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to

AGENCY FOR INTERNATIONAL DEVELOPMENT

January 1-December 31, 1966

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NORTH CAROLINA STATE UNIVERSITY

AT RALEIGH

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PREFACE

The validity of soil analysis, as a tool to guide farmers in the proper use of lime, fertilizers and other soil amendments, is dependent upon research. Questions that must be answered by research for a soil testing program include: (1) how to take representative soil samples; (2) how to analyze the soil samples accurately and rapidly; (3) how to interpret the results; (4) what factors should be considered in making recommendations; and (5) how to present the information so that farmers will understand and follow it.

Soil analysis data that has been obtained from an accurately conducted program is an excellent source of information for research, educational and commercial programs. However, a large number of farmers' samples must be tested to give an accurate picture of nutrient conditions (40,000 to 50,000 from an area the size of North Carolina or Iowa). A large number is necessary in order to overcome the bias caused by better farmers on better farms taking the largest proportion of samples tested within a given area, by a predominance of samples from high value crops, and by samples collected from problem areas.

A survey of soil-plant analysis programs in Latin America conducted by Project AID/csd-287 in 1964-65 showed that very few laboratories were testing more than 100 to 2,000 samples per year, and the capacity generally was only 10 to 15 samples per day. Obviously, it was imperative that soil testing programs in the Latin American countries be strengthened in order to obtain the volume of samples needed for summaries. All problems could not be attacked at once; neither could the program wait until all research answers were obtained. Information on comparable soil conditions was screened from the various parts of the world, and the best was tested to ascertain if it would fit conditions in Latin America. This procedure has been very helpful and has saved much research time, but additional research is still necessary.

First priority in the research development of the soil testing programs was finding techniques to increase the analytical capacity of the laboratories and getting information to interpret the results of the analysis. The next priority will be sampling soils and programming recommendations. When the volume of samples tested becomes sufficiently high to overcome major biases, summaries can be prepared for use in other research projects and in educational and commercial programs.

SUMMARY

The 1966 soil analysis program was directed largely to the following phases of research: (1) developing simple apparatus to increase the analytical capacity and accuracy of the laboratories in the cooperating countries; (2) obtaining data for the correlation of soil test results with crop response to fertilizers and lime; and (3) testing extractants and analytical procedures to ascertain the best methods for testing soils in a given region.

The multiple unit apparatus that was designed, constructed and tested included: dispensers, stirrers, a sample changer for colorimeters, a mercury valve syringe pump, and a pH unit to be used in conjunction with a pH meter. This apparatus has given the laboratories in each of the cooperating countries the capacity to accurately analyze more than 100 samples per day.

Several laboratory and greenhouse studies were completed in Peru to obtain data for the purpose of correlating soil test with crop response to fertilizers and lime; similar studies were initiated in El Salvador and Panama.

Studies were conducted to further improve the ascorbic acid technique for phosphorus determination. This technique worked equally well with the three extractants tested.

More than 50 soil samples were carefully selected for analysis from representative soil types in Uruguay for the purpose of obtaining information relative to the nutrient deficiencies that might be encountered in the soils of that country. More than 90 per cent of the samples were very low in available phosphorus. The samples ranged from quite acid to alkaline in reaction.

Ten soil samples were sent to the cooperating countries to be used as "checks" for the procedure they are using. The samples were analyzed by the Control Laboratory at Raleigh, using the North Carolina, Bray P-1, and Olsen extractants; the data obtained was forwarded to each of the cooperating laboratories.

Field meetings relative to taking representative soil samples were conducted by the four Regional Directors for local agricultural leaders. Peace Corps workers in several of the Latin American countries cooperated in helping local farmers take soil samples.

Two research seminars were conducted in Raleigh during the summer of 1966. The first was for a period of six weeks and the second for three weeks. All six phases of soil-plant analysis programs were stressed in the first seminar; sampling and laboratory techniques were discussed in the second. Fifteen persons participated in each session. Countries represented included Brazil, Bolivia, Peru, Ecuador, Colombia, Nicaragua, Honduras, El Salvador, Guatemala, and Mexico.

"Open House" meetings were held in Managua, Nicaragua; Panama City, Panama; and Recife, Brazil. The meeting in Managua was held in conjunction with the Annual PCCMCA Meeting.

"Guide sheets" to be used by the agronomists in the interpretation of soil test results and in making fertilizer and lime recommendations have been prepared for most of the cooperating countries. Of necessity, the suggestions are general but will be refined as additional information becomes available.

The Spanish and Portuguese versions of Technical Bulletin No. 2 entitled "Evaluation of Soil Fertility in Latin America: Soil Testing-Plant Analysis 1965" were published. Technical Bulletin No. 3 entitled "Soil Test Interpretation Studies: Laboratory and Potted Plant" was published in English. The Spanish and Portuguese versions of this bulletin are in preparation.

The U. S. Advisory Committee, composed of representatives from land-grant universities, the U. S. Department of Agriculture, and industry, met twice during 1966 to review the progress of the project and to advise on future activities.

Increased crop production is most likely to come from areas currently under cultivation but several areas in Latin America have good potential for colonization.

The Regional Directors of the project,who have visited the Llanos region of Colombia, the Selva region of Peru, and the Peten region of Guatemala, are of the opinion that these areas can be brought into production through the proper use of lime and fertilizers.

Communication with many of the farmers in the developing countries, relative to soil-plant analysis programs, is difficult. Flip charts, slide sets, and radio tapes have been developed as tools for acquainting farmers with soil-plant analysis as a source of information for the use of lime and fertilizers.

A staff conference was held in Raleigh in late August for the purpose of reviewing the program during the previous six months and outlining future activities.

The four Regional Directors completed two years of work overseas and returned to the United States for home leave. All returned to their posts of assignment following their home leave.

Only one change was made in the project staff during 1966. Dr. Nicholas Berenyi joined the staff as Assistant Professor to be in charge of the Control Laboratory.

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THE FERTILIZER REQUIREMENTS OF COUNTRIES IN LATIN AMERICA

INTRODUCTION [1/]

Increasing crop yields is a "must" in Latin American countries because the economy of these countries is based largely on agriculture. Many of the soils of Latin America are too acid and some are too alkaline for good crop growth. Nutrient deficiencies in the soils are widespread but the food production potential may be high if the proper kinds and quantities of fertilizer and lime are used. The soil properties vary greatly and reliable information is needed for good investments in fertilizers and lime.

There are six phases of a soil testing program: (1) research; (2) taking representative samples; (3) laboratory analysis; (4) interpretation of laboratory analyses; (5) recommendations; and (6) educational follow-up. Strengthening the phases of soil testing-plant analysis programs in Latin America that were found to be weak by the detailed summary (Part I of the Project) was the major objective of the project during 1966. Priority was given to increasing the analytical capacity of the laboratories, and as a result of these efforts most of the cooperating countries now have at least one laboratory with the capacity to analyze more than 100 samples per day. The time required to test samples and return the results with recommendations to the farmer has been greatly reduced. The larger capacity also encourages more frequent use of control samples to assure greater accuracy.

1/ Reports of progress should be considered in relation to the objectives of the project and past accomplishments. Since such background material is not an essential part of an annual report, a brief resume of the objectives, procedures and previous accomplishments are presented in the Minutes of the U. S. Advisory Committee Meeting, January 1966, Appendix A of this report.

Other phases of soil testing receiving attention included the development of potted plant studies to obtain information for the interpretation of the soil test results, the preparation of guide sheets for making fertilizer and lime recommendations, and the initiation of soil sampling programs.

New Staff

Dr. Nicholas Berenyi joined the staff in April as an Assistant Professor to be in charge of the Control Laboratory. Dr. Berenyi speaks and reads Spanish and was assigned the responsibility of serving an an interpreter of the soil science seminars conducted from June 5 to August 12, 1966. He also presented some of the lectures given during the seminars.

Home Leave - Continuing Assignments

The four Regional Directors completed two years of foreign service and returned to the United States for home leave during the summer months. After home leave all four of the Regional Directors returned to their former areas of assignment for another two-year period. The group unanimously expressed the opinion that from the experience gained from the program during the past two years that they are now much more familiar with the problems within their regions and with the difficulties that are encountered in conducting programs. Having won the confidence of their associates within the countries, the Regional Directors are optimistic about the chances of establishing successful soil-plant analyses programs. Much work is yet to be done and these countries will need guidance for several years.

Continuing Short-Term Appointments

Dr. C. B. McCants, Dr. E. J. Kamprath, and Dr. W. V. Bartholomew initiated the continuing short-term assignment phase of the project in 1966. Dr. McCants

assumed the responsibilities for the project in Venezuela, Dr. Kamprath for Colombia, and Dr. Bartholomew became a consultant "at large".

Dr. McCants made two trips to Venezuela; he spent the month of February in that country followed by a little over two weeks the last half of September. During these trips he organized an advisory committee and prepared an outline of a soil testing-soil fertility program which was favorably received by the Government of Venezuela (Appendix C). Steps have been taken by the Venezuelan Government to put the suggestions into operation.

Dr. Kamprath reviewed the soil testing program in Colombia during the last of February and the first of March, and advised the agricultural leaders of that country relative to the problems they were encountering in soil-plant analyses and soil fertility. He set up three of the multiple unit apparatus furnished by the International Soil Testing Project in a government soil testing laboratory in Palmira and two multiple units in a plant analysis laboratory in Tibaitata. Dr. Kamprath also organized a group of scientists into an advisory committee for a soil-plant analysis program (Appendix C).

Dr. Bartholomew spent the month of January in Guatemala, El Salvador and Honduras helping to improve the soil testing laboratories. In addition to being an outstanding soil microbiologist, Dr. Bartholomew is an expert in improvising laboratory apparatus. He worked with the soils personnel in these countries helping them to adapt techniques and equipment to multiple unit methods of analysis.

LABORATORY DEVELOPMENTS

Chemical analysis is only one phase of a soil testing program but a laboratory must have sufficient capacity to analyze rapidly and accurately all of

the samples that are submitted before other phases of the program can be developed. Samples should be analyzed and the results of the tests returned to the farmers within a two-week period (or less). Otherwise, little use will be made of the laboratory and the program will not be successful.

Multiple dispensers, with accompanying trays, measuring spoons and washers (Figures 1 and 2), have been placed in at least one laboratory in each of the cooperating countries of Latin America. This apparatus has been very helpful in speeding up the flow of samples in the laboratories where it has been put into full operation. The status of the laboratory operations at the close of 1966 may be briefly summarized as follows:

Brazil. Following the successful inauguration of laboratories in Rio, Campinas and Recife, the Ministry of Agriculture has built multiple unit apparatus (dispensers, trays, washers, shakers, and titration equipment, Figure 3) for laboratories at: IPEAN, Belém, Pará; IPEANE, Recife, Pernambuco; IPEAL, Cruz das Almas, Bahia; CEPLAC, Itabuna, Bahia; IPEACO, Sete Lagoas, Minas Gerais; DPFS, Rio, Guanabara; IPEACS, Km. 47, State of Rio; IAC, Campinas, São Paulo; EE, Londrina, Paraná; (SOUSACRUZ, Rio Negro, Paraná - private); IPEAS, Pelotas, Rio Grande do Sul. These laboratories are strategically located and have the capacity to analyze a few hundred samples per day. None of these laboratories have reached their full potential in handling samples but they have tested several times more samples during 1966 than during previous years. One bottleneck being encountered is making the recommendations after the tests have been completed. This is a time-consuming operation and can easily slow down the output of a laboratory that has a capacity of testing 400 or 500 samples per day. Approximately 50,000 soil samples were tested for fertility

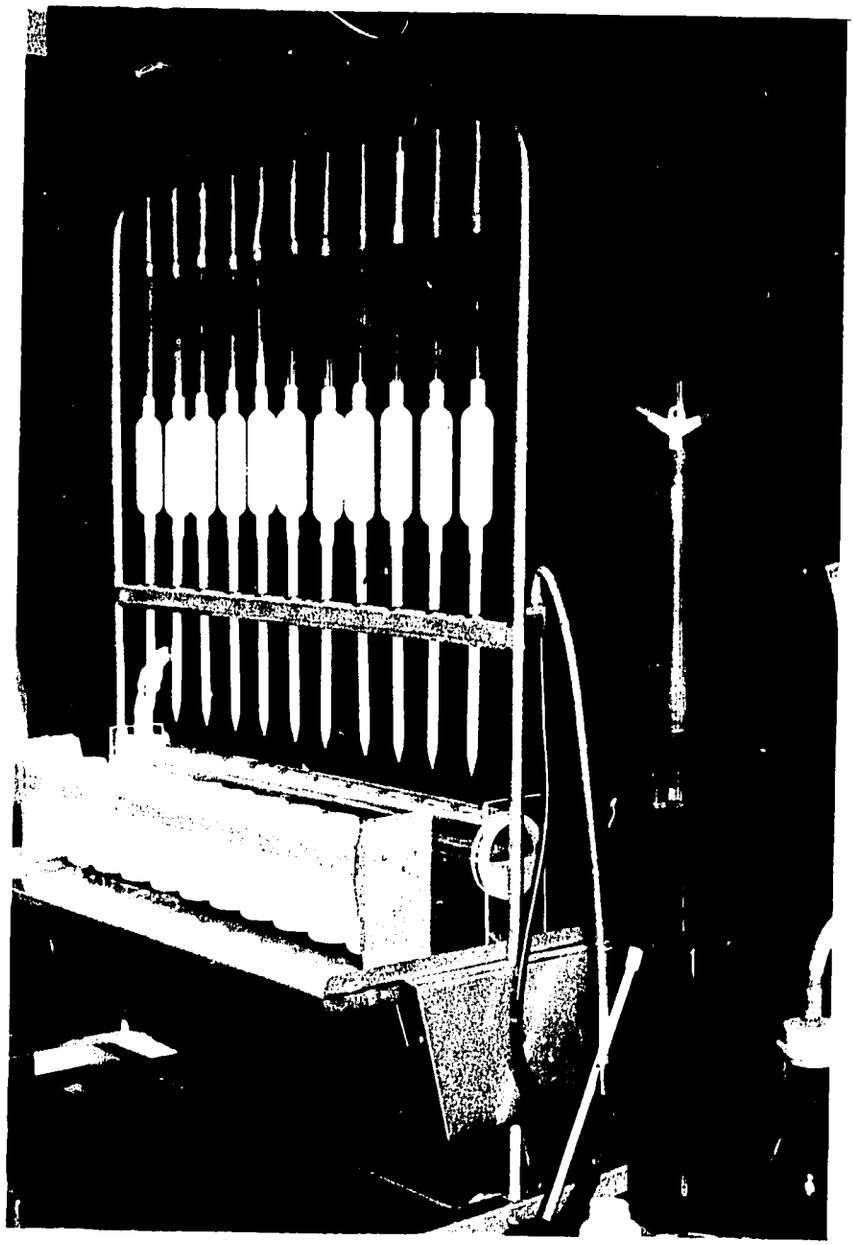

Figure 1. A multiple unit dispenser constructed of stainless steel with 50 ml plastic pipettes. The plastic trough maintains a constant supply of extracting solution with which to fill the pipettes. Five units like this have been furnished to laboratories in 13 countries of Latin America.

Figure 2. Miss Lilia Gutiérrez Moreno of Mexico, a participant in the second soil seminar demonstrates washing and rinsing with distilled water a tray of plastic bottles. This type of washer has been furnished to laboratories in 13 countries of Latin America.

Figure 3. Dr. Leandro Vettori demonstrates to Mestre Juca rapid titration techniques using small magnets in the flask for stirring the solution. The tray slides on the track under the automatic burrette. The apparatus was designed by Dr. Vettori and constructed by Mestre Juca for use in the laboratories of Brazil.

purposes during 1966. Most of these were analyzed by methods recommended by the International Soil Testing Project.

Peru. In addition to the multiple unit apparatus which handles eleven samples simultaneously, the laboratory at La Molina (SIPA) has developed (under the direction of Dr. Waugh, see Appendix D), apparatus to analyze 105 samples at one time. With this equipment one technician can easily make more than 500 determinations per day. The laboratory at La Molina is ready to handle almost any assignment for routine analyses that it is called upon to perform. It will analyze samples from all of Peru.

Ecuador. The laboratory in the Ministry of Agriculture in Quito is equipped and staffed to test more than 100 samples per day. Due to the changes in the government in Ecuador and the current political situation, the laboratory has not gotten into full operation. One of the major problems of the soil testing program in Ecuador is inadequate financial support. The National Bank of Ecuador has expressed considerable interest in soil testing as a source of information for making loans to farmers and have indicated a willingness to help solve the financial problem.

The soil-plant laboratory at the University of Ecuador in Quito has one unit of the multiple dispenser to be used for research purposes. However, the political situation in the country has also curtailed the operations of this laboratory.

Bolivia. A new multi-purpose agricultural building which will house the soil-plant analysis laboratory is being built at Santa Cruz. The multiple unit apparatus has been shipped to Bolivia but has not been installed in the new laboratory as yet.

Colombia. The soils laboratory at Palmira tests most of the samples for Colombian farmers. This laboratory was already equipped with multiple unit apparatus and has the capacity to test more than a hundred samples per day. However, five units of the multiple dispensers and accessory apparatus were sent to Colombia. Part of these were installed in the plant analysis laboratory at Tibaitata and part in the soils laboratory at Palmira. The program in Colombia cooperates closely with the Rockefeller Foundation program in soil science.

Venezuela. The multiple unit apparatus has been supplied to the soils laboratory in Maracay. The laboratory is well equipped with other apparatus and should be in a position to test farmers samples in a satisfactory manner.

Paraguay. During 1966, most of the activities of the soils laboratory were directed to testing samples for the cadastral survey of the triangle area north and east of Asunción. With the completion of this project, the laboratory is altering its activities to test farmers samples. The laboratory is adequately equipped to handle samples rapidly and accurately, but it is short of laboratory technicians and soil scientists.

Panama. Much of the activity of the soils lab in Panama was directed to the analysis of samples from the cadastral survey. However, farmers samples were taken care of too. The laboratory has the multiple unit apparatus (furnished by the International Soil Testing Project) in operation and has the capacity required for a successful program. Adequate financing is a problem for testing a large volume of samples.

Costa Rica. The soils laboratory is well equipped and is in a position to test a large volume of samples. A lack of trained personnel is a problem, the same as in many other countries. However, most of the phases of a soil test-

ing program can be successfully launched if there is adequate local organization and leadership.

Nicaragua. Good progress has been made in this laboratory but it, too, is short of trained personnel. It is confronted with an electrical problem in respect to rather extreme voltage variations which makes the operation of some instruments difficult, such as a flame photometer. The multiple unit apparatus, plus several other innovations for increasing the speed and accuracy of analysis, are in use in this laboratory.

Honduras, El Salvador and Guatemala. The activities of the soil testing laboratories in these three countries are reported together since their programs have been closely associated. Each country has a laboratory in the Ministry of Agriculture with the capacity to test more than 100 samples per day. The three countries are using the same analytical procedures, control samples, soil cartons, information sheets, and guide sheets. The laboratories in the three countries are all equipped with the multiple unit apparatus and accessory equipment. During 1966, each of the laboratories tested more than three times as many samples as previously tested during any one year and still reported the results in less than two weeks. No doubt, greater progress has resulted because of the intercountry cooperative efforts. (Figure 4)

Mexico. A set of the multiple unit apparatus has been sent to Mexico but as yet it has not been "set up" in their soil testing laboratory.

Analytical Methods

The Brazilian laboratories under the leadership of Dr. Vettori and Prof. Cate adapted a procedure for the analysis of phosphorus in the soil extract using ascorbic acid with bismuth sub-carbonate. This develops a blue color which is

Figure 4. Miguel Ernesto Menéndez of El Salvador is displaying the storage rack and trays which are in use (locally constructed) in the Ministry of Agriculture laboratory in San Salvador.

stable for several hours. Dr. D. L. Waugh in Peru did additional work with ascorbic acid as a reducing agent in the phosphorus determination (a modification of the Olsen and Watanabe procedure). He used four extractants for phosphorus, the North Carolina procedure with dilute hydrochloric and dilute sulphuric acid, Olsen sodium bicarbonate, Bray P-1, and Al-Abba (Purdue). The ascorbic acid was mixed with a molybdate solution containing antimony potassium tartrate. The blue color developed was found to be stable for at least 24 hours. The procedure was satisfactory for all four extractants tested. The modified procedure is presented in Appendix D.

New Apparatus

The multiple dispensers, with accompanying trays, washers, and shakers have been very helpful in speeding up the flow of samples through the soil testing laboratories. Additional apparatus is needed, however, and considerable attention was given to its development. Some of the apparatus that was designed, tested and developed for laboratory use included:

A unit to be used in connection with pH measurements was designed and built by Dr. W. V. Bartholomew. The soil samples are placed in 50 ml plastic beakers that are held in standard trays to permit easy handling and washing. The trays are placed on a track (Figure 5) leading to a support for the electrodes of the pH meter. A turn of a handle lowers the electrodes into the sample of soil and water and simultaneously turns on an electric stirrer. After the pH reading is recorded, a reverse turn of the handle raises the electrodes and automatically rinses them with distilled water. The entire operation takes only a matter of seconds.

Dr. A. H. Hunter developed a stirring mechanism (Figure 6) for use in place of a shaker for mixing soil with the extractant. This may eliminate a

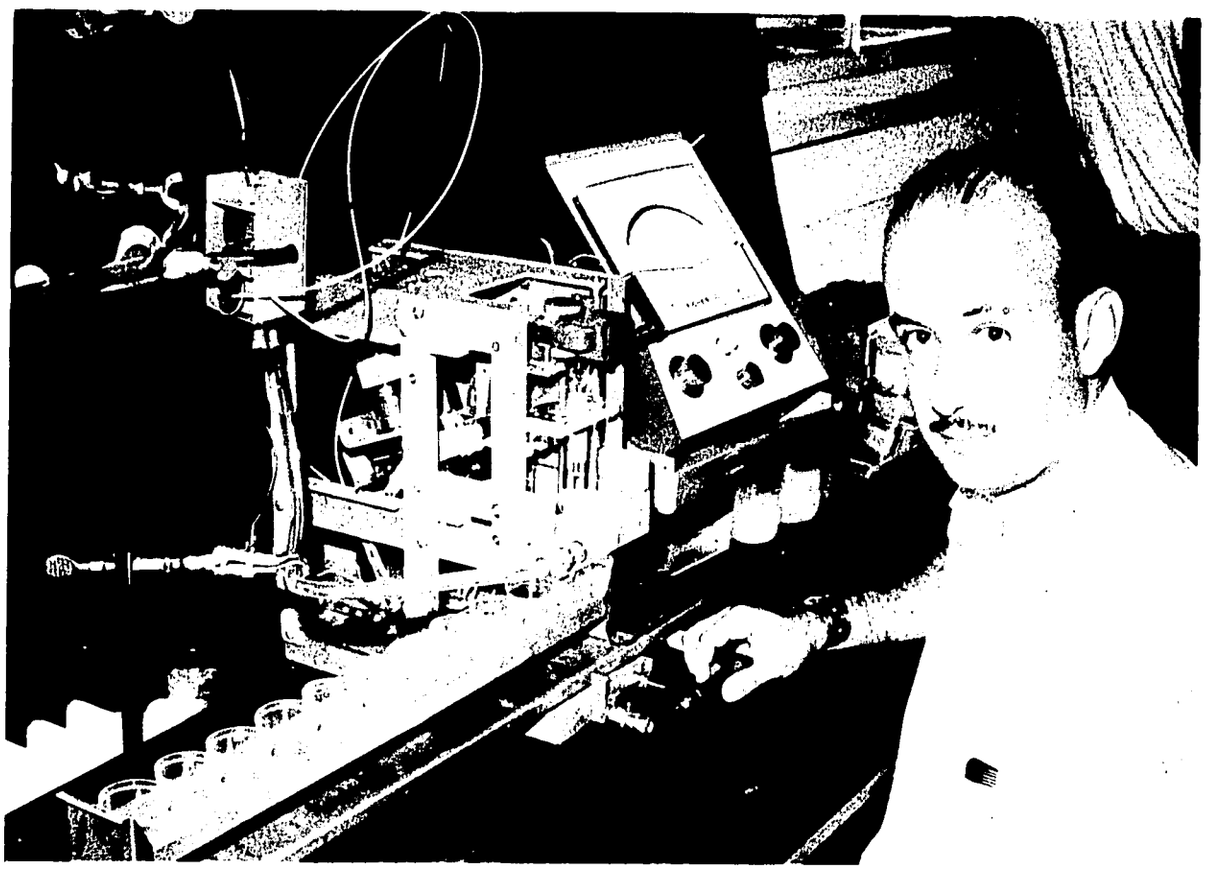

Figure 5. Salvador Castillo Orellana is testing the experimental model of the pH unit. The electrodes are automatically rinsed with distilled water as the electrodes are lifted from the samples.

Figure 6. A multiple unit stirrer, constructed to stir 33 samples simultaneously in 3 trays is shown by Miss Carmen Torres Villanes of Lima, Perú.

source of difference in analytical results between laboratories. Three trays of soil samples (33) are stirred simultaneously for a given period of time (time clock). The rapid stirring mixes soil and extractant thoroughly which permits a state of equilibrium to be reached quickly.

After thoroughly testing, a sufficient number of both the pH unit and the stirrer will be built for the laboratories in all of the cooperating countries.

Dr. Hunter designed and constructed a simple attachment which can be adapted to most colorimeters (Figure 7). The apparatus quickly fills the cuvette of the colorimeter by suction. As soon as the reading of the colorimeter is taken, the solution is withdrawn by depressing a small handle holding the suction tube so that it extends to the bottom of the cuvette. This eliminates the problem of using different cuvettes and makes possible the use of larger aliquots of the extractant solution in developing the color than where the color is developed within the cuvette. The technique is very simple and very rapid. The cost of constructing the apparatus is small.

Dr. Hunter also greatly improved a syringe pump with a mercury valve to quickly add measured quantities of reagents or water to samples (Figure 8). Such apparatus is very useful in adding a color indicator during titration procedures or for adding water for pH measurements.

Voltage fluctation is often a big problem in the operation of equipment in many laboratories. A simple technique for overcoming this problem as far as photometer is concerned is shown in Figure 9. A heavy duty, 6 volt, 150 amp-hr. battery is used as an electrical supply for the photometer. A small battery charger is connected through a pole switch to the battery. In one position the pole switch connects the charger to the battery; in the other position, the battery is connected to the photometer. A small variable resister

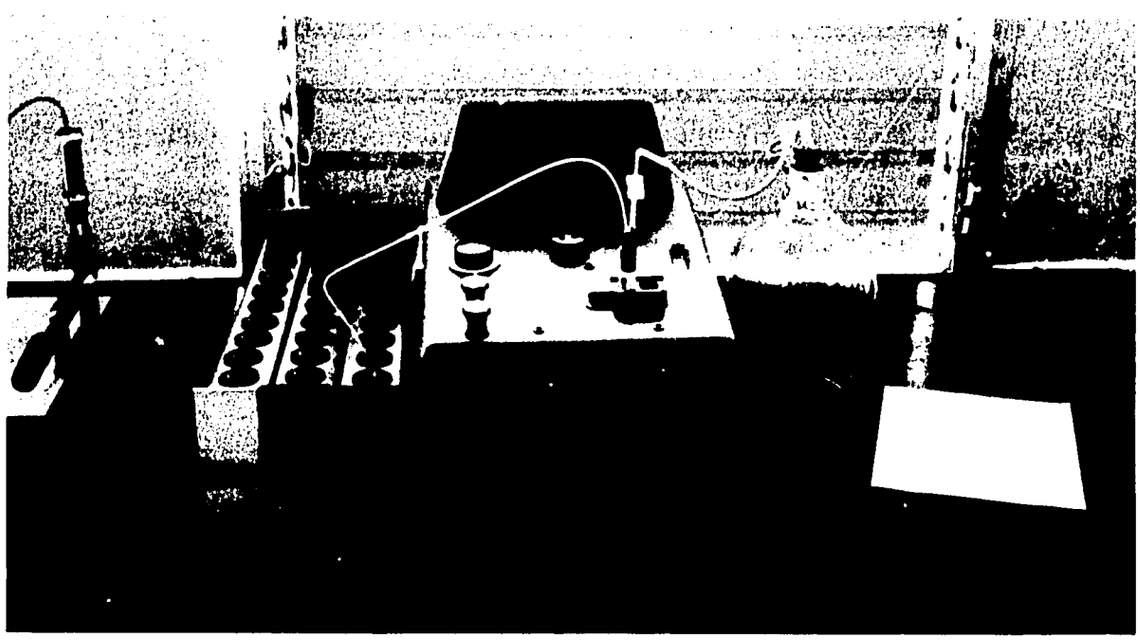

Figure 7. A solution changer was introduced in the soil testing laboratories in Costa Rica and Nicaragua by A. H. Hunter. Solution is drawn into the colorimeter tube by suction and then emptied by lowering the suction tube to the bottom of the cuvette.

Figure 8. A modified mercury syringe pump is demonstrated by Ramiro Montes Vargas in the Nicaraguan soil testing laboratory. The quantity of solution to be delivered by each stroke is determined by the syringe setting. The mercury valve is inside the flask.

Figure 9. The voltage to the colorimeter is kept constant (5.8 volts) by variable resistors in the line between the battery and the colorimeter.

of 8 to 10 ohms capacity is inserted in the line between the battery and the photometer. The voltage is regulated at 5.8 volts and remains constant throughout the day. The battery is charged during the night or weekends when the instrument is not in use. Readily reproducible results are obtained with a reasonably priced photometer using this apparatus.

Dr. Waugh has designed and built multiple unit apparatus of much greater capacity than the eleven sample unit commonly used (see Appendix D). His apparatus will handle 100 samples simultaneously, plus five control samples. Dr. Waugh also simplified the design of the trays used in soil testing, and introduced the idea of using anodized aluminum of differing colors. The color scheme is another technique which helps reduce mistakes in the laboratory through a mix-up of trays.

Control Laboratory and Control Samples

Additional space was made available in the Soil Science Department of N.C. State University to house the control laboratory (Figure 10). Special desks were installed to accommodate the requirements of the laboratory. The new equipment obtained for the laboratory was tested and calibrated, new apparatus constructed and put into use, and various laboratory procedures were studied for adaptation to routine analyses.

A major part of the work of the control lab during 1966 included testing and assembling apparatus for shipment to the cooperating countries, and working with the two seminars that were conducted from June 4 through August 13.

Ten bulk soil samples were collected from Oregon, Texas, and North Carolina to be used as control samples in the North Carolina laboratory, and as "check" samples in the cooperating laboratories. Each sample was passed through a

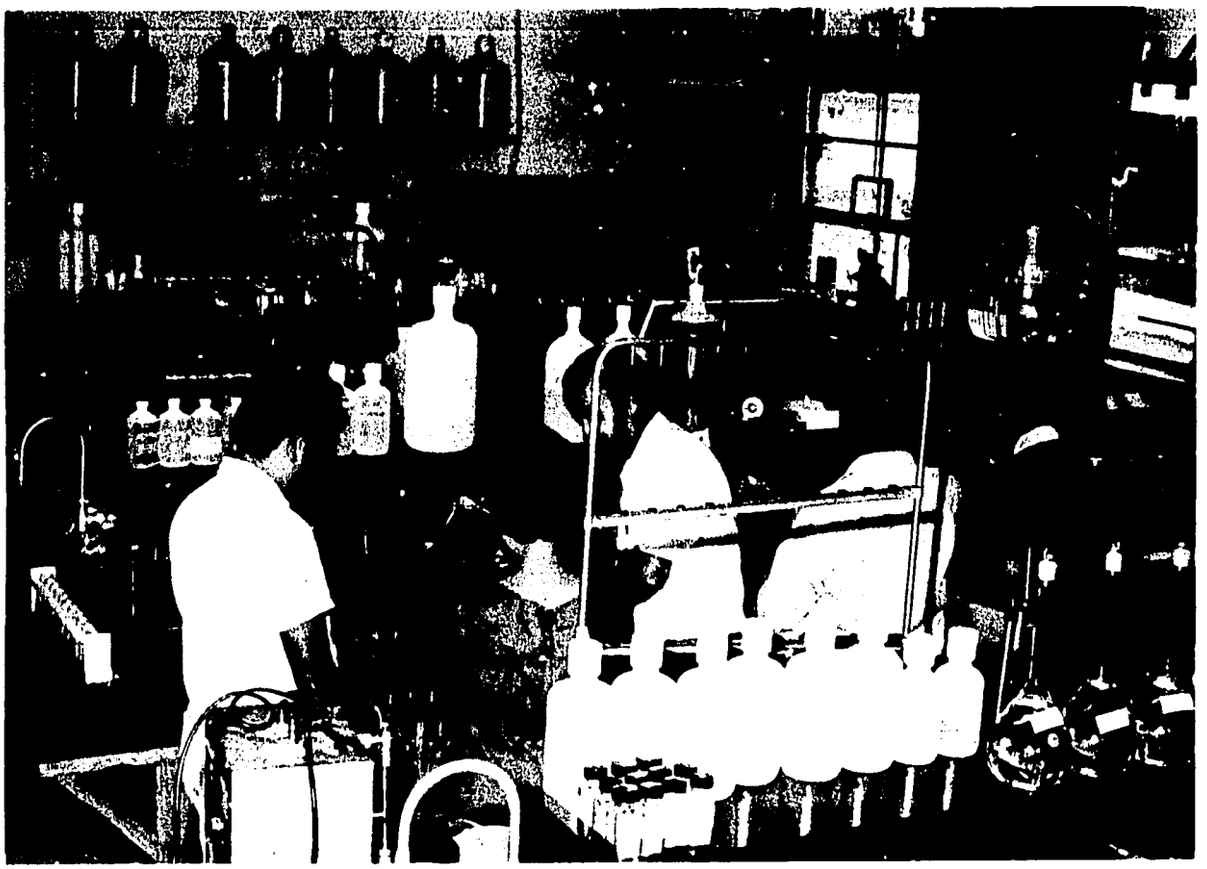

Figure 10. The Control Laboratory at North Carolina State University at Raleigh.

2 mm screen and thoroughly mixed. The samples were then analyzed by the control laboratory using the North Carolina, Bray P-1, and Olsen extractants. Portions of the ten samples plus the analytical data given below were sent to each of the cooperating laboratories:

Procedures

N. C. State Method of Analysis

Extracting solution:	0.05 N HCl + 0.025 N H_2SO_4
Ratio :	Soil:extracting solution = 1:10
Extracting condition:	Stir the soil solution with magnetic stirrer for 5 minutes; stand overnight and filter through Whatman No. 1 filter paper.
P determination:	Waugh's modification of Ascorbic Acid Method
Colorimetric Measurement:	Photelometer
K determination:	Flame Photometer
Ca and Mg determination:	Atomic Absorption Spectrophotometer
pH determination:	pH Meter
Ratio :	Soil:H_2O =1:1

Bray No. 1 Method for phosphorus

Extracting solution:	0.025 N HCl + 0.03 N NH_4F
Ratio :	Soil:extracting solution = 1:10
Extracting condition:	Same as for N. C. State Procedure

Olsen Method for phosphorus

Extracting solution:	0.5M $NaHCO_3$. pH = 8.5
Ratio :	Soil:extracting solution = 1:10
Extracting condition:	Same as N. C. State Procedure except the soil is stirred with 5 cc of charcoal (Darco G-60)

Control Samples

Sample No.		Sample Description
C-1	Amity	Volcanic ash soil from Oregon
C-2	Hayesville	Mountain soil, N. C. (high P fixer)
C-3	Georgeville	Piedmont, N.C.
C-4	Portsmouth	Coastal Plain, N.C.
C-5	Union	Volcanic ash soil from Oregon
C-6	Cecil	Piedmont, N.C.
C-7	Georgeville	Piedmont, N.C.
C-8	Houston	Texas blacklands
C-9	Norfolk	Coastal Plain, N.C.
C-10	Norwood	Texas blacklands

Phosphorus

Extractant

Sample No.	North Carolina	Bray No. 1	Olsen
	ppm	ppm	ppm
C-1	61	105	12
C-2	4	9	2
C-3	4	4	2.5
C-4	7	17	3
C-5	200^{+}	28	9
C-6	13	17	5
C-7	18	21	7
C-8	45	21	7.5
C-9	14	28	4.5
C-10	1	0	3

Sample No.	Potassium*		Exchangeable Al**	pH
	me/100 g	ppm	me/100 g	
C-1	0.42	164	0.25	5.2
C-2	0.20	78	1.00	5.2
C-3	0.31	121	0.05	5.8
C-4	0.21	82	2.55	4.6
C-5	2.16	842	0.00	7.6
C-6	0.21	82	0.00	6.6
C-7	0.24	94	0.10	5.3
C-8	0.54	211	0.00	7.8
C-9	0.08	31	1.25	4.5
C-10	0.28	109	0.00	7.8

Sample No.	Calcium*		Magnesium*	
	me/100 g	ppm	me/100 g	ppm
C-1	11.8	2360	1.42	170
C-2	1.8	360	0.25	30.0
C-3	5.7	1140	1.20	144.0
C-4	3.6	720	1.06	127
C-5	$20^{+}.0$	4000^{+}	2.0^{+}	240^{+}
C-6	9.5	1900	2.0^{+}	240^{+}
C-7	6.6	1320	1.18	142
C-8	$20^{+}.0$	4000^{+}	1.72	206
C-9	1.6	320	0.06	7
C-10	$20^{+}.0$	4000^{+}	1.74	209

* N. C. State extractant.
** 1N KCl extractant.

Inaugurations

After a laboratory has improved its capacity to analyze samples, an "inauguration" or "open house" is an effective technique for calling to the attention of government officials the potential to increase crop yields through proper fertilizing and liming practices. The multiple unit apparatus offers a tangible introduction to the fact that there is now available to their farmers a good source of information on the use of fertilizers and lime. The laboratory is only one phase of the program, however, and all phases need support; this can be emphasized during the "open house".

Three "open house" meetings were held during the first six months of 1966. One of these meetings was in the Ministry of Agriculture laboratory in Managua, Nicaragua, and was held in connection with the Annual PCCMCA Conference. Delegates from all of the countries of Central America, Panama, Mexico, a few from the South American countries and from the Islands of the Caribbean attended. The other "open house" meetings were held in Panama and in the Federal Government laboratory in Recife, Brazil. Federal Senator Jose Ermirio de Morais, Chairman of the Senate Agriculture Committee, inaugurated the laboratory in Recife.

SOIL SAMPLING

Obtaining representative samples is one of the most important phases of a soil-plant analysis program. The samples must represent the condition about which information is desired. If the samples are poorly taken then erroneous information may be obtained through the analysis. The area to be included in the sample, the number of cores for a composite sample, depth of sampling,

influence of climatic conditions, and crop residues are some of the factors that must be considered in getting good soil samples. Important factors to consider in obtaining plant samples include the kind of plant, the part of the plant to be sampled, the number of plants to include in the sample, location of plant in relation to other plants, the age of the plant, and climatic conditions such as drought or rainy periods.

Instructions for taking samples and information sheets to be submitted with the samples have been prepared in all of the cooperating countries (Figure 11).

Several field training meetings on how to take a representative soil sample have been conducted for local agricultural leaders in each of the following countries: Guatemala, El Salvador, Honduras, Panama, Costa Rica, Peru and Brazil. Special visual aids including slide sets and flip charts were prepared for use in these meetings to illustrate areas to be avoided, the number of composite samples to take, etc.

The Peace Corps workers have been very cooperative in taking local leadership in soil sampling. They have been particularly helpful in Peru and Guatemala.

RELATING SOIL TESTS WITH FERTILIZER AND LIME RESPONSES

Interpretation of the results of soil analyses are usually made by separating the soils into groups or classes in relation to the probability of crop response to the application of fertilizers. Frequently five classes are created although it is doubtful if more than three are justified. When the soils are separated into three classes or groups, one class would include those soils on

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Figure 11. Instructions for taking representative soil samples are presented in this bulletin prepared in Guatemala.

which a response is anticipated to the application of fertilizer, a second class where no response is likely to be obtained, and a middle or "maybe" class in between the responding and non-responding groups. One of the important goals of soil analysis is the establishment of a critical level below which the odds are high that a profitable response will be obtained, and above which the odds are against a large increase from fertilizer application.

Obtaining data for use in interpreting soil test results and for establishing critical levels in the soils of Latin America is a major problem. Most field trials which have been conducted in the past relative to the use of fertilizers were not designed for calibration purposes, and usually soil samples are not presently available from these sites.

To augment the data available and to test critical levels that have been established in other areas of the world, interpretation studies were initiated in several Latin American countries. The procedures followed, generally, were those developed by the project which were based on the philosophy that potted plant studies should be conducted from the information obtained from the analysis of the selected soil samples. After potted plant studies have been conducted on a number of soils, the results of the study may be plotted according to the Cate-Nelson technique to determine critical levels. The procedure also permits comparison of extractants for predicting the need of fertilizers containing the element in question.

During 1966, Dr. D. L. Waugh served as special advisor and co-leader to ten students working on research problems leading to Ingeniero Agrónomo degrees and to three graduate students (Master of Science) at the University of Agriculture in La Molina, Peru. Almost all of these research problems were relative to some phase of obtaining information for the interpretation of soil

analyses. Soil samples were collected from the major cultivated soils in the various regions of Peru. Typical results obtained in the phosphorus fixation studies are shown in Figure 12. A comparison of three extractants for available phosphorus is presented in Figure 13, and for three extractants of available (exchangeable) potassium in Figure 14. Studies were conducted also on soil acidity, availability of calcium and magnesium and some of the micronutrients.

Interpretation studies were undertaken in El Salvador under the guidance of Dr. Walker. The uptake of phosphorus by plants compared to soil test results are shown in Table 1.

Much of the existing plant response data in Brazil was reviewed by Prof. R. B. Cate for use in establishing critical levels in the soil for both phosphorus and potassium.

Phosphorus and potassium fixation studies were conducted in Costa Rica and Nicaragua. The data obtained in Nicaragua served as a guide to field trials conducted by FAO.

One of the objectives of these interpretation studies was to determine if critical levels established in one area of the world would apply to another area. If this is possible, then programs in developing countries can be pushed without first developing long and expensive research studies. Initial observations indicate that the critical level for exchangeable potassium of 0.10 to 0.12 me per 100 g of soil is approximately the same for soils in Brazil, Peru, and North Carolina. The critical level established for available phosphorus in Peruvian soils, using the Olsen sodium bicarbonate extractant, was found to be very similar to that obtained by Olsen working with the soils of Colorado. Of course, much more research is needed before any definite conclusions can be made for the critical levels of either phosphorus or potassium.

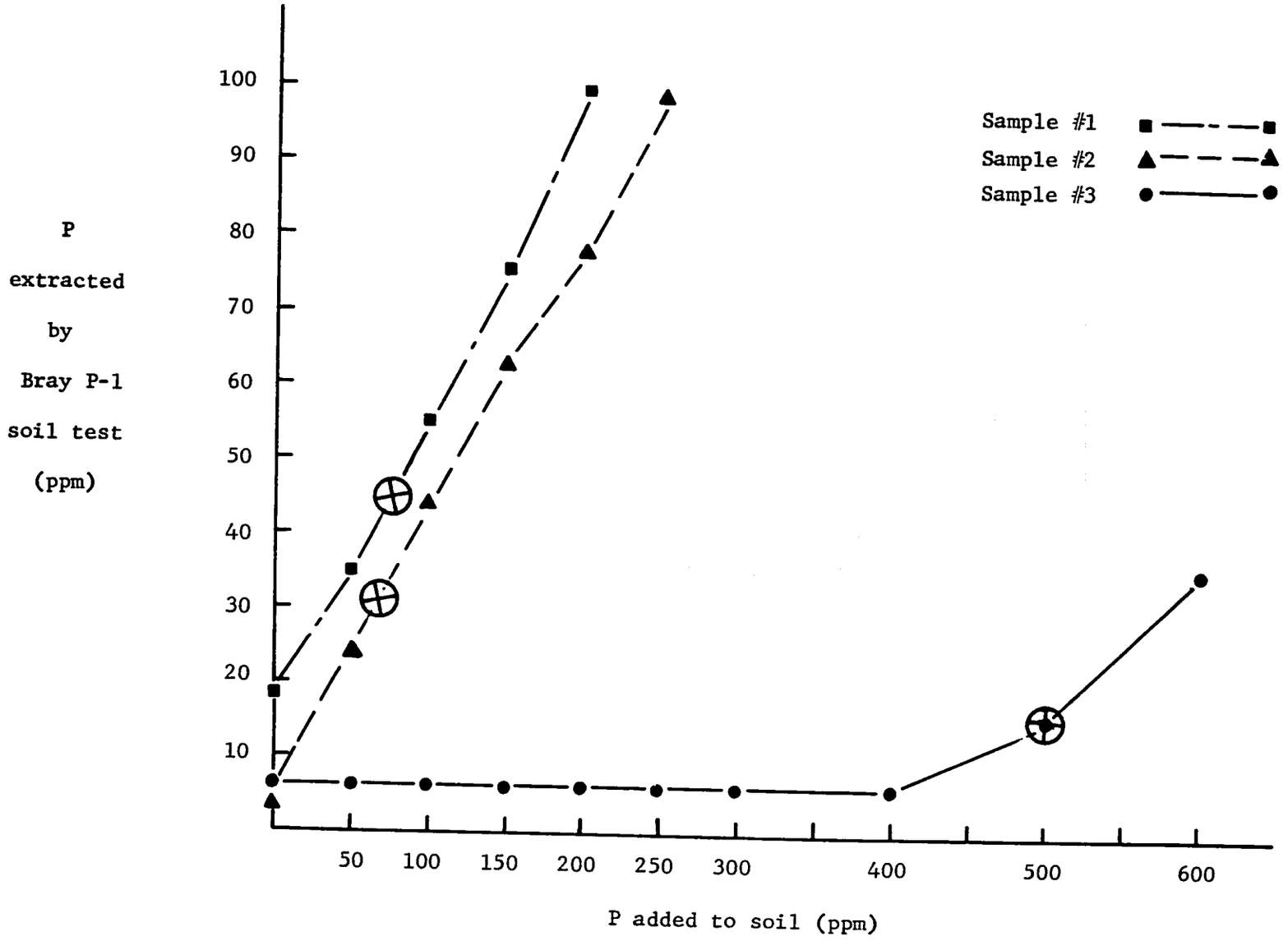

Figure 12. The amount of P extracted by soil test in relation to the rate of P applied on three soils of Perú. (Data in thesis from research conducted in SIPA by Mueller for Ing. Agrónomo degree, Universidad Agraria, La Molina, Perú, 1966. In Press.)

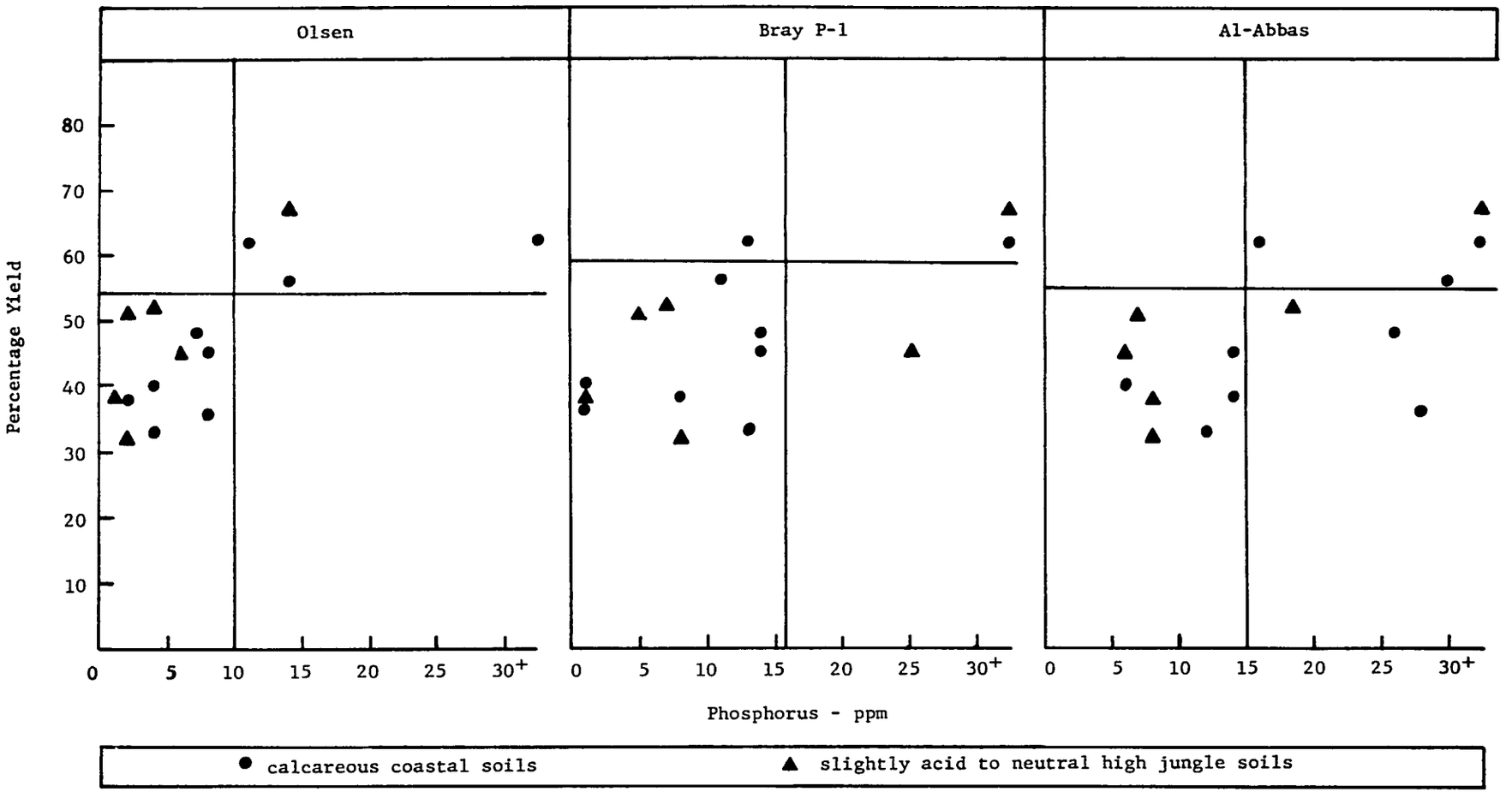

Figure 13. A comparison of percentage yield vs. soil test values for phosphorus by three analytical procedures with 15 soils of Perú. (Data in thesis from research conducted in SIPA by Mueller for Ing. Agrónomo degree, Universidad Agraria, La Molina, Perú, 1966. In Press.)

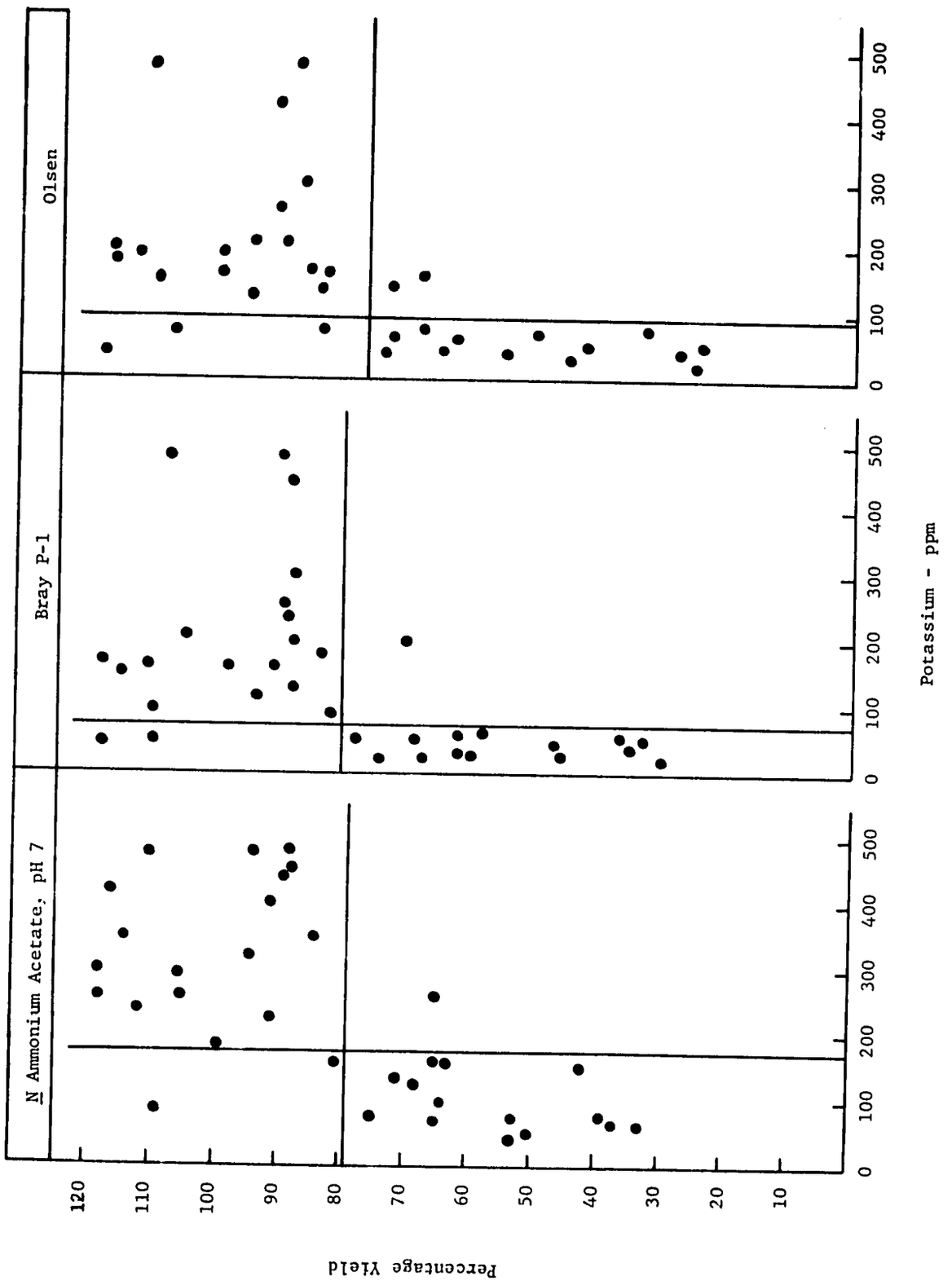

Figure 14. The percentage yield vs. soil test values for potassium as determined by the Olsen and Bray P-1 procedures compared with extracting by neutral ammonium acetate on 35 soils of Perú. (Data in thesis from research conducted by Durán for Ing. Agrónomo degree, Universidad Agraria, La Molina, Perú, 1966.)

Table 1. The relation of phosphorus uptake by plants to soil test values as determined with the North Carolina and Bray extractants (data of Miguel Ernesto Menéndez of San Salvador, El Salvador)

		NORTH CAROLINA			BRAY	
NUMBER	SOIL SERIES	X	$\bar{Y}$	Y	X	Y
1	Atd	12	8.1	11.16	13.5	9.25
2	Chlp	7	7.1	10.38	11.5	9.38
3	Usa	100	22.0	25.68	98.0	25.56
4	Ozc	99	21.2	25.52	98.0	25.56
5	Api	40	15.7	15.78	34.5	15.68
6	Joc	100	31.1	25.68	98.0	25.56
7	Esa	5	6.2	10.01	12.5	9.51
8	Mya	23	12.6	12.98	38.5	14.43
9	Toa	19	11.3	12.32	39.5	14.63
10	Baa	100	29.8	25.68	98.0	25.56
11	Sab	15	16.0	11.66	46.5	15.93
12	Esb	37	16.2	15.29	38.5	14.43
13	Eta	2	9.3	9.51	6.5	8.45
14	Pqb	9	15.9	10.67	14.5	9.94
15	Snd	18	18.6	12.15	30.5	12.93
16	Tbb	3	6.0	9.68	8.5	8.82
17	Sma	100	22.7	25.68	98.0	25.56
		$r = 0.873^{++}$			$r = 0.885$	
		$b = 0.165^{++}$			$b = 0.187$	
		$\hat{y} = 0.165X + 9.18$			$\hat{y} = 0.187X + 7.23$	

NOTE: X = Soil Analysis of Phosphorus ppm.

$\bar{Y}$ = Rate of Total Phosphorus Uptake (ppm) by plants.

$\hat{Y}$ = Calculated regression of Total Phosphorus Uptake (ppm) by plants

INFORMATION PROGRAMMING

After a soil has been found to be below the critical level for a given nutrient or nutrients, then suggestions must be made to the farmer relative to the proper use of fertilizers. This includes rates, methods and time of application of the materials suggested. Characteristics of the crop, including varieties and plant population, must be considered. Likewise, climatic conditions and management practices should receive attention. One of the most important considerations in making the fertilizer recommendation is economics. Capital may be limited or the crop grown may not have a high value (example; some small grains).

It is imperative that guide sheets be available for use in making fertilizer suggestions to farmers in order that the various factors influencing yield will be considered and to help in getting consistent recommendations. The approach in preparing the guide sheets is similar in many ways to "programming" a computer. The various factors to be considered and the relative importance of each in making a recommendation must be brought together in a simple "model" or outline. The Regional Directors undertook the responsibility of bringing all available information together to use as a basis for developing guide sheets for the laboratories in their regions. Of course, local agricultural specialists and leaders were consulted. In most instances only a small number of group separations relative to soil conditions, etc. were made for a given crop. As more data becomes available, more refinement can be made.

A summary sheet of fertilizer suggestions prepared by Prof. Cate for use in Brazil is shown in Table 2. This is an excerpt from the bulletin published by Prof. Cate in 1965. It is currently being revised in view of additional information that has become available.

Table 2. Fertilizer suggestions based on soil tests for various crops in Brazil.

Typical Crops (average yields)	Soil-Plant Analyses P	K	kg/ha of Fertilizer N	P_2O_5	K_2O
Most					
Fibers	Low	Low	25-50	25-50	25-50
Grains	Low	High	25-50	25-50	0
Cacao	High	Low	25-50	0	25-50
Coffee	High	High	25-50	0	0
Most	Low	Low	50-100	100	100
Fruits	Low	High	50-100	100	25
Sugarcane	High	Low	50-100	25	100
Tobacco	High	High	50-100	25	25
Most	Low	Low	100-200	200	200
Vegetables	Low	High	100-200	200	50
Bananas	High	Low	100-200	50	200
Tea	High	High	100-200	50	50
Most	Low	Low	0	100	100
Legumes	Low	High	0	100	25
	High	Low	0	25	100
	High	High	0	25	25

Dr. J. L. Walker worked with local agronomists in preparing "guide sheets" for Guatemala, El Salvador and Honduras. Much of the information upon which these sheets were based was taken from other areas but has been "spot checked" for applicability to this region. Coffee is an important crop in this region as in many countries of Latin America. A special set of guide sheets was developed by Dr. Walker for coffee and these are being prepared for publication.

FERTILITY STATUS OF SOME SOILS OF LATIN AMERICA

Soil test summaries are excellent sources of information for use in research, educational, and commercial programs. In preparing summaries of soil tests that have been made on samples submitted by farmers, it is desirable to have several thousand samples from an area in order to obtain an accurate picture of all soil conditions. A few of the laboratories in Brazil, particularly the laboratories at Campinas and Recife, tested more than 8,000 samples during 1966. The laboratories in other cooperating countries more than doubled the volume of samples tested during 1966 but few exceed 5,000 samples. The volume should increase sharply during 1967.

Although summaries have not been prepared on a country-wide basis as yet, observations of the tests indicate that a greater variation will be encountered in soils of the tropical regions than in most parts of the United States. General fertilizer recommendations are not likely to fit a high proportion of the soils in many of the regions.

Uruguay. In an effort to obtain some information relative to soil conditions that are likely to be encountered in Uruguay, Dr. Hunter carefully selected representative soil samples from the surface horizon (plow layer)

from the major types of soil which are either under cultivation or suitable for cultivation. Since a soil testing laboratory was not available within the country, the samples were sent to the control laboratory in Raleigh for analysis. The description of the soils and the results of the tests are shown in Tables 3 and 4. Almost 90 percent of the soils tested were found to be very low in available phosphorus and high in potassium. It is very important, however, to the farmers having soils low in potash or medium in phosphorus that they know this before purchasing fertilizer. The acidity of the soils is quite variable. Many soils need liming; others contain an excess of lime. The extreme phosphorus deficiency and the acid soil conditions (on some soils) no doubt contribute to the poor calf crop in much of Uruguay.

POTENTIAL COLONIZATION AREAS

Most of the increase in crop production is likely to come from areas currently in cultivation, at least during the next several years. However, there are several areas of undeveloped land, particularly in tropical regions, which can be brought under cultivation. One of the deterrants to colonization in these regions is adverse soil conditions, usually nutrient deficiencies, soil acidity, or both.

The Llanos region of eastern Colombia is a good example of such areas. It is a broad, flat plain of more than ten million acres that is largely covered with grass. Colombians frequently refer to it as the "desert" but the precipitation varies from 45 to 175 inches a year (from each to west). The region has been classified as Class III land by FAO surveyors which is suitable largely for grazing.

Table 3. The available phosphorus, potassium, calcium and magnesium, and the acility of selected soils of Uruguay.

Uruguay Sample	Bray No. 1	North Carolina Extractant				
	P	P	K	Ca	Mg	pH
	ppm	ppm	me/100g	me/100g	me/100g	
M-1	2	0	0.65	20+	4.4	5.45
2	4	1	0.39	12	5.4	5.45
3	5	1	0.43	11.2	3.9	5.3
4	7	1	0.49	12.2	3.7	4.7
5	8	8	0.37	18.8	4.8	5.5
6	7	2	0.52	10.4	2.8	4.6
7	12	12	0.70	19.0	4.9	5.0
8	5	1	0.39	14.4	6.2	4.85
9	6	1	0.29	17.6	5.0	5.5
10	6	1	0.54	9.6	3.4	5.3
M-11	3	2	0.47	20+	3.8	5.4
12	4	1	0.17	4.6	1.8	4.8
13	3	1	0.11	3.2	1.2	5.1
14	2	1	0.30	4.8	2.0	5.0
15	4	1	0.34	5.2	1.9	4.9
16	9	3	0.37	6.0	2.1	4.5
17	3	1	0.16	10.0	1.7	5.2
18	6	1	0.52	16.6	4.7	5.2
19	4	2	0.52	11.6	4.0	5.1
20	6	2	0.35	11.6	3.5	5.2
M-21	3	1	0.18	15.6	2.0	5.15
22	5	3	0.25	1.5	0.7	4.9
23	7	4	0.45	3.6	1.2	5.1
24	4	2	0.54	19.0	7.5	5.8
25	8	5	0.36	1.6	0.8	5.4
26	5	3	0.38	2.2	1.0	5.0
27	7	2.5	0.34	2.6	0.6	4.75
28	7	5	0.15	1.6	0.7	5.1
29	2	2.5	0.26	17.6	5.5	5.7
30	6	2.5	0.36	20+	5.8	5.5
M-31	6	2	0.36	20+	6.7	5.6
32	7	3	0.40	20+	6.5	5.5
33	8	5	0.32	20	6.0	5.6
34	6	4	0.17	3.0	1.0	5.4
35	8	6	0.28	17.6	4.0	5.8
36	8	7.5	0.51	20+	3.8	6.7
37	6	6	1.00	20+	5.5	7.3
38	5	5	0.52	20+	5.4	7.1
39	5	2.5	0.44	18.0	4.3	6.1
40	7	4	0.59	12.4	2.5	5.2
M-41	6	2.5	0.57	9.4	2.5	6.7
42	4	5	0.41	20+	2.8	6.5
43	6	5	0.59	20+	2.1	5.9
44	3	1	0.19	13.6	2.4	6.8
45	8	6	0.55	20+	2.5	5.5
46	4	2.5	0.49	7.0	1.4	6.3
47	6	7.5	0.26	20+	3.6	7.4
48	4	13.5	0.80	20+	1.5	5.4
49	4	1	0.25	7.6	1.2	6.0
50	17	20	0.88	20+	4.0	7.7
M-51	5	5	0.86	20+	4.7	6.8

Table 4. Description of soil samples taken in Uruguay.

Sample No.	Crop
M-1	Native pasture
M-2	Winter wheat
M-3	Field corn - harvested
M-4	Field corn - harvested
M-5	Wheat
M-6	Field corn
M-7	Improved pasture
M-8	Wheat
M-9	Native pasture
M-10	Native pasture
M-11	Native pasture
M-12	Native pasture
M-13	Native pasture
M-14	Native pasture
M-15	Native pasture
M-16	Wheat
M-17	Native pasture
M-18	Native pasture
M-19	Native pasture
M-20	Native pasture
M-21	Native pasture
M-22	Native pasture
M-23	Native pasture
M-24	Native pasture
M-25	Native pasture
M-26	Native pasture
M-27	Native pasture
M-28	Native pasture
M-29	Native pasture
M-30	Native pasture
M-31	Native pasture
M-32	Native pasture
M-33	Native pasture
M-34	Native pasture
M-35	Native pasture
M-36	Native pasture
M-37	Native pasture
M-38	Native pasture
M-39	Native pasture
M-40	Native pasture
M-41	Native pasture
M-42	Native pasture
M-43	Native pasture
M-44	Native pasture
M-45	Native pasture
M-46	Wheat
M-47	Improved pasture
M-48	Native pasture
M-49	Native pasture
M-50	Native pasture
M-51	Native pasture

The above soil samples from Uruguay were taken during June and July of 1965. They were taken in a manner generally accepted for sampling of farmer fields for the purpose of making chemical analysis for recommending fertilizer practices. Each sample is a composite of at least 30 individual samples taken to a depth of six inches. Most fields sampled were native pastures which were chosen as being quite typical of the major part of the land in the sampled area.

Dr. E. J. Kamprath, short-term consultant of the International Soil Testing Project, and Dr. J. M. Spain of the Rockefeller Foundation in Colombia inspected a large portion of the Llanos region (Appendix C). The analysis of soil samples taken from the Llanos region indicated the chief limiting factor for crop production is soil acidity and nutrient deficiencies. Phosphorus was found to be very low. These conditions can be easily remedied by the proper use of lime and fertilizer (Figure 15).

There are other large areas of land on the east side of the Andes mountains, extending through Ecuador, Peru and Bolivia, which appear to have excellent potential for agricultural development. Dr. Waugh has tested some soils from the "selva" region in Peru, and found that one of the limiting factors in bringing these soils into agricultural production is soil acidity and their lack of fertility.

Guatemala also has a large undeveloped area (Peten region) which may be suited for cultivation. Dr. Walker has gone over some of the region and prepared a report and map for the use of the USAID Mission in Guatemala.

The proper use of lime and fertilizers will be very important in bringing these new areas under cultivation. A good soil testing program will be a great aid in the colonization of these areas.

RESEARCH SEMINARS

Personal observations and group discussions are very important methods of disseminating information among the agricultural leaders of cooperating countries. Two seminars were conducted in Raleigh during the summer of 1966 for agricultural leaders to observe soil management practices, laboratory tech-

Figure 15. Corn will not grow on the soils of the Llanos region of Colombia without lime and fertilizers.

niques and to discuss mutual problems. The first started June 5 and continued through July 15. Since this seminar was largely designed for project leaders and administrators,all six phases of a soil testing-plant analysis program were discussed. Six field trips were taken to observe various soil conditions which require different types of management. Both good and poor management practices were observed and discussed. Field experiments and demonstrations were visited (Figure 16). Diagnostic techniques to determine the causes of poor plant growth were demonstrated to and practiced by the participants (Figure 17).

The second seminar lasted three weeks, July 25 through August 12, and covered the subjects of sampling and laboratory analyses (Figure 18).

A brief outline of the program for each seminar is presented in Appendix G. Each participant received an outline of the subject matter covered which was prepared for each seminar in both Spanish and English. The lectures were presented in Spanish, or, if presented in English, were interpreted into Spanish for the group.

Small groups were desired for the seminars since it was not known how large a group could effectively participate in this type of program. Fifteen persons registered for each seminar and this appeared to be an optimum size group. There were representatives from ten Latin American countries in the first seminar and from nine countries in the second. The countries sending participants included Brazil, Bolivia, Peru, Ecuador, Colombia, Nicaragua, Honduras, El Salvador, Guatemala and Mexico.

An anonymous questionnaire was completed by the participants relative to the strength and weakness of the seminars. It was a unanimous agreement that three or six weeks was insufficient time to cover the material included in the

Figure 16. Participants in the first seminar listen to an explanation by Dr. E. J. Kamprath of plot treatments and data obtained in the past on the field experiment.

Figure 17. Vladimiro Castellanos of Honduras, Demetrio Calderon of Perú and Miss Alicia Elena Aguilar of Mexico (left to right) are using tissue tests as a diagnostic tool to determine the cause of poor growth of soybeans.

seminars. All were of the opinion that a period of eight to twelve weeks would be optimum. They were also in agreement that the Soil Science Department of N. C. State University should continue working with the countries for a period of at least ten years in order that their programs would become firmly established.

The participants indicated in their "comments" relative to the seminars that the phases of the program which would be of greatest benefit to them included:

1) Becoming acquainted with and to fully comprehend the North Carolina philosophy of the role of soil-plant analysis in a soil fertility program.

2) Seeing the organizational structure of a program first hand, including the steps and personnel involved, and the responsibilities for carrying it out.

3) Observing good and poor soil management. The participants observed soils as poor, or poorer, than those in their countries but which had been made to produce economically through good management.

4) Learning where to turn for advice and help on problems which they will encounter in the future.

5) Becoming acquainted with persons from other countries having similar duties and responsibilities and to learn that they, too, have similar problems.

6) Hard work is a key part of any successful program.

It was quite obvious that most of the participants left the seminars with their viewpoints broadened considerably, and with a determination to get a job done "back home".

ADVISORY COMMITTEES

U. S. Advisory Committee

In 1965 a committee was appointed to serve in an advisory capacity to the International Soil Testing Project. The committee is composed of representatives from land-grant universities, other than N. C. State University, from the U. S. Department of Agriculture, and from industry. Members of the committee include:

Name	Institution or Agency
Dr. Douglas J. Lathwell	Cornell University
Dr. J. C. Engibous	International Minerals and Chemical Corporation
Dr. Werner L. Nelson	American Potash Institute
Dr. Robert W. Pearson	Soil and Water Conservation USDA/ARS
Dr. Robert T. Smith	Esso International Company
Dr. V. L. Sheldon*	Esso Chemical Company, Inc.
Dr. W. H. Garman	National Plant Food Institute

The purpose of the committee is to review the accomplishments of the project in relation to the objectives and to advise on future activities. Recommendations are prepared by the committee relative to phases of the program that need more attention and where less emphasis should be placed.

The U. S. Advisory Committee met twice during 1966. The first meeting was in early January and the second in late December. The recommendations prepared by the committee are as follows:

*Dr. V. L. Sheldon replaced Dr. Smith as a member of the committee.

January 1966.

Recommendations of the Advisory Committee

During the afternoon of the second day of the conference, the Advisory Committee met separately from the project staff for a discussion of the program. As a result of their deliberations, this committee offered the following recommendations for consideration by North Carolina State University and AID/W:

1. Low soil fertility is a major limiting factor in crop production in the developing countries. The International Soil Testing Program directed to this problem provides an excellent means of applying agronomic research results for increased crop production.

2. Major activities of the program should be the continuous training of people in:

    a. Laboratory techniques.
    b. Correlation experiments between fertilizer response and soil test results with emphasis on removal of limiting factors.
    c. Diagnostic approach on growing crops in farmers fields.

3. The program is desperately needed in other areas of the world, and the current contract should be amended immediately to provide advisory service to countries on a priority basis. Personnel may be drawn from other universities, public agencies, and industry for this purpose. In setting these priorities consideration should be given to need for increased food production; desire and ability to cooperate by the countries involved; and activities of supporting industries in establishing production, distribution, and marketing facilities.

4. At the conclusion of the current amended contract period a new contract should be drawn to support a long-term expanded program in Latin America and other areas of the world.

5. Specific recommendations for immediate attention are as follows:

    a. The International Soil Testing Program should act as a gathering agency and information center on related activities throughout the world.
    b. The ISTP Director should strongly encourage standardization of technical and reporting procedures throughout the region.
    c. Provision should be made for data retrieval to permit comprehensive summaries of soil tests and other related information at regular intervals.
    d. Supporting plant analyses data from correlation studies should be an integral part of the program.

6. The greatest value of this program is the continuity it offers in research and education in crop production in the developing countries.

December 1966

Recommendations of the Advisory Committee

During the afternoon of the second day of the conference, the Advisory Committee met separately from the project staff for a discussion of the program. As a result of their deliberations, the committee offered the following recommendations for consideration by North Carolina State University and AID/W:

1. The International Soil Testing Program appears to be making real progress and the Director and his staff are to be complimented. We encourage North Carolina State University at Raleigh to continue its support of the program.

2. The Advisory Committee reiterates and stands on the recommendations made to ISTP in January 1966. Specific attention is called to:

    a. Continuous effort in correlation experiments between fertilizer response and soil test results using adequate laboratory techniques is essential.
    b. ISTP should provide advisory service to countries on a priority basis with attention focused on need, ability of the countries to cooperate, and the possibility of establishing production, distribution, and marketing facilities.
    c. At the conclusion of the current contract a new contract should be drawn to support a long-term expanded program in Latin America and other parts of the world.
    d. In addition ISTP should act as a gathering agency and information center on related activities, the director should encourage standardization of technical and reporting procedures, provision should be made for data retrieval, and plant analysis data should be an integral part of the program.

3. The Technical Reports Series is serving a great need and should be continued in its present form. In addition to the reports already published and planned, a technical report on laboratory equipment and laboratory organization should be written as soon as possible. The widest possible dissemination of these reports should be encouraged. Public and scientific awareness of the program should be increased through the widest circulation of semi-technical and popular articles. Soil test information summaries along with current thinking on fertilizer practices and recommendations should be prepared for each country. When available, these reports should provide the basis for specifications for fertilizers brought into the countries by AID programs.

4. Although the Advisory Committee recognizes the needs of other parts of the world, we suggest the present level of support be maintained for the program in Latin America and that any immediate expansion take place in Latin America. If additional funds become available

any expansion into countries in other parts of the world should be proceeded by an evaluation of the position and needs of these countries by ISTP in cooperation with AID.

5. Because increased crop production is the ultimate objective of the project, all aspects of soil fertility and soil and crop management should be considered in the program of research and interpretation in the soil testing program.

6. The seminar and training concept is excellent and should be continued at Raleigh for the forseeable future. In 1967 the regional program directors should be brought to Raleigh to take part in the seminar. When sufficient experience is gained consideration should be given to taking the seminar program out to the cooperating countries.

7. This Committee can see no advantage to moving in the direction of regional centers at this time.

8. Mutual cooperation with both public and private agencies, particularly FAO, should be encouraged at all levels to avoid duplication of effort in the field. The ISTP should be recognized as providing leadership in the field for soil analysis programs."

The minutes of both meetings are presented in their entirety in Appendix A.

Advisory Committees in Cooperating Countries

Following completion of Part I of the project (summary of soil testing programs within each country), advisory committees were appointed to review the status of soil-plant analyses and to advise on future programs. The committees have been very helpful in most of the countries. The importance of their activities was recognized in Guatemala and Honduras where, in 1966, permanent coordinating committees for national soil fertility and analyses programs were established by presidential decree.

Activities of the committees in Venezuela and Colombia are given in the reports prepared by Dr. McCants and Dr. Kamprath which are presented in Appendix C. Activities to be undertaken with a time schedule established for 1967 were outlined in an advisory committee meeting held in Panama City in November 1966. A report of this meeting is presented in Appendix E.

In a committee meeting in Lima,Peru in October, Dr. Waugh reviewed the accomplishments to date of the program which included data obtained from interpretation studies conducted by university students under his supervision. The importance of selecting the correct fertilizer for the potato project in the Sierra region was emphasized. The committee endorsed the proposed program for the potato project and encouraged greater use of soil analyses in all parts of Peru.

STAFF CONFERENCE AND PROFESSIONAL MEETING

Staff Conference

Periodic staff conferences are very essential in conducting the project. Since the Regional Directors conduct their programs individually, these conferences give over-all direction and help tie the project together. An opportunity is given for the exchange of ideas and the discussion of problems encountered. It also enables the presentation and discussion of the plan of work for the ensuing six months. A staff conference was held in Raleigh in late August. All of the Regional Directors were in the United States on home leave so that travel costs were reduced to a minimum. The agenda for the conference was as follows:

Agenda

1. Report on activities the past eight months

    a. Operation of laboratories
        1.1 New apparatus
        2.1 Procedures and techniques
    b. Open house and other general meetings
    c. Soil sampling programs
    d. Preparation of guide sheets
    e. The 1966 Soil Seminars at Raleigh
    f. The 1965 Annual Report
    g. Publications

h. Interpretation studies
l. Miscellaneous

(Order of reporting: (1) Cate; (2) Hunter; (3) Kamprath; (4) McCants; (5) Walker; (6) Waugh; (7) Bartholomew; (8) Berenyi; (9) Fitts)

2. Activities in the Soil Science Department — R. J. McCracken

3. Observations and suggestions - ISTP Project — J. R. Wilson

4. Activities for next six months

   a. Guide sheets
   b. Soil sampling drives
   c. Interpretation studies
      1.1 Lab
      2.1 Potted plant
      3.1 Field
   d. Visuals
      1.1 Types
      2.1 How to use
   e. Publications
   f. Regional conferences
   g. Annual Report 1966
   h. Equipment and apparatus
      1.1 Obtaining for overseas labs
   i. Demonstrations
      1.1 Cooperative with Dr. Birdsall and FAO
   j. Soil test summaries
   k. Control lab

5. The 1967 Soil Seminars - Raleigh

6. The Tropical Soil Science Center

7. International Programs - N. C. State University — R. L. Lovvorn

8. Computer recommendations — L. A. Nelson, P. H. Reid, D. L. Waugh

9. Other programs related to increased crop production in Latin America

10. Administrative details

    a. Contract changes
    b. Allowance regulations

c. Insurance

11. Miscellaneous

Items on the agenda which drew considerable discussion were new equipment and apparatus for increasing efficiency of operations, visual and audio aids, recommendation guide sheets and the soil seminars. All of the directors were anxious for the laboratories in their areas to be fully equipped with apparatus to test samples rapidly and accurately. They were particularly interested in the new stirrers and pH meter attachments.

Expressing soil test results in meaningful terms is difficult. A simple term such as "low" when speaking of soil fertility levels may have a considerably different connotation among different people. Transmitting the information obtained from soil test or plant analysis to the farmer often is a difficult procedure. The staff were of the opinion that more attention should be given to this part of the program.

Professional Meeting

Dr. A. H. Hunter represented the project at the Annual Conference of PCCMCA which was held in Managua, Nicaragua, in March. He presented in Spanish a paper entitled "A Soil Fertility Testing Service Program". Inauguration of the soil testing laboratory in Managua was also held in conjunction with the PCCMCA meeting.

PUBLICATIONS

Two types of bulletins have been initiated for the project--one is a technical series and the other an informational series. Other publications

include instructional or guide sheets, pamphlets, brochures, soil cartons and charts.

Technical Bulletin No. 3 entitled "Soil Test Interpretation Studies: Laboratory and Potted Plant", by D. L. Waugh and J. W. Fitts, was published in December 1966. This bulletin is the second of a series related to soil test interpretation. The bulletin is being translated into Spanish and Portuguese and will be ready for publication in these languages soon.

Technical Bulletin No. 2 entitled "Evaluation of Soil Fertility in Latin America: Soil Testing-Plant Analyses, 1965", which was published in English in December 1965, was translated into Spanish and Portuguese. The bulletins in these languages were released in November of 1966.

Information sheets must be concise and simple. All of the regions have reduced the information required to the point that the information sheet is presented on the side of the soil carton.

Instructions for taking samples should be concise but clearly presented. Dr. Walker prepared a well illustrated circular for use in Central America with specific instructions for soil sampling (Figure 11).

Brochures for the two soil science seminars were published in both Spanish and English. The information presented in the seminar likewise was presented in both languages.

VISUAL AND AUDIO AIDS

In the developing countries of Latin America many of the people working in agriculture are poorly educated or illiterate. Thus, published materials in bulletins, pamphlets, brochures,magazines or newspapers have only a limited

audience. Visual and audio materials probably are the best means of communication but more information is needed on the types which are most effective.

Dr. Waugh developed a series of flip charts which proved very valuable in explaining to Peruvians the importance of obtaining information relative to the nutrient needs of the soils in the Sierra region where a large program was being launched to increase potato production. The percentage yield concept is illustrated by a drawing of corn of differing sizes (Figure 19). The law of the minimum is presented with bars to show the relative amounts of nitrogen, phosphorus and potassium in relation to the size of the plant (Figure 20). The critical level for phosphorus (6.5 ppm) is readily seen in the flip chart (Figure 21) which shows the relationship of soil test results with percentage yield on fertilizer trials with potatoes conducted in the Sierra region of Peru from 1959 to 1966. The soil test by the Olsen procedure has done an excellent job of separating the soils into those that will respond to phosphorus application and to those that do not need phosphorus. In his discussion to the Peruvians, Dr. Waugh pointed out the nine different fertilizer recommendations based on the three levels of phosphorus and potassium in the two-way table (Figure 22). The general fertilizer recommendation based on low phosphorus and medium potash fitted less than half of the soils being tested in the area.

The Peruvian farmers expect to spend about 80,000,000 soles (almost $3,000,000) for fertilizers for their potato crop. They are immediately faced with the question of what plant nutrients are needed for each potato field. Some fields will need liming; some will not. Some fields will need phosphorus or potash; others will not. All of the fields will need nitrogen but in varying quantities. By fitting the fertilizer and lime to the needs of the soil, Dr. Waugh pointed out

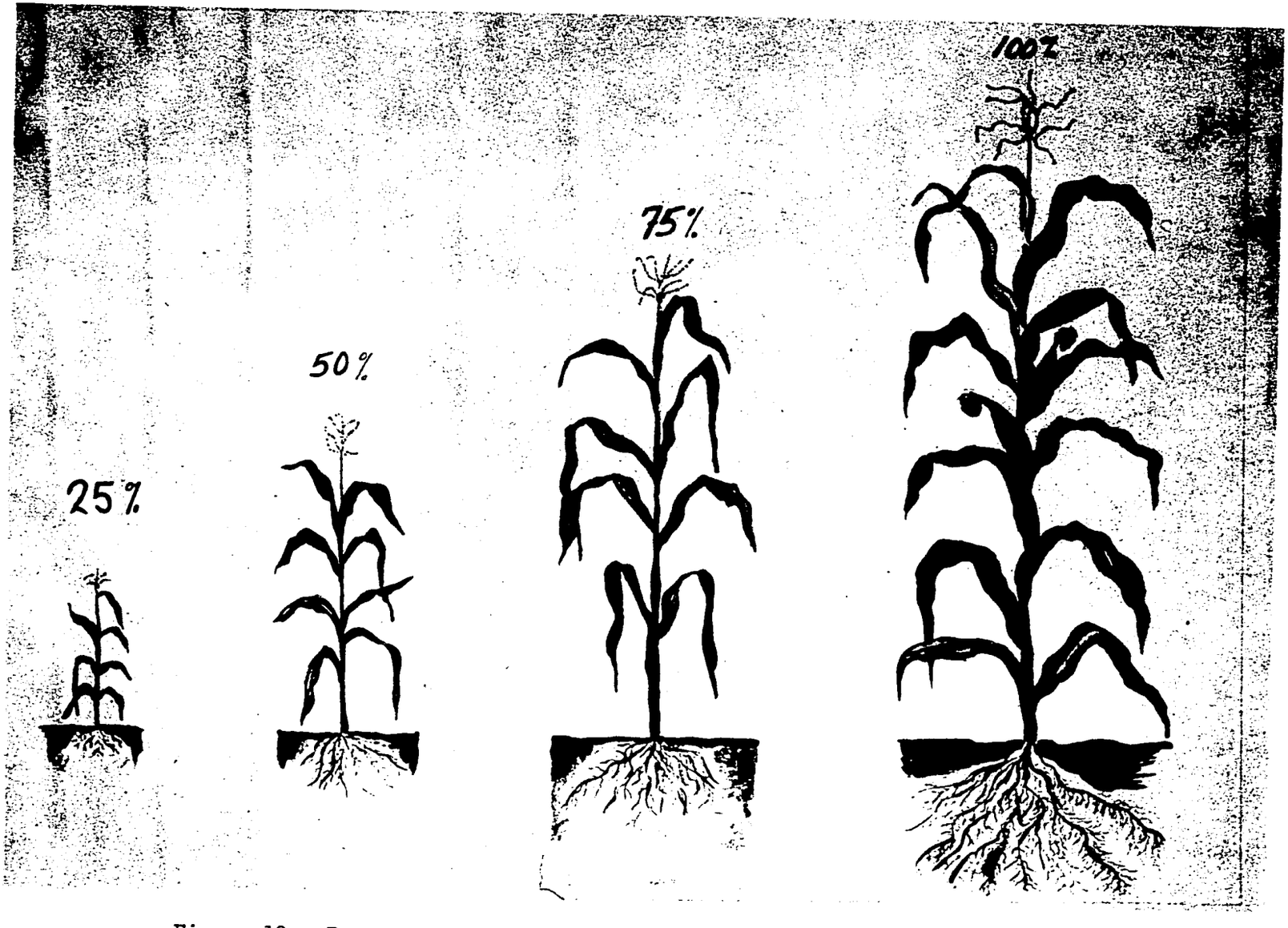

Figure 19. Percentage yield illustrated by different size of corn plants (flip chart).

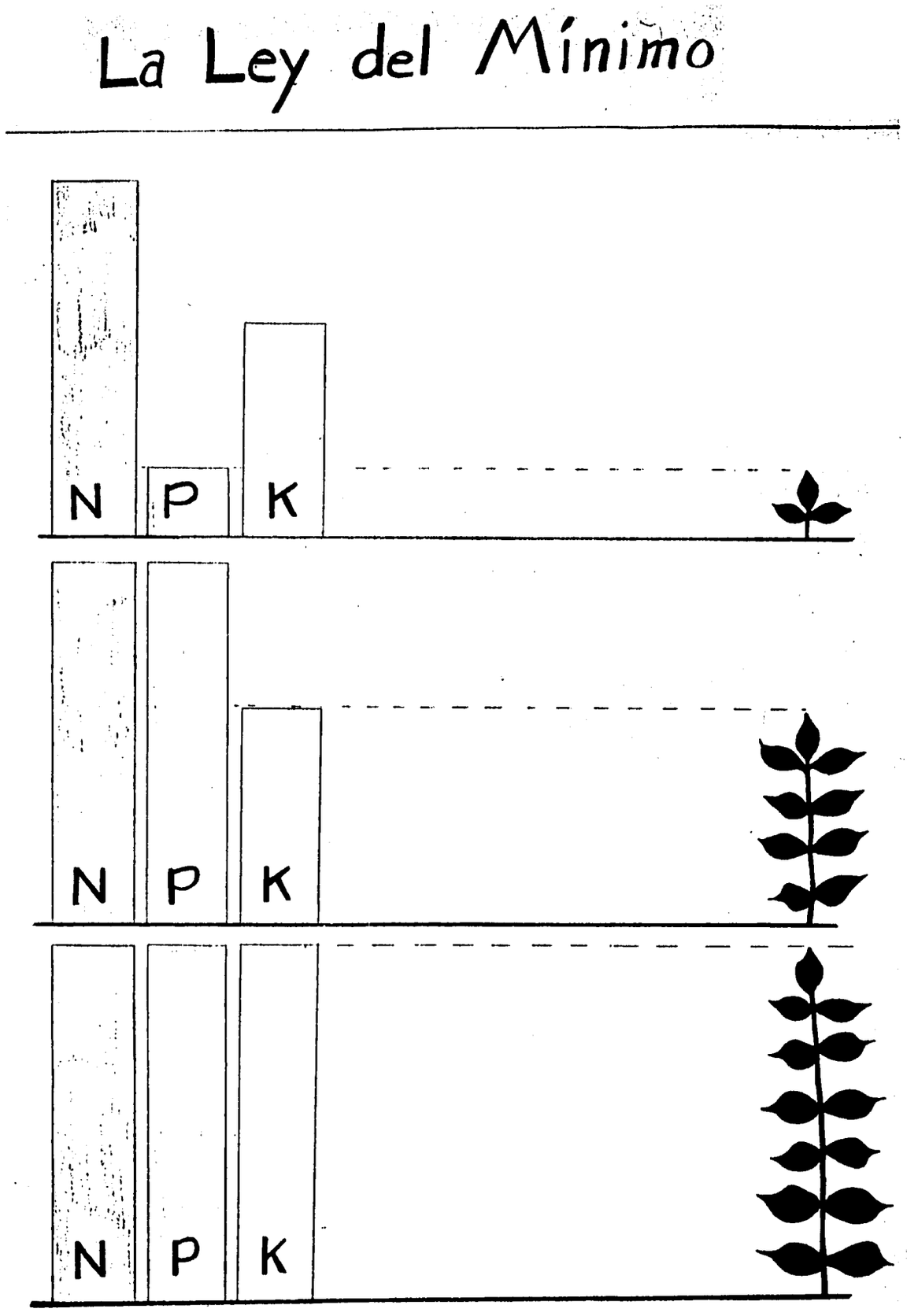

Figure 20. The law of the minimum as illustrated by the amount of phosphorus and potassium in relation to the height of the plant (flip chart).

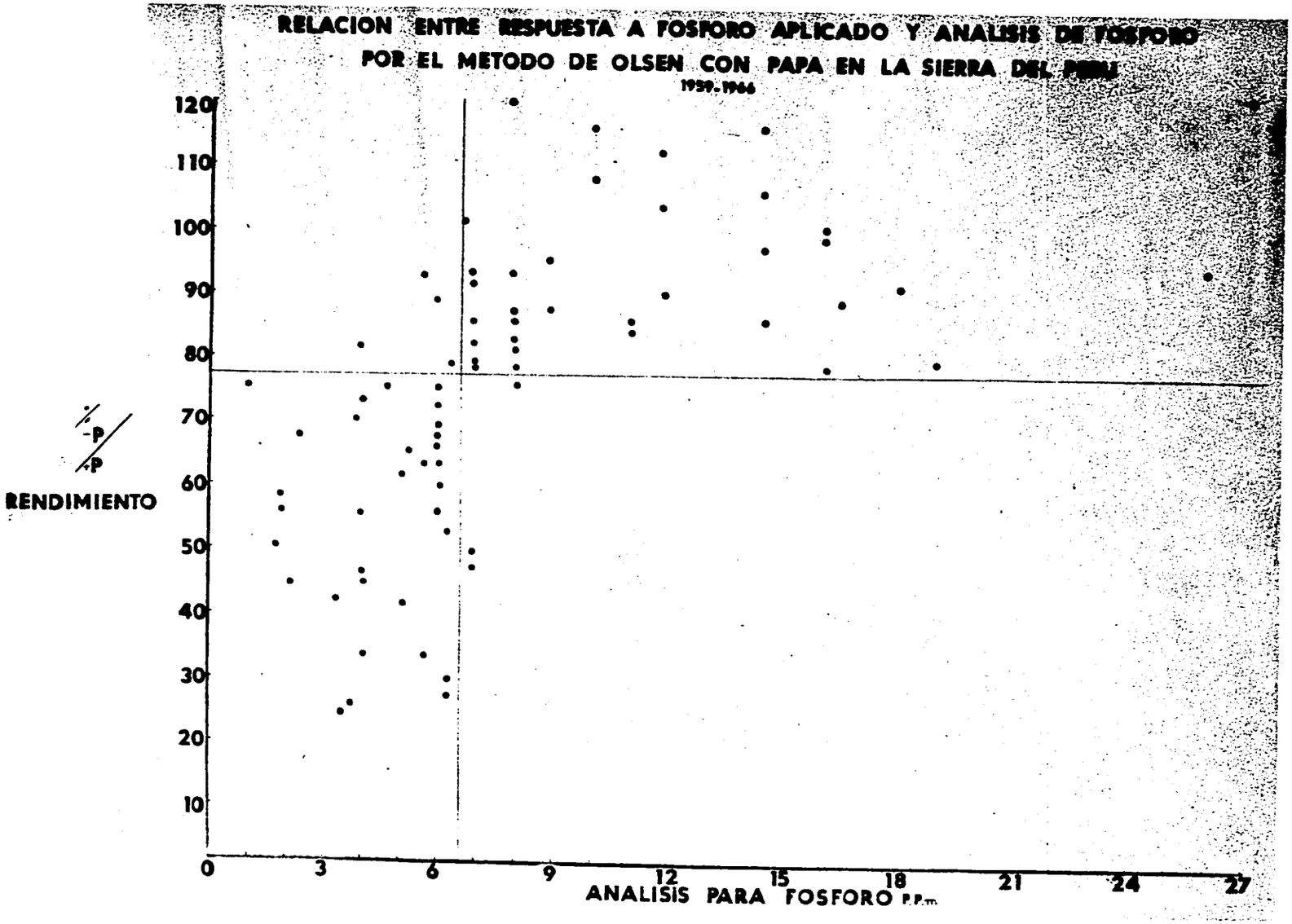

Figure 21. Interpreting soil test results in terms of percentage yield by the Cate-Nelson technique with fertilizer trials on potatoes in the Sierra region of Perú. (Data from cooperative studies by S.I.P.A. and North Carolina State University-Peruvian contract.)

Uso de Analisis en las Recomendaciones de Fertilizantes

Analisis para K (ppm)	Kg/Ha. →	Analisis para P (ppm)		
		Bajo (0-10)	Med. (11-20)	Alto 21+
		P_2O_5 / K_2O	P_2O_5 / K_2O	P_2O_5 / K_2O
	Bajo 0-75	160-200 / 160-200	80-100 / 160-200	0-50 / 160-200
	Med 76-150	160-200 / 80-120	80-100 / 80-120	0-50 / 80-120
	Alto 150	160-200 / 0-40	80-100 / 0-40	0-50 / 0-40

N Según Materia Org.	Altitud	Bajo 0-1 %	Med. 1-2 %	Alto 2+ %
	Hasta 3000m	160-240	160-200	80-120
	más que 3500 m	160-240	160-200	160-200

Figure 22. Two way table showing fertilizer recommendations for potatoes in relation to the soil levels of phosphorus and potassium (flip chart).

in his discussion, using the flip charts, that a return of 3 or 4 soles could be expected for each sole invested, assuming good management practices were followed.

To determine the fertilizer and lime requirements for the potato program would require testing about 10,000 soil samples at a cost of 400,000 soles. This is only 0.5% of the 80,000,000 soles that will be spent for fertilizer and lime. However, the returns from the improved use of fertilizers and lime are likely to exceed 150,000,000 soles.

Dr. Walker, in cooperation with the American Potash Institute, has been working with short tape recordings for radio broadcasting. Most of the farmers have small transistor radios and will listen to these recordings.

The American Potash Institute has a series of wall charts showing the amount of nutrient elements that are removed from soils by various crops. Dr. Walker helped translate these charts into Spanish, and the Spanish version will be ready for distribution soon.

Slide sets have been prepared by all of the Regional Directors to illustrate the various phases of soil analysis. These have been used quite effectively.

This initial start only serves to emphasize the importance of developing new teaching methods and means of communication with people who have had only a small amount of formal education.

APPENDIX A

United States Advisory Committee

Minutes of Meetings

January 6-7

December 19-20

MINUTES OF U. S. ADVISORY COMMITTEE MEETING

Raleigh, North Carolina - January 6-7, 1966

Attendance

Members of U. S. Advisory Committee and Addresses:

Dr. J. C. Engibous, Manager Agricultural Services, International Minerals and Chemical Corporation, Old Orchard Road, Skokie, Illinois 60078

Dr. Douglas L. Lathwell, Professor of Soil Science, Department of Agronomy, Caldwell Hall, Cornell University, Ithaca, New York 14850

Dr. Werner L. Nelson, Midwest Director, American Potash Institute, Inc., Willayne Plaza, 402 Northwestern Avenue, West Lafayette, Indiana 47906

Dr. Robert W. Pearson, Research Soil Scientist, Soil & Water Conservation Research Division, USDA-ARS, Alabama Agricultural Experiment Station, Auburn, Alabama 36830

Dr. R. T. Smith, Agricultural Chemicals Division, Esso Chemical Company, Inc., 15 West 51 Street, New York, New York 10019

Others

Mr. J. R. Wilson, Project Monitor, Rural and Community Development Service, Office of Technical Cooperation and Research, Department of State, Agency for International Development, Washington, D. C.

Dr. R. J. McCracken, Head, Department of Soil Science, N. C. State University, Raleigh, North Carolina 27607

Dr. J. W. Fitts, Director, International Soil Testing Project, Department of Soil Science, N. C. State University, Raleigh, North Carolina 27607

Dotty Goodson, Administrative Assistant, International Soil Testing Project, Department of Soil Science, N. C. State University, Raleigh, North Carolina 27607

The Committee was welcomed to the North Carolina Campus by Dr. R. L. Lovvorn, Director of Agricultural Research of N. C. State University. Dr. Lovvorn expressed the interest of the university administration in foreign programs, and commented on some of the responsibilities of universities in the United States to other countries. He also pointed out that the university administration believes the International Soil Testing program is making progress, but that it is always desireable to have other competent people review the program. It is the earnest desire of the leaders of the project and the university administration that constructive suggestions and criticism will be made by the Advisory Committee.

REVIEW OF PROGRAM TO DATE

The need for a soil fertility evaluation project in Latin America and the background of developing the present project was reviewed by J. W. Fitts. He pointed out that soil fertility problems are some of the greatest limiting factors in increasing crop production in much of Latin America. The kinds of fertilizers needed in respect to soil conditions and crops grown is one of the big questions faced by government officials within these countries, and is also one of the first questions asked by fertilizer companies that are interested in building plants or in expanding trade in these regions.

The objectives of the project, which are listed below, were explained by Dr. Fitts:

1. Documenting the fertilizer and soil fertility requirements for increased crop production.
2. Developing and maintaining improved soil testing-plant analyses programs.
3. Initiating fertilizer trials and demonstrations.

4. Assisting countries in providing the necessary fertilizer and lime required.

5. Preparing summaries of the results of soil tests and plant analyses.

The project places considerable emphasis on soil testing as a program rather than the mere operation of a laboratory. Soil testing is a program to obtain information about the soils, particularly the surface horizon, which can be used as a basis for improved soil management practices.

The Soil Testing Project was divided into two parts. The first part of the program was concerned with the completion of questionnaires to determine the status of soil testing and plant analyses in cooperating countries. These questionnaires emphasized the six phases of a soil testing program and the organization of soil testing-plant analyses studies. This part of the project has been completed and a summary of the information obtained from the questionnaires is published as Technical Bulletin 2 of the International Soil Testing Series. In general, soil testing-plant analyses programs are still in their infancy in the Latin American countries. The number of samples tested is relatively small in all of the laboratories; there has not been a sufficient number tested to prepare summaries of the results or to obtain a good picture of the nutrient requirements. However, the tests do indicate that soil fertility problems are widespread throughout Latin America.

The second part of the project is concerned with strengthening the various phases of soil testing-plant analyses programs. An advisory committee has been appointed in most of the cooperating countries. Conferences have been held with the advisory committees to review the information obtained in the questionnaires and to develop plans for improving their soil testing-plant analyses programs. Since a soil testing-plant analyses program involves research, education and

service, it is important to coordinate the activities of the various organizations and agencies in order to move the program forward and to avoid duplication.

Only one laboratory was found in Latin America that had multiple-unit equipment. A successful soil testing-plant analyses program must have laboratories with a high capacity in order to analyze the seasonal load of samples that are submitted. Therefore, one of the first steps in the second phase of the project was to develop and build apparatus to increase the capacity of the laboratories. Leadership in perfecting apparatus for soil testing was taken in Brazil through the efforts of Robert Cate, Jr., Leandro Vettori and Mestre Abreu. Similar apparatus is being designed and constructed at N. C. State University in Raleigh which will permit a laboratory to analyze several hundred samples per day. One laboratory in each of the cooperating countries will be equipped with this apparatus.

Problems confronting the project in Part II of the program include:

1. Methods of analyses that should be used
2. Interpretation of the results of analyses
3. Satisfactory procedures to obtain data for interpreting soil tests and plant analyses through:
    a. laboratory techniques
    b. greenhouse studies
    c. field trials
4. The use of control samples to assure accuracy of analyses and to reduce errors
5. "Pin pointing" problems in analyses and in special soil conditions that will be encountered

In order to solve the problems listed above, as well as providing facilities to train scientists from the cooperating countries in the various phases of soil testing, it became obvious that a control laboratory at N. C. State University was

a necessity for the project. The contract has been amended to include a control laboratory.

The committee visited the control laboratory that will soon be in operation, and observed several pieces of new apparatus which are being developed for use in the cooperating soil testing-plant analyses laboratories.

A publication series has been initiated which includes both research and information bulletins. The first research bulletin was concerned with a technique for assembling interpretation data and the second with the status of soil testing-plant analyses in Latin America. Several other publications are in the process of being written or in the planning stage. These include procedures for conducting laboratory, greenhouse and field trials; soil sampling; soil acidity; factors affecting phosphorus availability, and directions for constructing laboratory apparatus.

Other phases of soil testing-plant analyses programs that need attention are recommendations for the use of fertilizers and other soil amendments, follow-up educational programs to assure current interpretation of analyses, availability of materials recommended, and use of good managerial practices. Development of visual aids which depict the various phases of soil testing-plant analyses is of paramount importance in the training of farmers and agricultural leaders in the cooperating countries.

DISCUSSION OF PROJECT BY COMMITTEE

During the presentation of the objectives and current activities of the project, members of the committee raised several questions and made various comments on the program. There was some discussion relative to countries where soil testing and plant analyses programs would have the greatest impact.

Soil testing is an excellent source of information for nutrient requirements, but several thousand are needed each year from an area no larger than North Carolina for example, to identify all of the variations that exist in soils. If the fertilizers and soil amendments suggested by soil testing are not available to farmers, then the interest in a soil testing program will be short-lived. In other words, farmers will take samples for testing as a guide for use of fertilizers and lime in order that they may obtain the greatest return from the money they are to invest. However, if fertilizers and lime are not available, it is difficult to create a demand for soil testing which would provide sufficient information to document the nutrient requirements of the soils of a given area. The greatest need for the soil testing-plant analyses project is in those countries where fertilizer plants are being constructed, or where definite arrangements are being made to assure a supply of the lime and fertilizers required to overcome the nutrient deficiencies. Governments of countries that must import fertilizers and other soil amendments needed to increase crop production should take steps to remove the deterrents to importing the required materials.

Crops and soils that should be included in a soil testing-plant analyses program and the level of yields that farmers in developing countries should arrive to attain were questions that received considerable attention to the discussion by the committee. In using fertilizer and other soil amendments, several factors, including economics, must be considered. Return from the money invested is related to the kind of crop, soil and climatic conditions, and to management levels. In general, the committee members were of the opinion that all crops grown in a country should be included in a soil testing-plant analyses program. Fertilizer rates suggested should be the optimum rate for economic return in respect to the costs involved, the kind of soil conditions encountered and the value of the crop produced. These factors should be considered in making guide sheets.

Soil testing and plant analyses are sources of information which can be very helpful in soil management. The two complement one another and should be coordinated. In developing countries, it was suggested that consideration should be given to developing both soil and plant analyses programs concurrently rather than individually.

Several extractants and techniques of analyses are used in the various soil testing laboratories in the United States. It was recognized by the committee members that there is no universal soil testing procedure. The committee commended the project for the effort in attempting to reduce to a minimum the number of procedures used through the coordination of soil testing procedures and research in regions having similar soils, crops, and climatic conditions.

Members of the committee were intrigued with the approach of organizing the program in Venezuela and Colombia. These countries have several well trained soil scientists and the greatest benefit from the Soil Testing-Plant Analyses Project probably will be through consultation on research and educational problems. Dr. C B. McCants and Dr. E. J. Kamprath, full professors on the N. C. State University staff, have agreed to work in these countries on a continuing short-term basis. Dr. McCants will work in Venezuela and Dr. Kamprath in Colombia. They will make at least one trip a year to these countries and not more than two. On each trip they will be in the country at least one month and not more than two. This arrangement will give continuity to the program and make available experienced soil scientists to consult with the scientists within developing countries. The committee suggested that a similar procedure be initiated in other countries who have trained but inexperienced scientists, and that capable scientists for the project might be recruited for short-term assignments from other universities, governmental agencies and industry.

The continued cooperation between the project and other projects, such as the Birdsall fertilizer demonstration program in El Salvador and the FAO Freedom from Hunger program, was encouraged.

Some discussion was held relative to the preparation of summaries and of maps that would be useful to educational and research agencies and to industry. Careful thought should be given in developing the soil testing-plant analyses programs to provide techniques which permit information to be readily retrieved for preparation of summaries.

RECOMMENDATIONS OF THE ADVISORY COMMITTEE

During the afternoon of the second day of the conference, the Advisory Committee met separately from the project staff for a discussion of the program. As a result of their deliberations, this committee offered the following recommendations for consideration by North Carolina State University and AID/W.

1. Low soil fertility is a major limiting factor in crop production in the developing countries. The International Soil Testing Program directed to this problem provides an excellent means of applying agronomic research results for increased crop production.
2. Major activities of the program should be the continuous training of people to:
    a. Laboratory techniques.
    b. Correlation experiments between fertilizer response and soil test results with emphasis on removal of limiting factors.
    c. Diagnostic approach on growing crops in farmers' fields.
3. The program is desperately needed in other areas of the world, and the current contract should be amended immediately to provide advisory service

to countries on a priority basis. Personnel may be drawn from other universities, public agencies, and industry for this purpose. In setting these priorities consideration should be given to need for increased food production; desire and ability to cooperate by the countries involved; and activities of supporting industries in establishing production, distribution, and marketing facilities.

4. At the conclusion of the current amended contract period a new contract should be drawn to support a long-term expanded program in Latin America and other areas of the world.

5. Specific recommendations for immediate attention are as follows:

    a. The International Soil Testing Program should act as a gathering agency and information center on related activities throughout the world.

    b. The ISTP Director should strongly encourage standardization of technical and reporting procedures throughout the region.

    c. Provision should be made for data retrieval to permit comprehensive summaries of soil tests and other related information at regular intervals.

    d. Supporting plant analyses data from correlation studies should be an integral part of the program.

6. The greatest value of this program is the continuity it offers in research and education in crop production in the developing countries.

MINUTES OF U. S. ADVISORY COMMITTEE MEETING

Raleigh, North Carolina - December 19-20, 1966

Attendance

Members of U. S. Advisory Committee and Addresses:

Dr. J. C. Engibous, Manager
Agricultural Services
International Minerals & Chemical Corporation
Skokie, Illinois 60078

Dr. W. H. Garman, Vice President
National Plant Food Institute
1700 K Street N.W.
Washington, D. C. 20006

Dr. Douglas J. Lathwell
Professor of Soil Science
Department of Agronomy
Cornell University
Ithaca, New York 14850

Dr. V. L. Sheldon, Manager
Marketing Technical Service
Esso Chemical Company, Inc.
60 West 49th Street
New York, New York 10020

Dr. Werner L. Nelson
Midwest Director
American Potash Institute
Willayne Plaza
402 Northwestern Avenue
West Lafayette, Indiana 47906

Dr. Robert W. Pearson
Research Soil Scientist
Soil & Water Conservation Research Div.
USDA-ARS
Alabama Agricultural Experiment Station
Auburn, Alabama 36830

Others:

Dr. Alvin D. Ayers
TCR/ARDS
Agency for International Development
Department of State
Washington, D. C. 20523

Dr. R. J. McCracken, Head
Department of Soil Science
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Dr. J. W. Fitts, Director
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Dotty Goodson, Administrative Asst.
International Soil Testing Project
Department of Soil Science
N. C. State University
Raleigh, North Carolina 27607

Dr. R. L. Lovvorn, Director of Agricultural Research, greeted the committee and, on behalf of the university administration, thanked them for their interest in the International Soil Testing Project. In his discussion, he pointed out some of the problems that universities face in balancing their staff, both in relation to the number of persons in the various disciplines and to the responsibilities

assigned to each position. Dr. Lovvorn stated that suggestions and comments by the committee are always greatfully received by the leaders of the International Soil Testing Project and the university administration.

New participants on the Advisory Committee were Dr. W. H. Garman, Vice President, National Plant Food Institute, and Dr. V. L. Sheldon, Manager, Marketing Technical Service, Esso Chemical Company, Inc. Dr. A. D. Ayers, AID/W, became the Project Monitor in the early fall and he, too, was attending the Advisory Committee Meeting for the first time.

CURRENT STATUS OF THE PROGRAM

Staff

All of the staff members remained with the project that were working with it a year ago. The four Regional Directors were in the United States on home leave during the summer of 1966 and all returned to their same posts. Dr. N. M. Berenyi is the only new staff member. He is in charge of the Control Laboratory in Raleigh.

Laboratories

Modern laboratories, equipped with multiple unit apparatus to permit analyzing more than 100 samples per day, have been established in most of the cooperating countries, including Colombia, Venezuela, Ecuador, Perú, Paraguay, Brazil, Panamá, Costa Rica, Nicaragua, Honduras, El Salvador and Guatemala. The special multiple unit apparatus have been sent to Bolivia and Mexico but laboratories in these countries are not operational as yet. The revolution in Ecuador greatly reduced the soil testing activities in that country but they expect to resume their program soon. Brazil has nine laboratories that have been equipped with multiple unit apparatus and other labor saving devices.

The number of soil samples that are anticipated for analysis during 1967 in each of the modernized laboratories varies from 5,000 to 25,000. The average should be about 8,000 to 10,000 samples per laboratory.

DISCUSSION OF PROJECT

Objectives of the Program

The objectives of the project remain the same, but emphasis upon various phases of a soil testing program change from time to time; likewise, the emphasis differs from one country to another, depending upon local conditions. The ultimate goal of a soil testing - plant analysis program is increased crop yields. This goal will be obtained through better soil management, including the use of fertilizers, lime and other soil amendments as needed.

One of the major problems encountered by the project is the availability of the kinds of fertilizers and lime that are recommended. Increased crop yields cannot be obtained if the fertilizers that are needed are not available; the soil testing program has then fallen short of its goal as farmers soon lose interest in soil testing.

Soil testing is a tool to guide governments and banking interests in making loans for the purchase of fertilizers and lime. If a million dollars are made available to farmers in the form of a loan to purchase fertilizers and lime, the question is how should this million dollars be invested to give the greatest return to the country as a whole. Obviously, lime should be used only on acid soils; not on those that are neutral or calcareous. Acid soils should be limed in order to obtain good returns from fertilizers. Soils that are deficient in nitrogen and phosphorus do not need a complete fertilizer but, where all primary nutrients are deficient, then a complete fertilizer should be added. A heterogeneous distribution of fertilizer will fit some soil conditions but will miss the needs of

the major part of the region. Applying the fertilizers and lime that are needed greatly increase the return from the investment in the area as a whole. Spending one or two per cent of the money available for the purchase of fertilizers and lime to obtain a soil test is an excellent investment.

Seminars

During the summer months of 1966, two seminars were conducted by the project in Raleigh. Fifteen participants from ten Latin American countries attended each seminar. The first seminar, which was conducted for a period of six weeks, emphasized all six phases of a soil testing-plant analysis program. The second seminar, which lasted three weeks, emphasized the laboratory phase of soil-plant analyses.

Several field trips were taken during each seminar to obtain soil samples, to study management problems, and to practice diagnostic techniques in evaluating plant growth. Considerable time was spent in the laboratory studying multiple unit apparatus, laboratory techniques, and organization of a soil-plant analysis program.

Based on the experience gained in 1966, only one seminar will be conducted during 1967 which will be for a period of nine weeks. The longer period will offer a better opportunity for the participants to conduct soil sampling studies and potted plant trials to obtain interpretation data. The seminar will be limited to 20 participants.

Control Laboratory

The Advisory Committee visited the control laboratory and observed several new pieces of apparatus designed for improving the speed and ease of testing a large volume of samples. Stirrer (designed by A. H. Hunter), a pH machine (developed by W. V. Bartholomew), and a track with automatic type buret for titration (suggested by R. B. Cate, Jr.) were included in the new apparatus.

The activities of the laboratory in general have been concentrated on getting apparatus assembled, tested and shipped to the laboratories in the cooperating countries. Also the staff and laboratory equipment were utilized extensively in both seminars. Therefore, not as much work has been done on analytical procedures or in analyzing control samples as had been anticipated. More emphasis will be placed upon these activities in the future.

Publications

Technical Bulletin No. 3 entitled "Soil Test Interpretation Studies: Laboratory and Potted Plant" by D. L. Waugh and J. W. Fitts, which was ready for release, was reviewed with the committee. It is anticipated that this bulletin will have considerable impact upon soil testing worldwide, since it offers a simple procedure for calibration of testing methods. The bulletin will be published in Spanish and Portuguese in addition to the English edition.

The first draft of Technical Bulletin No. 4 entitled "Soil Acidity and Response to Liming" by E. J. Kamprath has been completed and should be ready for publication within a few months.

Annual Report

An annual report of the activities of the project will be prepared using a format similar to the 1965 report.

RECOMMENDATIONS OF THE ADVISORY COMMITTEE

During the afternoon of the second day of the conference, the Advisory Committee met separately from the project staff for a discussion of the program. As a result of their deliberations, the committee offered the following recommendations for consideration by North Carolina State University and AID/W.

1. The International Soil Testing Program appears to be making real progress and the Director and his staff are to be complimented. We encourage North Carolina State University at Raleigh to continue its support of the program.

2. The Advisory Committee reiterates and stands on the recommendations made to ISTP in January 1966. Specific attention is called to:

   a. Continuous effort in correlation experiments between fertilizer response and soil test results using adequate laboratory techniques is essential.

   b. ISTP should provide advisory service to countries on a priority basis with attention focused on need, ability of the countries to cooperate, and the possibility of establishing production, distribution, and marketing facilities.

   c. At the conclusion of the current contract a new contract should be drawn to support a long-term expanded program in Latin America and other parts of the world.

   d. In addition ISTP should act as a gathering agency and information center on related activities, the director should encourage standardization of technical and reporting procedures, provision should be made for data retrieval, and plant analysis data should be an integral part of the program.

3. The Technical Reports Series is serving a great need and should be continued in its present form. In addition to the reports already published and planned, a technical report on laboratory equipment and laboratory organization should be written as soon as possible. The widest possible dissemination of these reports should be encouraged. Public and scientific awareness of the program should be increased through the widest circulation of semi-technical and popular articles. Soil test information summaries along with current thinking on fertilizer practices and recommendations should be prepared for each country. When available, these reports should provide the basis for specifications for fertilizers brought into the countries by AID programs.

4. Although the Advisory Committee recognizes the needs of other parts of the world, we suggest the present level of support be maintained for the program

in Latin America and that any immediate expansion take place in Latin America. If additional funds become available any expansion into countries in other parts of the world should be proceeded by an evaluation of the position and needs of these countries by ISTP in cooperation with AID.

5. Because increased crop production is the ultimate objective of the project, all aspects of soil fertility and soil and crop management should be considered in the program of research and interpretation in the soil testing program.

6. The seminar and training concept is excellent and should be continued at Raleigh for the forseeable future. In 1967 the regional program directors should be brought to Raleigh to take part in the seminar. When sufficient experience is gained consideration should be given to taking the seminar program out to the cooperating countries.

7. This Committee can see no advantage to moving in the direction of regional centers at this time.

8. Mutual cooperation with both public and private agencies, particularly FAO, should be encouraged at all levels to avoid duplication of effort in the field. The ISTP should be recognized as providing leadership in the field for soil analysis programs.

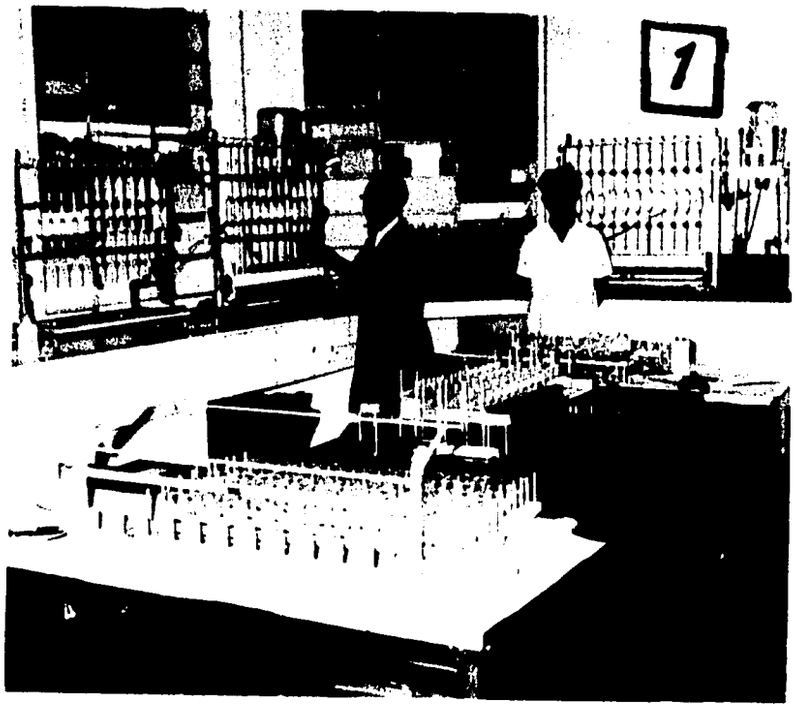
APPENDIX B

Laboratory Activities in Brazil

Photo 1. Dr. Leandro Vettori and Mestre Juca inspect multiple unit dispensers and other laboratory apparatus they have designed and built for 10 soil testing laboratories in Brazil.

Photo 2. Titrating samples for aluminum determinations using track and stirrer apparatus designed by Dr. Vettori and Mestre Juca.

Photo 3. Potassium is determined with a flame photometer.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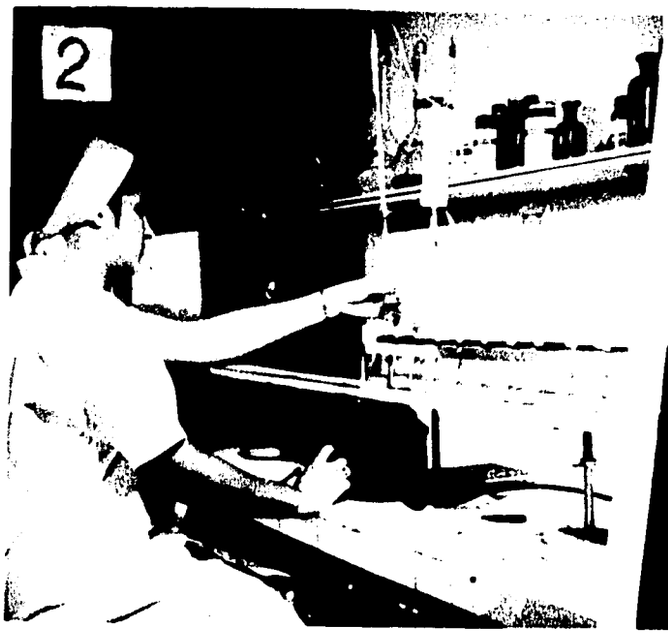
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3

Photos 1-4 were taken in Soil Testing Laboratory in Recife, Brazil.

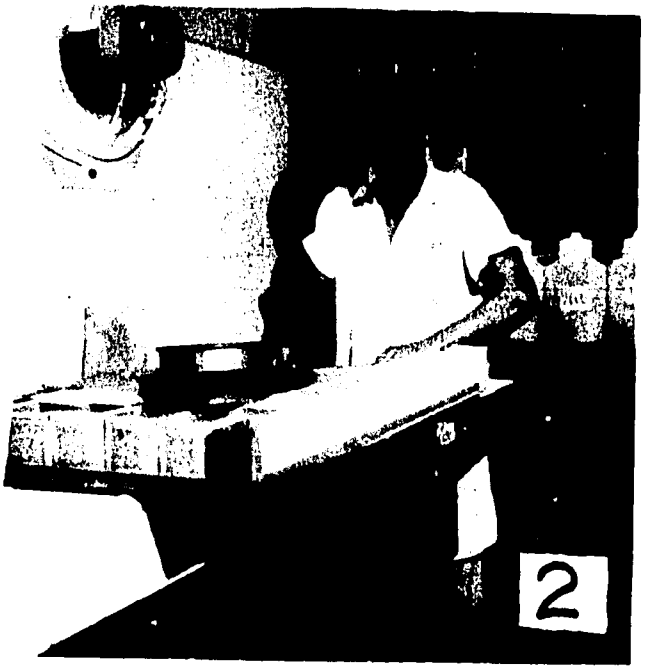
Photo 1. Shaking 5 trays of soil samples (55) on a shaker constructed especially for soil testing laboratories.

Photo 2. Measuring soil samples for analysis.

Photo 3. pH measurements of soil samples.

Photo 4. Adding 100 ml of extracting solution to 10 ml of soil samples.

1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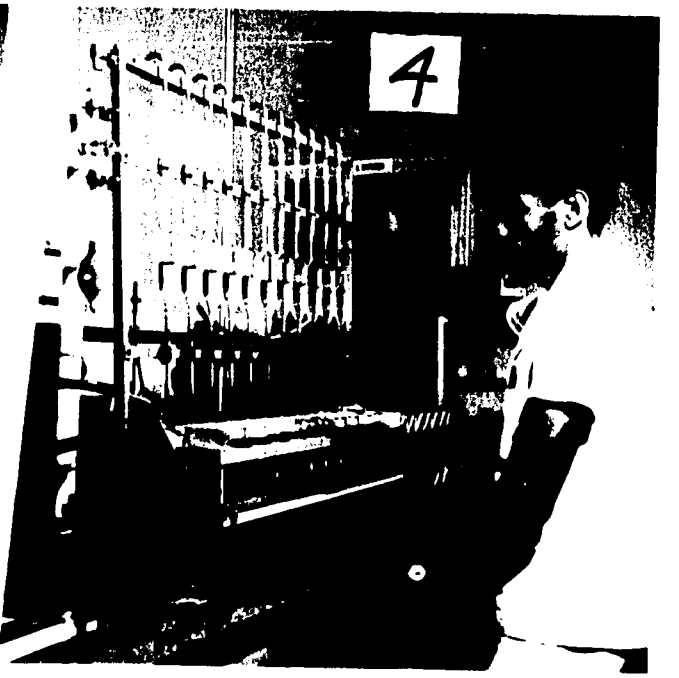
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APPENDIX C

Reports of Soil Testing Programs

Colombia

Venezuela

SOIL TESTING AND RELATED SOIL FERTILITY WORK IN COLOMBIA

E. J. Kamprath

INTRODUCTION

North Carolina State University has a Contract with the Agency for International Development (AID) to support soil testing and plant analyses programs. One of the principal objectives of the project is the evaluation of the soil fertility status of Latin American soils. Information of this kind will be extremely helpful in determining the fertilizer and lime requirements for increasing food production.

The International Soil Testing Project has Regional Directors who are responsible for the program in most of the countries of Latin America. In Colombia the Rockefeller Foundation has been working with the Colombian Government to develop an agricultural research program; also a number of soil scientists in Colombia have taken graduate work in the United States. Due to the presence of these soil scientists in Colombia, a decision was reached that it would not be necessary for the International Soil Testing Project to locate a full-time scientist in that country. Instead, a full Professor on the Soil Science staff in Raleigh would be requested to work in Colombia on a short-term consulting basis. Periodic trips, not to exceed two or three per year, were anticipated. Arrangements were made in my program which permitted me to assume the responsibilities of the International Soil Testing Project in Colombia as part of my duties at North Carolina State University.

The purpose of my trip in February-March, 1966 was to initiate the soil testing-soil fertility program in Colombia, and to acquaint the

the persons working in soil fertility with the objectives of the project. Since I had spent a month in Colombia in 1965 with the Rockefeller Foundation reviewing their soil testing program, I did not have to spend much time familiarizing myself with their program. I was in Colombia from February 16 to March 14, 1966.

PERSONS CONTACTED

Discussions were held with the following persons:

1. Dr. James Spain, Soil Scientist, Rockefeller Foundation, Bogota
2. Donald Dobson, Acting Chief, Rural Development Division, USAID/Colombia, Bogota
3. James Fowler, Director, USAID/Colombia, Bogota
4. Dr. U. J. Grant, Director, Rockefeller Foundation, Bogota
5. Fernando Penaranda, Director General of ICA, Bogota
6. Dr. A. Cardona, Director of Research, ICA, Bogota
7. Dr. Alvaro Gartner, Director of Education, ICA, Bogota
8. Fernando Ruan, Chief, Division Recursos Naturales, Ministerio de Agricultura, Bogota
9. Jose Vergara, Division Recursos Naturales, Bogota
10. Desar Rodriguez Amador, Division Recursos Naturales, Bogota
11. Victor Vega, Chief, Soil Survey, Instituto Geografico "Augustin Codazzi", Bogota
12. Francisco Silva, Soil Laboratory, Instituto Geografico "Augustin Codazzi", Bogota
13. John Jeffers, Instituto Geografico "Augustin Codazzi", Bogota

14. Herman Villegas Galarza, Dean of the Facultad de Agronomia, University of Caldas, Manizales
15. Dr. Franz Hanke, Facultad de Agronomia, University of Caldas, Manizales.
16. Dr. Silvio Echeverri, Director of the Centro Nacional de Investigaciones de Cafe, Chinchina
17. Miss Maria Mejia, Centro Nacional de Investigaciones de Cafe, Chinchina
18. Mr. Mario Lopez, Centro Nacional de Investigaciones de Cafe, Chinchina
19. Dr. James Haynes, Agricultural Diversification Officer, USAID/Bogota
20. Gildardo Marin, Soil Testing Laboratory, ICA, Palmira
21. Jario Gomez, Soils Section, ICA, Palmira
22. Rodrigo Lora, Soils Section, ICA, Tibaitata
23. Jaime Navas, Soils Section, ICA, Tibaitata
24. Gilberto Rodriguez, Soils Section, ICA, Tibaitata

AREAS AND INSTITUTIONS VISITED

1. Soils and Plant Analyses Laboratory at Tibaitata.

The main plant analysis laboratory of ICA is located at Tibaitata just outside of Bogota. Also headquartered here are a number of soil scientists doing soil fertility field trials for the purpose of obtaining soil test correlation data. I discussed with them the objectives of the International Soil Testing Project and possible research projects for obtaining fertilizer response data in soil test correlation data. In the plant analysis laboratory, I set up and demonstrated some multiple unit equipment which was furnished by the International Soil Testing Project. This equipment will

help to speed up the analyses and also increase the number of samples which can be analyzed daily.

2. Soil Testing Laboratory at Palmira.

The soil testing laboratory operated by ICA is located at the Experiment Station at Palmira. The purpose of the visit was to consult with Gildardo Marin, Director of the Laboratory, relative to (1) the operation of the laboratory, (2) changes in procedures, (3) possible changes in the soil test interpretations, (4) fertilizer recommendations, and (5) research projects for getting more information on sampling and interpretations of the soil test results. Multiple unit equipment which the International Soil Testing Project had furnished for speeding up soil analyses was assembled and demonstrated.

3. Centro Nacional de Investigaciones de Cafe.

The Centro Nacional de Investigaciones de Cafe is located at Chinchina and operates a soils laboratory. Coffee is one of the most important crops grown in Colombia for export. It has been found that by growing coffee without shade and by applying fertilization, yields can be increased 10 to 20 times. The purpose of this visit was to acquaint myself with their laboratory and the nature of the research being conducted. It also was felt desirable to discuss with their soils personnel the objectives of our project, and bring to their attention the equipment set up at Palmira and the procedures used at the Government laboratory.

4. Facultad de Agronomia, University of Caldas at Manizales.

Since the Facultad de Agronomia at Manizales was very close to Chinchina, Mr. Marin suggested that I visit the school. This would provide an opportunity for me to meet the soil scientists, to see their laboratories, and to discuss with them the various phases of soil testing-soil fertility programs.

5. Instituto Geografico "Augustin Codazzi" Soils Laboratory, Bogota.

The soil survey work is conducted by the Instituto Geografico "Augustin Codazzi". The main function of the soils laboratory is to provide chemical, physical and mineralogical data on soil samples collected for characterizing soils mapped by the soil survey group. The objective of my visit was to become familiar with their laboratory and discuss with them the objectives of our project, and how we might be of assistance to them.

6. Visit to the Llanos.

USAID is interested in the agricultural potential of areas which currently are not being intensively used but may have possibilities. The Llanos region (Eastern Plains) occupies approximately 30 per cent of the area of Colombia. The area is covered with grass and at present is used almost exclusively for grazing. A trip was organized by members of the Rockefeller Foundation and ICA. The four-day trip was made by Jeep and airplane into the Llanos. The area covered was from Villavicencio 300 kilometers east to the Caviona Ranch (close to Orocue) and by plane an area 100 kilometers south of Orocue. The objective of the trip was to become acquainted with

the area, to observe the soils to see if nutrient deficiencies or water holding capacity might be problems that would be encountered if put under cultivation, and to make plans for some experimental work at the La Libertad Experiment Station.

CONFERENCES

1. Soils Section, Tibaitata.

On May 10 I gave two lectures to the Soils Section at Tibaitata on the liming of acid soils. Topics covered were the role of exchangeable aluminum in acid soils, the effect of aluminum on plant growth, the pH to which mineral and organic soils should be limed, and the role of aluminum in phosphorus fixation.

2. Meeting on Soil Testing in Bogota.

A meeting on soil testing was arranged on March 11 in Bogota by the Division Recursos Naturales of the Ministry of Agriculture. Dr. James Haynes of USAID also was very helpful in making plans for the meeting. Persons in the Bogota area who are working on soil testing were invited to the meeting. Sixteen persons attended the meeting which was held at the Ministry of Agriculture. A list of the participants is attached to the back of this report.

I presented a discussion on the International Soil Testing Project and how it would operate in Colombia. Mr. Marin discussed the activities of the Soil Testing Laboratory at Palmira. A demonstration was given of the use of the equipment supplied by the project.

There was considerable interest by the group in the project and

the seminars on soil testing to be conducted at North Carolina State University during June, July and August 1966.

ACCOMPLISHMENTS

The multiple dispensing laboratory equipment supplied by the project was set up in the soils and plant laboratories of ICA at Tibaitata and Palmira. This multiple unit equipment should more than double the output of the laboratories without increasing the staff and without sacrificing accuracy. A demonstration of the equipment was given in Bogota to persons interested in soil testing. The laboratories at Tibaitata and Palmira put the equipment into use immediately.

The meeting on soil testing in Bogota was the first time a group of this kind was brought together. Since these persons have common interests in soil testing and soil fertility, this group could serve as a nucleus for dealing with common problems in soil testing, soil fertility and fertilizers.

Discussions were held with Mr. Marin on making certain changes in the soil testing program. Organic matter is currently being determined by a titration procedure which requires the use of orthophenathroline which is quite expensive and cannot be obtained in Colombia. Preliminary studies were made on the colorimetric determination of organic matter using 1 gram of soil and 2N potassium dichromate. Changes also were suggested in the manner of handling the samples when they were received at the laboratory. This would decrease the amount of time required in handling and making records of the samples received.

Mr. Marin had prepared a soil test summary which is given in Table 1.

Table 1. Soil test summary 1965 of samples tested at Palmira.

	Mountains % of samples	Atlantic Coast % of samples	Cauca Valle % of samples
pH			
less than 5.5	68	2	23
5.5-7.3	32	82	63
greater than 7.3	0	16	14
Organic Matter			
less than 5%	25	91	78
5 to 10%	21	8	22
greater than 10%	54	1	0
Available phosphorus			
low (0-20 ppm)	88	45	64
medium (20-40 ppm)	5	12	18
high (over 40 ppm)	7	43	18
Available potassium			
low (0-.15 me/100 g)	7	4	7
medium (.15 to .30 me)	29	18	32
high (over .30 me)	64	78	61
Number of samples	76	121	555

Mr. Marin and I prepared some two-way summary tables of the results for phosphorus and potassium. This approach presents a better idea of the fertilizer ratios needed.

Cauca Valle

		Potassium		
		High	Medium	Low
Phosphorus	High	16%	1%	0
	Medium	16%	3%	0
	Low	29%	28%	7%

Atlantic Coastal

		Potassium		
		High	Medium	Low
Phosphorus	High	42%	5%	0
	Medium	8%	2%	1%
	Low	28%	11%	3%

Mountains

		Potassium		
		High	Medium	Low
Phosphorus	High	7%	0	0
	Medium	4%	0	0
	Low	53%	29%	7%

The soil test summaries show that phosphorus is the nutrient which is most often deficient. Very few of the soils tested are deficient in potassium. This would indicate that most of the fertilizers should contain a relatively high phosphorus content in comparison with potassium. Several of the large fertilizer companies are making the following grades: 10-30-10; 12-24-12; 8-24-14; 10-20-10; and 20-20-0. There seems to be justification for a fertilizer with a 1-3-0 ratio for the soils which are low in available phosphorus and high in available potassium.

Most of the soils of the Atlantic Coast and Cauca Valle have a satisfactory pH for plant growth. A large number of the Mountain soils have a pH of less than 5.5. However, since many of these soils have more than 10% organic matter, it may not be necessary to lime these soils above pH 5.2.

AGRICULTURAL POTENTIAL OF THE LLANOS SOILS

Very little information is available on the response of the Llanos soils to lime and fertilization. Limited chemical data show that these soils are quite acid, high in exchangeable aluminum, and very low in available phosphorus. Some of these areas have been mapped by FAO. South of the Meta River is a high terrace plain with less than 3% slope. The soils have good structure and the internal drainage appears to be adequate. FAO has mapped a portion of these soils, approximately 12 to 15 million acres, as Class III which is defined as suitable for grazing and/or subsistence agriculture. Dr. Spain and I are of the opinion that, with adequate liming and fertilization, the soils mapped as Class III would be quite productive for growing cultivated crops. The rainfall in this area ranges from 40 to 80 inches of rain a year. Field experimental work needs to be con-

ducted in this area to determine what the potential of these soils is when adequately limed and fertilized.

South of the high terrace plains are some dissected plains which are suitable for grazing. Studies are also needed in these areas to determine fertilization practices which would increase the cattle carrying capacity of the soils.

PROGRAMS NEEDED TO INCREASE FOOD PRODUCTION

The programs underway on soil fertility research and soil testing by ICA are well organized and well planned. These need to be expanded to keep pace with increasing food needs. One of the weakest phases of the soil fertility program seems to be the activities of the extension service in getting the information to the farmer. An AID Contract to start an extension education program has been signed in which the University of Nebraska will work with ICA and certain universities in Colombia. One possible method of starting this program would be to work with the farmers who are taking soil samples. A farmer interested in soil testing is also interested in good seed, adequate stands, weed control and other good management practices. An ideal place to start such a program would be the Cauca Valle where considerable agronomic research data is available, a good agricultural college is located, and where the soil testing laboratory of ICA is located.

One phase of soil testing is the taking of representative samples. As the soil testing program expands,it is very important that extension workers hold meetings explaining and demonstrating how to get representative samples. Good use can be made of visual aids,such as slides,showing

how to sample a field. The project will make these available to the soil testing laboratories.

Another important phase of soil testing is the follow-up meetings to explain to farmers the meaning of the soil test results and recommendations. This is another important extension activity. Again educational material can be prepared which will help to explain the soil tests.

As the soil testing program expands, additional correlation data for the various soils will have to be obtained in order to make meaningful lime and fertilizer suggestions. This will require both greenhouse and field experiments to measure the response of crops to fertilization. The data obtained will have to be interpreted and guidelines prepared for making lime and fertilizer recommendations.

PEOPLE ATTENDING SOIL TEST MEETING AT BOGOTA, COLOMBIA

GERMAN VALENZUELA SAMPER Gerente Tecnico	Federación de Cafeteros Tel: 419245 Av. Jiménez No. 7-65 Bogotá
ALFONSO GARCIA ESPINEL Gerente	Agro-Estudios Otda. Apartado Aéreo 20360 Avenida Caracas No. 54-73
REGULO PERDOMO V. Jefe Dpto. Promocion	ABONOS COLOMBIANOS S.A. Carrera 8° No. 15-42 Piso 9° Bogotá - Col. NOTA: 10 ejemplares de cada publicación
RICARDO A. BERNAL. P. Subgerente	Agro-Estudios Ltda. Avda. Caracas No. 54-73 - Of. Bogotá
EDUARDO PALACIO G.	Agro-análisis Avda.Caracas No. 54-73-Of. 404
ARTURO McCORMICK	Instituto de Investigaciones Tecnológicas Apartado Aéreo 7031 Bogotá, D. E.
FRANCISCO GALEANO S.	Instituto de Investigaciones Tecnológicas Apartado Aéreo 7031 Bogotá
FRANCISCO SILVA	LAB. DE SUELOS Instituto Geográfico "Agustín Codazzi" Carr. 30 No. 48-52
GILBERTO VARELA L.	Instituto de formento Tabacalero Carrera 7° No. 13-58 - Piso 7° Bogotá
JORGE S. INFANTE	COLINAGRO Avda. Jiménez No. 8-74 - 4° piso Bogotá
JORGE ORTEGA NAVARRO	Carrera 8° No. 17-62 Bogotá
RAFAEL E. GOMEZ SILVA	Calle 3° No. 12-A 17 Bogotá Laboratorio Químico Nacional Ciudad Universitaria

EUGENIO DE GAMBOA V.	CAJA DE CREDITO AGRARIO Calle 15 No. 8-32 Bogotá
FERNANDO RUAN RUAN	División de Recursos Naturales Ministerio de Agricultura
CESAR RODRIGUEZ AMADOR	Conservación de Suelos Ministerio de Agricultura
JOSE VICENTE VERGARA	Suelos Ministerio de Agricultura

A NATIONAL PROGRAM FOR EVALUATING AND IMPROVING THE NUTRITIONAL STATUS OF VENEZUELAN SOILS

C. B. McCants

During the period February 7 to March 4, 1966, a study was made in Venezuela of the research and applied programs in progress to assess and improve the nutritional status of the soils used for agricultural purposes; of particular interest is the nature and extent to which soil analysis is presently being used to achieve these goals. The purpose of this study was to obtain information for preparing recommendations relative to the advisability of initiating a cooperative program through which the International Soil Testing Project, North Carolina State University, would aid in developing and promoting a soil testing program which would lead to the efficient use of fertilizers and the economical production of crops. During the course of this study, discussions were held with the following persons and organizations:

1. Mr. Victor J. Pra Sisto, General Agriculturist, USAID to Venezuela, Caracas

2. Dr. Sebastian A. Romero, Former Director of Investigations, Ministry of Agriculture, Caracas

3. Mr. George Casas, Director of Investigations, Ministry of Agriculture, Caracas

4. Mr. Jose L. Penalver, Director of Extension, Ministry of Agriculture, Caracas

5. Dr. Luis J. Medina, Secretary, National Agricultural Research Council, Ministry of Agriculture, Caracas

6. Mr. Hernan Oropeza, Director, Agricultural Research Center, Ministry of Agriculture, Maracay

7. Mr. Emilio Hidalgo and staff, Soils Section, Agricultural Research Center, Ministry of Agriculture, Maracay

8. Mr. Luis M. de Eleizalde and staff, Institute of Edaphology, College of Agriculture of the Central University of Venezuela, Maracay

9. Mr. Samuel Strebin, Los Majaguas Irrigation and Agrarian Reform Project, Ministry of Public Works, Guanare

10. Mr. Elbano Fontana and staff, Araure Experiment Station, Ministry of Agriculture, Araure

11. Mr. Oscar Padilla and staff, Division of Edaphology, Ministry of Public Works, Guanare

12. Mr. Jose Alvarado, Mucuchies Experiment Station, Mucuchies

13. Mr. Gonzalo Raga, Director, Arid Land Experiment Station, Barquisimeto

14. Mr. Pedro Mago and staff, Western Experiment Station, Yaritagua

15. Mr. Agustin Dupoy and staff, Central El Palmar, San Mateo

16. Mr. Carlos Sanchez, Soils Section, Shell Service for the Farmer, Cagua

17. Mr. Manuel Pinto Arochas, Experiment Station for Tobacco, Maracay

18. Mr. Albert Gross, Chemistry Laboratory, Tabacalera Nacional, Maracay

19. Mr. Egildo Lujan, Instituto Venezolano Petroquimica, Caracas

A constant companion during this study was Mr. Rafael Gonzalez who received the Master of Science degree from North Carolina State University in 1964. His field of advanced study was soil fertility. He has been associated with the soil fertility research programs in the Ministry of Agriculture since 1958 and presently is a member of the staff of the Soils Section, Agricultural Research Center, Ministry of Agriculture. His assistance was invaluable, not only as an effective guide and, where necessary, an excellent interpreter, but also as a source of considerable historical and technical information on soils related problems in Venezuela.

All of the persons contacted were most hospitable and freely gave their time and available information on soil fertility research in progress, fertilization practices employed and soil testing procedures used.

Soils presently used for agricultural purposes in Venezuela have a wide range of genetic, chemical and physical properties. They range from the fairly fertile and high calcareous alluvial soils to the acid and probable high-phosphorus fixing lateritic type. A wide range of cereal, fruit, vegetable, oil and stimulate crops are grown. These soil and plant factors interact to produce a complex fertilization situation which is likely to be compounded in the future. The information obtained indicates that at the present time, major production of agricultural crops is on soils which have reasonably high native levels of phosphorus and potassium. It is common knowledge, however, that these reserves are not inexhaustible. The continued cropping of these soils coupled with higher yields per unit area resulting from improved varieties, better insect and disease control, and general improvement in other management practices predictably will lead to deficiencies in both major and micronutrients unless corrective measures are taken. These facts plus the expressed interest of principle administrative officials in incrasing the efficiency of crop production provide sufficient justification for a long-range and soundly based soil testing program which will permit an accurate assessment of the nutritional status of the soils and from which accurate fertilizer recommendations can be made. The extensiveness and complexity of the soil fertility problems that are now present and likely to evolve coupled with the limited number of technically trained people available to cope with these problems, focus attention on the need for developing such a program. It is emphasized that the need is for a program and not just the creation of laboratories to perform soil analysis. To develop a successful program, however, will require the enthusiastic and cooperative efforts of the administrative and technical staffs of both governmental

and industry agencies. There was unanimous agreement that this is generally desired and can be achieved.

Although limited in numbers, the professional staff in charge of the various laboratories and responsible for conducting plant growth studies in the field and greenhouse are well-trained, are competent and are dedicated to the improvement of agriculture in Venezuela. The necessary physical facilities for conducting research in the laboratory, the greenhouse and the field appeared to be adequate. At the present time there are at least six laboratories in the country that perform soil analysis for guides in making fertilizer recommendations. It is difficult to estimate the potential capacity of these laboratories since several of them are designed to analyze samples from cooperating crop producers, such as sugar cane or tobacco. The indications were, however, that neither the government supported nor the private laboratories are being realized anywhere near to full capacity. The methods of analysis varies between laboratories and for all of them there is a lack of adequate data for the interpretation of analytical results for fertilizer recommendations. Experiments to provide data to aid in the interpretations of soil analysis are generally quite limited and many of the fertility experiments that are conducted are lacking in well-defined goals and objectives. There is also a lack of uniformity or an organized system for submitting samples and reporting results and recommendations.

From the information received and personal observations, an outline for a proposed action program was developed. A copy of the proposal is attached to this report. The proposal was discussed with Dr. Medina and Mr. Oropeza on February 24, with Mr. Hidalgo on February 27, with Mr. Pra Sisto on March 2, and with Mr. Casas on March 3. Each of them endorsed

the proposed objectives, organization and procedures. All parties agreed on the importance of developing interest in and support for the program at the highest levels in government, industry and farm organizations. There was further agreement on the need for active cooperation among the various agencies and organizations working in soil fertility related problems.

The cooperation of the International Soil Testing Project, North Carolina State University, in this program can make an effective contribution to its success. This cooperation, in the form of technical assistance of an advisory nature is highly encouraged and can be amply justified. Venezuela has the potential for developing a soil testing and fertilizer utilization program of such success and prestige as to be a model for other countries in Latin America. For maximum contribution of the representative of the International Soil Testing Project, however, it is recommended that the present arrangement for assistance be modified. Under the present plan, the person is to travel to the country for once and not more than twice each year for periods of time not less than one month and not more than two months on each trip. It is recommended that this policy be modified so that more frequent trips can be made and that the period of time spent during each trip be of shorter duration. It is suggested that for at least the first 12 to 18 months of the project, a trip be made by the advisor at approximately three to four month intervals and that the duration of the visit be for about two weeks. Since the experiments are to be conducted by the technical staffs in Venezuela, the primary contribution of the advisor is to provide technical guidance and this can be most effective through frequent reviews of the program. This procedure will also minimize the loss of time from active research

work by the Venezuelan scientist assigned to act as liaison during the visit. This proposal for frequent visits of short duration was wholeheartedly received and is highly recommended by Mr. Pra Sisto and Dr. Medina.

Mr. Casas suggested that appropriate action be taken between the Ministry of Agriculture and the International Soil Testing Project so that technical assistance can be provided. It is recommended that the Director of the Project correspond with Mr. Casas and that the necessary arrangements be made. It is further recommended that tentative plans be made for the technical advisor to return to Venezuela in July or August for a period of about two weeks to review the progress that has been made and to provide such other assistance as needed to further implement the program.

A NATIONAL PROGRAM FOR EVALUATING AND IMPROVING THE NUTRITIONAL STATUS OF VENEZUELAN SOILS

I. Objectives

A. To develop an effective soil testing program

1. To accurately evaluate the nutritional status of agriculturally important soils of Venezuela

2. To accurately predict the amounts of specific nutrients required for maximum economical crop yields

B. To promote the efficient use of fertilizers

C. To improve the efficiency of land use for agricultural purposes

II. Organization

A. Advisory Committee

1. Function

a. To stimulate interest in the potential contribution of the program to the progress of agriculture in Venezuela

b. To encourage support of the program from all agriculturally related businesses

c. To periodically review the progress of the program

2. Membership[1/]

a. Ministry of Agriculture, Division of Investigations

b. Faculty of Agronomy, College of Agriculture

c. Ministry of Agriculture, Division of Extension

d. Ministry of Public Works, Division of Edaphology

e. Instituto Venezolano de Petroquimica

f. Shell Service for the Farmer

[1/] Only the organizations are indicated

g. Various Crop Producers Associations

h. International Soil Testing Project, North Carolina State University

i. USAID

B. Technical Committee

1. Function of the committee

a. To study and evaluate various laboratory procedures for chemically estimating the nutritionally related properties of soils

b. To conduct and evaluate greenhouse and field experiments for interpreting chemical analysis of soils

c. To develop techniques and procedures for rapid analysis of samples and for early reporting of recommendations

d. To develop uniform procedures for submitting soil samples to the laboratory and for reporting fertilizer recommendations

2. Membership[1/]

a. ,Coordinator

b. Ministry of Agriculture, Center for Agricultural Investigations

c. Ministry of Public Works, Division of Edaphology

d. Shell Service for the Farmer

e. Estacion Experimental de Tabaco

f. Representatives from the Faculty of Agronomy in the colleges of agriculture that have research programs relating to evaluating the nutritional status of soils

g. Instituto Venezolano de Petroquimica

3. Function of the coordinator

a. To arrange and preside over periodic meetings of the technical committee for program planning and progress reports

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[1/] Only the organizations are indicated

b. To act as a liaison between the various organizations participating on the technical committee

c. To conduct appropriate research

III. Procedures

A. Phase I

1. Preparation of a report on past and current programs of soil analysis for fertilizer recommendations

   a. Name of organization

   b. Personnel involved

   c. Objective of work

   d. Results of research

   e. Present status of program

   f. Plans and suggestions for future work

   g. Subject matter of special interest

2. Summarize and interpret results from previous field experiments involving variable rates of nutrients

B. Phase II

1. Initiate laboratory experiments

   a. Phosphorus fixation

   b. Lime requirement

   c. Potassium fixation and release

   d. Nitrification studies

   e. Soil salinity studies

2. Initiate greenhouse experiments

   a. Response to rates of phosphorus

   b. Response to liming

   c. Response to rates of potassium

   d. Response to rates of nitrogen

   e. Relation of soil salinity to plant growth

3. Study and evaluate correlations of data from laboratory studies with those from greenhouse experiments

4. Conduct field experiments to provide data for further interpretations of chemical analysis of soils

5. Develop methods for analysis of multiple samples to reduce time in reporting results

6. Develop uniform methods of submitting samples and reporting results

C. Phase III

1. Nationwide educational program on methods of sampling soils for analysis

2. Promotion of the use of soil testing information for increasing crop production and the efficient use of fertilizers

A PROGRESS REPORT

ON

THE NATIONAL PROGRAM FOR EVALUATION AND IMPROVING THE NUTRITIONAL STATUS OF VENEZUELAN SOILS

C. B. McCants

INTERNATIONAL SOIL TESTING PROJECT

NORTH CAROLINA STATE UNIVERSITY

RALEIGH, NORTH CAROLINA

SEPTEMBER, 1966

INTRODUCTION

A study was made in Venezuela from February 7 to March 4, 1966, of the programs planned and in progress to assess and improve the fertility of the agriculturally important soils of that country. Of particular interest was the status of the soil testing activities and the modifications needed to enable them to make a greater contribution to the soil fertility programs for the various crops. This study was made at the request of the Ministry of Agriculture of Venezuela and under the sponsorship of the International Soil Testing Project. In the report which followed this study, recommendations were made for the establishment of an organization to develop and promote a soil testing program which would evaluate the nutritional status of soils of Venezuela and would promote the efficient use of land and fertilizers.

During the following six months, contact was maintained through correspondence with several people associated with the program and written suggestions were offered as considered appropriate. From September 13-25, 1966, there were discussions in Venezuela with persons representing various organizations involved and interested in the proposed program. This report and the recommendations contained herein are the outgrowth of these discussions.

VISITS AND DISCUSSIONS

Mr. Ray Deschamps and Mr. Harold Christ of the Rural Development Division of USAID/Venezuela expressed agreement with the objectives and organization of the program proposed following the study made in February. They also concur with the guiding philosophy of the International Soil Testing Project in this program -- that of backstopping the soil fertility

programs in Venezuela by providing consultation, recommendations, and technical information as needed. This technical assistance will be required for several years to insure a reasonable probability of a successful program.

Dr. Luis Medina, speaking for the Ministry of Agriculture, stated that the program is receiving attention and interest at the highest levels of administration within the Ministry and that a continuation and expansion of this interest is anticipated. A proposed Memorandum of Understanding which would place on official record the nature of the cooperative program between the government of Venezuela and the International Soil Testing Project was discussed with Dr. Medina and a copy given to him for study. He expressed agreement with the proposal and suggested that after it has been discussed with other officials in the Ministry of Agriculture, that Dr. Fitts plan to be present in Caracas for the official signing of the Memorandum.

During a visit to the fertilizer manufacturing facilities of Instituto Venezolano de Petroquimica (IVP) at Moron, the officials stated that plans have been made and work started for a substantial increase in the fertilizer production capacity of this plant. Although a portion of the expanded production is intended for export, it is also anticipated that the sales of fertilizer in Venezuela will increase substantially during the next few years. The evidence thus indicates there will be available within the country amounts of fertilizers adequate to meet the anticipated requirements. It further appears that the capacity to produce fertilizer has advanced more rapidly than programs to provide information on the efficient use of these fertilizers. Officials of IVP expressed enthusiastic agreement

with the objectives and basic procedures of the proposed program and indicated they will give it their full support. They further indicated a willingness and interest in modifying fertilizer formulations to meet agronomic needs as they are demonstrated. The Company has on its staff one Enginiero Agronomo and ten perito agronomos who take soil samples, receive the reports of the soil analyses made in the Company's laboratories and make fertilizer recommendations to growers. The cooperation and assistance of these people can contribute significantly in obtaining information for correlation studies and in the all-important educational phase of the soil testing program. The expressed interest and cooperative spirit demonstrated by the officials of IVP suggest that this assistance can be expected.

The Advisory Committee and the Technical Committee, which were formed in accordance with the recommendations made following the study in February, met in July for general organization and to plan for a subsequent meeting to discuss matters pertaining to the responsibilities of the Committees. These meetings were held on September 19 and 20 and consisted of an excellent program. The participants, the minutes of the meetings, and the technical reports presented will be available later and thus the details are not included in this report. The program consisted primarily of the following subjects.

1. Discussion by the advisor from the International Soil Testing Project of (a) the fundamental factors in a soil fertility program, namely, information, fertilizer materials and education and (b) the fundamental phases in a soil testing program, namely, soil sampling, research, analyses, calibration, recommendation and education.

2. Discussion of the responsibilities of the Committees in developing a soil fertility program.

3. Presentation of technical reports on the type of soil testing and soil fertility programs conducted by the various institutions.

A significant aspect of the meeting was that it brought together and into discussions, persons from the Universities, Ministry of Agriculture, IVP and private agencies who are working on related soil fertility problems. A fine display of mutural interest and cooperation prevailed throughout the meetings. A continuation of this attitude and approach will contribute immensely to a rapid and progressive development of the National Program.

RECOMMENDATIONS

General agreement was expressed by all with whom the matter was discussed that a soil testing program is an essential part of a sound soil fertility program and that such a program is needed in Venezuela. Thus, a recognition of the need to establish a soil testing program is established. Although there are ten or more laboratories in Venezuela in which soil samples are analyzed, there does not exist within the country a soil testing program. While there are weaknesses in each of the six essential phases of the program, the most serious deficiencies are considered to be related to the absence of adequate data to interpret soil analyses and to make fertilizer recommendations. In addition, a problem that will arise when there is any substantial increase in the number of samples submitted for analyses is the low capacity of the laboratories to analyze samples. The laboratories as presently organized and operated do not have the capacity to provide information on a large number of samples in a short time. Failure

to provide this information to the grower within a two to three week period after the samples are submitted to the laboratory will be a major obstacle in the development of a soil testing program. In view of these limitations, it is recommended that the following indicated committee assume responsibility for programing the work directed toward the solution of these problems.

I. Technical Committee

a. Initiate field and greenhouse experiments to provide data on plant response to specific nutrients or nutritional conditions. Retain samples of all soils used in these studies for chemical analyses.

b. When there is sufficient number of soil samples available, analyze each one by various extracting methods for the nutrient of interest.

c. Make correlation studies of the relationship between plant response to a nutrient and the quantity extracted.

d. Prepare guide sheets for making fertilizer recommendations from soil analysis information.

II. Advisory Committee

a. Select two persons and make the necessary financial and other arrangements for them to attend a course on principles of soil testing and laboratory procedures to be presented by the International Soil Testing Project at North Carolina State University during the summer of 1967. This course will provide the participants with basic information on soil testing, the latest in equipment and procedures for rapid analysis of soil, and personal experience in the operation

of this equipment. These persons can then serve as advisors in the establishment and operation of the soil testing laboratories in Venezuela.

b. Consider the feasibility of establishing a central laboratory or one or more regional laboratories to perform all of the soil analyses for fertilizer recommendations. A limited number of efficiently operated laboratories can probably meet the soil testing needs of the country.

When sufficient progress has been made in this work, work should then be undertaken to making improvements in the other phases of the soil testing program, particularly in taking representative soil samples and fitting the soil fertility program into the total crop management program.

It is further recommended that the soil fertility research specialists of CIA at Maracay prepare for publication a summary of the results from their experiments on the response of various crops to rates of different nutrients. From this summary a map of general fertility conditions in the country can be prepared which will focus attention on areas of the greatest need for additional research. The summary will be of further value in determining fertilizer treatments for additional field and greenhouse investigations.

The advisor from the International Soil Testing Project will continue to be available at all times to review written reports, experimental plans, and suggested procedures and to make specific recommendations on these subjects. In addition, he will make follow-up trips to Venezuela as the needs arise to review the progress of the Program, to consult with the various participants and to make appropriate recommendations.

APPENDIX D

The Soil Testing Program

Bolivia

Ecuador

Peru

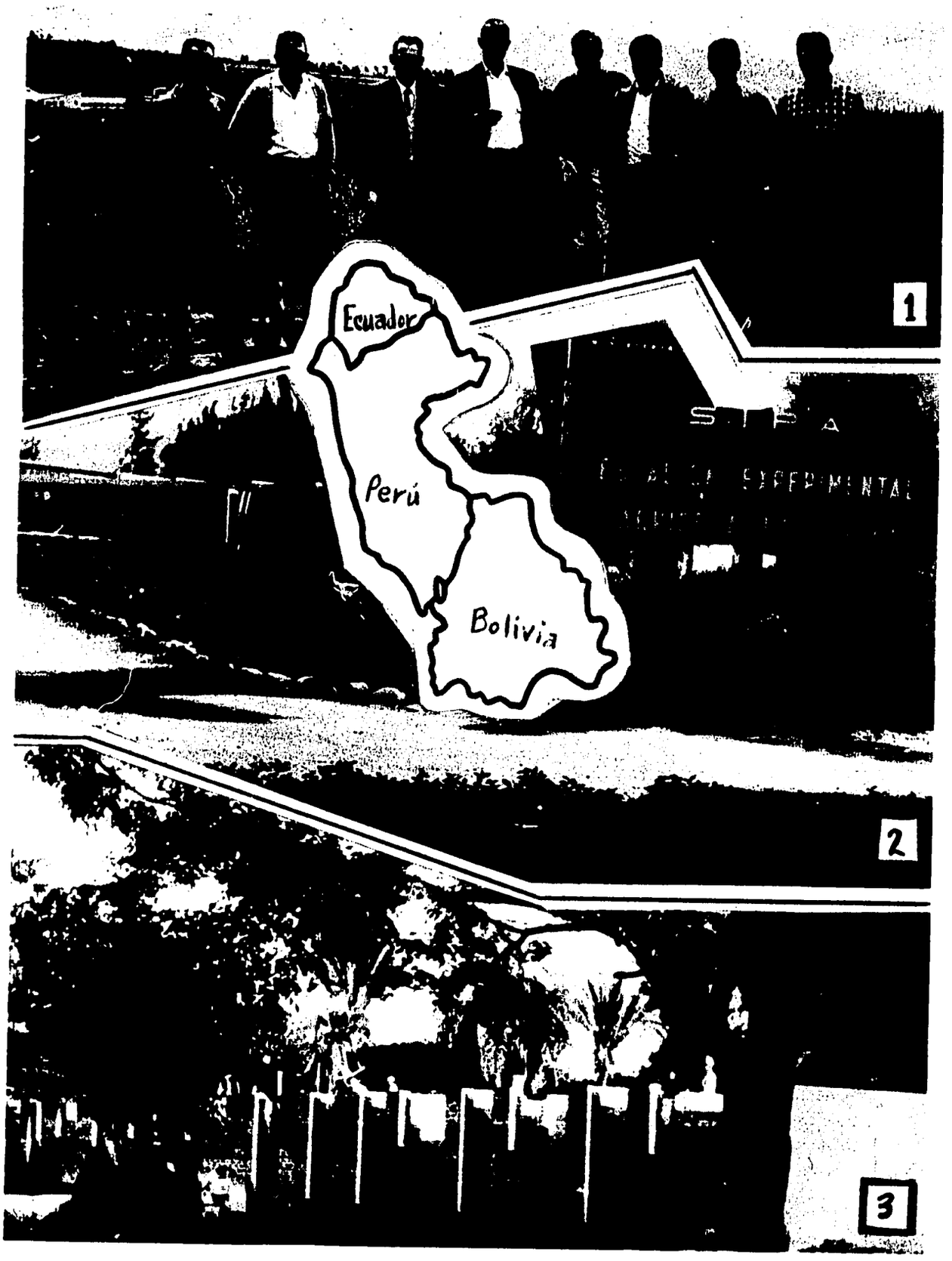
Phosphorus Determination

SOILS RESEARCH AND LABORATORY FACILITIES

1. Experimental station "Santa Catalina" just outside Quito, Ecuador. Picture taken on day of field trips to see FAO fertilizer demonstrations in wheat. Most of the field research has been carried out by INIAP on this station and others, as well as the various field trials in conjunction with FAO. The soil testing laboratory in the Ministry of Agriculture in Quito will base recommendations on this information.

2. SIPA experimental station at La Molina, site of crop and soil investigations and of the soil testing laboratory serving as the analytical center of national soils program of Perú.

3. The recently completed agricultural service center in Santa Cruz, Bolivia, is seen here during mid-construction. Being located in the major colonization area of the jungle region this laboratory facility is now ready to move forward with a farmer service program of soil testing and nutrient evaluation.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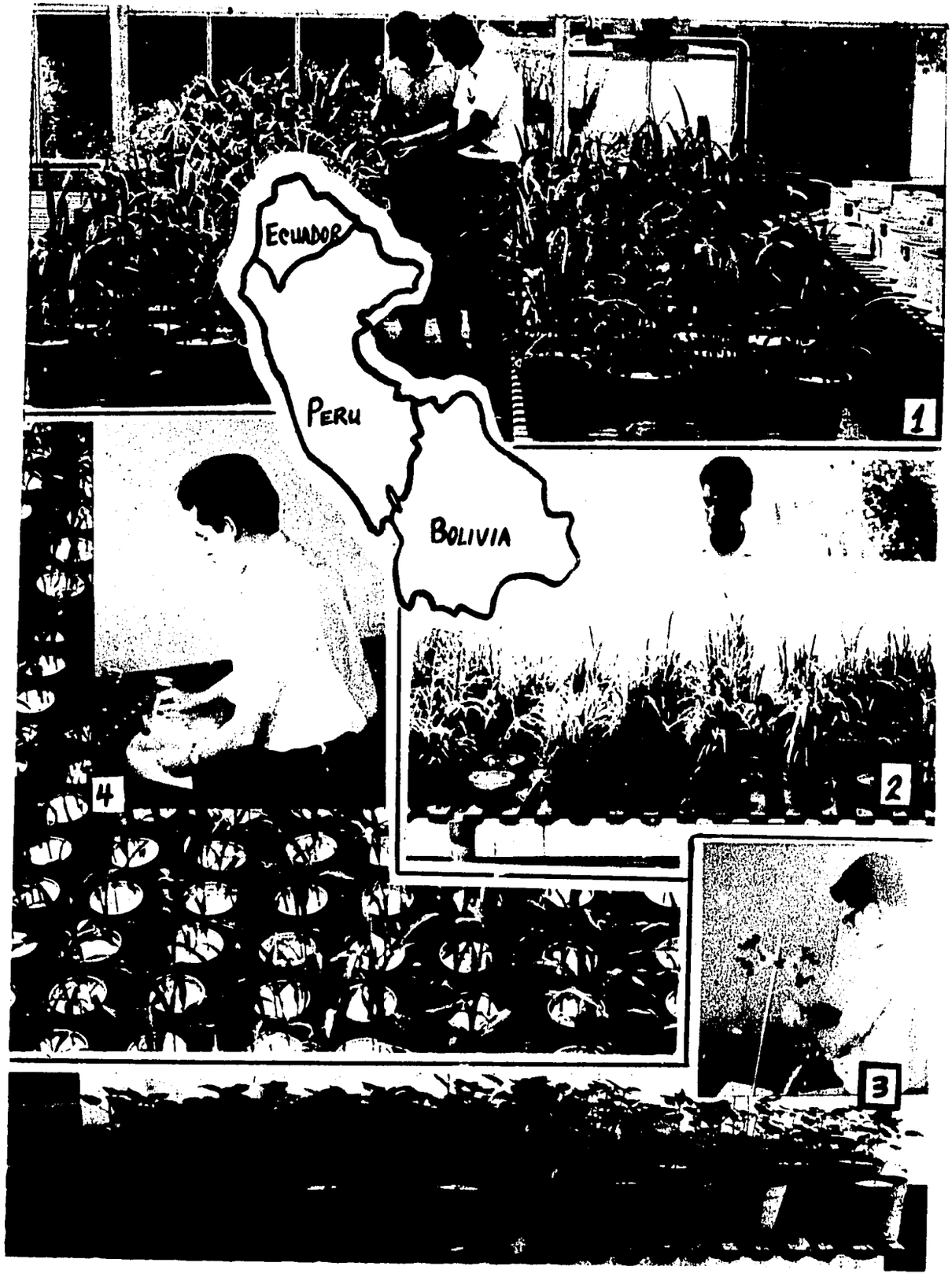
SOIL TEST CORRELATION STUDIES: LABORATORY AND POTTED PLANT

1. Study of phosphorus fixation and plant response to applied phosphorus employing the method outlined in Technical Bulletin No. 3 of the International Soil Testing Project. The study indicated the superior analytical value of the Olsen method for the wide cross-section of soils in Perú. Work carried out in greenhouse at the Universidad Agraria as joint project between SIPA and the University. Thesis study in partial fulfillment of requirements for Ing. Agr. degree by Sr. Mueller, shown here with Dr. Waugh.

2. Study of potassium correlation between soil test and response in sorghum to potassium applied. Photo shows second of three crops grown to accomplish near exhaustion of plant-available soil potassium. The results served to help select Olsen as a suitable soil test method for potassium in Peruvian soils. The exhaustive cropping portion also provided more detailed information regarding critical levels of potassium in the distinctly different soils of Perú. Results reported in Technical Bulletin No. 3. Thesis study was carried out at the greenhouse of the Universidad Agraria in partial fulfillment of the Ing. Agr. degree. The thesis was presented and approved by the university in November. Ing. Durán can be proud of this very fine piece of research.

3. Study of the relationships between aluminum, calcium and magnesium in jungle soils of Perú. The method employing normal KCl as extractant proved to be very indicative of liming requirement. Thesis study was carried out in greenhouse at the Universidad Agraria at La Molina in partial fulfillment of the requirements for Ing. Agr. degree. The student, Sr. del Aguila plans to continue his studies of aluminum at the Master degree level under the new graduate program of the Universidad Agraria.

4. Study of uptake of phosphorus under intensive cropping conditions. Very good correlations were obtained with Al Abbas, Bray P-1, and Olsen methods. Olsen was selected as the routine test for the Peruvian soil testing program because of its superiority in the high calcareous soils of the coast, and also because of its suitability for routine potassium determinations in the same extraction. Thesis study was carried out by Sr. Luna in partial fulfillment of requirements for Ing. Agr. degree, the work being done at the Universidad Agraria greenhouse, La Molina. Sr. Luna plans to continue studies of the phosphorus-zinc relationship for his Master's degree project under the new graduate program of the Universidad Agraria.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SOIL TEST CORRELATION STUDIES: Laboratory and Potted Plant

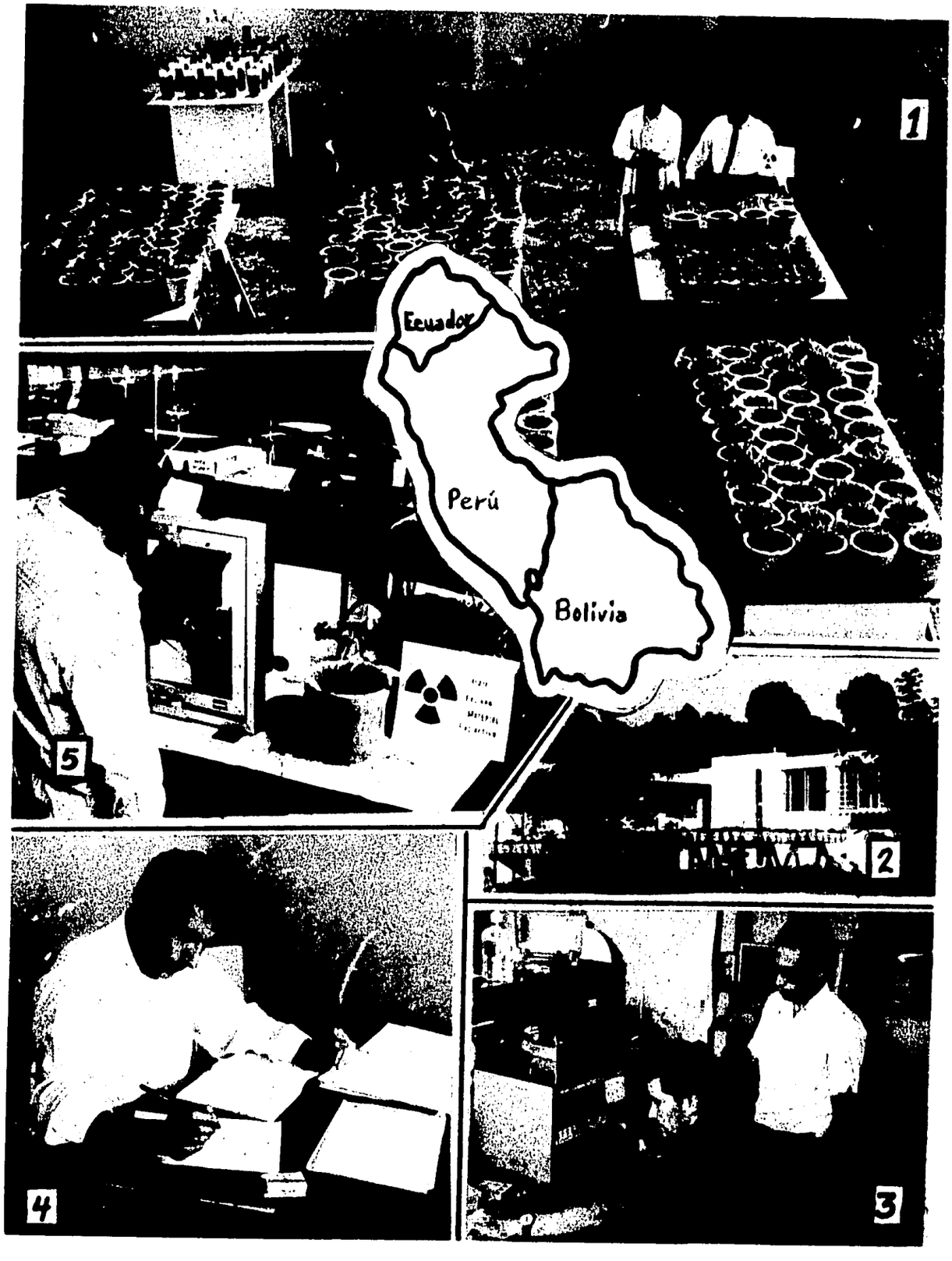
1. Intensive phosphorus study of A values using radiophosphorus. This special study was a joint effort between the radioisotope project of SIPA and the International Soil Testing Project. Left to right, Dr. Donovan Waugh, Ing. Augusto Reyna V., Dr. Eugene Doll (advisor representing the International Atomic Energy Commission), and Ing. Julio Lugo C. In the left background a special salinity study is just being initiated also.

2. The facilities for potted-plant work at SIPA. Because of increased interest in potted-plant work (based on these and other studies), a plan has been presented to complete these facilities.

3. Special salinity studies in SIPA. Sr. Isaias Castillo V. and Ing. Juan García A. (left to right) are shown doing sodium determinations in the salinity section of the soil testing laboratory.

4. Ing. Mario Cano O. prepares and summarizes soil test correlation data from a number of field and potted-plant studies. The guide sheet for potato recommendations was completed (based on the correlation studies), and guide sheets for other crops are being prepared as other correlation data become available.

5. Techniques of applying and handling radiophosphorus are demonstrated here by Ing. Julio Lugo C.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FIELD CORRELATION AND CALIBRATION STUDIES

1. N-P-K factorials with potatoes in the sierra of Perú. SIPA has conducted over 80 separate factorial experiments which have been used to correlate and calibrate the soil tests for P, K, and Organic Matter.

2. N-P-K studies in wheat in the sierra of Ecuador have formed the main research emphasis of INIAP. Although many of the studies did not have the proper kind of "check" to permit the separate evaluation of individual nutrient response, the trials have provided information regarding levels of nutrients which gave maximum yields under different soil test levels.

3. Potted-plant studies with large amounts of soil and dwarf banana have been carried out by Dr. T. Cochrane in Bolivia (British Tropical Mission). As a part of his soil survey program, Dr. Cochrane has collected large soil samples from each of the soil types encountered. These samples were evaluated for nutrient availability both by means of soil analysis and by these potted-plant studies with dwarf banana. Correlation data is being prepared from this work and will provide the initial information upon which to establish the soil testing program in Bolivia.

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SOIL TESTING LABORATORY, SIPA, LA MOLINA

1. Front view of soils department.

2. Receiving soil samples. All samples are arranged in wood trays in groups of 50 (10 rows of 5). Sr. Honorato Rojas and Sr. Rogelio Yaucee prepare the samples for analysis (left to right).

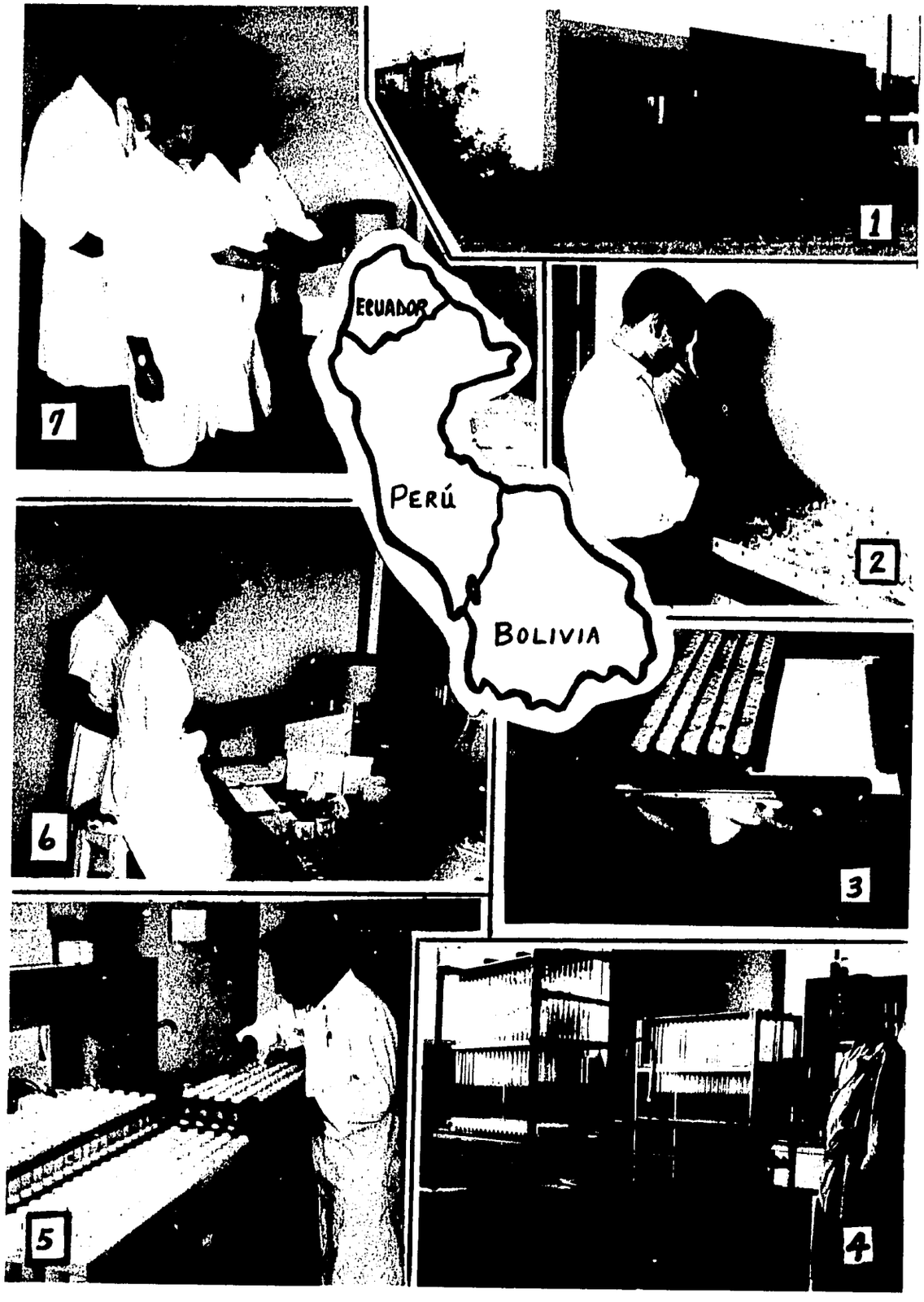
3. Soil sample shaker built by "Mogarsa" in Lima. This shaker handles two extraction trays at a time (200 samples) and operates with a swirling action. It is not necessary to stopper the bottles with this arrangement, and the extraction is comparable to both the old shaker and the newly developed stirrer, as shown by duplication between control samples employed by the International Soil Testing Project.

4. Sr. Juventino Valdivieso gets the feel of the new constant suction dispenser unit which works with 100 samples at a time (actually there are 105 units, 5 being for the control samples--the control position can be moved to any one of the 21 rows of 5). Three of these pipette machines were constructed by "Mogarsa" in Lima.

5. Trays for extraction, dilution, and color development are checked over by Sr. Cirilo Casaña H. The trays correspond to the 105 unit pipette apparatus and are made of a specially coated aluminum. Different color trays are used for the different analyses. Built by "Mogarsa."

6. Srta. Carmen Torres, head chemist of the laboratory, instructs a new chemist on the use of the flame photometer and other lab instruments. Sra. Lucia Morales observes closely and becomes familiar with all the instruments as a part of her vacation "practica" required by the University.

7. Sra. Deolinda F. de Villanueva also is instructing students doing vacation "practica" in the soil testing laboratory. As director of the laboratory she finds the new emphasis on farmer service challenging as well as rewarding. Students are (left to right): Srs. Luis Palacios M., Carlos F. Cavere P., and José Benítez J.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SOIL SAMPLING IN PERU

1. SIPA extension office in the sierra town of Abancay. These offices are located in a large number of rural areas and will provide the backbone of the farmer contact.

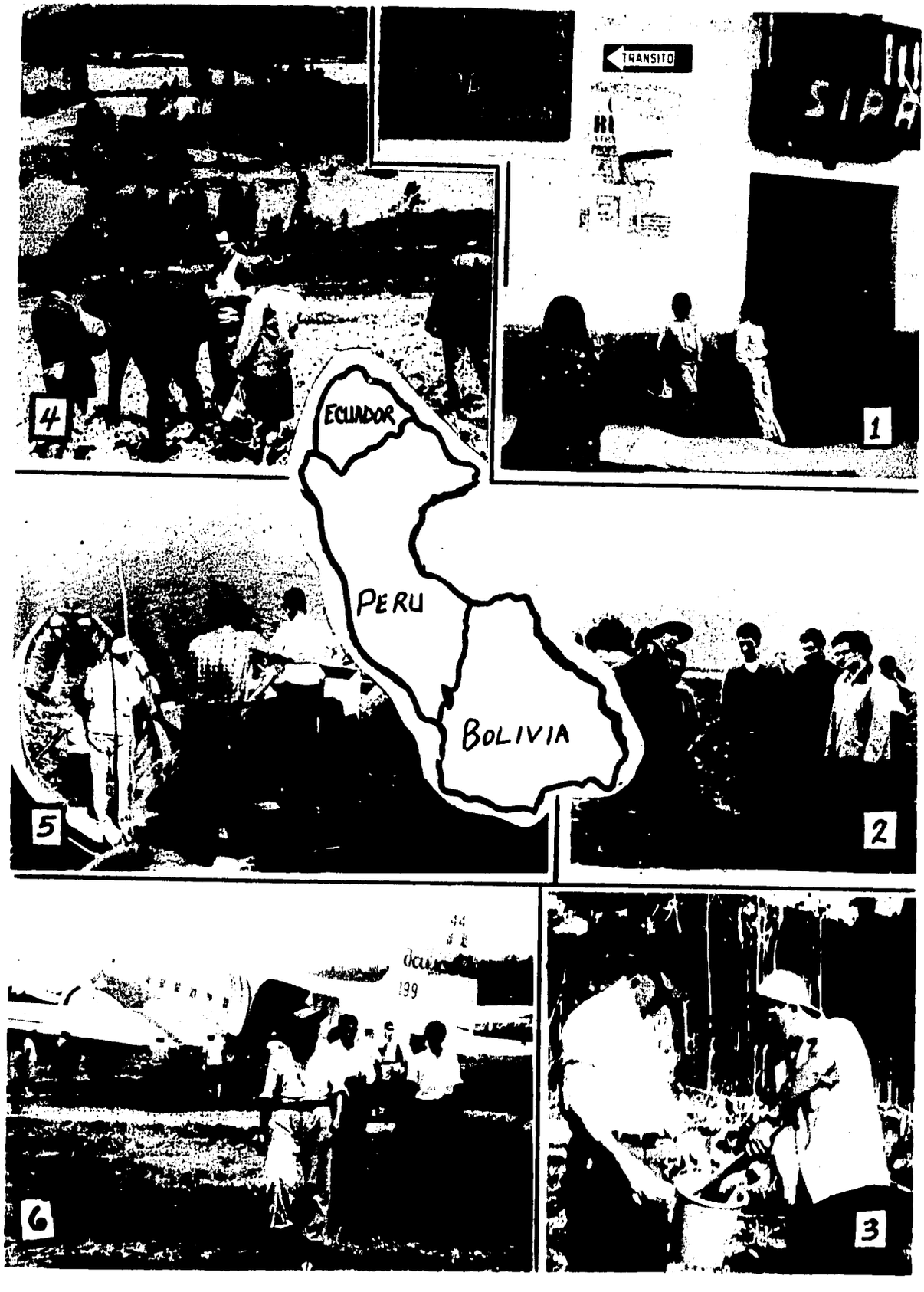
2. SIPA extension specialists from Cuzco get out into the field and take soil samples in stride as the sample training meetings are held in their area.

3. Ing. Pancorbo and Dr. Waugh take a soil sample in the jungle area of Puerto Maldonado during sampling training meetings.

4. The soil testing program draws into it representatives from the potato project, peace corps, credit programs and SIPA extension agents. This field training in soil sampling gives all interested parties the chance to participate in the soil testing service.

5. Soil sampling (not fishing) in the jungle of Perú sometimes calls for a trip up the Amazon.

6. Faucett airline of Perú makes farmer service to outlying areas a reality by providing free air transport of soil samples submitted through a SIPA extension agent. Samples are shipped in special boxes which hold 10 soil sampling cartons.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SOIL TESTING AS A PROGRAM FOR SERVICE TO FARMERS

1. Ing. Carlos Valverde, Director of the Soils Department of SIPA at La Molina, has been responsible for effective administrative programming. Through his efforts the national plan of soil testing has become a reality.

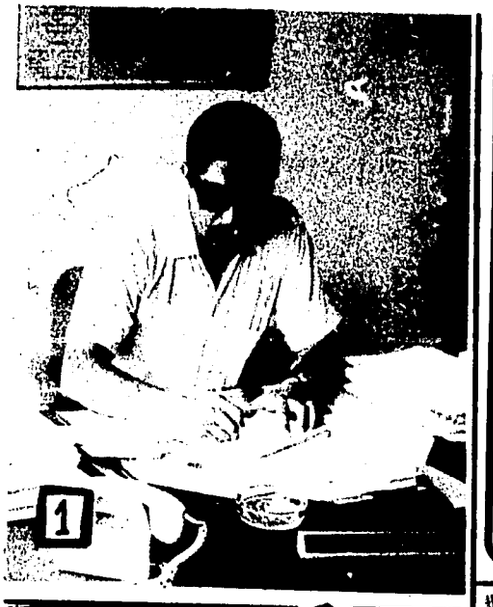
2. The "emblem" of the soil testing service in Perú in this attractive design. The shipping carton used in air transport of the samples carries this design. Future plans are to use it for folders, posters and general advertising of the farmer service.

3. Large supply of soil sampling probes, soil cartons, shipping service and soil test report forms were made up for distribution to the SIPA extension agents.

4. Extension agents will be contacting farmers to get soil samples under several impact programs. In these areas, fertilizer loans will be made only where the farmer has had his soil tested by the La Molina laboratory.

5. Correlation of soil test results with plant response provides the critical soil test levels below which the farmer can expect a response to fertilizer. The correlation between response to applied phosphorus in potatoes in some 80 field trials is very high, with 92% of the points falling in positive quadrants (according to the interpretation method of Cate and Nelson, Technical Bulletin No. 1).

6. Preparation of soil test report forms is not new to Srta. Flor de María Morales C. (typing) and Srta. Judith Guabloche J. However, the new in-depth soil testing program will represent a new scope in this phase of farmer service. Report forms are very simple and easy to read. The extension agent uses these to base the entire fertilization program for each individual farmer, transposing the nutrient recommendation supplied by the lab into kg. of fertilizer grades available in his area. Adjustments are also made in accordance with the overall managerial capability of the farmer.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DEPARTAMENTO DE SUELOS Y ABONOS
SERVICIO DE ANALISIS
ESTACION EXPERIMENTAL AGRICOLA "LA MOLINA"
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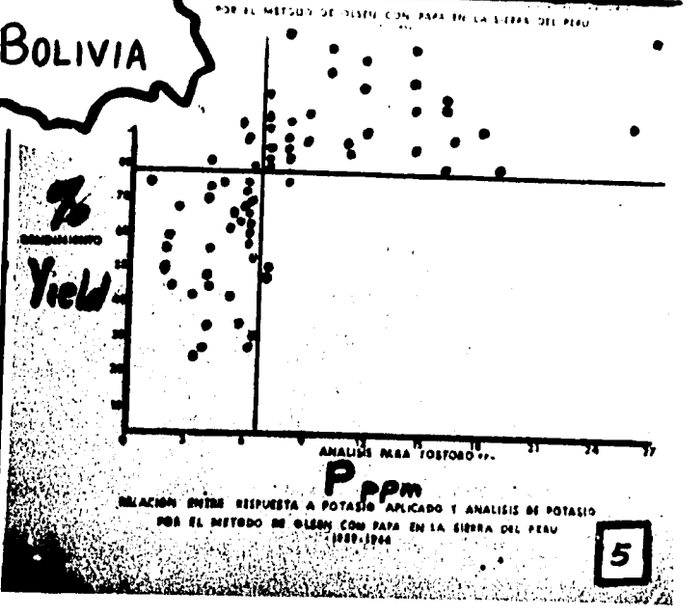
POR EL METODO DE OLSEN CON PAPA EN LA SIERRA DEL PERU
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RELACION ENTRE RESPUESTA A POTASIO APLICADO Y ANALISIS DE POTASIO
POR EL METODO DE OLSEN CON PAPA EN LA SIERRA DEL PERU
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Phosphorus Determination

(Ascorbic acid technique as modified by D. L. Waugh)

The blue color colorimetric method of Olsen and Watanabe, Soil Sci. Soc. Amer. Proc. Vol. 29, No. 6 - 1965, was modified for an automated system of analyses. The procedure was found to be equally good for Olsen's sodium bicarbonate, Mehlich (North Carolina) hydrochloric and sulfuric acid, Al-Abba (Purdue) and Bray P-1 extractants.

Ascorbic acid is added directly to the molybdate solution containing antimony potassium tartrate, thus eliminating one step. The blue color that is developed is stable at least 24 hours and organic matter dissolved from the soil by the extractant does not interfere. This permits the omission of charcoal during the shaking procedure. A red filter (882 mμ) is recommended in the Olsen procedure but a 550 mμ filter has been found to be satisfactory when determining 0 to 14 ppm P in solution.

<u>Procedure</u>:

Solution A: per liter

1.0 g ammonium molybdate

0.024 g potassium antimony tartrate

16 ml conc. sulfuric acid

(Note: Solution A is light and heat sensitive. It must be stored in a brown bottle in a cool place.)

Solution B:

Made up the day of analysis as it does not stay fresh more than one or two days.

0.88 g ascorbic acid per liter of Solution A

Analysis of Soil:

Extract the soil with a soil to solution ratio of 1:10. Shake or stir thoroughly. Filter through Whatman No. 1 or comparable filter paper. (Filtering may be eliminated on some soils by allowing the samples to stand until the soil settles--usually overnight.)

Place 10 ml of solution B in the colorimeter tube (or small beaker if suction is used to transfer final solution to colorimeter).

Add 1 ml of extract to the colorimeter tube and bubble a small stream of air through to mix.

After approximately 30 minutes read the sample on a colorimeter (Olsen suggests a filter of 882 mu wavelength but 660 mu wavelength has been found to be satisfactory too).

The color is stable for at least 24 hours and probably longer.

APPENDIX E

Laboratory Activities

Nicaragua

Costa Rica

Advisory Committee Meeting

Panama

Photo 1. Ramiro Montes Vargas is determining potassium with a flame photometer in the soil testing laboratory at Managua, Nicaragua.

Photo 2. Extracting solution is being added to soil samples using the multiple unit dispenser in the Managua laboratory.

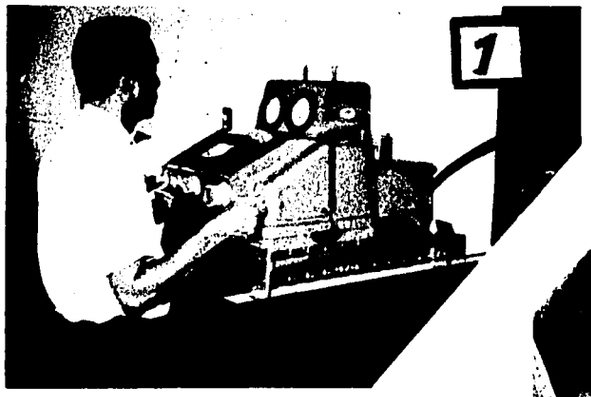
Photo 3. Titration for calcium and magnesium is rapidly completed with this apparatus in the soil testing laboratory in Nicaragua.

Photo 4. The "original" multiple unit stirrer constructed in the soil testing laboratory in Costa Rica by Dr. A. H. Hunter.

Photo 5. A well arranged laboratory for colorimeter determination and titration measurements.

Photo 6. Mr. Montes points to the small rubber bulbs that supply the pressure to quickly fill the burettes in this titration apparatus.

Photo 7. Adding a measured quantity of solution to each sample held in the bottles in trays by the improved mercury valve syringe pumpt. This is the soil testing laboratory in San Jose, Costa Rica.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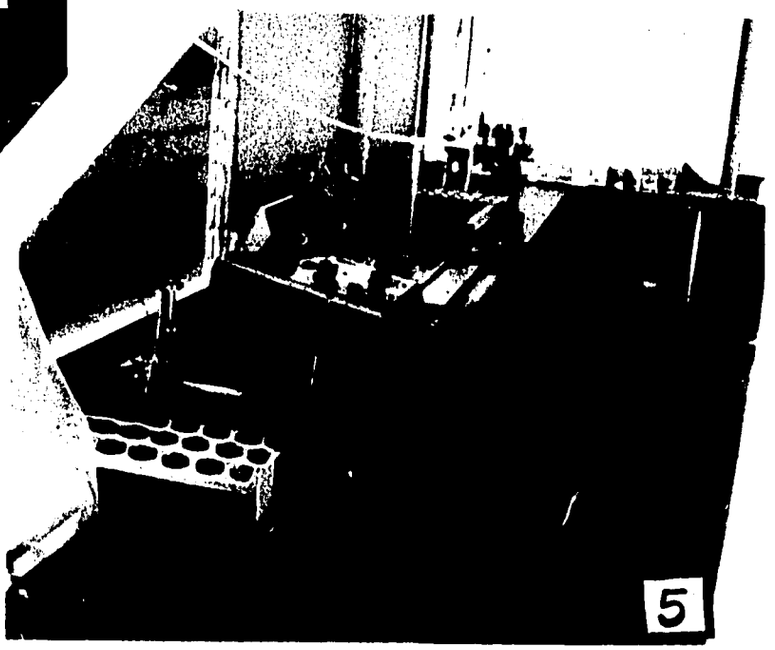
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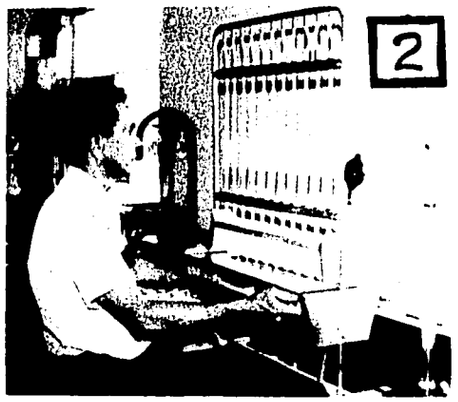
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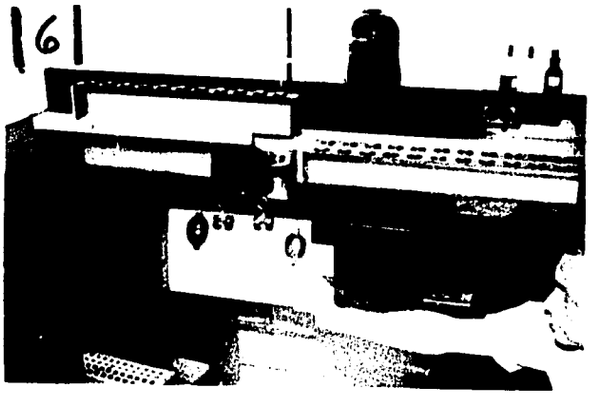
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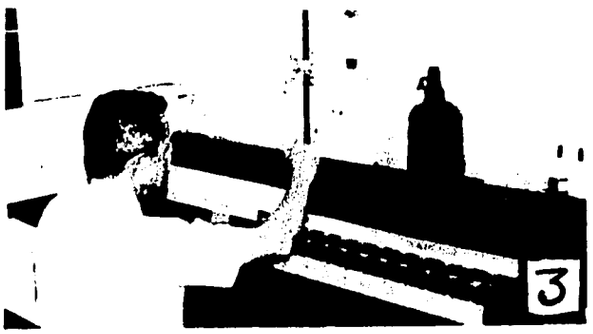
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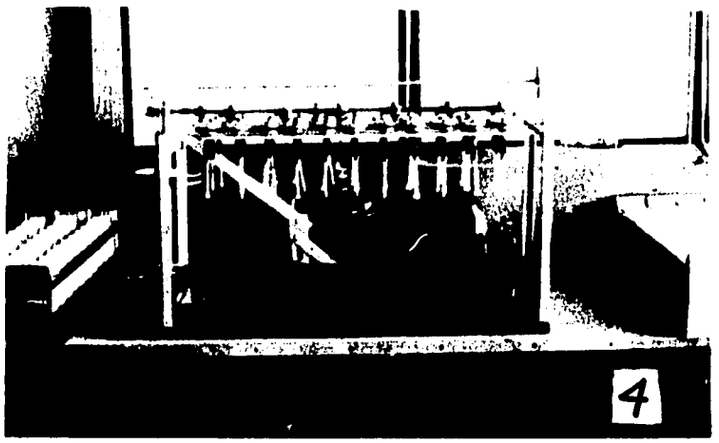
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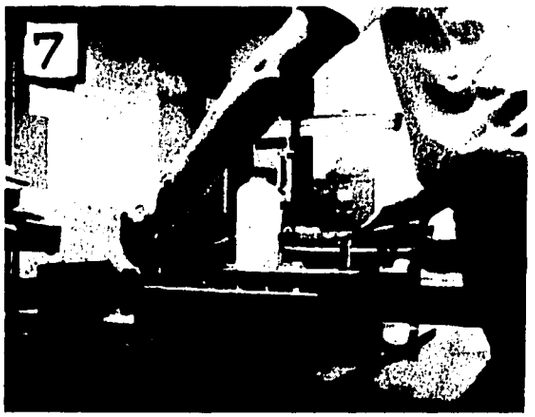
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Report of Advisory Committee Conference

Panamá - November 7, 1966

Arvel H. Hunter

INCREASING CROP PRODUCTION THROUGH A SOIL FERTILITY ANALYTICAL SERVICE PROGRAM

Attendance:

Dr. Reinmar Tejeira (Ministry of Agriculture and Commercial Industries)

Ing. Castro, Ing. Casanova (Esso)

Ing. Ocaña, Ing. Gordon

Ing. Carrión (Instituto Fomento Económico)

Ing. Adamos, Ing. Albotros

Mr. T. O. Stephens (USAID Mission - Panamá)

Dr. A. H. Hunter and Dr. J. W. Fitts (International Soil Testing Project)

Purpose:

(a) To review the current status of the Soil Fertility Analytical Service Program as it relates to increasing crop yields through better utilization of fertilizers and soil amendments in Panamá.

(b) To discuss and outline an enlarged 1967 program for increasing crop production through increased use of fertilizer, and lime combined with improved management practices.

Discussion:

That increased crop production can and should be achieved in Panamá is not generally questioned. The length of time required and what methods may be effectively employed to bring about this increased production were the major topics of discussion of this conference. It was generally agreed that a major

step toward increased crop production is to get farmers to use larger quantities of fertilizers and lime. Not only is increased use of these materials desirable, but equally important in their proper use, i.e. overliming can be as detrimental to crop growth as no lime; also the greater use of most fertilizer elements usually does not result in decreased yields but the increase in yield can certainly be greatly improved by applying the nutrient elements in the quantities and ratios which result in a balanced nutritional supply to the plants.

The need then is for an intensified program aimed not only at increasing fertilizer use but also at insuring that the right rates and ratios are used on the individual farm and crop.

The Soil Fertility Analytical Service Program can and should play a major role in such an intensified program.

Attached is a brief outline of the purpose and present status of the Analytical Service Program as well as a few suggestions with regards to steps which may be taken to make it even more effective. It is recognized, of course, as noted in the attached outline that the assistance and cooperation of several other agencies is required if the goal of increased production is to be achieved.

Suggestions - Based on Conference:

It was suggested that an intensified program for increasing crop production through the increased use of fertilizers and lime be initiated during 1967.

Areas:

In order to gain experience in the operation of the program and to prevent trying to cover more areas than can be effectively supervised, it is suggested that the first years activities be restricted to one or two important agriculture districts of the country. It is very important to the future work that the first years program be an outstanding success.

Crops:

It is also suggested that for the first year the number of crops involved be limited. Perhaps the program should at first be aimed at three basic food crops--corn, rice and beans.

It is suggested that the following steps be taken to carry out the program.

Responsible agency or agencies should be assigned to each step, the target date for initiation or completion determined, and responsible committee chairman and members appointed.

1. Intensified soil sampling drives.
   a. Area and crops defined.
   b. Needed materials.
      1. Soil sample cartons
      2. Instruction sheets
      3. Soil sampling tools
      4. Publicity
   c. Instructions concerning program and how to take soil samples given to people responsible for supervising the sampling.
   d. The sampling drive completed.

      Date of initiation of training _____

      Date of completion of drive _____

      Responsible agencies _____

      Committee chairman _____

      Committee members _____
2. Laboratory analysis
   a. Schedule for laboratory to be fully capable of analyzing all samples with all the desired analysis i.e. Phosphorus, Potassium, pH, lime requirements.

b. Methods

Methods of sample preparation and chemical analyses should be simplified and automated so that all samples can be analyzed within 1 week or less after being received.

c. Materials and supplies

1. Chemicals - an inventory of all chemicals needed and those on hand should be made.

2. Needed chemicals for the year ordered so that laboratory work does not have to stop for lack of supplies.

d. Laboratory instruments - all laboratory instruments should be checked for proper operation and a supply of commonly needed replacement parts ordered or stocked.

e. Records sheets for recording analytical data should be printed and stocked.

Date for laboratory to be fully operational _____

Responsible agency _____

Chairman _____

Members _____

3. Reports and recommendations

a. Decision made as to whether fertilizers are to be suggested in terms of kilos of plant nutrients or kilos of fertilizer grade.

b. Guide sheets for the crops should be prepared.

c. Person responsible for making recommendations assigned.

d. Provisions made for typing and mailing of recommendations.

e. Training given to extension agents and fertilizer company representatives regarding the interpretation of the laboratory resulta and how to use recommendation sheets.

Date for preparations to be completed _____

Date for initiation of training meetings _____

Responsible agency _____

Chairman _____

Members _____

4. Credit arrangements

   a. Estimate of total credit needed for program.

   b. Plans for how and where credit is to be obtained.

   c. Necessary forms and procedures prepared.

   d. Credit information to be given to farmers and other interested personnel.

   Date for credit program to be prepared _____

   Responsible agency _____

   Chairman _____

   Members _____

5. Availability of fertilizers and lime.

   a. Inventory of fertilizers and lime on hand in the area of interest and of estimated needs for program.

   b. Stocks to be increased according to estimated need.

   c. Arrangements made for puchase of fertilizers by farmers.

   d. Arrangements made for delivery of fertilizers to farm.

   e. Arrangements made for instruction of farmers on proper timing of application and methods and tools for proper placement.

   f. Arrangements for training of local fertilizer dealers in the above mentioned steps.

   Date for all arrangements to be complete _____

   Date for initiation of training meetings _____

Responsible agencies _____

Chairman _____

Members _____

6. Interpretation Studies

The research needed for interpretation of laboratory analysis is a continuing requirement but a planned program for its progress should be initiated and revised from year to year as needed.

Some first studies which will be of major importance at the beginning are fixation and correlation studies and lime requirement studies, which should be conducted first in the laboratory, then in the greenhouse, and then in the field. These studies will provide for the selection of the best methods of analysis for the soils of the country and for the refinement needed in making the best recommendations of rates of materials to be used.

It is suggested that the methods published by the International Soil Testing Project be used in these studies. The bulletin on laboratory and greenhouse studies will be available by January 1, 1967.

Date of initiation of studies _____

Responsible agencies _____

Chairman _____

Members _____

AHH:mce.
11-23-66

A SOIL FERTILITY ANALYTICAL SERVICE PROGRAM

A. H. Hunter

The function of a Soil Fertility Analytical Service Program is: (1) To collect and catagorize the information available from research and demonstration experience concerning the fertilizer. Lime or other soil amendment requirements for obtaining the highest economical production; (2) To analyze soil and/or plant samples by a proven practice in order to obtain information concerning crops and soils which can be used as a guide for predicting fertilizer or soil amendment requirements in order to obtain maximum yields at minimum costs; (3) To make this information available to the farmer advisors and the whole farm population so that it may have maximum effect on all crop production and therefor on country economy.

The following statements briefly describe how a "Soil Fertility Analytical Service Program" functions:

1. All farmer advisory personnel such as extension agents, fertilizer agents, etc., are trained in the functions and purposes of the service program so that they in turn can train and advise the farmers.
2. Representative soil and/or plant samples are collected from the area on which information is desired, placed in containers provided by the program and submitted to the laboratory for analyses and interpretation.
3. The samples are properly prepared and analyzed in the laboratory by proven methods.
4. The resulting data are interpreted by competent agronomists or by mechanical analyzers which have been properly programmed in order to provide suggestions or recommendations for proper use of fertilizer and soil amendments.

5. The analytical results and suggestions are compiled and sent to the farmer and farmer advisors. A copy of the information is retained in the laboratory for future use in preparing summaries concerning soil characteristics and plant nutrient needs.
6. The farmer advisor meets with the farmer to aid him in putting into action the suggested practices, and also to provide him with current information on another proven management practices such as pest control, planting dates, proper varieties, etc.
7. Demonstration plots are established to visually illustrate to the farmer the value of the suggested practices. These serve as part of the continuing education program to keep farm advisors and farmers abreast of and aware of the most recent discoveries and proven managerial practices.
8. Since all information comes as a result of experience and research, it is important that a continuing research progress be maintained in order to provide the necessary information for increasing production, improving the quality and reducing the cost of production.

The Soil Fertility Analytical Service Program should aid in the flow of information from researcher to farmer and from farmer to researcher. This flow of information brings the latest technical advances to the attention of the farmer and also provides the research people with a better understanding and recognition of the current and salient problems of the farmer which require further study.

It is hoped that this brief discussion of how a "Soil Fertility Analytical Service Program" operates will serve to indicate the important role such a program can play in increasing agriculture production.

The Soil Fertility Analytical Service Program is a public service and the key to its success lies in <u>rapid</u>, <u>accurate</u>, <u>dependable</u>, and <u>courteous</u> service. There are, of course, other factors and problems which are not a part of the

service program which will have to be dealt with in order to realize maximum benefit from the program.

Of major importance are:

1. Availability of fertilizer, lime and agriculture credit - even with the best fertilizer and lime recommendations they will be of little value to the farmer unless they are available at the time and place needed. The same is true with regard to credit. It's an unusual farmer that operates without credit.
2. Improve seed - proper fertilizer use will usually increase yields even with the poorest varieties but maximum benefits only come from the best adapted varieties.
3. Pest control - this does not usually become any more difficult with the proper use of fertilizers but its importance with regards to profits become greatly increased.
4. Markets for products - with the country importing many of the basic food crops and having a favorable market for export crops it would seem that markets would be available. However, without well organized marketing facilities the individual farmer may find problems of marketing increased production even though there is an overall demand for his produce.

STATUS OF THE PROGRAM IN PANAMA

An analytical service for farmer has already been provided in Panama for some time. The laboratory is also very occupied with analytical work for the Panama Cadastral Survey. As a result, a large number of samples have been and are being analyzed. Laboratory space has been somewhat enlarged and air conditioning installed.

Part of the multiple analysis equipment furnished by the North Carolina State

University - USAID Contract has been put into use, the other part is not needed until expanded analytical work is initiated.

Several soil samples from various locations have been gathered. These are being used as standard or control samples. They are also being used in experimental studies concerning phosphorus and potassium fixation and lime requirements. Some field fertility experiments on rice were established this year which will provide further information on correlation between soil analysis and crop response.

Standard samples for checking and improving the accuracy of analytical results were analyzed in Nicaragua, Costa Rica and Panama. These have also been sent to North Carolina State University for analysis in laboratories in the U. S.

Publications to provide help in some of the phases of a soil testing program have been or are being published by the International Soil Testing Project. These concern methods for determining critical levels of nutrient elements; laboratory and greenhouse procedures for correlation of crop response to analytical procedures; principles of sampling; factors affecting phosphorus availability; factors affecting lime requirements.

Before the service program can exert its maximum beneficial effect on the agriculture of Panama there are other phases of the program which need to be initiated and/or strengthened. These are as follows:

1. Much publicity needs to be given the program among extension agents, other farmer advisors and the farmers themselves. There may be many people who are already aware of the service and how it can aid them but a large percent need to be advised and educated cocerning the operation and benefit of the program.
2. The laboratory needs some further organization so that greater numbers of samples can be analyzed in a shorter time. Efficiency is a continuing problem to be worked on in all laboratories.

3. Soil sample boxes need to be provided for the farmer and help given in sending the samples to the laboratory. The sample boxes could be distributed through the extension service and commercial company representatives.
4. More training meetings for extension agents and other farmer advisors need to be initiated. There is a continuing need for instruction on soil sampling procedures and the philosophy of interpretations and recommendations.
5. Intensified sampling programs for certain areas could be initiated to demonstrate the value of the program in the area. These have been effectively used in other places.
6. Special laboratory, greenhouse and field studies need to be initiated to prove and improve the present laboratory as a basis for making recommendations.
7. Demonstration plots need to be established to provide visual education to farmers with respect to the value of proper fertilization.
8. As soon as sufficient samples have been analyzed from a particular area so as to provide a reasonable representation of the areas a soil test summary should be prepared which will provide better information concerning fertilizer and soil amendment requirements.

In reviewing the average yields per unit of land of some of the basic food and export crops in Panama it can be seen that in general they are comparatively low. In other countries soil Fertility Analytical Service Programs have been very effective in increasing crop yields. This occurs not only because the farmer learns, through the recommendations the proper rates and ratios of fertilizer to use but he also becomes interested and concerned about other good fare management practices.

It is quite possible that through a well conducted service program yields of some of the important crops could be doubled within a period of 2 to 5 years, if this were accomplished, the following figures illustrate the economic value to the country.

Producto	Compendio Estadístico 1963-1964		1968-1973	
	Superficie	Production	Production	Increased Value per Year
Maíz	94,100	1,672,200	2,344,400	$ 6,103,500
Frijoles	19,500	105,700	211,400	877,300
Arroz	103,300	2,450,300	4,900,600	15,534,900
Azúcar	20,240	85,360	170,720	1,024,300
		Total Increase		$23,540,000

APPENDIX F

Laboratory Activities

El Salvador

Honduras

Meeting in Guatemala

Photos 1-4. Soil Testing Laboratory in El Salvador

Photo 1. Washing filter tubes in tray.

Photo 2. General view of dispensing equipment and soils in laboratory.

Photos 3 & 4. Removing aliquots of filtering solution for phosphorus and potassium determinations.

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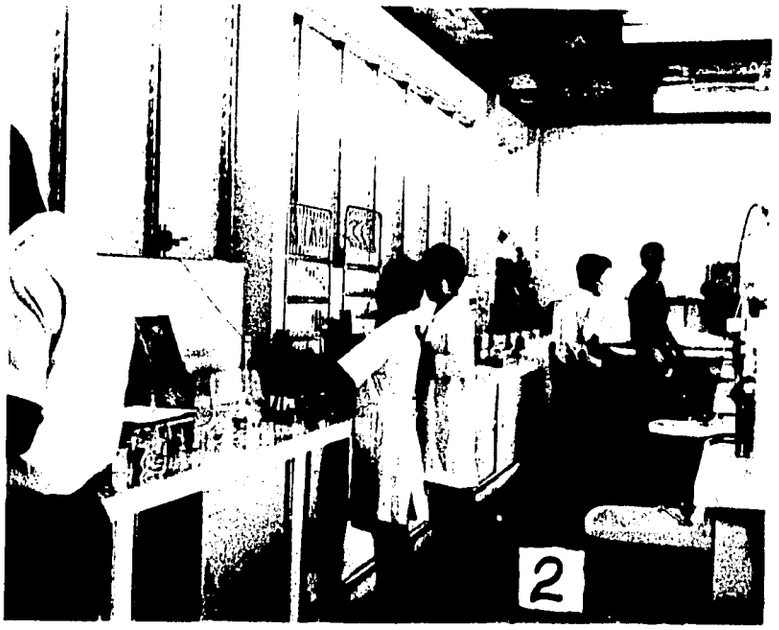
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4

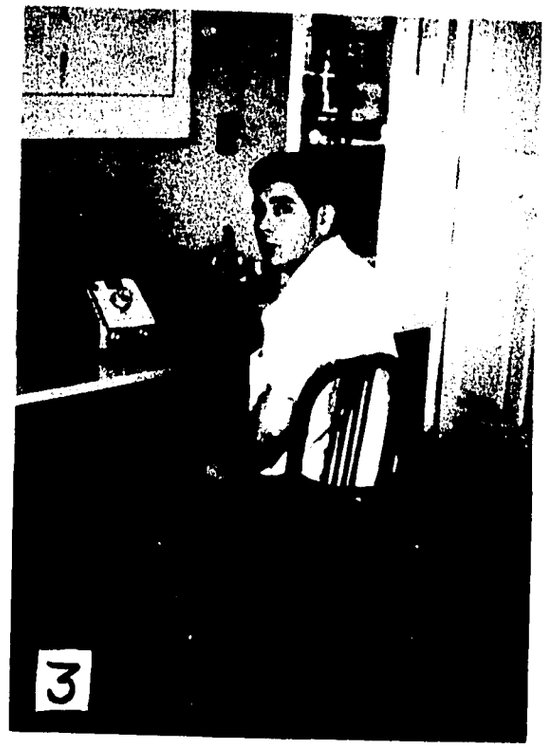
Photos 1-4. Soil Testing Laboratory in Tegucigalpa, Honduras

Photo 1. Filtering eleven samples simultaneously.

Photos 2 & 4. Adding extractant to soil samples.

Photo 3. Colorimetric determination of phosphorus.

1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Dr. J. L. Walker discusses soil fertility assessment and use of soil amendments with the farm advisers and fertilizer industry representatives in Guatemala.

APPENDIX G

The Soil Science Seminars in Raleigh

Brochures

Program Outlines

Photos of Activities

Assessing and Correcting Nutrient Deficiencies in the Soils of Latin America

Program

of the

INTERNATIONAL SOIL TESTING PROJECT

AID/csd-287

June 5–July 15, 1966

Soil Science Department
NORTH CAROLINA STATE UNIVERSITY
Raleigh, N. C.

SUBJECT MATTER THAT WILL BE COVERED

Concepts of soil testing and plant analyses

Research

- Outlining problems
- Laboratory, greenhouse, and field studies
  - Observations will be made of each
- Correlation studies
- Methods of analyses
- Sampling problems

Sampling

- Soils
  - Composite
  - No. of cores
  - Depths
  - Seasonal effects
  - Variables
- Plants
  - Portion to sample
  - Seasonal effects
  - Daily variations

Laboratory procedures

- Techniques for speed and accuracy
- Methods of analyses for specific conditions
- Laboratory equipment and apparatus
  - Construction
  - Servicing
- Use of control samples

Interpretation of results

- Factors to consider
- Guide sheets

Making recommendations for improved crop production

- Guide sheets for soil and plant analyses
- Economic considerations
- Good soil management
- (all day field trip to observe successful land management practices)

Follow-up programs

- Availability of fertilizers and other soil amendments
- Understanding the tests and recommendations
- Visuals for educational programs
- Summary of analyses

General summary and disucssion

****

Operating A Soil-Plant Analyses Laboratory

Program

of the

INTERNATIONAL SOIL TESTING PROJECT

AID/csd-287

July 24-August 12, 1966

Soil Science Department
NORTH CAROLINA STATE UNIVERSITY
Raleigh, N. C.

SUBJECT MATTER THAT WILL BE COVERED

Concepts of soil testing and plant analyses

Sampling and sub-sampling

Receiving samples in the laboratory

Preparation of samples

Elements to be analyzed
- Forms in which they occur

Methods of Extraction
- Multiple Unit techniques
- Shaking and filtering

Principles of flame photometry

Principles of atomic absorption analyses

Colorimetric measurements

pH measurements

Soluble salts

EDTA titrations

Use of control samples
- Accuracy of analyses

Checking and adjusting equipment
- Spare parts that should be available

Visit to the North Carolina Department of Agriculture
- Soil testing laboratory
- Seed testing laboratory
- Fertilizer and pesticide laboratories

Visit to the North Carolina State University Plant Analyses Laboratory

General Summary and Discussion

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ASSESSING AND CORRECTING NUTRIENT DEFICIENCIES IN THE SOILS OF LATIN AMERICA

SEMINAR

INTERNATIONAL SOIL TESTING PROJECT

AID/csd-287

JUNE 5-JULY 15, 1966

SOIL SCIENCE DEPARTMENT
NORTH CAROLINA STATE UNIVERSITY
RALEIGH, N. C.

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A SOIL AND PLANT ANALYSES PROGRAM

Six weeks will be devoted to discussing the six phases of a soil and plant analyses program. Included will be lectures, group discussions, laboratory work and field trips. Each day will be divided into four periods of one and a half hours duration. The first period will be devoted to lectures by Dr. Berenyi and Dr. Fitts. Group discussions and summary statements will be conducted during the second period. Special lectures and demonstrations will be given during the third period. Laboratory work, consultation and library activity will be assigned to the fourth period. Of course, there will be some overlap of activities between periods.

Five field trips will occupy a full day and another five will be of one-half day duration.

A condensed schedule of activities for the six-week period is attached. An outline of subject matter to be covered in each period follows the condensed schedule.

CONDENSED SCHEDULE

	FIRST PART 0830-1000 McKimmon Room	SECOND PART 1030-1200 Room 202	THIRD PART 1330-1500 Auditorium	FOURTH PART 1530-1700 Room 206
June 6	Welcome Outline of program Announcements	Tour of Soils Building	Tour of Campus and surrounding areas	Evening Picnic 1021 Gardner St.
June 7	History of Soil Testing - ISTP A Soil Testing Program	Outline of Discussions	Laboratory	Laboratory
June 8	Factors Effecting Field-Soil Fertility relative to building fertility	Soil Testing in Participants' Countries	Laboratory	Laboratory
June 9	Soil Sampling	Soil Testing in Participants' Countries	SOIL SAMPLING (bus)	
June 10	Soil Sampling	Soil Testing in Participants' Countries	Dr. S. B. Weed Assoc. Professor Soil Chemistry & Soil Mineralogy "Soil Mineralogy"	Laboratory
June 13	Analytical Procedures	Soil Testing in Participants' Countries	Dr. R. J. Volk Prof. Soil Chem. "Plastic-rubber-glass"	Laboratory
June 14	FIELD TRIP - PIEDMONT			

	FIRST PART 0830-1000 McKimmon Room	SECOND PART 1030-1200 Room 202	THIRD PART 1330-1500 Auditorium	FOURTH PART 1530-1700 Room 206
June 15 1/	Analytical Procedures	Three most important problems in soil testing-plant analyses or soil management in participants' countries	Dr. E. J. Kamprath Prof. Soil Fertility "Soil Acidity"	Laboratory
June 16 1/	Analytical Procedures		Dr. E. J. Kamprath "Soil Phosphorus"	Laboratory
June 17 1/	Analytical Procedures		Soil Testing Laboratory (bus) Dr. P. H. Reid - Director Soil Testing Division	
June 20	Analytical Procedures	Questions for Discussion	Dr. C. B. Davey Prof. Forest Soils	Laboratory
June 21	Interpretation	Questions for Discussion	Laboratory	Laboratory
June 22	Interpretation	Questions for Discussion	Perkin-Elmer Atomic Absorption Spectrophotometry and Flame Photometry - Robert Kociza W. V. (Bill) Moseley	
June 23	FIELD TRIP: Coastal Plain, Rocky Mt. and Wilson Planters Cotton Oil Co. in Rocky Mt. Norfleet Sugg W. D. Lewis - County Extension Chairman - Wilson			
June 24	Interpretation	Questions for Discussion	Clayton Research Station William Alsbrook - Director	
June 27	FIELD TRIP - Laurinburg Hervey Evans Jr., Farm Manager - McNair Farms			

1/ Meet Room 202 on these dates.

	FIRST PART 0830-1000 McKimmon Room	SECOND PART 1030-1200 Room 202	THIRD PART 1330-1500 Auditorium	FOURTH PART 1530-1700 Room 206
June 28	Interpretation and Recommendations	Questions for Discussion	Jarrel Ash - Atomic Absorption and Flame Photometer Jarrel Ash - Atomic Absorption Charlie Neville and Alberto Goldwasse	
June 29	Recommendations	Questions for Discussion		
June 30	Recommendations	Questions for Discussion	Dr. W. V. Bartholomew Prof. Soil Microbiol. Soil Organic Matter and Nitrogen	Laboratory
July 1	Recommendations	Questions for Discussion	Laboratory	Laboratory
July 4	Recommendations	Questions for Discussion	Laboratory	Laboratory
July 5	Recommendations	Questions for Discussion	Laboratory	Laboratory
July 6	Seeing Soil Management Problems - S. E. Younts and Al Plant (bus) Southern Director of American Potash Institute and Foundation of International Potash Research and Agronomist			
July 7	Research	Questions for Discussion	Dr. W. V. Bartholomew Improving in the Laboratory	Laboratory
July 8	Research	Questions for Discussion	Seed Lab and Control Lab George E. Spain - Director Soil Testing Division E. W. Constable - State Chemist	
July 11	Educational	Questions for Discussion	Laboratory	Laboratory

	FIRST PART	SECOND PART	THIRD PART	FOURTH PART
	0830-1000 McKimmon Room	1030-1200 Room 202	1330-1500 Auditorium	1530-1700 Room 206
July 12	Educational	Questions for Discussion	Laboratory	Laboratory
July 13	Educational	Questions for Discussion	Laboratory	Laboratory
July 14	Durham, Chapel Hill, Research Triangle			
July 15	Educational	SUMMARY AND CONCLUSIONS		

OPERATING A SOIL-PLANT ANALYSIS LABORATORY

SEMINAR

INTERNATIONAL SOIL TESTING PROJECT

AID/csd-287

JULY 24-AUGUST 12, 1966

SOIL SCIENCE DEPARTMENT
NORTH CAROLINA STATE UNIVERSITY
RALEIGH, N. C.

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Miss Flora M. Espinosa	Instituto Salvadoreño de Investigaciones de Café	Santa Tecla, EL SALVADOR

PROGRAM SCHEDULE

Date	FIRST PART 8:00-10:00 a.m. McKimmon Room	SECOND PART 10:30-12:00 a.m. Room 202	THIRD PART 1:30-3:00 p.m. Room 206	FOURTH PART 3:30-5:00 p.m. Room 206
July 25	Welcome Registration Outline of Program	Tour of Soils Building	Tour of N.C. State University Campus and surrounding area Evening Picnic, 1021 Gardner St.	
July 26	Lecture	Group Discussions	Laboratory	
July 27	Lecture	Group Discussions	Visit to the N.C. State Soil Analyses Laboratory	
July 28	Lecture	Group Discussions	Laboratory	
July 29	Lecture	Group Discussions	Laboratory	
August 1	FIELD TRIP: Beaufort County in Eastern North Carolina (Soil management problems - Visit to the Phosphate Mine)			
August 2	Laboratory*		Jarrell Ash - Atomic Absorption and Flame Photometer Jarrell Ash - Atomic Absorption W. J. Gundry Alberto Goldwasser Ray Zickus	
August 3	Laboratory*			
August 4	Laboratory*		Lecture	Group Discussions
August 5	Laboratory*		Lecture	Group Discussion

*Two groups will be working in the State's Soil Laboratory.

Date	FIRST PART 8:00-10:00 a.m. McKimmon Room	SECOND PART 10:30-12:00 a.m. Room 202	THIRD PART 1:30-3:00 p.m. Room 206	FOURTH PART 3:30-5:00 p.m Room 2o6
August 6	Lecture		Laboratory	
August 8	Lecture	Group Discussions	Laboratory	
August 9	Lecture	Group Discussions	Laboratory	
August 10	DURHAM, CHAPEL HILL, BURLINGTON			
August 11	Lecture	Group Discussions	Laboratory Group Dinner in Raleigh Restaurant	
August 12	SUMMARY AND EVALUATION OF SEMINAR			

Photo 1. Mrs. Maria Teresa de Rivera House of Honduras, Mr. Rafael Oros Villegas of Bolivia, Miss Flora M. Espinosa of El Salvador and Miss Lilia Gutiérrez Moreno of Mexico are working as a team in determining calcium and magnesium with an atomic absorption spectrophotometer.

Photo 2. Mr. Jorge Humberto Cáceres Rueda of Ecuador and Mrs. Deolinda Flores de Villanueva of Perú measure potassium with a flame photometer. Note small plastic tube is used to suck solution from beakers in the tray into the instrument.

Photo 3. Mr. Jorge Alberto González Spiralli of Guatemala measures control samples in preparation for analysis.

Photo 4. Mr. & Mrs. Rivera House of Honduras remove an aliquot of soil extracted for phosphorus determination by means of a multiple unit dispenser.

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Photo 1. Seminar participants observe a fertilizer demonstration on tobacco. This field demonstration was part of the program of the County Agricultural Agent.

Photos 2 and 3. Dr. Al Plant is leading the discussion with seminar participants on soil management problems.

Photo 4. Mr. W. D. Lewis, County Agricultural Agent, presented the functions and duties of his office in relation to the farmers in Wilson County. Dr. N. Berenyi is interpreting.

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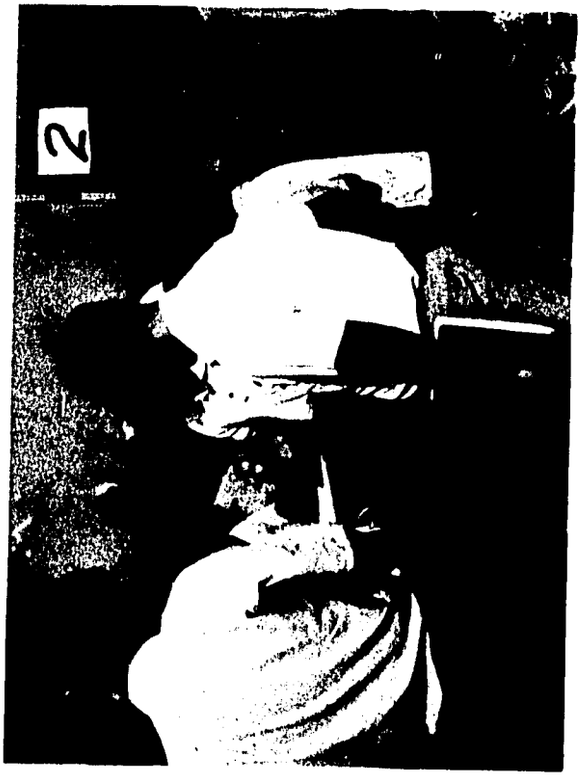
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Photo 1. Participants in first seminar are observing plant tissue testing as a diagnostic tool for determining the cause of poor plant growth.

Photo 2. Dr. R. J. McCracken pointed out the characteristics of the Davidson soil profile along a road cut. This soil has characteristics very similar to several soils in Latin America.

Photo 3. Dr. Al Plant demonstrates plant tissue analysis to participants of the second soil seminar.

Photo 4. Seminar participants are practicing diagnosing the cause of poor crop growth.

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