here in the past from poor support but, under the auspices of the new agricultural sector program, a fine laboratory with greenhouse was inaugurated on March 3, 1972. The soil fertility program is now serving as a catalyst to the Ministry of Agriculture and is setting the pace for the rest of the agricultural development activities.

There is no immediate move towards the formation of an autonomous agency for agricultural research, or research and development, such as the new ICTA in Guatemala or the CENTA, in process of being established in El Salvador. Such a proposal has, however, recently been discussed among influential Costa Ricans. The agricultural sector development program and the regionalization scheme have stimulated interest in soil fertility. These developments have resulted in the organization and coordination of soil fertility and related work on a national level, rather than the scattered and isolated efforts which existed formerly.

Thirty correlation field trials were carried out in 1972, of which 18 were successful; the others were destroyed by a severe drought. This program is being expanded in 1973. During 1972 major emphasis was placed on the organization and activation of the laboratory. In 1973 emphasis will shift to the field. Eight Peace Corps volunteers are expected to work in the soil fertility program. The NCSU project technician appeared to be in close touch with the NCSU soils research (contract csd - 2806) activity at Turrialba.

E. Nicaragua:

Progress with the soil fertility project in Nicaragua has been slow. Contrary to expectation, however, the project has not been brought to a complete stop because of the earthquake damage. The soils laboratory was not damaged and the major setback to the program appears to result from the fact that personnel have to travel farther now than formerly because their homes were destroyed and their new quarters are more distant.

The program in Nicaragua has suffered from the common ailments of many Latin American agriculture ministries mentioned previously. Internal problems within the Nicaraguan government have

limited progress and the fact that two laboratories, which tend to compete for funds and personnel, have been set up, rather than one, has further complicated the picture. The realization of the importance of the soil fertility project to the success of an agricultural development project is expected to improve prospects for the program now that the Nicaraguan government is organizing an agricultural sector program. The staff is enthusiastic and nine technicians have attended the soil fertility seminars at Raleigh.

F. Panama:

Work of the project has been hampered by changes in the Ministry of Agriculture and resignations of personnel. Only one trained senior technician now remains in the soils laboratory.

A considerable number of correlation studies with potted plants have been done, however, although facilities for this work need improvement. Last season's field experiments were almost all lost to drought.

The appointment of a new Director General in the Ministry of Agriculture offers the possibility of considerable improvement. This man has visited project headquarters in Raleigh and is favorably disposed towards the project.

G. Ecuador:

There are three soil testing laboratories in Ecuador that analyze soil samples for farmers. All use the multiple unit equipment and standardized procedures developed by the International Soil Test Project. Of the two laboratories in the highlands, one is a relatively small unit operated by the Ministry of Production in Quito. It is apparently becoming less important in the testing of soils for farmers and more important to the soils classification program of the Ministry of Production. The main soil test laboratory in the highlands is a new, spacious and well equipped laboratory inaugurated August 15, 1972, operated by the semiautonomous National Institute of Agricultural Research (INIAP) at the Santa Catalina Experiment Station near Quito. The Chief of the Soils Department of INIAP, Ing. Washington Bejarano, and his staff, are competent, well trained and dedicated.

The laboratory now functioning in the coastal area is operated by a private fertilizer company, FERTISA. It too is equipped and operated like other project laboratories and is staffed by competent, well trained professionals. Another laboratory is scheduled to be established at the Boliche Experiment Station, operated

by INIAP, about 25 miles from Guayaquil. This will be essentially the same as the one now being operated by INIAP at Santa Catalina, near Quito.

Most of the soil analyses for farmers have thus far been done by the FERTISA laboratory. The Ministry laboratory in Quito has never operated at a very high volume as a service laboratory nor has the Ministry had a strong and viable soil fertility and evaluation program. The INIAP laboratory and fertility program are too new to have produced any significant results as yet. It is expected that the new INIAP laboratory and soil evaluation program in the highlands and the one yet to be installed in the lowlands will result in a sharp increase in field correlation studies and in the number of farmer samples analyzed. Table 4 shows the activity of the FERTISA laboratory over a period of several years.

Table 4. Soil Analyzes Performed by the FERTISA Laboratory per Year for Farmers and for Research, by Regions.

Year	Coast		Highlands		Oriente ^{3/}		Total	
	Farmers	Research	Farmers	Research	Farmers	Research	Farmers	Research
1968 ^{1/}	1,520	2	160	-	-	-	1,680	2
1969	2,472	564	1,430	-	57	-	3,959	564
1970	1,853	546	3,366	1	2	-	5,221	547
1971	1,085	136	2,060	-	6	-	3,151	136
1972	1,459	333	2,599	3	21	-	4,079	336
1973 ^{2/}	83	17	303	15	-	-	386	32
	8,472	1,798	9,918	19	86	-	18,476	1,617

^{1/} From May 30, 1968

^{2/} Until February 7, 1973

^{3/} Lowlands to the east of the Andes mountains

The FERTISA laboratory, headed by Ing. Cesar Herrera, a dedicated and enthusiastic agronomist, has collaborated closely with INIAP and the Ministry of Agriculture in research and demonstration activities and the company has provided free fertilizer for these activities. A similar cooperation has been extended to the several universities in the country and many students have prepared their Ingeniero Agronomo theses on research projects involving the use of fertilizers provided by FERTISA.

The INIAP soils research laboratory at the Pichilingue experiment station on the coast, which does not do routine analyses for farmers, has been active for several years in soil fertility studies and has performed correlation studies with potted plants on several coastal soils as well as field correlation studies. Five field correlation trials are now in operation on cacao and these will continue for several years. Similar work is in progress on coffee, with some results already published. The Pichilingue laboratory has been experimenting for some time with foliar analyses, especially on oilpalm, coffee, and cacao. The head of the soils laboratory, Ing. Jose Lainez, has attended the NCSU soil fertility seminar at Raleigh and is an enthusiastic cooperator in the program. Eighty-six field demonstrations on annual crops, with the fertilizer supplied by FERTISA, are in progress in the highlands and eight in the lowlands.

Ten Ecuadorean technicians have attended the NCSU soil fertility seminars since 1966. Nevertheless, a serious shortage of personnel is evident and will become more pronounced when the INIAP laboratory at Boliche is opened. Recruitment and training of personnel at both the professional and subprofessional levels are urgently needed.

H. Brazil:

There are now 35 laboratories making soil analyses and fertilizer recommendations for farmers in Brazil. Several of these have a capacity of as many as 1000 samples per day. These are operated by a diversity of organizations including the Regional Research Institutes of the Ministry of Agriculture, State Governments, Universities and autonomous agencies. There are some laboratories operated by fertilizer companies and even a couple which operate privately. The number of samples analyzed per year has increased dramatically since the inception of the project. Much of the multiple-test equipment used in these laboratories was made in Brazil. Table 5 shows the development of soil testing and fertilizer use in Brazil.

Table 5. Soil Samples Analyzed and Metric Tons of Fertilizer Used in Brazil

	1965	1970	1971	1972	1973	1974	1975
Use of N-P ₂ O ₅ -K ₂ O							
Actual	290,000	998,000	1,126,000	1,400,000	-	-	-
Target		1,000,000	1,200,000	1,400,000	1,600,000	1,800,000	2,000,000
Soil Samples Analyzed							
Actual	20,000	200,000	275,000	360,000	-	-	-
Target	-	200,000	200,000	350,000	480,000	630,000	800,000

Twenty-one Brazilian soil scientists have attended the soil fertility seminars at Raleigh. This number includes professors of soil science from five universities as well as specialists from all of the Regional Research Institutes and the principal state institutes and autonomous agencies. Since the Project's methods and philosophy have become established in several Brazilian universities, it is hoped that Brazil will soon be able to turn out good soil fertility specialists.

The preparation of soil fertility data from various sources for computer analysis is progressing well in Brazil. There are now three Ministry employees engaged full time in the preparation of the computer cards. Table 6 shows the present status of this activity.

Table 6. Progress in the Preparation of Brazilian Soil Fertility Data for Computer Analysis.

	Approximate Number of Items	Approximate Number of Cards Coded	Percent Punched
Soil Survey Profiles	800	12,000	10
Complex Trials	400	16,000	5
Simple " (FAO)	600	5,400	100
Demonstrations (FAO)	400	1,600	100
	2,200	35,000	25

In addition, there are data from 3000 complex trials and 2000 FAO simple trials and demonstrations yet untouched. Two preliminary studies of the FAO simple trials with corn, beans, and rice were carried out in 1972 in cooperation with the economic analysis office of the Ministry of Agriculture with very promising results. Using two years data, indications of optimum application levels of 50-80 Kg/Ha. of P_2O_5 for all three crops and 55-75 Kg/Ha. of N for corn were obtained.⁵ Soil analyses, soil mapping units, varieties, rainfall and yield levels were not included in these preliminary studies, but third year data from one state indicate a confirmation of the pattern demonstrated.

Most of the laboratories continue to upgrade the guide sheets used in making recommendations on a subjective basis. The principal thrust of the project now is to rationalize the guide sheets through computer analysis of response data.

Three "impact" programs, of which soil testing and soil fertility studies form an integral part, have been in operation in Brazil for several years. These are the FAO project on corn, beans, and rice already mentioned above; the "TATU" (Armadillo) project which is concerned mainly with wheat and soybeans in the Santa Rosa area of the state of Rio Grande do Sul; and the cacao development program of the Executive Commission for the Economic Recuperation of the Cacao Region (CEPLAC) in the state of Bahia.

The TATU project, started in 1967, involves participation of a number of organizations including the Federal University located at Porto Alegre, the University of Wisconsin (by means of a contract with USAID), the State extension service, Federal Research Service, cooperatives and banks. It has been successful in rejuvenating the area and reversing the trend towards impoverishment and outward migration which had been under way for several years. The area involved is about $1\frac{1}{2}$ times the size of Illinois with about 9000 participating farmers whose properties average between 15 and 30 hectares. The main crops of the area are soybeans and wheat, grown in rotation. The TATU project has contributed directly to Brazil's soybean production which has grown from practically none to about three million tons, making it the world's third largest producer. The yield of wheat has also substantially increased. People have moved back into the area, new industries are developing, and property values have increased more than tenfold as a direct result of the TATU project.

The cacao development project, under the auspices of CEPLAC in Bahia, has been in progress since 1963. Founding its recommendations on solid research, it has evolved into one of the most successful agricultural research and development organizations to be found anywhere. Soil fertility studies, including a series of 21 field experiments started in 1964 involving fertilizer and shade, form a cornerstone of the "package" of recommendations now offered to the

farmer. This package includes shade reduction, use of fertilizer, and the control of diseases and insects. Some dramatic increases in yield have been obtained. In an area where fertilizer was formerly obtainable only with difficulty, two fertilizer companies have been induced to establish themselves to supply the demand. The development of fertilizer use is shown in Figure 1. Since September 1972, CEPLAC has used a computer in making its fertilizer recommendations. The CEPLAC soil fertility project is making a substantial contribution to the success of the cacao development program.

III. EVALUATION

A. Personnel:

The evaluation team was very well impressed with the quality of the contractor's personnel, both those in the field and those at the Raleigh campus. These men display a high degree of competence, dedication and enthusiasm. The men posted in the field demonstrate an unusually high level of language competence and have the reputation of getting on exceptionally well with their local counterparts. They have proved to be very capable in generating cooperation among the agencies with which they work.

B. Program Objectives:

The committee believes that the project is fulfilling its objectives in a highly satisfactory manner. The following objectives are taken from Amendment No. 1, dated January 1, 1970, to contract LA-646.

- "1. Develop and adapt techniques to identify the major, secondary and minor nutrient element deficiencies and diagnose special problems such as acidity or alkalinity of the major cultivated soils."

The contractor's staff has worked conscientiously and effectively since the beginning of the project to devise precise and simple analytical procedures to determine the nutrient status of soils. Such procedures, once proven, are standardized to the extent feasible throughout the International Soil Test Program. This work continues and is reported in numerous publications (see Appendix 1).

- "2. To devise, initiate and conduct programs that will correct Crop nutrient deficiencies and improve adverse soil conditions."

The contractor's staff has successfully cooperated with local personnel in all countries in carrying out field and greenhouse

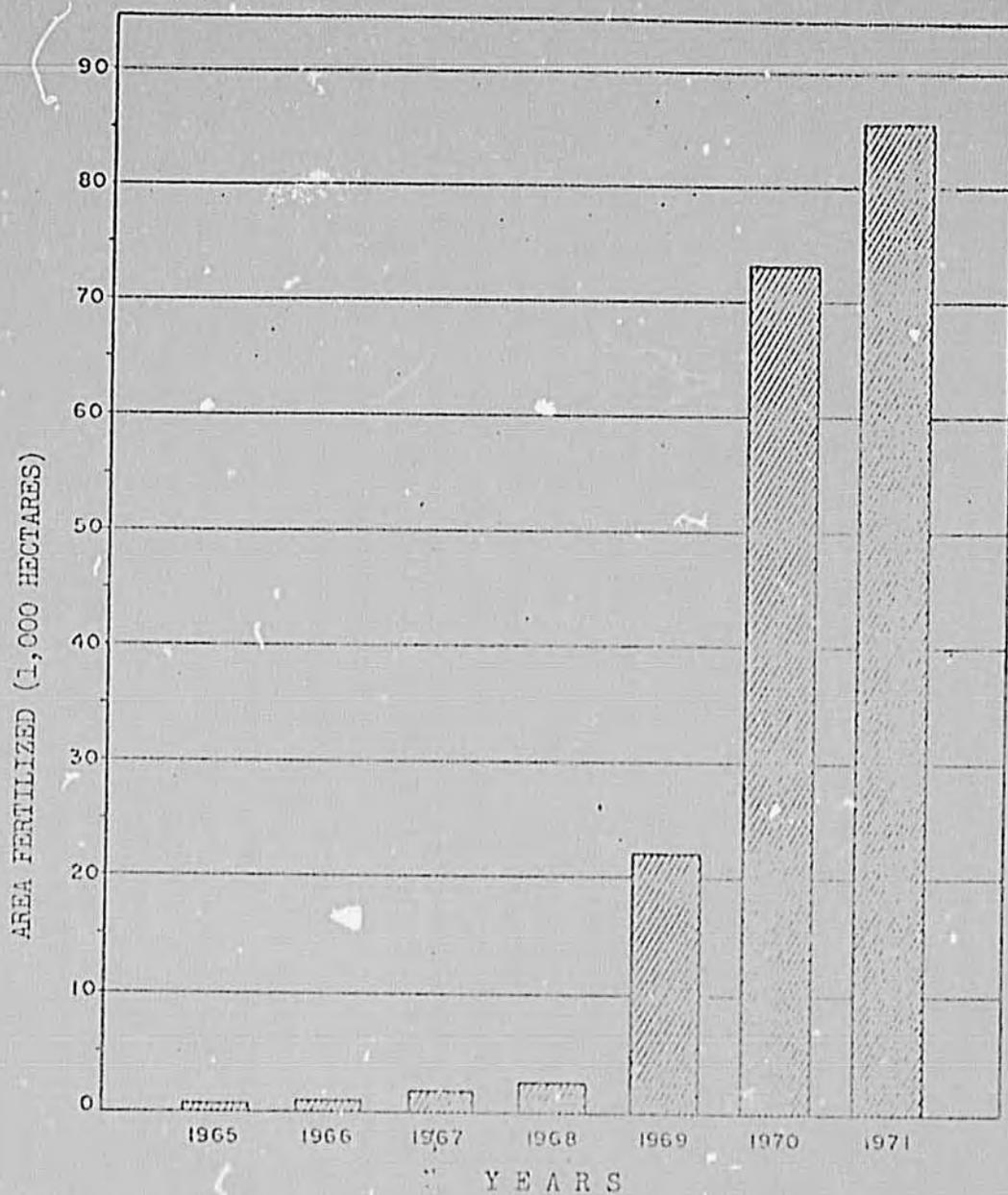


Figure 1. Development of the Use of Fertilizer in Bahia, 1965 - 1971.

correlation studies to determine the fertility needs of soil groups and in the incorporation of improved practices in soil fertility programs. Successful cooperation is in progress, also, with research personnel in programs to solve special soil fertility problems. Among these might be mentioned minor element deficiency problems in Ecuador, problems related to the Campo Cerrado soils of Brazil, and sulfur deficiency in certain soils of Costa Rica.

- "3. To give technical advice for use by the cooperating countries in establishing their own laboratories; design laboratory equipment, work out techniques and procedures necessary, train and organize educational activities that will enable local technicians to give their farmers advice needed for crop production."

The contractor has been remarkably successful in the design, organization and establishment of laboratories in all of the cooperating countries, and in the training of local personnel to operate them. Special multiple-test equipment has been devised by the contractor's personnel which greatly increases the capacity of the laboratories to analyze farmers' samples. This equipment is simple and easily maintained and local personnel are trained in its operation and maintenance. The equipment is even manufactured in one cooperating country (Brazil).

The contractor's personnel have devised simple and practical statistical methods for the determination of critical levels of soil nutrients. Several publications have been released on this and related subjects. These techniques and procedures have aided greatly in the development of guide sheets for the making of fertilizer recommendations to farmers.

Annual seminars of seven weeks duration are held at the NCSU campus for personnel from cooperating countries. In addition, workshops and short courses are held in cooperating countries. Such courses have been held in three countries and one is scheduled for May 1973 (see Appendix 2.). These activities have been well received and have proven very effective for the training of local personnel.

- "4. To test, introduce and demonstrate techniques that will stimulate farmers to use fertilizers and lime correctly."

The contractor's personnel have worked very effectively with local extension and development organizations in the formulation and implementation of campaigns to induce farmers to fertilize correctly. Bulletins, slide sets, and radio programs have been prepared to assist these endeavors. Such operations are now in progress in Guatemala, El Salvador, Costa Rica and Ecuador. The contractor's personnel have also contributed to this kind of endeavor in Bolivia.

and Guyana. The contractor is farther behind with regard to the achievement of this objective in Honduras, Nicaragua and Panama. The degree of success, as has been noted earlier in this report, varies from country to country, a higher level of success being expected in those countries which have achieved a relatively sophisticated degree of organization and development of local institutions.

- "5. To develop and prepare data and other information for use by manufacturers, governments, credit suppliers and marketing agencies in developing facilities that will provide an ample supply of fertilizers and lime at the time farmers need them."

The contractor's personnel have been active in the accumulation and organization of data and information relative to the availability and utilization of fertilizer and soil amendments. They have also been industrious in the gathering of data from fertilizer trials and other soils research. This information, together with soil survey data, variety information, meteorological data and other pertinent information is in process of being prepared for computer analysis in Brazil. A similar effort is being started in Guatemala which, it is hoped, will be extended to include all of Central America. Interest in this approach has been voiced in Ecuador. In Guatemala, Costa Rica and El Salvador, Colombia, and Brazil the contractor's personnel have been able to contribute directly to the development of the USAID agricultural sector analysis and strategy.

IV. RECOMMENDATIONS

A. Project Organization:

In response to country interest and Mission requests, there is reason to believe that the activities of the project will be expanding to additional countries in the near future. This may call for the opening of one new region. The present organization of regions leaves something to be desired; for instance, the grouping of Ecuador and Panama as a region is strictly ad hoc. The evaluation committee wishes to suggest a regrouping of countries, based upon the projected formation of new regions as well as upon technical and logistic considerations.

The project now has four technicians resident in the field, as shown on page one of this report. Two of these are stationed in Central America. There is a very strong demand for additional services in that area and ROCAP has offered to fund an additional technician for one year in order to expedite the provision of such services. The committee proposes that Panama be attached to Central America, to form a natural group with the other countries of the Isthmus. The addition of a third technician to this area would make it possible for each to serve

two countries. The eventual aim should be to develop soil fertility information and recommendations on a regional basis throughout the Isthmus. Thus, the technicians could organize sets of field experiments which follow soil groupings and geographic features with less regard to national boundaries. Consideration should be given to the assignment of responsibility for this activity to ROCAF rather than to the country Missions if ROCAF develops a viable regional agricultural program.

The soil fertility work in Brazil has advanced to such a stage that the reviewing team believes that a full-time resident technician is no longer needed in that country. The committee recommends that this position be eliminated within one year and that Brazil be serviced in the future by TDY visits of personnel from Raleigh or other L.A. regions, as needed. The Brazil position can be transferred to one of the new developing regions.

The Committee suggests the following grouping of countries:

<u>Region</u>	<u>Countries</u>	<u>Resident Technicians</u>
I. ROCAF	Guatemala Honduras El Salvador Nicaragua Costa Rica Panama	three for the region
II. Andean	Ecuador Peru Bolivia	one for the region
III. Brazil	Brazil	none (to be serviced by TDY)
IV. Rio de la Plata	Paraguay Uruguay	one (to be serviced initially by TDY)
V. Caribbean	Dominican Republic Haiti West Indies Guyana	none (to be serviced by TDY)

B. Country Recommendations:

1. ROCAP Countries

- a. A unified program of field trials extending throughout the region, following soil groupings, should be established. This will require the development of a degree of interagency and international cooperation, but national boundaries should not be a limiting factor.
- b. Computerization of data for all countries of the Isthmus should be done as a single operation.
- c. Training operations need to be expanded and improved in all countries, but especially in Honduras and Panama. A seminar, in Guatemala, would benefit the region and would provide the opportunity for technicians from the several countries to observe the progress made in that country. Increased attendance at the Raleigh seminars should be encouraged but local or regional workshops should be expanded to reach additional personnel.
- d. The use of specially trained Peace Corps volunteers as a means of expanding field operations should be developed throughout the region. This could serve as a further bond to strengthen unification of the programs of the several countries.
- e. Fertilizer placement studies on perennial crops should be included in the research and demonstration program.

2. Ecuador

- a. Training should be increased at all levels and there should be increased attendance at NCSU seminars. Use of Agronomos from the vocational agricultural schools as lab technicians should be encouraged.
- b. Peace Corps volunteers should be used in the field to allow expansion of the field correlation-demonstration and sampling programs. This should be coordinated with Guatemala and Costa Rica -- volunteers may receive training in Costa Rica.
- c. Experiments with perennial crops, including cacao, should be continued several years and should be used as demonstrations to farmers.
- d. Fertilizer use and placement studies on perennial crops, both in newly established plantations as well as old plantations, should be included in the research and demonstration program.

3. Brazil

- a. Plans should be made to hold a seminar at CEPLAC, Itabuna, Bahia, to take advantage of the progress made there, which makes an excellent demonstration of what is possible. CEPLAC has excellent facilities for meetings.
- b. The computerization of the extensive Brazilian soil test data should be continued.
- c. Fertilizer use and placement studies on cacao, coffee, and other perennial crops, both in newly established as well as old plantations, should be included in the research and demonstration program.
- d. When applicable, the research results from Brasilia on depth of rooting should be publicized for use in other fertility programs.

1. TECHNICAL BULLETINS (ISFE Series)

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3. Soil Test Interpretation Studies: Laboratory and Potted Plant. Waugh, D. L., and Fitts, J. W. Tech. Bul. No. 3 of the International Soil Testing Series.
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5. Soil Test Interpretation Studies: Field Trials. Hunter, A. H., and Fitts, J. W. Tech. Bul. No. 5 of the International Soil Fertility Evaluation and Improvement Series.
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6. Soil Nitrogen - Supply Processes and Crop Requirements. Bartholomew, W. V. Tech. Bul. No. 6 of the International Soil Fertility Evaluation and Improvement Series.

October 1972 - English
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2. PRELIMINARY REPORTS

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2. Systematic Forms for Manual or Mechanized Data Collection Processing and Reporting for Use in Soil Fertility Evaluation and Improvement Programs. Waugh, Donovan L., and Cate, Robert B., Jr. Preliminary Report No. 2 of the International Soil Fertility Evaluation and Improvement Series.

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6. PUBLICATIONS IN COUNTRIES

- a. Publications by Dr. J. L. Walker
- b. Publications by Dr. R. B. Cate, Jr.
- c. Publications by Dr. Sam Portch
- d. Publications by Dr. D. L. Waugh
- e. Publications by Dr. J. W. Fitts
- f. Publications by Dr. Gordon Miner

6. (a)

LIST OF PUBLICATIONS BY DR. JAMES L. WALKER

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4. Publications on Equipment for Central American Labs:
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17. Walker, J. L. Present Status of a Soil Testing Program in Nicaragua. 7 pgs. 1964. Middle American Regional Office, ISTP, N. C. State Univ.
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46. - 1966 Walker, J. L., Survey of the Agricultural Suitability of the Soils of Guatemala: System of Classification. No. Pages 30
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67. - 1969 Walker, J. L., Nutrient Status of Crops in the Five Physiographic Regions of Guatemala. No. Pages 8
68. - 1969 González, J. A., Wald, J., del Cid, M., and Walker, J. L., Guatemala: Soil Fertility Analyses Summary. No. Pages 11
69. - 1969 Montes, R., Walker, J. L., Nicaragua: Soil Fertility Analyses Summary, January 1, 1967 through September 30, 1969. No. Pages 7
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98. Advised degree candidate at the University of San Carlos, Guatemala, on thesis "Bean Response to Nitrogen Applications and Inoculants in Guatemala", Rolando Aguilera. 1972. (In Spanish) - Ing. Agr. degree.
99. Advisor to degree candidate at the University of San Carlos, Guatemala. Thesis: Evaluation of the Fixation and Availability of Phosphorus in 14 Soil Series in Guatemala, J. A. Gonzalez. 1971. (In Spanish). Ing. Agr. degree.

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LIST OF PUBLICATIONS BY DR. ROBERT B. CATE, JR.

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2. Galvao, S. J., and R. B. Cate, Jr. 1971. Survey of the fertility of soils of the Northeast (Brazil). Published in Portuguese) by the Research Division of the Brazilian Ministry of Agriculture.
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6. Map Showing Geographical Distribution of Cultivated Land in Brazil, Expressed as Percentage of Total Land Surface in Each Physiographic Zone of Each State. 1964. Published by USAID, Rio de Janeiro, Brazil.
7. Cate, R. B., Jr., and M. Camargo. Map Showing Estimated Lime Needs of Cultivated Soils of Brazil. 1964. Published by USAID, Rio de Janeiro, Brazil.
8. Cate, R. B., Jr. 1967. Soil Testing in Brazil 1964-1967. (Appendix to 1967 Annual Report, International Soil Testing Project).

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LIST OF PUBLICATIONS BY DR. SAM PORTCH

1. Palacios, Juan A., and Sam Portch. 1972. Fixation Curves as a Basis of Selecting the Levels for Fertilizer Treatments. (In Spanish). Published by the Ministry of Agriculture of Panama as a Special Report.
2. Palacios, Juan A., and Sam Portch. 1972. Laboratory Fixation Studies Carried out at the Soils Lab. MAG of Panama. (In Spanish).
3. Portch Sam. Why Soil Sample and How to do it Correctly. Paper given at the International Soil Fertility Meeting, Quito, Ecuador, August 15-17, 1972. (In Spanish).
4. Portch Sam. Soil Summary for 1968-1969. Paper presented at the CAFSP meeting on May 5, 1972, Panama. (CAFSP - Advisory Committee on Soil Fertility of Panama). (In Spanish).
5. Cooperation was given in the preparation of the following publications:
Field Experiment Data for 1970-1971.
Greenhouse Data Summary. Both published in Spanish by MAG, 1972.
6. A nation-wide TV broadcast was made covering a news article which had appeared in the local newspaper of Panama in May "Discussion of the findings of the Panama soil summary and its implications" and with special mention of the involvement of ISFE project in their soil fertility program.
7. Several news articles have been published involving ISFE project:
May 5, 1972. "La Estrella de Panama" - Summary of Soil Data 1968-1969 with comments about the meeting of the Advisory Committee for Soil Fertility of Panama.
May 19, 1972. "La Estrella de Panama" - Lack of Soil Fertility Limits the Agricultural Production in Panama. (Also published in "La Granja" 6/1/72)
May 5, 1972. "La Estrella de Panama" - Fertilizer Demonstration with Farmers from Chilibre.
March 27, 1972. "La Estrella de Panama" (front coverage) - Experiments to Improve Production are Being Carried Out.
March 1, 1972. "La Granja" - Basic elements for a Good Soil Analysis Service. (Taken from "La Estrella de Panama", Agricultural Section, February 15, 1972).

June 30, 1972. "La Estrella de Panama" - Use of Fertilizers - Demonstration Plots and You Can Observe a Great Difference at Sabas de Leon's Place.

February 1, 1972. "La Granja" - Soil Fertilization (by S. Portch) and an article by Portch, Sam, and Ing. Efrain Tapia: Taking a correct soil sample as a first step to an accurate soils fertilization.

February 16, 1972. "La Granja" - Article by Sam Portch - Why play with the use of fertilizer.

April 1, 1972. "La Granja" - Practical Demonstration Developed by the Soils Dept., MAG of Panama.

January 1, 1972. "La Granja" - Article by Sam Portch - Inducing the Improvement of Fertilization of the Country at a medium Level.

December 12, 1971 and January 28, 1972. "La Estrella de Panama" - Publicity was received for the CAFSP objectives and the ISFE involvement, and the election of a president and a vice-president for this committee. ("La Granja" also published this article on 2/1/72).

January 1972. "El Agricultor" - Coverage was given to a presentation given by Dr. J. W. Fitts of ISFE on Soil Fertility in Panama.

September 1972. "La Estrella de Panama" - Coverage was given about 2 technicians from MAG of Panama who attended the First International meeting on Soil Fertility and Fertilizers held in Santa Catalina Exp. Sta., in Ecuador, where they had just inaugurated their model soils lab with the cooperation of ISFE.

1972. Alvarez, Victor; Cesar Parreño, Eduardo Guijarro and with the cooperation of Dr. Sam Portch the following article was published in a local newspaper from Ecuador: Wheat fertilization and its relation to soil analysis.

6. (d)

LIST OF PUBLICATIONS BY DR. DONOVAN L. WAUGH

1. Waugh, D. L. Chemical Methods for Soil Analysis. November 1967. (In Spanish). Proceedings of Symposium on Methods of Evaluation to Determine Crop Fertilizer Needs, held in Lima, Peru, sponsored by OAS.
2. Waugh, D. L. Fertilization of Potatoes and its Relation to Soil Test. 1968. Paper presented at the International Potato Congress, Lima Peru.
3. Waugh, D. L. 1971. Co-author of the Special Report to AID by the Tennessee Valley Authority entitled, Lime, Fertilizer and Agricultural Potential in Paraguay. Published in English and Spanish.
4. Waugh, D. L., M. Cano, and F. Quevedo. 1969. The Soil Fertility of Soils of the Valleys of the Department of Maquegua.
5. Waugh, D. L. - co-author of the following publications:
 - Ezeta, Fernando. 1968. Soil preparation in the laboratory as a source of error in analysis. Agr. Exp. Sta. La Molina, Peru. (In Spanish).
 - Ezeta, Fernando. 1969. Micronutrient fertilization in potato product on coastal soils. Agr. Exp. Sta. La Molina, Peru. (In Spanish).
 - Villavicencio, Manuel. 1969. Effect of liming on micronutrient availability of highly weathered soils from the low selva. Agr. Exp. Sta. La Molina, Peru. (Spanish).
 - Villachica, Hugo. 1969. Effect of liming on micronutrient availability of moderately weathered soils from the high selva. Agr. Exp. Sta. La Molina, Peru. (Spanish).
 - Nunez, Gary. 1970. K supplying power of coastal Peruvian soils under intense cultivation. Agr. Exp. Sta. La Molina, Peru (In Spanish).
 - Cano, Mario. 1967-1970. Soil test recommendation guidelines for Peruvian soils based on soil analysis. Agr. Exp. Sta. La Molina, Peru. (In Spanish).
 - Lugo, Julio. 1968. Radiophosphorus measurements of available soil phosphorus for wheat and corn production. Agr. Exp. Sta. La Molina. (In Spanish).

Gonzalez, Enrique. 1970. P fixation and availability in major soils of Paraguay. Agricultural School, University of Paraguay, Asuncion, Paraguay. (In Spanish).

Codas, Silvio. 19 . Soil acidity evaluation in soils of Paraguay. Agric. School, University of Paraguay, Asuncion, Paraguay. (In Spanish).

Zavaleta, Moises. 1970. Potato fertilization in the Northern Sierra of Bolivia. Ministry of Agriculture, La Paz, Bolivia. (In Spanish).

Torrico, Carlos. 1971. Cacao response to N, P, K and lime in the Yungas. Ministry of Agriculture, La Paz, Bolivia. (In Spanish).

Carrera, Walter. 1970. Use of soil analysis in the preparation fertilizer recommendations in the national wheat program. Ministry of Agriculture, Cochabamba, Bolivia. (In Spanish).

Iriarte, Eduardo. 1969. Soils productivity classification of designated wheat growing areas of Bolivia. Ministry of Agriculture, Cochabamba, Bolivia. (In Spanish).

Villarroel, Hugo. 1970. A potato production program for southern Bolivia based on soil analysis. Ministry of Agriculture, Potosi, Bolivia. (In Spanish).

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Claure, Gonzalo. 19 . Potato fertilization and its relationship to soil analysis in the Toralapa Valley. Ministry of Agriculture, Cochabamba, Bolivia. (In Spanish).

6. Waugh, D. L. - Special advisor and co-leader for research theses leading to Ing. Agr. Degrees for soils students in various countries; four of these theses have been published by the students; all in Spanish:

Duran, Percy. 1968. Leaching capacity and potassium evaluation in different soils of the country (Peru). Univ. Agraria La Molina, Peru.

Luna, Miguel. 1968. Correlation among chemical analysis methods with P absorption for corn plants under greenhouse conditions. Univ. Agraria La Molina, Peru

Aguila M., Edmundo del. 1968. Study of aluminum toxicity using cotton as the testing plant. Univ. Agraria La Molina, Peru.

Taibe, Elmer. 1967. Preliminary studies of micronutrient availability in Peruvian soils. (Unpublished due to accidental death of student). Univ. Agraria La Molina, Peru.

Villavicencio, Flaminio. 1969. Organic matter as a measure of nitrogen availability in Peruvian soils. Univ. Agraria, La Molina, Peru.

- Lopez, Berta. 1970. Soil test summaries and their use in program planning for the National Wheat Program. Agricultural College at Cochabamba, Bolivia.
- Saravia, Gustavo. 1970. Response to N, P, and K in 4 improved potato varieties in the Lequesana region. Expt. Sta, Chinoli. Agricultural College at Cochabamba, Bolivia
- Zuleta, Lucio. 1969. Potato response to K, S, and Mg in southern Bolivia. Tarija. Agric. College Cochabamba, Bolivia.
- Mestanza, Saul. 1968. Determination of B levels in soils of different cacao zones in Ecuador. Pichilingue Expt. Sta., Guayaquil, Ecuador.
- Lainez, Jose. 19 . Plant analysis as a diagnostic technique for coffee and cacao fertilization in Ecuador. Phichilingue Expt. Sta., Guayaquil, Ecuador.
- Caceres, Jorge. 19 . P fixation and availability of major soils of Ecuador. Quito, Ecuador.
- Brolo, Julio. 1972. P fixation and availability in major soils of Guatemala as measured by several methods of soil analysis. Agricultural School, Universidad de San Carlos de Guatemala, Guatemala.
7. Co-advisor for 3 graduate level (M.S.) thesis projects for students at the University of La Molina, Agricultural School, Peru:
- Benitez, Jose. 1970. Soil analysis methods for magnesium and their relationship to magnesium availability in Peruvian soils. Univ. Agraria La Molina, Peru. (In Spanish).
- Luna, Miguel. 1970. Adaptation of soil phosphorus methods for evaluation of coastal soil fertility. Univ. Agraria La Molina, Peru.(In Spanish).
- Aguila, Edmundo del. 1970. Soil acidity relationships in soils of the high selva in Peru. Univ. Agraria La Molina, Peru. (In Spanish).

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LIST OF PUBLICATIONS BY DR. J. W. FITTS

1. Fitts, J. W. Soil Management - Afghanistan. 1967. Agriculture Division U.S. Agency for International Development, Kabul, Afghanistan. Publication 67-3. September 27.
2. Fitts, J. W. Soil Testing - Turkey. 1967. Contract AID/csd-287. September
3. Fitts, J. W. Soil Fertility Evaluation Needs - India, 1971. The Ford Foundation, New Delhi, India. March.
4. Fitts, J. W. Chemical Fertilizer Use as an Index of Agricultural Development. March 1971. The Ford Foundation, New Delhi, India.

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PUBLICATIONS BY DR. GORDON S. MINER

1. Montes, Ramiro; Oscar Lahman; Alvaro Cordero, & Gordon Miner. 1972. A comparison of the various extracting solutions for available phosphorus in the soil and their critical levels in greenhouse studies. Paper prepared by the Soils Labs of the Ministries of Agriculture and Livestock of Nicaragua and Costa Rica. (In Spanish).
2. Cordero, A.; J. Ulate, R. Brenes, R. A. Alvarado, F. Berns, N. Bonilla, and with the cooperation of Dr. Gordon S. Miner. 1972. Corn Response to N-P-K fertilization in Costa Rica. Paper prepared by the Agronomy Dept. of the Ministry of Agriculture and Livestock of Costa Rica. (In Spanish).
3. Sancho, E.; A. Romero, J. I. Murillo, A. Cordero, and with the cooperation of Dr. Gordon S. Miner. 1972. N-P-K Fertilization studies on dryland rice in the Pacific humid region of Costa Rica. Paper prepared by the Agronomy Dept. of the MAG of Costa Rica. (In Spanish).
4. Gordon S. Miner. December 1972. Proposal for fertility evaluation through field research. MAG, Costa Rica.
5. Paper presented on Soil Sampling. A series of lectures on this subject was given to: Peace Corp Volunteers at Liberia, Costa Rica, December 6, 1971; personnel of Regional Agricultural Center in San Carlos, C.R., Dec. 9, 1971; Regional Agricultural Center in San Sudio de General on Dec. 20, 1971; Peace Corp Volunteers on January 10, 1972.
6. Paper presented on Goals and Objectives of the National Soil Fertility Evaluation Committee in Costa Rica. Meeting was held July 5, 1972, with participation of representatives of private industries, University of Costa Rica, IICA (OAS), MAG, and AID.
7. News Articles:

News article on "Tico Times" about ISFE program in Costa Rica, October 1972.

A notification in the official gazette was published about the National Soil Fertility Committee becoming a National Commission in Nicaragua and the involvement of the ISFE project. 1972.

8. Collaboration was given in the preparation of the following:

Guide sheets for the laboratory covering main crops. Published by the Ministry of Agriculture and Livestock of Costa Rica. January 1973.

Soil Sampling Bulletin was published by MAG of Costa Rica, October 1971.

Plan of Work for MAG Soils Laboratory. September 1971 and published by MAG.

Outline of lab procedures used in Costa Rica. 1972. Published by MAG Costa Rica in Spanish and also distributed in Nicaragua.

P Correlation Study. November 1972. Published by MAG, C.R.

7. INVITATIONAL PAPERS BY ISFEI STAFF

1. Semi-Automated NaHCO_3 Soil Tests in Peru: Correlation, Interpretation and Phosphorus Recommendations for Potatoes. M. Cano and D. L. Waugh. Presented at SSSA Meetings before Division S-4, Tucson, Arizona, August 1970.
2. Potassium/Magnesium Balance in Potato Fertilization on Calcareous Soils of the Peruvian Coast. F. Ezeta, F. Villavicencio, J. Benitez, and D. L. Waugh. Presented at SSSA Meetings before Division S-8, Tucson, Arizona, August 1970.
3. A Soil Fertility Evaluation and Improvement Program in Latin America. J. W. Fitts and W. V. Bartholomew. Invitational paper - ASA and SSSA Meetings 1970.
4. The Use and Effect of a Flocculant with some Common Soil Test Extraction Solutions. A. H. Hunter. Presented before Division S-2 at SSSA Meetings in Tucson, Arizona, August 1970.
5. Soil Testing in Relation to Management Recommendations and Regional Evaluation. R. B. Cate, Jr. Paper presented before FAO/UNDP Latin American Seminar on Systematic Land and Water Resources Evaluation held in Mexico. November 1971. (Translated into Spanish).
6. Organizing for International Research - International Network. J.W. Fitts. Paper presented at the AAAS Conference in Washington, D. C., December 27-28, 1972.
7. The Role of the International Soil Testing Project in the Soil Testing Program of Latin America. A. H. Hunter. Paper presented in the Seminar for Latin America Fertilizer Executives, TVA, Sept. 18-29, 1967, Muscle Shoals, Alabama.

8. OTHER RELATED PUBLICATIONS

1. A Symposium: Economic Impact Through Soil and Plant Analysis. Sponsored by the Honduras Ministry of Natural Resources and the International Soil Testing Project - North Carolina State University/AID, held in Tegucigalpa, Honduras, May 8-13, 1967.

May 1967 - English
May 1967 - Spanish

SEMINARS HELD AT N.C. STATE UNIVERSITY, RALEIGH

<u>DATE</u>	<u>TITLE OF SEMINAR</u>	<u>NUMBER OF PARTICIPANTS AND COUNTRIES REPRESENTED</u>
June 5-July 15 1966	Assessing & Correcting Nutrient Deficiencies in the Soils of Latin America.	3 from Mexico 1 from Colombia 1 from Bolivia 3 from Peru 2 from Guatemala 1 from Nicaragua 1 from El Salvador 1 from Ecuador 1 from Honduras 1 from Brazil Total: 15
July 24-Aug. 12 1966	Operating a Soil-Plant Analyses Laboratory.	3 from Mexico 2 from El Salvador 2 from Peru 1 from Nicaragua 2 from Honduras 1 from Colombia 2 from Guatemala 1 from Bolivia 1 from Ecuador Total: 15
June 5-Aug. 4 1967	Nutrient Deficiencies of Tropical Soils Seminar	6 from Venezuela 11 from Brazil 1 from Afghanistan 1 from Uruguay 2 from Peru 1 from Ecuador 1 from Colombia 1 from El Salvador 1 from Paraguay Total: 25
July 14-Aug. 24 1968	Soil Fertility Evaluation Seminar.	2 from El Salvador 1 from Costa Rica 2 from Venezuela 3 from Nicaragua 1 from Ecuador 1 from Brazil 1 from Panama 1 from Paraguay 1 from Mexico 1 from Chile Total: 14

<u>DATE</u>	<u>TITLE OF SEMINAR</u>	<u>NUMBER OF PARTICIPANTS AND COUNTRIES REPRESENTED</u>
June 9-July 26 1969	Soil Fertility Evaluation Seminar.	8 from Brazil 2 from Bolivia 3 from Ecuador 1 from Colombia 1 from Nicaragua 2 from Honduras 3 from El Salvador 3 from Guatemala 3 from Dominican Republic Total: <u>26</u>
June 7-July 23 1971	Soil Fertility Evaluation Seminar.	3 from Guatemala 1 from El Salvador 2 from Honduras 2 from Nicaragua 3 from Costa Rica 3 from Panama 1 from Venezuela 2 from Ecuador 1 from Uruguay 5 from India 1 from Iran 1 from South Korea Total: <u>25</u>
June 5-July 21 1972	Soil Fertility Evaluation and Improvement - Second and Third Generation Problems.	3 from Costa Rica 1 from Colombia 2 from Ecuador 2 from El Salvador 1 from Guyana 1 from Haiti 2 from Nicaragua 1 from Uruguay 1 from Paraguay Total: <u>14</u>
June 18-Aug. 3 1973	Soil Fertility Evaluation and Improvement - Identification and Correction Soil Fertility Problems.	

SEMINARS HELD IN THE COUNTRIES

<u>DATE</u>	<u>LOCATION</u>	<u>NO. OF PARTICIPANTS ATTENDING BY COUNTRY</u>
March 13-24 1972	San Jose, Costa Rica	3 from Panama 3 from Nicaragua 6 from Costa Rica
April 12-28 1972	Guatemala City, Guatemala	15 from Guatemala 4 from El Salvador 1 from Honduras
Sept. 11-22 1972	Sta. Catalina Lab. Ecuador	11 from Ecuador 1 from Panama
May 21-June 1 1973	Georgetown, Guyana	

APPENDIX 3 -
Cooperating Countries

COOPERATING COUNTRIES
WITH FERTILITY PROGRAMS AND FUNCTIONING LABORATORIES

<u>Country</u>	<u>Laboratories</u>
Brazil <u>1/</u>	35
Ecuador <u>1/</u>	3
Guatemala <u>1/</u>	2
Nicaragua <u>1/</u>	2
Panama <u>1/</u>	1
Costa Rica <u>1/</u>	1
El Salvador <u>1/</u>	1
Honduras <u>1/</u>	1
Bolivia	1
Peru	1
Paraguay	1
Guyana	1
Colombia	1
Venezuela	1

1/ Countries having memoranda of agreement with the
International Soil Fertility and Evaluation Project