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THE FERTILIZER REQUIREMENTS OF COUNTRIES IN LATIN AMERICA

ANNUAL REPORT 1965

INTERNATIONAL Soil Testing

CONTRACT AID/csd-287
NORTH CAROLINA STATE UNIVERSITY
AT RALEIGH

S T A F F

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SUMMARY

Increasing crop production through the proper use of fertilizers and other soil amendments is the principle objective of the soil testing and plant analyses program. The major efforts of the project during 1965 have been directed to initiating and strengthening soil fertility evaluation programs in the cooperating countries of Latin America.

Questionnaires, which were designed to introduce the concept of a complete soil testing program and to learn what is being done in soil testing-plant analyses in Latin America, were completed during 1965. The results of the survey were published in Tech. Bul. No. 2 of the International Soil Testing Series. Soil testing-plant analyses programs generally were found to be in their infancy in these countries.

The advisory committees, which were appointed in each of the cooperating countries in 1965, have reviewed for their respective areas the status of soil testing-soil fertility work now under way and have outlined plans for strengthening the six phases of their soil testing-plant analyses programs. A United States Advisory Committee was appointed to review progress of the project and to offer constructive suggestions and criticisms.

Soil laboratories in Latin America lack the capacity to test the large number of samples during "rush periods" that are required for successful soil testing programs. Multiple unit apparatus was constructed and supplied to cooperating laboratories in twelve countries; these laboratories will have a capacity of more than 100 samples per day and will serve as a model for other laboratories. Help was given also to the Brazilian Ministry of Agriculture in constructing multiple unit apparatus for use in six laboratories in that country.

A Control Laboratory was established in Raleigh to work on problems encountered in the cooperating laboratories. The use of control samples is being introduced to the cooperating laboratories and ten bulk samples were collected

from Oregon, Texas and North Carolina for this purpose. Control samples were collected also in several of the Latin American countries for their own use as well as for exchange with other laboratories. The Control Laboratory in Raleigh will study procedures, techniques and apparatus best suited to Latin America.

Two technical bulletins of the International Soil Testing Series were printed. The first presents a "Rapid Method for Correlation of Soil Test Analyses with Plant Response Data". The second is a summary of the status of soil testing-plant analyses in Latin America - 1965.

Training sessions on techniques for obtaining representative soil samples were initiated for local agricultural leaders in Brazil and in some of the Middle American countries. Instructions were prepared for use in training meetings which outlined steps to follow and supplies required for collecting representative soil samples. Mailing cartons or bags and information sheets relative to the soil samples are now available in most of the Latin American countries.

Maps were prepared in Brazil showing the cultivated areas of the country and regions of acid soils where liming is a problem. Maps were also prepared for El Salvador, Guatemala and Honduras, showing major cropping areas where fertilizers are most likely to be used.

Two staff conferences, one in Raleigh and one in Guatemala, were held to discuss the accomplishments to date, problems encountered and to work out details for the ensuing program. Several professional meetings were attended by the various staff members in which reports were given relative to the project.

During 1965 three new staff members were added to the project. Dr. E. J. Kamprath and Dr. C. B. McCants, Professors of Soil Science, N. C. State University, will work as short-term consultants in Colombia and Venezuela respectively. Miss Fang-Hui Liao joined the staff to work as a research chemist in the Control Laboratory in Raleigh.

Dr. W. V. Bartholomew served as a special consultant to set up the multiple unit apparatus in the Middle American countries. Dr. A. H. Hunter, Regional Director for Uruguay, Argentina and Paraguay was transferred to the Middle American region and is now responsible for the project in Costa Rica, Panama and Nicaragua.

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THE FERTILIZER REQUIREMENTS OF COUNTRIES IN LATIN AMERICA

INTRODUCTION

Good soil management is essential in crop production. The proper use of fertilizers is an important part of good soil management. Soil testing-plant analyses programs as a guide to the proper use of fertilizer are still in their infancy in Latin American countries. This information stands out in the summary of the questionnaires that were completed in Part I of the Contract, "The Fertilizer Requirements of Countries in Latin America". Part II of the project is concerned with strengthening the various phases of a soil testing-plant analyses program in order that fertilizer use will increase in a logical manner. Part II was initiated in 1965 with the appointment of advisory committees in each of the cooperating countries to review their current status in soil testing-plant analyses programs, and to take steps to strengthen each phase.

Additional Staff and Reassignments

Obtaining qualified personnel, who have the experience, training, and interest needed in an international program, is a major problem. Furnishing continuity to a program is another problem. A new approach to these problems is being initiated in Venezuela and Colombia. Both of these countries have some able young scientists who need the benefit of consultation and guidance of experienced scientists. Dr. E. J. Kamprath and Dr. C. B. McCants, full professors on the staff of the Soil Science Department of N. C. State University at Raleigh, have joined the international staff on a part-time basis to work with the agricultural personnel in these countries. Dr. Kamprath will be a consultant for the project in Colombia. Each year he will make at least one trip to that country

but no more than two. On each trip he will work in Colombia for at least one month and not more than two. Dr. McCants will work on a similar arrangement in Venezuela. Since they will have this assignment for at least three years, continuity will be given to the program. Consultation through correspondence will be available during the period of time the scientists are on their regular assignments in Raleigh.

With the development of the Control Laboratory in Raleigh, two positions were created--one a Soil Scientist to be in charge of the laboratory and the other a chemist to make the analyses and aid in research. Miss Fang Hui Liao has joined the staff as Research Instructor in Soil Chemistry. Miss Liao received the M.S. degree from Michigan State University and has completed most of the requirements for the Ph.D. degree.

Interest in soil testing-plant analyses is very high in the Middle American countries and additional help for that region was imperative. In Uruguay the Ministry of Agriculture combined their soils laboratory with the laboratory of the National University. The responsibility of the new laboratory is for analyzing soil survey samples, and no samples will be tested for farmers seeking advice on soil fertility problems. A soil testing-soil fertility program in Uruguay will be delayed for a few years. The USAID Mission in Argentina expressed the opinion that the program should not be expanded in that country at the present time. With these adverse situations facing the project, Dr. Hunter was moved from Montevideo, Uruguay to San José, Costa Rica in July. His new region includes Panama, Costa Rica and Nicaragua.

Moving Dr. Hunter from Uruguay left Paraguay without a regional director to help them with their soil testing-plant analyses program. This responsibility was assumed temporarily by Dr. Fitts. He will assist Paraguay in much the same way

as Dr. Kamprath and Dr. McCants will work in Colombia and Venezuela.

During the conference of Project Contractors for Brazil that was held in Rio De Janeiro in July 1965, Dr. Richard Newberg, Chief, Office of Agriculture and Rural Development, USAID/Brazil, suggested, that in view of the big problem in increasing crop production in Northeastern Brazil, which appears to be closely related to soil fertility deficiencies, and in view of Robert Cate, Jr.'s knowledge of the region, that consideration should be given to transferring the headquarters of the International Soil Testing Project from Rio de Janeiro to Recife. The responsibilities of the project will remain the same but, since more attention is usually given to the area where the headquarters are located, it appeared that such a move would be desirable. The Government of Brazil approved the recommendation; so, the headquarters for Brazil was moved from Rio de Janeiro to Recife in October.

Title Change

The title of regional soil scientists was found to be non-descriptive of the responsibilities and activities of the overseas staff. Since these men are directing the project within their region, it appeared more appropriate to designate the positions as regional directors, which would be more descriptive of their duties. Therefore, the change has been made in the title of the overseas men from regional scientists to regional directors.

INITIATION OF PROJECT - PART II

Representatives of the Ministry of Agriculture and USAID Country Mission in each of the cooperating countries met with the Regional Director to appoint an advisory committee for the International Soil Testing Project. An effort was made to have each interested agency and company represented on the committee but, at the same time, retain a small committee so that it might be more effective.

Country Advisory Committee Conferences

The information obtained from the soil testing-plant analyses questionnaires was explained to the advisory committees of the cooperating countries. A set of sixty kodachrome slides was used to illustrate the various phases of soil testing-plant analyses. Based upon this information, the committees discussed steps they believed should be taken to strengthen their soil testing-plant analyses programs. Responsibilities of the various organizations were discussed and several of the committees established goals to work toward during the ensuing year. A typical example of the actions proposed in the various meetings is as follows:

1. Preparation of a report of the actions taken at the meetings to be reviewed by the participating groups. This report will include responsibilities to be assumed by the various agencies.
2. Upgrade one laboratory (usually in the Ministry of Agriculture) to a capacity of at least 100 sampes per day. This will require use of multiple dispensers and similar apparatus.
3. The International Soil Testing Project will supply about 10 control samples with accompanying data for the country laboratory to use. North Carolina procedures will be made available, too, if desired.
4. Guide sheets for interpreting soil test results and for making fertilizer and lime recommendations will be prepared. Of course, all available information will be drawn upon in preparing the guide sheets.
5. The Extension Service, with the help of the International Soil Testing Project and other agencies, will initiate educational programs designed to train agricultural leaders on: (a) taking representative soil samples, (b) area testing programs, (c) follow-up meetings to explain soil test results and to aid in getting recommended materials, and

(d) establishing demonstrations of existing data.

6. Encourage publication of existing data.

7. Take steps to get adequate support for a successful soil testing program.

INITIATION OF A CONTROL LABORATORY IN RALEIGH

Control Laboratory

In developing Part II of the project it became obvious that a Control Laboratory in Raleigh was a necessity. The responsibilities of the laboratory will include: (1) obtaining bulk soil samples for use as control samples in the cooperating laboratories, (2) analyzing samples from cooperating laboratories to help them adjust to new procedures, (3) helping to solve special problems encountered in the cooperating countries, and (4) conducting training sessions for soil testing-plant analyses leaders and for laboratory technicians.

The contract was amended to authorize the establishment of the Control Laboratory in Raleigh and steps have been taken to get it into operation. Satisfactory space for the laboratory was found in the Soil Science Department. Several alterations were necessary in the laboratory including the addition of some new laboratory benches and desks. Basic equipment and supplies had to be obtained; this included construction of several pieces of apparatus which are not available commercially. The laboratory was completed, however, and will be in operation in early 1966.

Control Samples

The survey of soil testing laboratories indicated that very few laboratories in Latin America were using control samples but, in operating a soil testing laboratory, the use of control samples is a "must". A control sample is one on which

the data are known, and is inserted with the farmers' or research samples in order to check equipment and techniques for errors. Ten control samples have been obtained for use in the laboratory in Raleigh and for sending to cooperating laboratories. Two of the samples are from the volcanic ash soils of Oregon, two from the black land soils of Texas, and six from North Carolina. After air drying, the 200 pound samples were passed through a 2 mm screen and thoroughly mixed. The first five of the samples have been analyzed and the following results obtained.

Table 1. Soil test results of five soil samples that will be used as "Controls" in cooperating laboratories.

Sample	pH	Available P ppm	Exchangeable K me/100 g	Exchangeable Ca me/100 g	Exchangeable Mg me/100 g	Organic Matter %
1	5.5	37	0.27	8.4	1.22	2.3
2	5.3	4	0.13	0.44	0.20	2.5
3	6.1	2	0.20	2.20	0.80	1.6
4	4.8	5	0.16	1.02	0.64	4.6
5	8.2	82	1.08	19.3	4.10	4.2

Obviously a good range in acidity and in available nutrients was obtained in these five samples.

Control samples have been collected in the various regions under the supervision of the Regional Directors for use in their areas. Several of these have already been submitted to the Control Laboratory in Raleigh for analyses.

In soil analyses, samples usually are measured rather than weighed. Using a given volume of soil for analyses is much more rapid than weighing. The question is sometimes raised relative to accuracy of measuring samples and the variation that

might be expected in scoops. The soil chemist in the Control Laboratory used three different scoops and weighed 10 measured samples from each of four soils. The results are presented in Table 2. Very little variation was obtained between scoops, between measured samples of the same soil, or between soils. The weight of soils high in organic matter will be less for the same volume than for mineral soils.

Table 2. Weights obtained by laboratory chemist with three scoops of 5 ml. capacity in measuring samples from four different soils at the Control Laboratory, Raleigh, North Carolina.

	Georgeville Soil (Piedmont Region N. C.)			Portsmouth Soil (Coastal Plain N. C.)		
Trial	Scoop 1 gms	Scoop 2 gms	Scoop 3 gms	Scoop 1 gms	Scoop 2 gms	Scoop 3 gms
1	5.10	5.09	5.01	5.01	5.12	5.09
2	5.08	5.10	5.08	5.12	5.13	5.07
3	5.0	5.1	5.02	5.07	5.13	5.01
4	5.11	5.12	5.0	5.03	5.1	5.11
5	5.03	5.11	5.04	5.06	5.12	5.05
6	5.10	5.11	5.08	5.03	5.10	5.0
7	5.0	5.15	5.0	5.06	5.12	5.10
8	5.0	5.17	5.02	5.10	5.16	5.07
9	5.10	5.10	5.02	5.06	5.15	5.05
10	5.05	5.11	5.10	5.06	5.13	5.10
Ave.	5.06	5.12	5.04	5.06	5.12	5.06

	Hayesville Soil (Mountains N. C.)			Amity Soil (Oregon)		
Trial	Scoop 1 gms	Scoop 2 gms	Scoop 3 gms	Scoop 1 gms	Scoop 2 gms	Scoop 3 gms
1	5.01	5.04	5.0	4.55	4.64	4.86
2	5.0	5.07	5.03	4.45	4.73	4.82
3	5.0	5.02	5.06	4.64	4.68	4.70
4	5.01	5.06	5.04	4.41	4.72	4.70
5	4.98	5.1	5.02	4.85	4.73	4.69
6	5.00	5.1	5.01	4.80	4.71	4.81
7	4.9	5.1	5.10	4.45	4.73	4.68
8	4.9	5.11	5.11	4.54	4.69	4.69
9	5.01	5.11	5.1	4.73	4.68	4.93
10	4.9	5.1	5.01	4.44	4.67	4.81
Ave.	4.97	5.08	5.05	4.59	4.70	4.77

Dr. Ludwig Muller of the Instituto Interamericano de Ciencias Agrícolas de la OEA, Centro de Enseñanza e Investigación, in Turrialba, Costa Rica was working on a plant nutrition problem with coffee and he suspected micronutrient deficiencies. Difficulty was encountered in getting analyses of plant parts for zinc, iron and manganese. Sixty plant samples from coffee were collected by Dr. Muller and submitted to the Control Laboratory in Raleigh for analyses. The samples were prepared for analyses in the Control Laboratory and then the analyses were made on an atomic absorption spectrophotometer in the Soil Science Department.

Shipping Control Samples Between Countries

Transmission of insects, nematodes and diseases (both plant and animal) is a problem in shipping soil samples from one country to another. Procedures to do this were worked out with the Plant Quarantine Division and the Plant Pest Control Division of the U. S. Department of Agriculture. Plastic cartons which can be tightly sealed with filament tape have been adopted for this purpose. Special labels are furnished to attach to the cartons at the time of shipment. As soon as the samples arrive at the Control Laboratory in Raleigh, they are fumigated with methyl bromide. After analyses are completed, any unused portion of the soil is further treated in a steam autoclave. Samples are treated with methyl bromide before shipping from the laboratory in Raleigh to cooperating laboratories, and such samples are appropriately tagged to indicate they have been fumigated.

HIGH CAPACITY LABORATORIES

Introduction of Multiple Unit Apparatus in Laboratories of Latin America

A successful soil testing program must have a laboratory that has a capacity to handle "peak loads". Unfortunately, it is impossible to obtain a uniform flow of samples to a laboratory throughout the year. Therefore, a laboratory must have

a much higher capacity per day than will be indicated as necessary when considering the total number of samples tested annually. Only one laboratory was found in Latin America with a capacity of over 50 samples per day. To test the volume of samples required, a laboratory must be able to handle over 100 samples per day. This can be easily accomplished by adapting techniques which handle a number of samples at one time rather than singly. Through the use of relatively inexpensive apparatus, the efficiency of the technician can be greatly increased without sacrificing accuracy. In fact, the accuracy of the analyses is likely to be increased.

The dispensing apparatus with the accompanying trays,etc., which were developed by Dr. E. W. Constable of the North Carolina Department of Agriculture more than 20 years ago, have been widely adapted in soil testing laboratories. Improvements have been made from time to time by various laboratories. Of course, each laboratory has adapted the apparatus to their particular needs. Most of the laboratories have built their own apparatus or have had it constructed for them. Multiple unit apparatus is not commercially available.

Robert Cate, Jr., the regional director for Brazil, realized that the capacity of laboratories in Brazil had to be greatly increased in order to have a successful program in that country. Through his efforts in working with Dr. Leandro Vettori and Maestre Abreu of the Ministry of Agriculture in Rio de Janeiro, multiple unit dispensers and trays were developed that have many advantages. The dispensers shown in Photos 3, 5, 10, 11 and 14, Appendix A, can be equipped with pipettes of a capacity up to 100 ml. The extraction solution to be used for removing available nutrient elements from the soil samples is placed in a 20 liter bottle. A constant supply is maintained in the reservoir trough on the dispenser through creation of a vaccum in the supply bottle. The pipettes have a capillary tube at the top of the stem which permit accurate filling. The height of the solution in the capillary stem is regulated by the hydrolic head developed in the standpipe next to the dispenser.

The dispensers are equipped with eleven pipettes. The odd number permits analysis of ten samples plus one control sample.

Washing glassware is always a problem when large numbers of samples are analyzed. The flasks in the trays in the Rio de Janeiro laboratory are rapidly washed by inverting over a series of spigots mounted in a trough which has been placed over a regular desk sink (Photos 6 and 7, Appendix A). A large bottle under the trough catches the soil and acts as a trap. This is a very effective, but inexpensive, arrangement for cleaning glassware.

Pipettes can be assembled on a board as illustrated in Photo 11, Appendix A. Donovan Waugh, the regional director in Peru, Ecuador and Bolivia, was responsible for "automating" the laboratory at La Molina, Peru. This apparatus was used first in a research laboratory to speed analyses of samples in a correlation study.

Obtaining materials for building the multiple unit apparatus is time consuming in the United States, and is much more difficult in most of the Latin American countries. Rather than take the time of the regional directors to obtain materials and make arrangements for construction of the apparatus locally, a decision was reached that such apparatus would be built in Raleigh. One laboratory in each cooperating country was selected as the laboratory to be equipped to handle large numbers of samples. The selected laboratory will be responsible for getting soil testing programs under way, and can serve as a model from which apparatus can be built locally for other laboratories. Four models of dispensers were built in Raleigh by Drs. Bartholomew and Fitts in an effort to simplify the apparatus. Arrangements were then made to have them built in the N. C. State University shops. One set of the apparatus was sent to each of the following countries for use in their laboratories: Perú, Ecuador, Paraguay, Panamá, Costa Rica, Nicaragua, Honduras, El Salvador, Guatemala and Mexico. The apparatus will soon be available for Venezuela and Colombia laboratories also.

Apparatus shipped to each country included:

5 multiple dispensers complete with standpipes and solution supply tanks

10 trays complete with 4 oz. plastic bottles

10 filter trays complete with glass filter tubes

1 trough equipped with spigots for washing bottles and rinsing in distilled water

1 foot pedal valve for the washer

12 4 oz. plastic bottles which will fit the extraction trays and can be used for phosphorus fixation studies.

"Inauguration" of Model Laboratories

As soon as the soil testing laboratory in Rio de Janeiro was equipped to analyze several hundred samples per day, similar apparatus was built by the Ministry of Agriculture shops under the supervision of Maestre Abreu for the laboratories in Campinas and in Recife, Brazil. Soon after the laboratories were satisfactorily in operation, inauguration ceremonies were held to acquaint the people with the new facilities. The occasions also served to focus attention on the possibilities of using soil testing-plant analyses as a vehicle to improve management practices. Photographs of news articles from local papers shown in Photos 15, 16 and 17, Appendix A, indicate the interest in these laboratories.

In Paraguay, President Alfredo Stroessner inaugurated the new soil testing laboratory in Asunción. There the government had constructed a new building (Photo 1, Appendix A) to house soil testing-plant analyses at the Facultad de Agronomía. There is considerable interest in developing a good soil testing program in Paraguay. A goal of 10,000 samples was set for 1966 which should have a considerable effect upon the consumption of fertilizers and upon crop production.

Donovan Waugh explains the new apparatus to the Minister of Agriculture and Livestock, José Aray Marín, of Ecuador in Photo 14, Appendix A. The apparatus was placed in the soil testing laboratory of the Ministry of Agriculture in Quito. With a few changes in the arrangement of the laboratory, the capacity can be greatly increased.

Planning Revision of Laboratory Facilities

Seldom is it possible to plan a completely new space for a laboratory, such as happened in Paraguay. Usually the laboratory must be adapted from existing space which may include offices as well as an old laboratory. To make the maximum use of the new multiple unit apparatus and to streamline activities, it is often desirable to make alterations in the available space. James Walker helped prepare plans for revision of the space in the laboratories in Honduras and in Guatemala. An example of the completed plans in Honduras is shown in Photo 2, Appendix A. A similar diagram was prepared for the Guatemala laboratory.

Donovan Waugh prepared similar plans for revision of the laboratory in the Ministry of Agriculture in Quito, Ecuador. This included estimates of materials that were needed.

Developing Additional Apparatus

Conditions differ from one country to another and from one laboratory to another. Apparatus must be adjusted and adapted to the local conditions. Efforts are being made by the regional directors and by the staff in the Control Laboratory in Raleigh to improve on apparatus for specific analyses. Bob Cate placed plastic cups in a tray similar to those used with the multiple dispensers for pH measurements. This permits use of the dispenser for adding water, and also the washer can be used for cleaning the cups.

Donovan Waugh has developed a dispensing unit which handles over 100 samples simultaneously rather than the 11-unit dispenser supplied to the cooperating laboratories. This apparatus will be very helpful to those laboratories that require a very high capacity such as 1,000 samples per day.

Arvel Hunter has been working with stirrers rather than shakers to mix the soil and extraction solution. He has also been working with measuring spoons and a soil crusher to increase the speed of this phase of laboratory operations.

The Control Laboratory in Raleigh has been designing new apparatus to speed up pH measurements and soluble salt determinations. Attention has also been given to adapting colorimeters to DC current with resistors to stabilize the voltage.

Preparation of Guide Sheets

After the analyses of soils or plants are completed,the results must be interpreted relative to the probability of obtaining a response from application of fertilizers or lime. The next step is making suggestions on the use of fertilizers and lime to the farmers. Factors other than fertility, including climatic conditions, management practices and economics, must be considered in making the recommendations. Guide sheets for use of the agronomist and for reference by local agricultural leaders are very essential. An outline for preparation of guide sheets for various crops is shown in Illustration 5, Appendix D. This was prepared for use in Guatemala, El Salvador, and Honduras by Dr. Walker.

PUBLICATIONS

Bulletins

One of the most important parts of a research project is publication of the results. Two types of publications have been initiated for the project; one is a technical series and the other an informational series. The first two technical

bulletins were published during the second half of the calendar year. Technical Bulletin No. 1 entitled "A Rapid Method for Correlation of Soil Test Analyses with Plant Response Data" (Illustrations 1-3, Appendix D) presents a simple but very effective method for interpreting soil test data without having to resort to difficult statistical procedures. The technique has been applied successfully to data that has been obtained during the past several years in the Instituto Agronómico in Campinas, Brazil. Technical Bulletin No. 1 also serves as a basis for developing greenhouse and field trials that are greatly needed in most areas in order to interpret soil test results.

Technical Bulletin No. 2 (Illustration 4, Appendix D) presents the results of the soil test-plant analyses questionnaires for Latin America that were completed by the regional directors. The bulletin shows that soil testing and plant analyses generally are in their infancy in Latin America.

Donovan Waugh has prepared the first two drafts of an informational series bulletin on laboratory and greenhouse techniques for obtaining information to interpret soil testing-plant analyses data. The bulletin will be ready for printing during the next few months.

Map Preparation

Frequently information is available from several sources and, if assembled, it can be very useful. Robert Cate, Jr. has gathered information from census reports and soil survey data which he used to prepare two maps. These are included in Appendix F of this report, and show the cultivated areas of Brazil and the areas under cultivation which are acid and will need lime for good crop production. The maps have proven to be very helpful in program planning in Brazil. The acidity map is very useful in research and educational programs for indicating regions where liming studies are needed, and where farmers must be trained on the use of lime.

It also shows where the greatest potential is likely to exist for marketing liming products.

James Walker followed a similar approach in bringing information together in Guatemala, El Salvador and Honduras, to show areas of specific crop production where soil fertility problems are most likely to need greatest attention. Photograph 24 in Appendix F shows the map he prepared for Guatemala. The maps for El Salvador and Honduras are similar to this one. Such information is useful in planning soil sampling programs for soil testing and in locating areas to establish demonstrations.

Interpretation Studies

Although many field trials have been conducted in various countries of Latin America, very few greenhouse or field studies have been made with the objective of obtaining information to interpret soil test results. Donovan Waugh initiated this important part of a soil testing program by enlisting the help of both the Agrarian University at La Molina and the SIPA staff members in obtaining samples from approximately 50 of the more important agricultural soils of Peru. About 50 kilograms of soil were taken from each of the major soils and transported to La Molina for studying. Three students majoring in Agronomy at the Agrarian University worked on specific problems with these soils in fulfilling the thesis requirement of the Ingeniero degree. After air drying, the soils were crushed to pass a 2 mm. screen and thoroughly mixed. Then portions of the samples were taken to the laboratory for routine analyses and for phosphorus fixation studies. Several of the soils were found to have high phosphorus fixation properties. From the laboratory data, the rates of phosphorus and potassium to apply in the greenhouse studies were predicted. Studies in the greenhouse were then conducted to determine response to the applied phosphate and potash. Photos 21, 22, and 23, Appendix C, show some of the difference in growth of plants as a result of the fertilizer treatments. After

harvesting the crop, the plant material was taken to the laboratory for analyses.

The soils were analyzed by four procedures--the North Carolina Mehlich procedure, Bray No. 1, Olsen sodium bicarbonate, and the new Purdue method. The soils in the study predominately were near neutral in reaction and were derived directly or indirectly from volcanic ash. Preliminary results from this study indicate that the North Carolina procedure, which was developed for acid soils, gave the poorest results and the Bray No. 1 procedure was the best. The Olsen bicarbonate method currently used in Peru may be changed in the future to the Bray procedure, if additional results confirm the information obtained in the preliminary study.

Before leaving Uruguay, Arvel Hunter made several trips to obtain soil samples from the major agricultural soils of that country. Approximately 80 samples were collected and these were prepared for analyses. Since Uruguay did not have a soil fertility laboratory in operation, the samples were shipped to the Control Laboratory for testing. The samples have not been analyzed as yet, but as soon as the information is available a report on the fertility status will be prepared and sent to Uruguay.

Frequency Distribution of Soil Test Results

One of the objectives of the International Soil Testing Project is to prepare summaries of the results obtained in soil and plant analyses. Very few areas have a sufficient number of samples tested as yet to give a meaningful summary. The three laboratories which have been modernized in Brazil (Rio de Janeiro, Campinas and Recife) are keeping records of the results of their tests in a manner which permits ready summarization. Figures 1 and 2 show the frequency distribution of results obtained in phosphorus and potassium analyses in the Rio de Janeiro, Campinas and Recife laboratories. Soils containing less than 9 ppm. phosphorus would be

Fig. 1 - Frequency Distribution of Soil Test Results

PHOSPHORUS

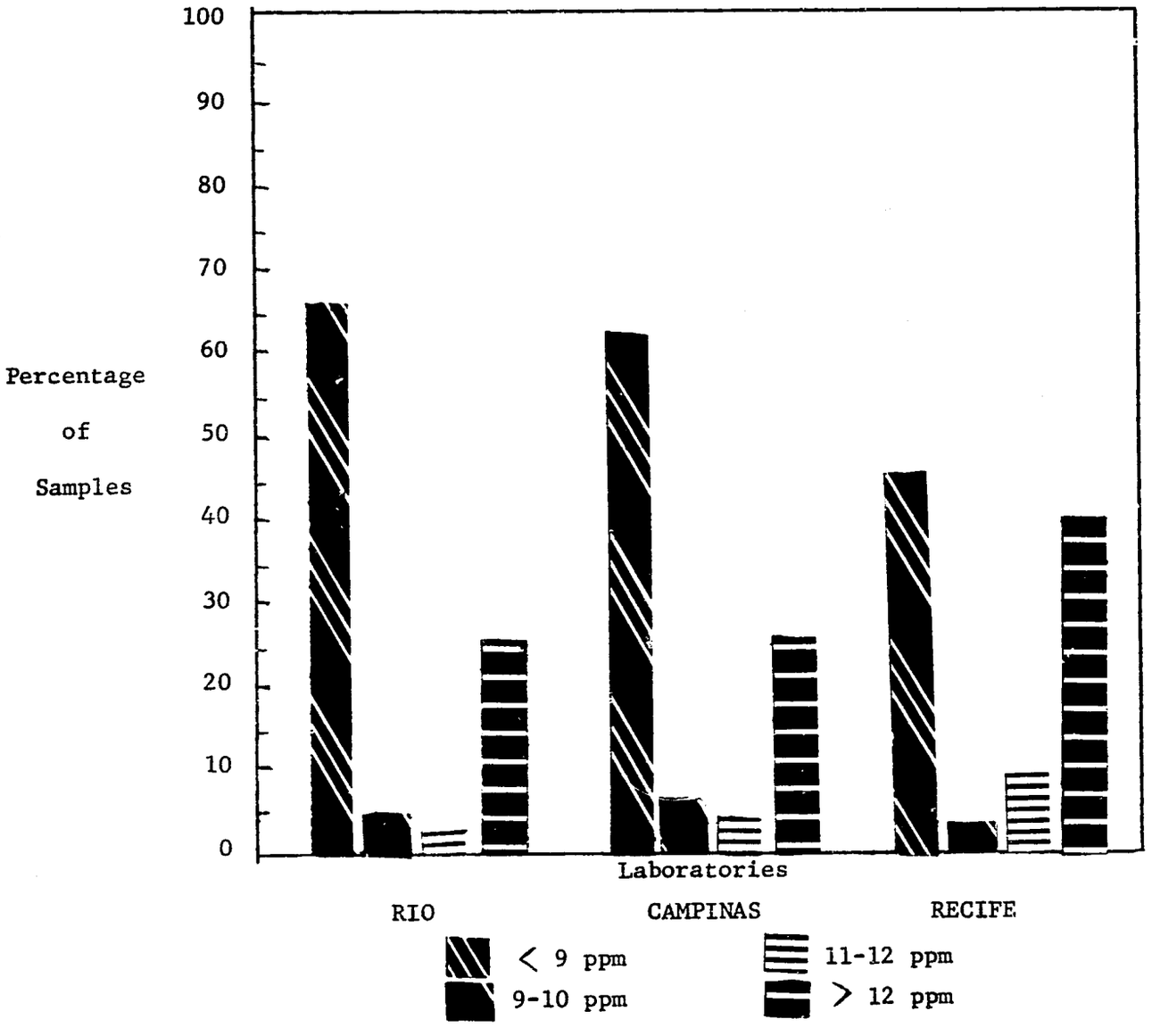
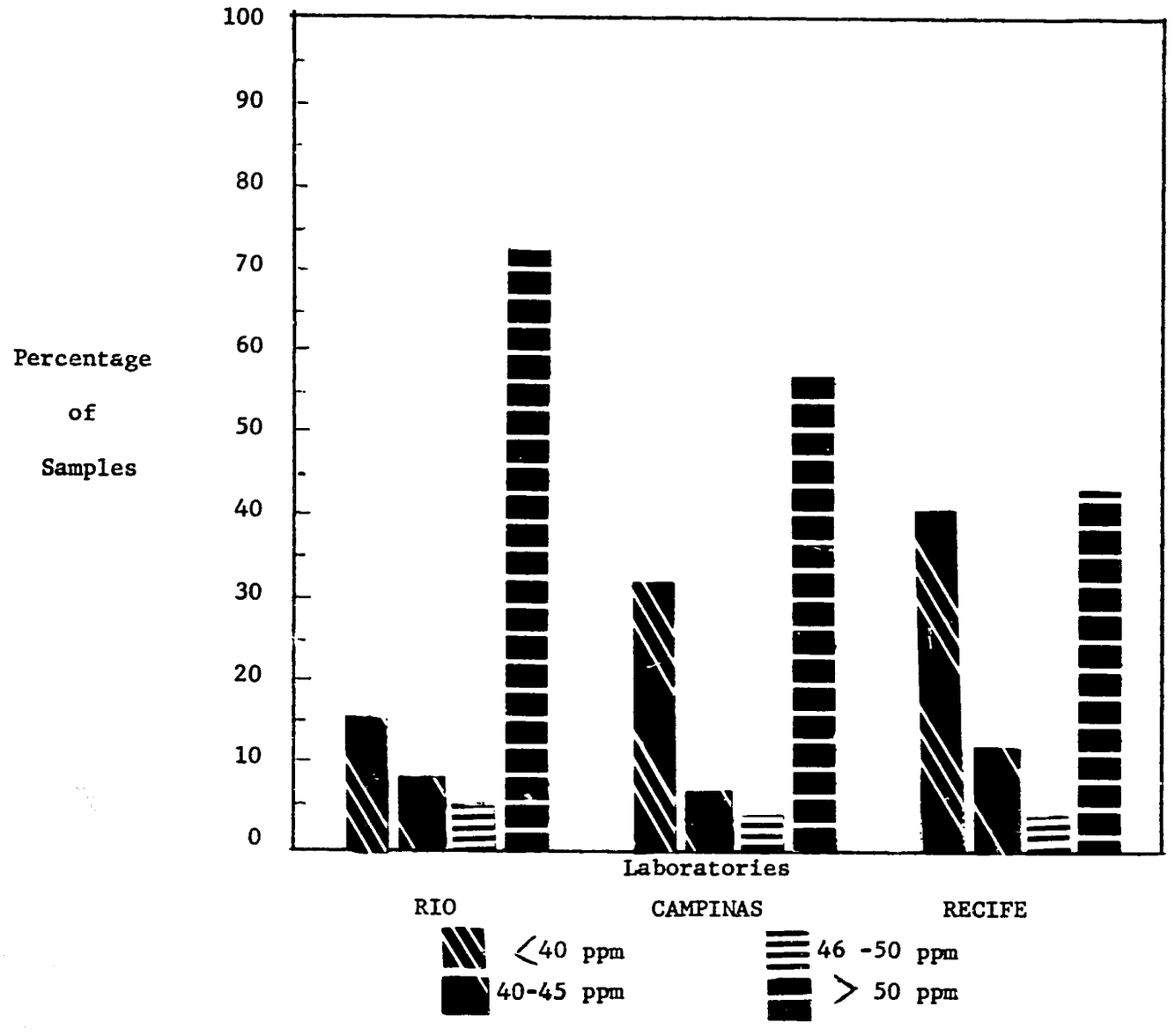


Fig. 2 - Frequency Distribution of Soil Test Results

POTASSIUM



expected to respond to application of phosphate fertilizers. Those above 12 ppm. probably will not respond and those between 9 and 12 (narrow range) are questionable. The same is true of the potassium results. Those less than 40 ppm. probably will respond to potash fertilizers and those above 50 ppm. probably will not. The results show how closely the tests are following the correlation procedure outlined in Tech. Bul. 1, and illustrated in Appendix D.

MEETINGS

Soil Sampling

Obtaining representative soil samples is one of the more critical phases of soil testing. The source of greatest error is in soil sampling rather than in the laboratory; therefore, too much emphasis cannot be given to soil sampling. Training local agricultural leaders on correct procedures to follow in sampling soils for nutrient analyses is essential in order that they may transmit the information to those persons collecting the samples. James Walker and Robert Cate, Jr. prepared outlines of materials and equipment needed for sampling soils, and for holding sampling meetings. Included in the outlines are instructions for taking the samples. Of course, this information was printed in Portuguese for Brazil and Spanish for Walker's region. Each regional director then conducted several training sessions in the field for the local leaders. The training sessions usually lasted most of one day, with the morning given over to demonstration and discussion. In the afternoon the group practiced sampling fields and discussed the various conditions which they encountered. Some of the problems encountered in sampling are shown in Photos 19 and 20, Appendix B. Examples of cartons used for submitting samples are shown in Photo 18, Appendix B.

Reports to Governments on Soil Testing Programs

Following the conferences with the advisory committees, the regional directors prepared reports for review by the local governments relative to a soil testing-plant analyses program, and suggested steps that are needed to strengthen their programs. Dr. Waugh, in the report attached in Appendix E, presented a program in which he pointed out the high cost of trying to maintain several laboratories in Perú, when transportation to Lima is readily available and relatively cheap. The report had considerable influence in changing the planning for soil testing-plant analyses laboratories in Perú. Emphasis is now being placed upon developing a large laboratory with a high capacity in Lima.

Dr. Hunter prepared a report, presented in Appendix E, outlining soil testing programs for the Panamanian, Costa Rican and Nicaraguan Governments. An example of the report prepared by Dr. Walker for the governments in his region is also presented in the Appendix E. In his report, Dr. Walker specifically outlined responsibilities of the various agencies and organizations.

Training Soil Testing Directors

Plans are being developed to conduct training sessions for soil testing-soil fertility leaders and for laboratory technicians at the Control Laboratory in Raleigh during the summer of 1966. Costa Rica, however, wished to send their soil science director to Raleigh before then in order that they could get their program under way sooner. Ing. Oscar Vargas came to Raleigh in September for a three-month training period. Although the Control Laboratory was not ready for use, a program was worked out for Mr. Vargas. He audited two courses in soil fertility and fertilizers, and one in soil classification. He spent considerable time in the N. C. State Soil Testing Laboratory and made a few field trips to observe field studies. He also participated in seminars and in discussions with other soil scientists on soil testing-soil fertility problems.

Professional Meetings

Participation in numerous meetings and conferences by the Project Director and Regional Directors is essential for operation of the project. Objectives of the program activities under way and progress that has been made should be presented to interested groups. Valuable suggestions and ideas for improving the program are frequently obtained in such meetings. Some of the major meetings and conferences in which the staff participated include:

(a) AID Research in Agriculture and Rural Development Conference, Washington. A report was given by Dr. Fitts on the present status of the International Soil Testing Project. This annual conference for contract leaders of AID Research projects is a valuable meeting, which gives an opportunity for the leaders to become familiar with the overall research programs, to coordinate activities, and to learn the experience of others in conducting their projects.

(b) Conference in Rio de Janeiro - World Soil Resources Conference of the United Nations (FAO) for correlation of South American soils. Purpose of the meeting was to discuss the third draft soil map of South America, and the soil potentialities or capabilities evaluation. Attended by Donovan L. Waugh. Dr. Waugh's report of the meeting is included in Appendix E.

(c) AID Contractors in Brazil Conference in Rio de Janeiro. Attended by the Regional Director, R. B. Cate, Jr. and Project Director, J. W. Fitts. The theme of the conference was "Bottlenecks in Brazilian Agriculture; How Soon Can They be Eliminated?". Overall problems and individual contract problems were discussed.

(d) Latin America Soil Science Meeting and Brazil Soil Science Meeting, Piracicaba, Brazil. Attended by R. B. Cate, Jr., D. L. Waugh, and J. W. Fitts. Paper by Cate and Fitts presented by Cate on the International Soil Testing Project and the accomplishments to date. Cate's presentation was followed by an enthusiastic endorsement of the project

by the Brazilian Soil Scientists, of which over 100 were in attendance at the meeting.

(e) North Carolina Soil Science Society Annual Meeting. Attended by J. W. Fitts. He presented a paper entitled "Progress Report on the International Soil Testing Project".

(f) Soil Conservation Society of North Carolina Annual Meeting. Attended by J. W. Fitts. The opening address of the meeting was presented by Dr. Fitts in which he discussed foreign aid programs and their importance to the United States. He also explained the International Soil Testing Project.

(g) American Society of Agronomy and Soil Science Society of America Annual Meetings. Attended by J. W. Fitts. Participated in committee discussion of soil testing-plant analyses programs. Also listened to several research reports relative to soil testing, plant analyses and soil fertility programs.

(h) Conference in New York by the Project Director, J. W. Fitts, with representatives of the Esso Chemical Co. and Esso International, Inc. Progress of the International Testing Project was reviewed and avenues of mutual cooperation were discussed.

Staff Conferences

The regional directors conduct their programs individually, and have little opportunity for consultation with other staff members relative to problems encountered, progress being made, etc. Therefore, it is very essential for the staff to get together at least twice a year to review accomplishments, exchange ideas, discuss problems, and outline future activities. The first conference for the staff was held in Raleigh in April; the second in Guatemala in late November.

The agenda for the first meeting was as follows:

Attendance

R. B. Cate, Jr., A. H. Hunter, D. L. Waugh, J. L. Walker, Raleigh staff, and Consultants from Soils and Statistical staff in Raleigh.

Purpose

To review information gained in country meetings and to coordinate activities for the second phase of the Soil Testing Project.

Agenda

1.0 Summary reports of questionnaires

- a.0 strong points of programs by countries
- b.0 phases of programs that need strengthening
- c.0 publication of summaries
  - 1.1 regions
  - 2.1 amount of detail

2.0 Soil sampling

- a.0 additional studies needed
- b.0 programs for Extension
  - 1.1 outlines for training meetings
  - 2.1 information sheets and soil cartons
    - a.1 types to use
    - b.1 availability
  - 3.1 sampling programs on area basis

3.0 Preparing samples for analyses

- a.0 apparatus to use for crushing
- b.0 storage cartons, trays and racks
- c.0 coding of samples

4.0 Calibration procedures

a.0 Greenhouse or shadehouse studies

1.1 type to use

2.1 statistical design and analyses

b.0 Field studies

1.1 objectives

a.1 annual response

b.1 building soil fertility to certain levels

2.1 types of studies to recommend

3.1 statistical designs and analyses

5.0 Extractants to recommend

a.0 elements for which tests will be made

b.0 extractants to use for each element in relation to soil conditions

6.0 Secondary elements and micronutrient problems

a.0 how to handle in respect to soil, crop, and climate

7.0 Soil acidity and lime requirement measurements

a.0 procedures to follow

b.0 interpretation of results

8.0 Developing model laboratories

a.0 equipment and apparatus needed

b.0 when to obtain equipment and how to get apparatus constructed

1.1 preparation of diagrams for construction of apparatus

9.0 Preparation of guide sheets for use by laboratories in interpreting results of soil tests and in making recommendations on use of fertilizers and lime

10.0 The Control Laboratory

a.0 Responsibilities in analyses

1.1 assembling bulk samples for control

2.1 checking control samples from cooperating labs

3.1 trouble shooting for cooperating labs

4.1 research on problems and conditions

b.0 Training program

1.1 for program directors

2.1 for laboratory technicians

c.0 Shipping samples from country to country

1.1 quarantine fumigation

2.1 proposal for fumigating samples in Raleigh

11.0 Publications

a.0 technical articles

b.0 management series

12.0 Preparation of Visual Aids

a.0 types needed

b.0 slide sets and movies available

13.0 Educational programs

a.0 graduate research studies

14.0 Revolving Fund

a.0 procedures, etc.

15.0 Monthly reports

16.0 Fiscal year report

17.0 Relations with other programs

18.0 Pro-ags for cooperating countries

a.0 furnishing office space and secretarial help

19.0 Miscellaneous

A report of the April conference was submitted to AID/W and to cooperating agencies. The format was prepared for the report of the questionnaires that had been completed on soil testing-plant analyses in Latin America. A decision was reached that country and regional summaries would be prepared by the regional directors;a general summary would be the responsibility of the project director.

The necessity of quickly improving at least one laboratory within a country was noted in order to have a sufficient capacity to test samples submitted within a reasonable time. A decision was made to furnish multiple unit apparatus, including dispensers, to one laboratory within each country. This was to be done to avoid delays in getting soil testing programs under way.

There was considerable discussion on the necessity of establishing a Control Laboratory in Raleigh to help solve some of the problems of laboratories in cooperating countries. The Control Laboratory would also be responsible for submitting control samples to the cooperating laboratories and for testing control samples sent to it from the same laboratories. A request was made for the Control Laboratory to organize two short courses for soil testing-soil fertility leaders and laboratory technicians.

The agenda for the second staff conference was as follows:

Attendance

Staff Member	Headquarters	Countries Assigned
R. B. Cate, Jr.	Recife, Brazil	Brazil
A. H. Hunter	San José, Costa Rica	Panamá, Costa Rica, Nicaragua
J. L. Walker	Guatemala City, Guatemala	Guatemala, Honduras, El Salvador, Mexico
D. L. Waugh	Lima, Peru	Peru, Bolivia, Ecuador
E. J. Kamprath	Raleigh, N. C.	Colombia
C. B. McCants	Raleigh, N. C.	Venezuela

Staff Member	Headquarters	Countries Assigned
J. W. Fitts	Raleigh, N. C.	Project Director
D. Goodson	Raleigh, N. C.	Administrative Assistant
Milton Lau	Guatemala	USAID Mission/Guatemala
B. J. Birdsall	San Salvador	USAID Mission/El Salvador

Purpose

To review progress made and problems encountered in initiating the second phase of the program and to project activities for the next six months.

Agenda

1.0 Review of activities of the past seven months

A. Establishing model laboratories

1.1 present status of laboratories

a.1 staff

b.1 equipment

c.1 supplies

B. Open House or inauguration of laboratories

1.1 number held and accomplishments

C. Research programs

1.1 those undertaken

a.1 organizations and persons responsible

b.1 progress to date

D. Soil sampling programs

1.1 agencies involved

2.1 training sessions

E. Advisory Committees

2.0 Program for the next eight months

A. Completing the model laboratories; one in all cooperating countries by March 1966

B. Open House programs for new laboratories

C. Research programs

- 1.1 agencies to be responsible
- 2.1 objectives and procedures
  - a.1 laboratory
  - b.1 greenhouse
  - c.1 field

D. Educational programs

- 1.1 agencies to conduct
- 2.1 organization
- 3.1 coordination of activities
- 4.1 demonstrations

E. Development of Visual Aids

- 1.1 soil sampling information
  - a.1 guides to take samples
  - b.1 information sheets
  - c.1 sample cartons
- 2.1 follow-up programs

F. Control Laboratory

- 1.1 exchange of samples
- 2.1 problems encountered in laboratories
- 3.1 problem soils

G. Advisory Committee meetings

H. Annual report for 1965

1.1 summary edition

2.1 visuals

I. Publications

1.1 to be prepared or being prepared

3.0 General considerations

A. Country or regional conferences

1.1 type of program

2.1 subject matter

B. Home leave

1.1 procedures, regulations, etc.

C. Expressing nutrient elements in tests

D. Weights of measured soils

E. Availability of suitable grades of fertilizers

1.1 that will be recommended

2.1 steps that might be taken to get suitable fertilizers

3.1 standardization of fertilizers or grades for areas

F. Availability of liming materials

1.1 distribution

G. Short courses

1.1 subject matter

2.1 selection of persons who should attend

3.1 length

4.1 time of year

H. Administrative problems

I. Individual consultations (1/2 day)

1.1 technical problems and policies - J. W. Fitts

2.1 administrative details - D. Goodson

J. Miscellaneous

The progress reports as presented at the conference by the Regional Directors for their respective regions are as follows:

BRAZIL - Robert B. Cate, Jr., Regional Director

The Ministry of Agriculture has manufactured equipment for five modern soil testing labs. Three of these are in operation and the other two are being installed in December. Additional equipment is being produced, and it is hoped that four more labs will be installed by early 1966. A list of these various labs is given below:

In Operation	Being Installed	Planned for Near Future
Rio (federal)	Cruz das Almas (federal)	Pelotas (federal)
Campinas (state)	Itabuna (cacao)	Sete Lagôas (federal)
Recife (federal)		Belém (federal)
		Km. 47 (federal)

All of the federal labs will use virtually identical sample containers, instructions, report forms, guide sheets, and filing techniques. The other two labs differ slightly in these respects, but all are expected to use the same basic methods of extraction, determination, and interpretation. Specific recommendations, of course, will vary with the climate,soils,etc.,but it is hoped that these variations from the present Rio-Campinas-Recife norms will only occur when warranted by adequate data. All labs will exchange control samples.

Sample containers and instructions are presently being distributed primarily through extension agencies, cooperatives and banks. Publicity has been restricted so far, but as the operations in the various labs become routine more attention will be given to publicizing their activities. It is hoped that the Ministry will launch a major educational campaign in early 1966, assuming all of the regional labs are ready for operation.

Two maps have been published--one showing the distribution of cultivated land in Brazil, and the other giving an estimate of the proportions of this land that need lime in the various areas. Soil testing by uniform methods is already producing data on which to base more and better maps of fertilizer and liming needs. In the meanwhile, graphs are being prepared to show the frequency distribution of High and Low P and K levels in the samples analyzed at the three operating labs.

The regional director for Brazil was senior author of ISTP Technical Bulletin No. 1, and a junior author of Technical Bulletin No. 2. Others are planned.

The USAID/Brazil Soil Fertility-Soil Testing Committee reviewed activities of the International Soil Testing Project in their semi-annual meetings. A paper relative to the International Soil Testing program was presented at the Brazilian Society of Soil Science and the Latin American Soil Science Society meetings in Piracicaba.

PERU, ECUADOR, BOLIVIA - D. L. Waugh, Regional Director

This report, which includes activities from May through November 1965, will be divided into three sections.

I. Preparation of Plans for Soil Testing in Perú, Ecuador and Bolivia

With the survey of soil laboratories being completed during the first year of work on the program (June 1964 to April 1965), plans were made in each of these three countries to develop the soil testing programs. The most complete plans were made in Ecuador, where four meetings have taken place with the National Soils Committee. This committee was organized from the start and includes representatives from nearly every area of activity which has any interest in soils. At the last meeting the committee finally elected a chairman and vice-chairman: Dr. Julio Peña and Ing. Victor Alvarez, respectively. However, since that time, the latter of these men has more or less been shifted out of the soils activities, at least for

the moment, and the former is nearing retirement. There is, therefore, little if any push in the program at this time.

At the other extreme, the program in Bolivia has had no real organization attempted as yet. The supply of soils technicians in Bolivia is small (but reasonably competent) and the general idea of soil testing, as we refer to it as a program, has not really been developed. A detailed floor plan has been prepared to build a complex of office and laboratory units at Santa Cruz. This center would contain both soil analyses lab space and extension offices, in addition to other offices, and would make an excellent center for the soil testing program of Bolivia. The only other laboratory actually running analyses is the one at the University in Cochabamba. While doing a commendable job of soil analyses, this lab cannot at the present time be considered ideal as a service center for farmer samples for Bolivia, owing to its being the part of a university system (autonomous) rather than a part of the Bolivian Ministry.

The plan for soil testing in Perú has been completed and submitted to the Ministry for budgetary approval. The plan, in general, is to concentrate all effort for routine soil analyses as a service in the SIPA laboratory at La Molina, and to advance the laboratory facilities at the University (Universidad Agraria) for teaching and research purposes. The plan cannot take full effect until the SIPA lab proves that it can effectively handle the entire service area of analyses.

The anticipated program of soil testing as a service is somewhat unique in design, especially for Perú. A cost study of analyses in Perú showed that the operation of a number of small labs in Perú (by SIPA) can never reach a very efficient level, due to the high costs in the establishment of laboratories and staffing them at even a marginal level. A far better alternative would be to automate one central laboratory (which would require that it be in Lima), which would be responsible for servicing the entire country as it is able. The extension-

fomento offices located throughout the country would serve as the agent to properly take farmer samples, send to the central analyses center (by air-freight contract), and take the information back to the farmer following analysis. Goals of number of analyses were set at 25,000 the coming year (1966), with increases of 25,000 samples per year. Since the entire service would be handled by SIPA, the efficiency and consistency of the service to the farmer should be rather uniform across the country.

Perhaps the greatest potential of the SIPA service analysis proposal is that it can then be tied in closely with the supervised credit program, which is aimed specifically at getting credit to small operation farmers. The technical base provided by soil testing will greatly improve the chance for success in the fertilizer promotion program.

2. Automation of Soil Laboratories; Open Houses

In an attempt to help every country develop one automated laboratory, International Soil Testing and North Carolina State University constructed a series of automating equipment. Most of the items (constant suction pipette units, trays, washer unit, etc.) have been installed now in the Ministry Laboratory in Quito, Ecuador and in the SIPA lab at La Molina. The decision was made to postpone shipment of equipment to Bolivia until such time as it can be decided which lab will actually handle routine farmer service. This will depend primarily on whether or not the proposed soils center at Santa Cruz is actually completed.

In addition to the automating apparatus supplied by the project, the lab at La Molina has constructed provisional models of all types of apparatus. With the lack of a few miscellaneous pieces of equipment to complete the new automation, these provisional models have served their purpose galantly, helping complete about a thousand P analyses to be included in the study of methods for phosphorus.

Also, the lab at La Molina is experimenting with a larger system of automation, which includes working with a series of 105 samples at a time.A pipette model has been constructed at a local metal shop and accessories for it at a heavy plastic shop. Preliminary tests show the equipment to be very good in potentials, but needing a few modifications before the contract is let to make up the remaining pieces of automation for the service laboratory.

3. Experimentation and Correlating Research for Methods of P Analyses

In the course of the past six months, four separate research projects have been initiated to provide the basis for selection of soil testing methods appropriate for Perú. A study has been started in the Universidad Central in Ecuador, also. Of the four studies taking place in Perú, all of them are thesis projects for students from the Agrarian University. As Regional Director of soil testing, I have been permitted to serve as co-professor on the studies, two of which are in conjunction with Ing. Carlos Valverde (SIPA), and two of which are with Ing. José Estrada (Universidad Agraria). A fifth study is planned for another thesis beginning in January 1966.

The study to date with correlation of phosphorus methods points to Bray No. 1 as the most likely candidate. The North Carolina extractant, being acid, extracts much too much P from most of the soils which are calcareous, and it does not look as though it would be possible to separate soils low in phosphorus from those which are high. The Olsen test, which the lab has been using, and the new Purdue test both give predictions more or less as good as Bray No. 1; however, due to the fact that the Bray No. 1 test is much easier to carry out, and probably more reproducible, the extra work involved in Olsen and Purdue tests does not seem warranted. Studies of correlation will, however, be continued both in potted-plant studies and in field trials, the objective being to improve the interpretation of the Bray test and make it increasingly more applicable to Peruvian conditions.

NICARAGUA, COSTA RICA, PANAMA - A. H. Hunter, Regional Director

The work of establishing increased soil fertility-testing programs in this area is progressing quite well, and I think at a satisfactory rate, considering the various problems involved, not the least of which is the problem of obtaining sufficient budget for carrying on such a program.

One can sympathize somewhat with the reluctance that the Ministries of Agriculture have in providing such budgets as one observes the lack of effectiveness of the type of such services which have been provided in the past. This emphasizes the great need for establishing some type of educational program designed to demonstrate the value which a properly conducted soil testing program can have on the economy of a country. Plans are being formulated, therefore, for undertaking such a program which can be concentrated on a small segment of agriculture within the country. It is intended to initiate these programs as soon as the laboratories are equipped so as to be capable of handling the number of analyses which such a program would require of it. The target date for this is set at mid-March 1966.

In all three countries the Ministry of Agriculture laboratories, which will have the responsibility of carrying out the soil fertility-testing programs, are also charged with the responsibility of running chemical and physical analyses for the characterization of soils in their presently operating (Costa Rica and Panama), or soon to be established (Nicaragua), soil classification programs. This may be advantageous from the standpoint that the analyses for the classification program will be accomplished more rapidly, and support will be more readily available to the soil fertility-testing program in its early stages and aid it to reach a point where it will demand support on its own merits.

At present, the multiple analyses equipment furnished by the International Soil Testing Project at Raleigh, North Carolina, has been set up in all three

laboratories. Plans have been drawn up for each laboratory to utilize the available space to the best advantage for making large numbers of analyses. There is already much enthusiasm expressed for the labor and time-saving devices and ideas which have come from the International Soil Testing Project. The methods to be used will be uniform for all of Central America unless in the future good reasons can be shown for changing methods for an area. The use of similar methods should help facilitate the interchange of information which becomes available in each area. The importance of this becomes increasingly evident in view of the small amount of soil fertility information which is presently available and the small number of people now engaged in work which will produce the needed information.

The laboratories in Nicaragua and Panama are presently quite well equipped with respect to the electronic equipment needed for the basic soils analyses, although there is a dire shortage of general laboratory supplies and reagents. The laboratory in Costa Rica at present has only one piece of electronic equipment (a portable pH meter) but monies have now been promised for the purchase of a flame photometer and a colorimeter. In Costa Rica, new space for a laboratory and necessary offices has been made available recently and within the past month the laboratory area has been remodeled. It is expected to be in operation by the middle of December 1965. Ing. Oscar Vargas, who will be in charge of the Soil Fertility-Testing program in Costa Rica, will be returning in December from an intensive training session at North Carolina State University. He received instruction in all phases of a soil fertility-testing program and this should greatly aid in the progress and program in Costa Rica. It is hoped that the other directors of the program and the laboratory directors from each of the countries will be able to receive this intensive training at North Carolina State University during 1966.

Soil samples from major cropping areas are now being gathered in all three countries in preparation for doing laboratory and greenhouse studies concerning

fixation of phosphorus and potassium. These studies are intended to give some basic information with regard to the critical levels of these elements as measured by the extracting solution to be used. This information, of course, is necessary to allow better interpretation of the laboratory results for making recommendations to farmers.

It is anticipated that in Costa Rica, and perhaps Nicaragua, a tissue analyses service will also be initiated and coordinated with the soil analyses to better serve the coffee industry of these countries.

In Costa Rica there have been definite plans for at least one fertilizer industry to set up a soil testing service laboratory; also the Province of Guanacaste desired to have its own service. At the present time, plans for these two services have been suspended in favor of supporting a good central service operated by the Ministry of Agriculture. In Nicaragua and Panama, there is also strong support for the central service under the direction of the Ministry of Agriculture.

As soon as the business of getting laboratories established and capable of operating at a capacity sufficient to serve the needs, then increased attention will be given to the other phases of the soil fertility-testing program.

It has been suggested that the three laboratories hold "Open House" programs during the month of February 1966 to which Government officials and other interested people will be invited. This will give opportunity for these people to see what is being done and what is expected to be done in bringing this service to the farmers.

GUATEMALA, EL SALVADOR, MEXICO, HONDURAS - J. L. Walker, Regional Director

Official Project Coordinating Committees have been established in Guatemala, El Salvador, and Honduras. These committees usually comprise agronomists from the soil and crop production departments of the government as well as university, extension service, agrarian reform, and fertilizer company representatives. USAID, OAS, and FAO advisers also have been invited to work with these committees and are doing so at the

present time. The first regional coordinating meeting was held by representatives of these committees in El Salvador in November 1965 under the sponsorship of the International Soil Testing Project.

The International Soil Testing Project has proposed uniform soil sample instructions, sample containers, and information sheets and submitted designs for these to be used throughout the region. These have all been accepted and will be in use sometime during 1966. A training session on how to collect soil samples for obtaining fertilizer recommendations has been held. About 30 agricultural specialists attended. The sampling instructions and information sheets suggested by the International Soil Testing Project were successfully used during this field day in Guatemala. The International Soil Testing Project has proposed a uniform method for soil sample analyses. This will soon be in use throughout the region.

Regional control samples have been collected and analyzed at N. C. State. These are now being used to standardize methods of analyses throughout the region. All laboratories will be using the same six regional control samples by the end of January 1966. The laboratories plan to regularly exchange future control samples every three months in order to maintain regional standardization.

The International Soil Testing Project was requested by the Ministries of Agriculture of Guatemala, El Salvador, and Honduras to submit blue prints suggesting changes to be made to modernize the soil analytical laboratories. These suggestions for modernization have been accepted with the modernization work now in various stages in the three countries. It is expected that the improved financial state within the Ministry in Guatemala and Honduras for 1966 will enable this work to be completed by late 1966. The work in El Salvador has largely been completed by the present date. The problem is to continue the service while the working areas are being modified. The International Soil Testing Project has built and installed multiple analyses equipment for the laboratories in Guatemala, El Salvador and Honduras. Personnel

of these laboratories are now being trained in the use of this equipment which will enable each laboratory to analyze a minimum of 100 farmers' soil samples daily.

A uniform method of interpreting soil testing data and fertilizer suggestion guide sheets, both suggested by the International Soil Testing Project, will soon be in use throughout the region.

Supplementary equipment, such as sample trays, dryers, etc., necessary to streamline laboratory operations and increase laboratory capacity has been designed by ISTP. Blue prints for this equipment have been furnished to the laboratories in the three cooperating countries as well as to one of the laboratories in Mexico. This equipment is now being built in the three northern Central American laboratories.

Priorities in soil sample areas for developing impact programs to increase agricultural production were established and agreed upon at the recent regional coordinating meeting in El Salvador. A basis for establishing these priorities was existing soil and topographic maps, agricultural statistical data and the crop area and potential land use maps prepared for this purpose by ISTP.

At the conclusion of the regional progress reports, considerable attention was given to soil sampling and soil sampling programs. Taking samples to evaluate soil fertility is quite different from samples needed for soil classification purposes. The plow zone in soil has large lateral variations so that composite samples are necessary for the fertility evaluation of a land area. Soil samples for classification are usually taken at a point in the landscape and reflect the sequential changes in the horizons from the surface to the parent material. It is important to have information about the nature of the lower horizons in making fertilizer recommendations but, since these properties of soils change little from year to year, soil survey data is adequate. Collecting soil samples for control purposes offers a third procedure which differs somewhat from taking samples for classification or soil testing. At least 100 kilograms of soil are needed for a control sample since it

will be used for several months. Control samples are usually taken from the surface horizon but need not represent a particular soil type. They are selected for certain characteristics such as acid conditions; low or high levels of essential elements, such as phosphorus or potassium.

Considerable discussion was given to techniques to employ in laboratory and greenhouse studies to interpret soil tests and plant analyses. Phosphorus and potassium fixation, available forms of nutrients in soil and extraction methods were included in the discussion. Greenhouse techniques, including size of samples to use, plants to grow, number of treatments and watering procedures, reached attention.

Dr. Birdsall then reviewed the first year's results with his fertilizer demonstration program in El Salvador during 1965. He presented a number of kodachrome slides which dramatically told the story of the success of the demonstrations. How the two projects can cooperate in the future to achieve the correct use of fertilizers was discussed. It was agreed the projects supplement one another and both will benefit from cooperative efforts in increasing crop production in Central America.

U.S. Advisory Committee

In order to obtain an unbiased review of the project and to get suggestions for improving the program, an advisory committee in the United States was requested by the project director. Persons invited to serve on the committee are:

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

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

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

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

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

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.

The committee will meet at least once a year but no more than twice. The first meeting of the committee will be in early 1966.

AMENDMENTS TO CONTRACT AID/csd-287

As programs develop, especially those associated with research projects, it becomes necessary to change them from time to time. This is partially due to encountering unforeseen situations and partially to adapting procedures which will improve the activities of the project. During the past year, amendments were made to the contract as follows:

a) West Africa was deleted from the contract. A survey was made of that region in the summer of 1964 and a report submitted to AID/W. The report noted that nutrient deficiencies and acid soil conditions appear to be widespread in that region. However, the initiation of a soil testing-plant analyses program in that region would require starting with the acquisition of some and the strengthening of other areas of fundamental information. Since both Latin America and West Africa have not progressed as far in soil testing-soil fertility programs as had been anticipated when the project was initiated, a decision was reached to concentrate the efforts of the project in Latin America at present. Therefore, West Africa was deleted by amending the contract.

b) In summarizing the results of the questionnaires that had been completed for soil testing-plant analyses programs in Latin America, it became evident that a Control Laboratory in Raleigh was a necessity. Therefore, a request was made and approved to amend the contract to permit establishing a Control Laboratory in Raleigh. Two positions were altered to assume the responsibilities in conducting the activities assigned to the Control Laboratory. One position is that of Director of the Laboratory and the other is a soil chemist.

c) Conditions to improve soil testing-soil fertility and plant analyses programs in Uruguay and Argentina were found to be unfavorable at present. At the same time, additional help was greatly needed in the Middle American region. The contract was amended to delete the position in Uruguay and Argentina and to add it to Middle America with headquarters in Costa Rica.

d) Criticisms and suggestions for improving a project is a very essential part of a program. A request was approved to amend the contract to permit the establishment of an advisory committee in the United States. The number of persons on the committee shall not exceed six, and will be composed of competent persons experienced in soil testing-soil fertility programs in industry, agricultural experiment stations, agricultural colleges, and the United States Department of Agriculture.

e) Contract personnel working in a foreign country should have a "working" knowledge of the language of that country. The contract was amended to permit orientation and language training for staff members and dependents who are working in overseas assignments.

f) Maintaining good health is important in any position but persons going overseas should be in good physical condition. The contract was amended to require all employees and their dependents who are returning to their post of assignment after a period of home leave to be examined by a licensed doctor of medicine.

Some minor amendments were also made to the contract relative to position titles, time of conducting country conferences and hiring of hourly help for both clerical and laboratory work.

APPENDIX A - Laboratories

Buildings and Plans, Photos 1-2

Multiple Unit Apparatus, Photos 3-13

Inauguration of Laboratories, Photos 14-17

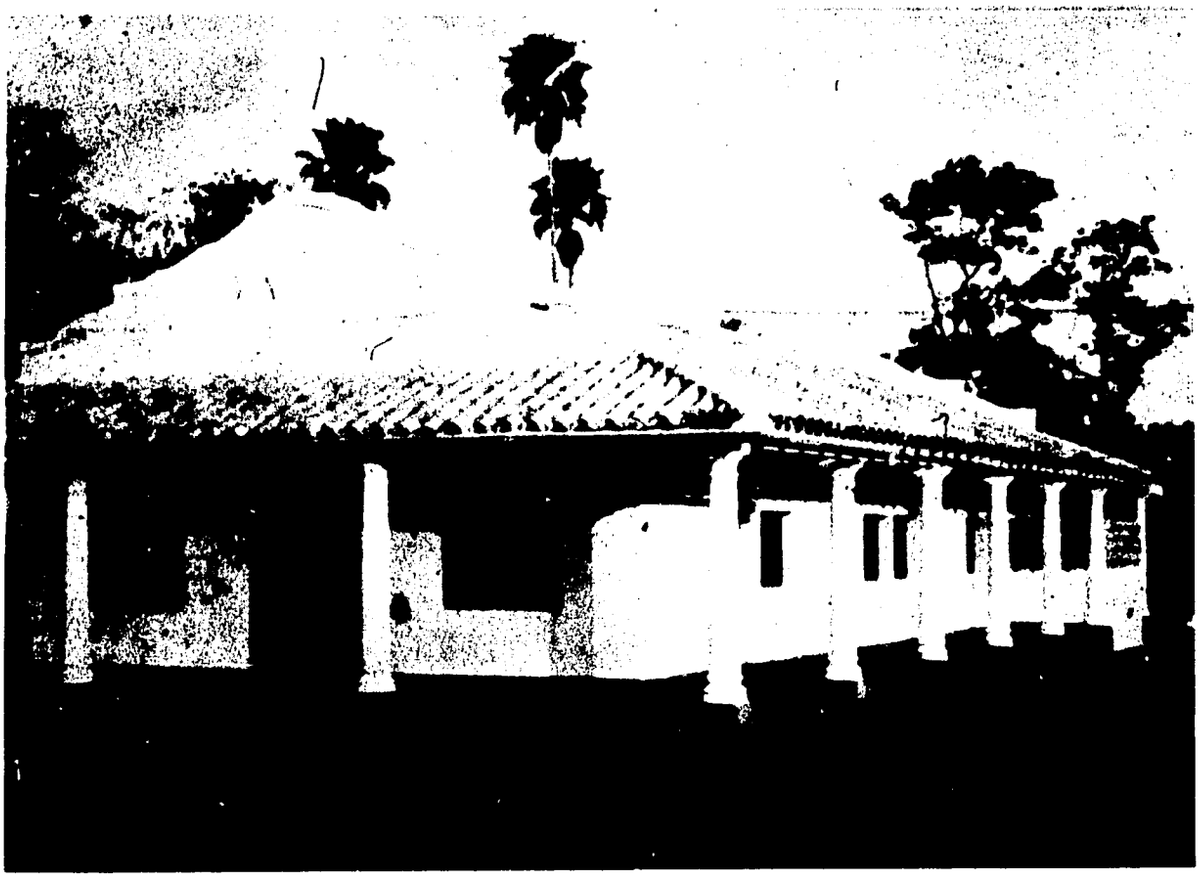


Photo 1. Asunción Lab, Paraguay. The new building to house soil testing-plant analyses on the Central University Campus. This is a modern equipped laboratory having a capacity for analyzing several hundred samples per day.

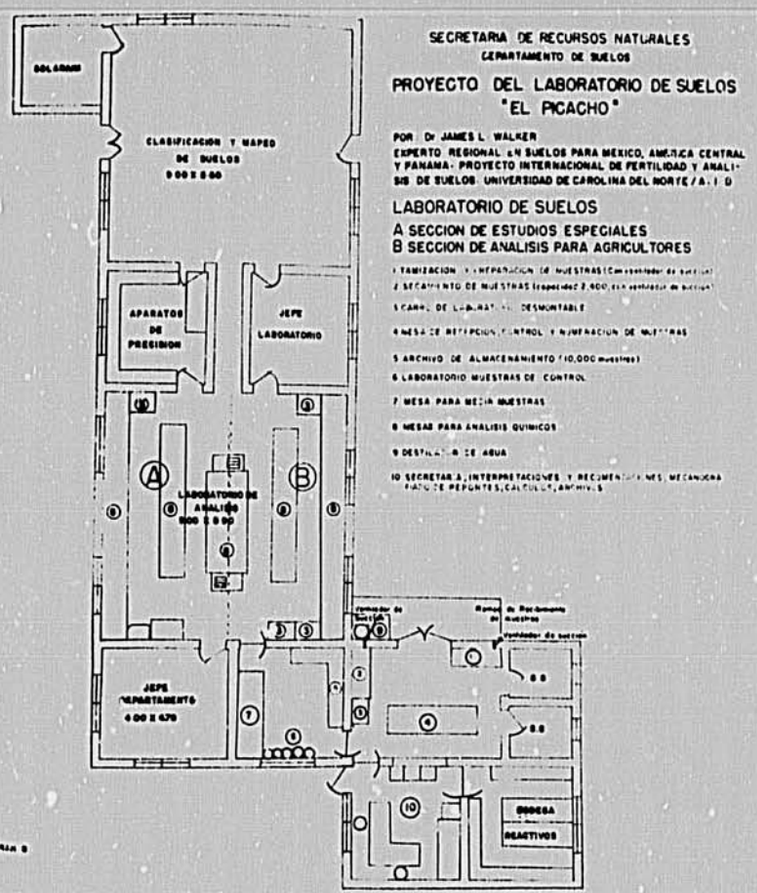


Photo 2. Tegucigalpa Lab, Honduras. Plans for rearranging the soil testing laboratory to accommodate the new multiple unit apparatus which will greatly increase the capacity of the laboratory.

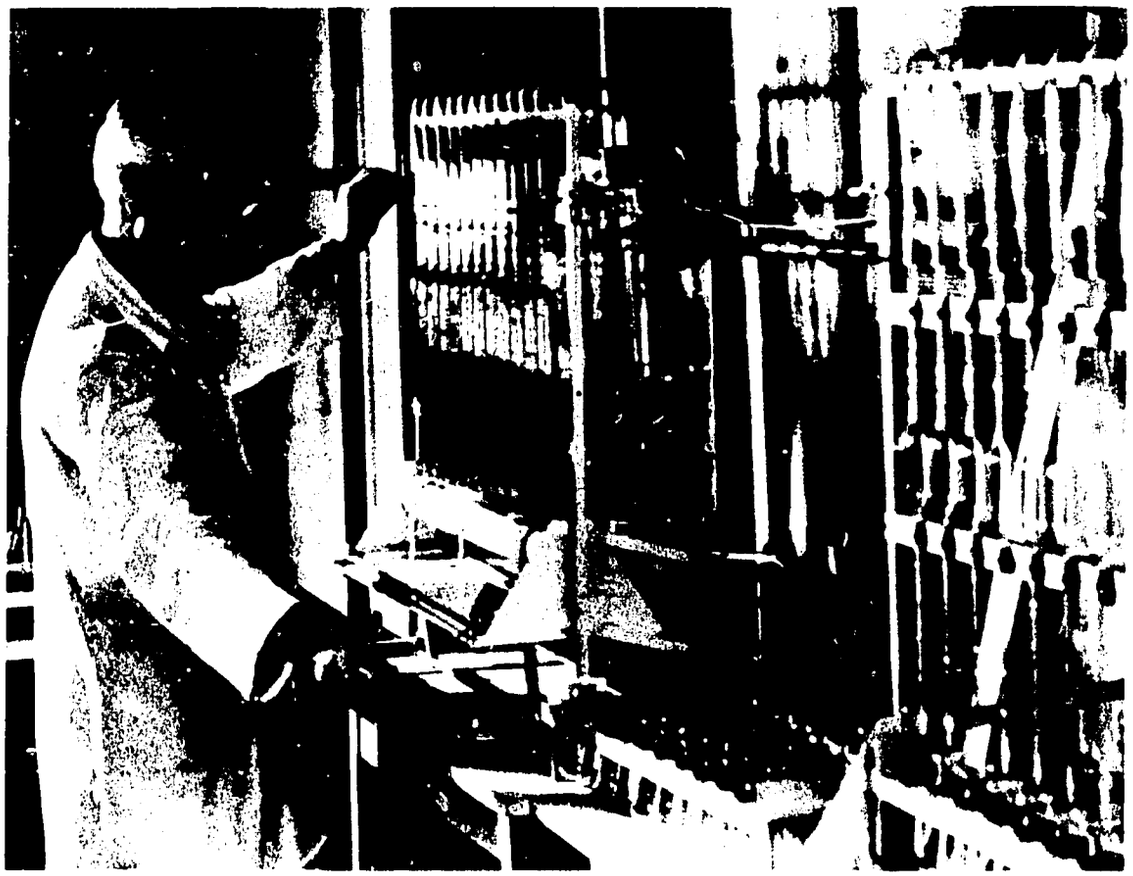


Photo 3. Rio de Janeiro Lab, Brazil. Dr. Vettori demonstrates filling 100 ml glass pipettes from trough on dispenser that was designed and constructed by Dr. Vettori, Maestre Abreu and R. B. Cate, Jr. The supply bottle which maintains a constant volume of extractant solution in the trough is behind the dispenser. Note extraction trays between the two dispensers.

Photo 4. Rio de Janeiro Lab, Brazil. Dr. Vettori illustrates placing a given volume of soil from cardboard containers held in one tray by means of a measuring scoop to the flasks in another tray.

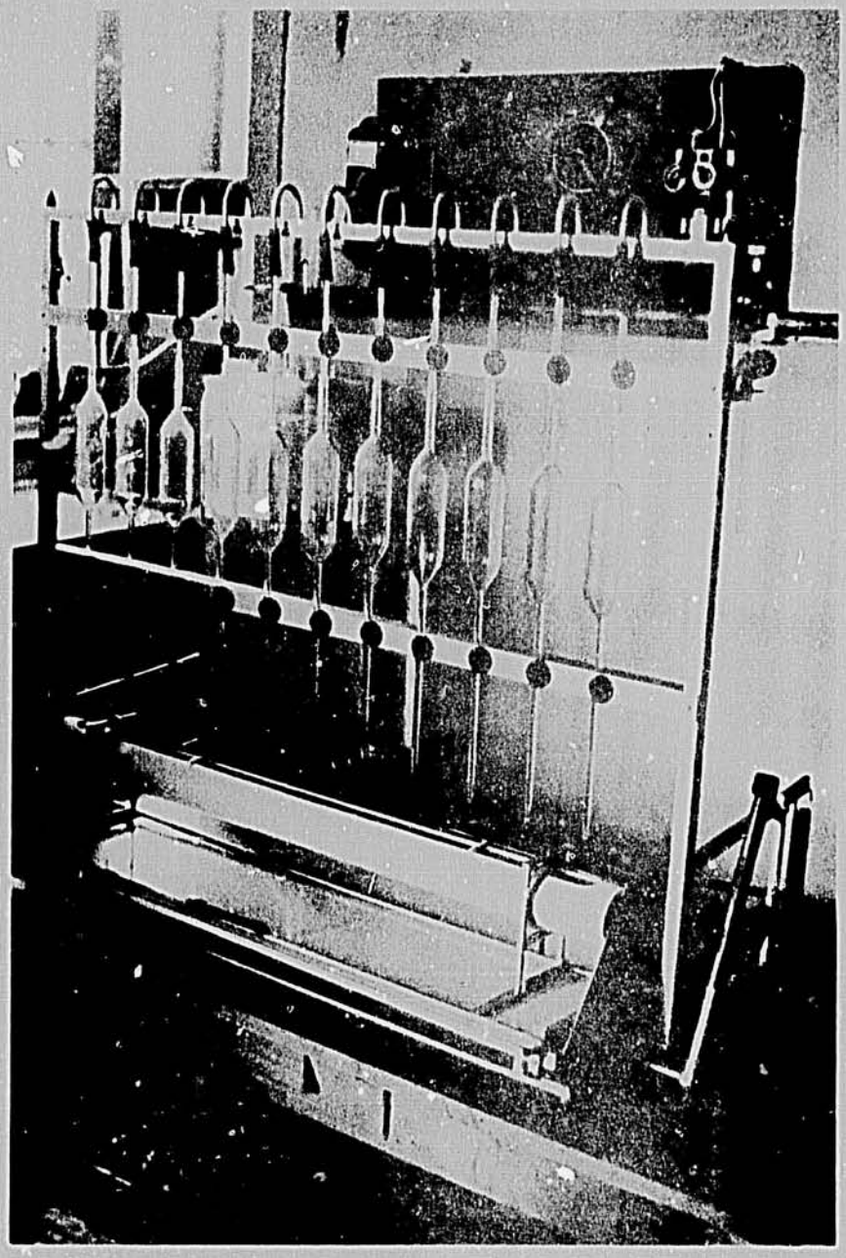


Photo 5. Rio de Janeiro Lab, Brazil. A close-up view of dispenser with 11 glass 100 ml pipettes. The plastic trough below the tips of the pipettes serves as a constant level reservoir for the extractant solution. The lever on the right is used to lift the trough around the ends of the pipettes. Suction lifts the solution into the pipettes.

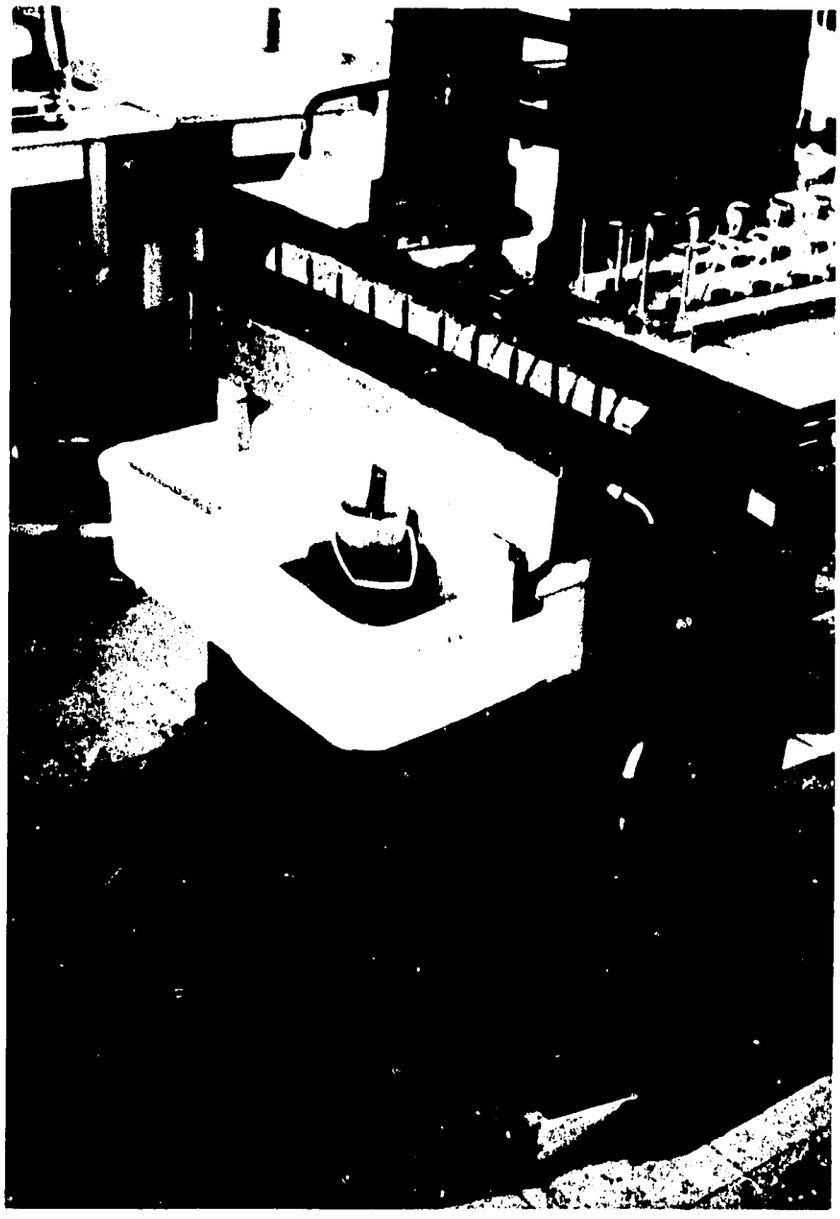


Photo 6. Rio de Janeiro Lab, Brazil. A metal trough with 11 spigots for washing glassware. The bottle in the sink acts as a trap to catch the soil washed from the flasks. Water to the spigots is controlled by a foot pedal on the right.

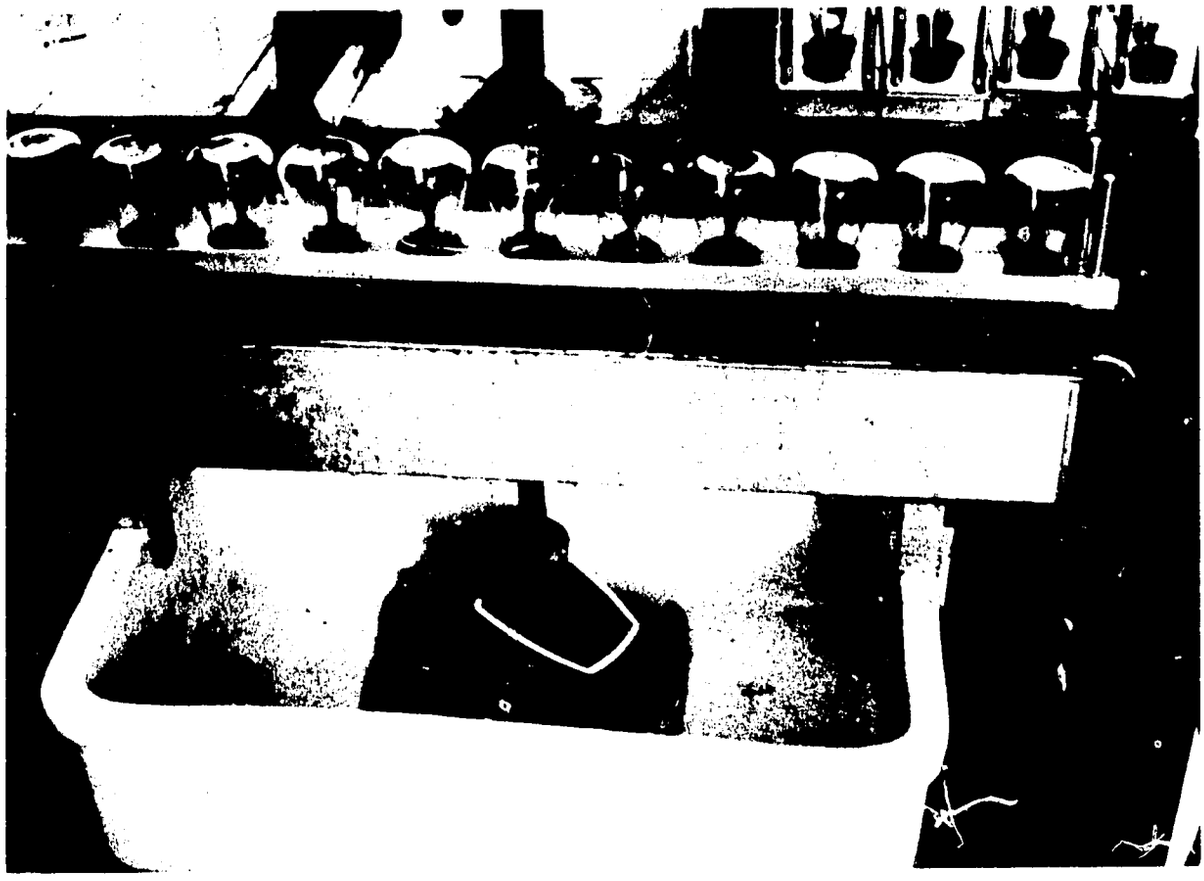


Photo 7. Rio de Janeiro Lab, Brazil. A tray of 125 ml flasks being washed in specially constructed trough mounted over conventional laboratory desk sink. Bottle beneath trough acts as a trap to remove soil and similar heavy material.

Photo 8. Rio de Janeiro Lab, Brazil. Mrs. Vettori determines potassium in solutions through use of a flame photometer. Note special tray on the right for holding solutions.

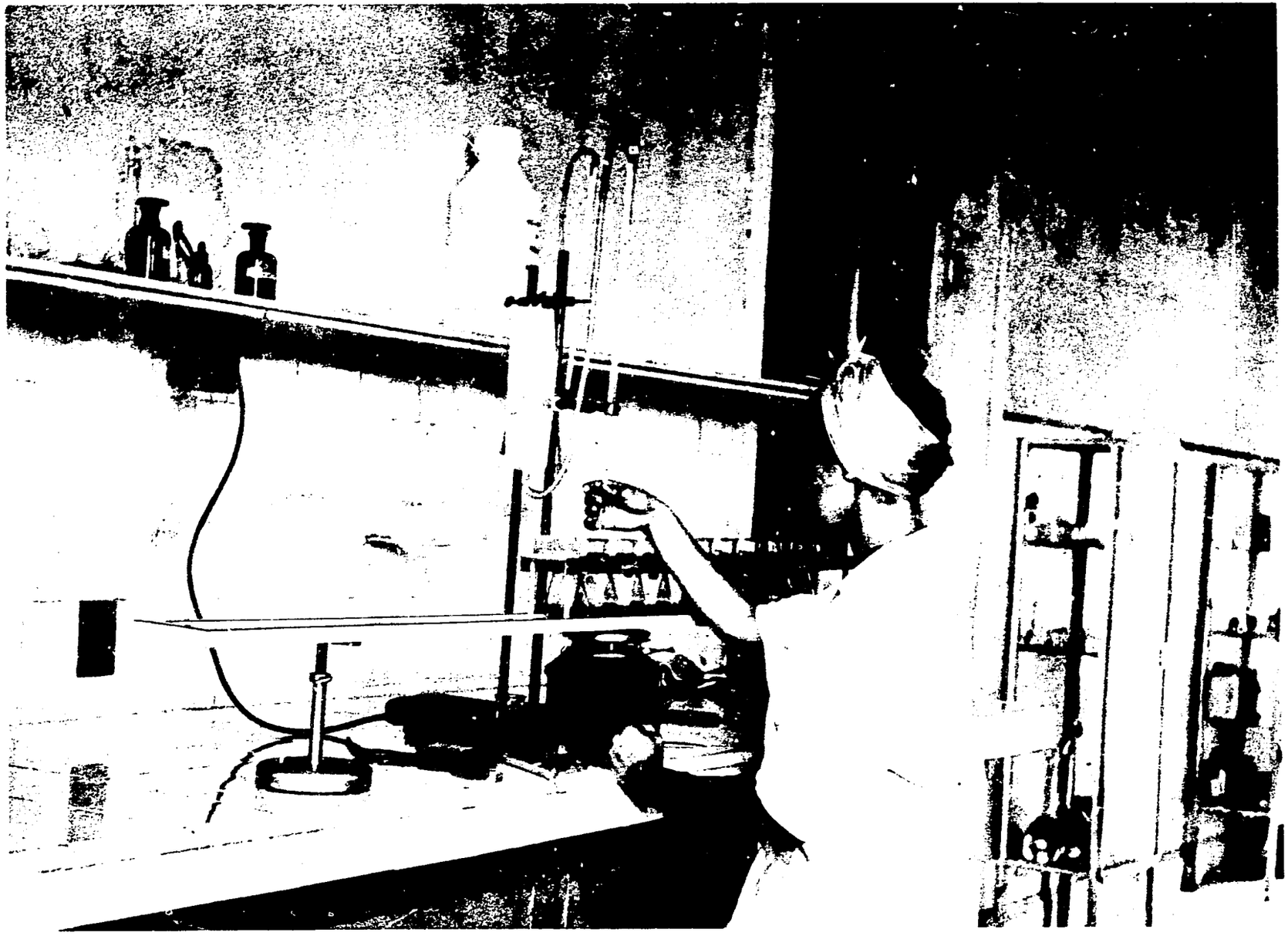


Photo 9. Recife Lab, Brazil. EDTA titrations for calcium and magnesium. Tray of flasks move along elevated track. Magnetic stirrer beneath the track thoroughly mixes the solutions during titrations.

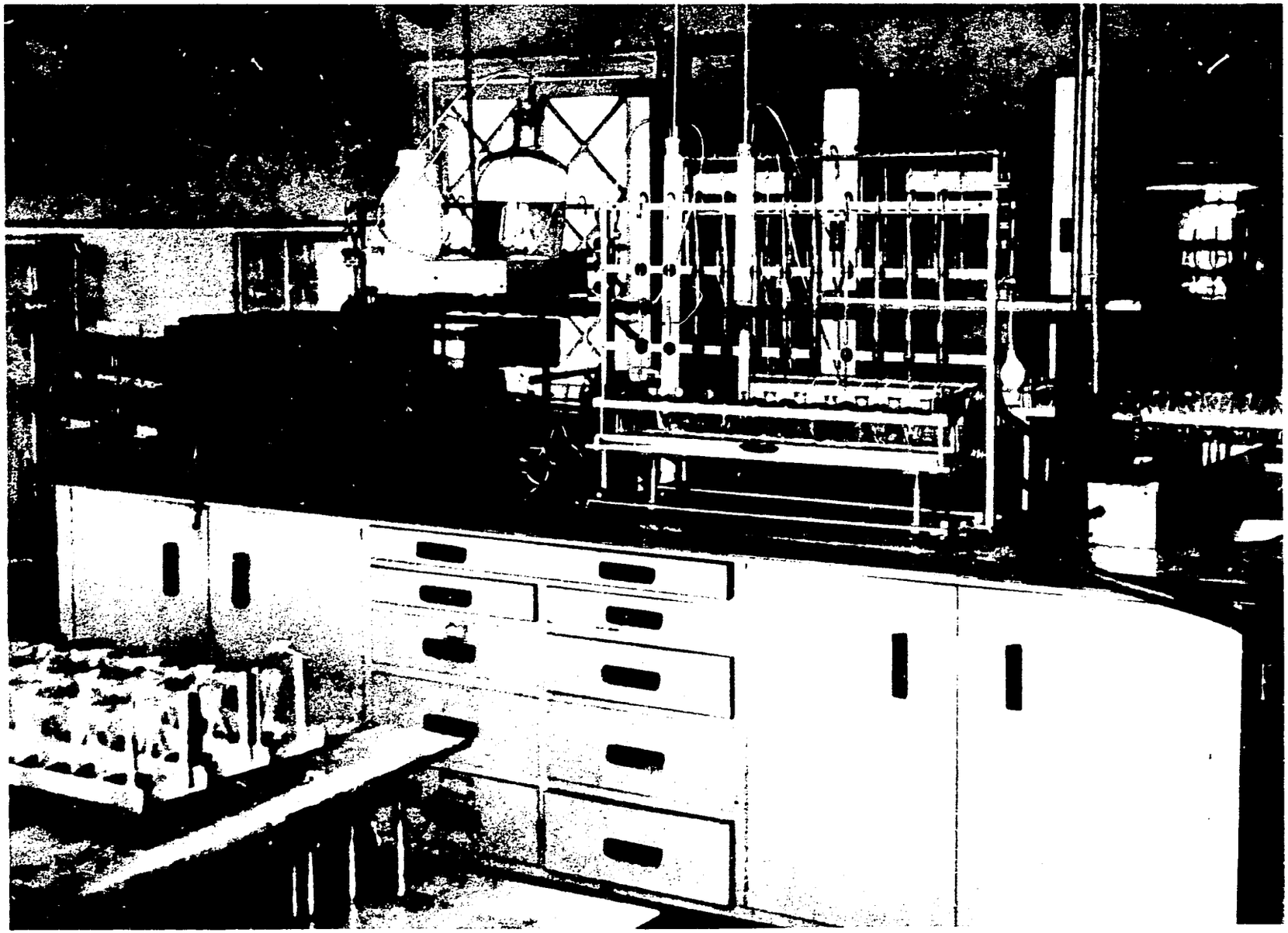


Photo 10. Recife Lab, Brazil. General view of laboratory with multiple unit apparatus to permit rapid analyses. Note dispenser, shaker and washer on desk and trays stored on table at the left.

Photo 11. La Molina Lab, Peru. Filling 11 pipettes in one operation from tray with 11 flasks by controlled suction. Capillary tubes attached by tygon tubing to tops of pipettes make accurate volume measurements possible.

Photo 12. La Molina Lab, Peru. Filtering 11 samples in one operation by inverting an extraction tray over filter tray.

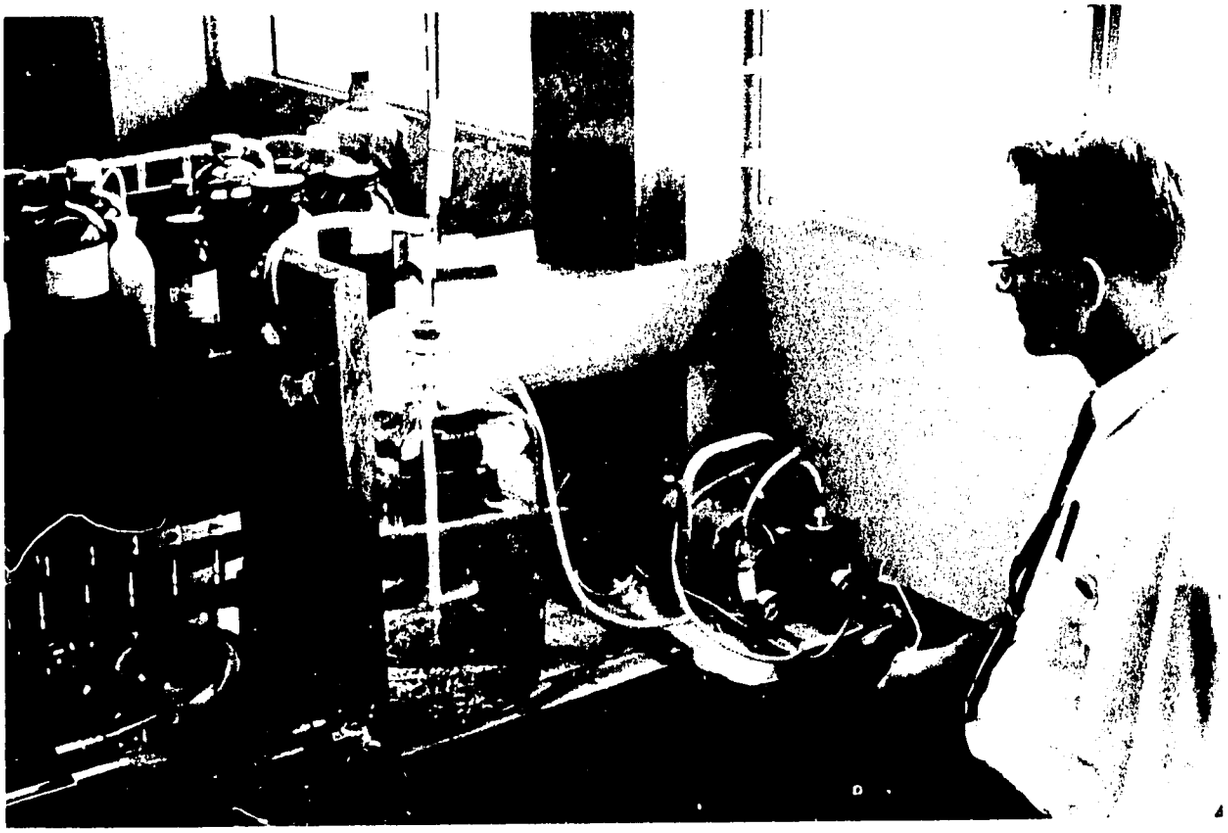


Photo 13. La Molina Lab, Peru. Donovan Waugh inspects a pressure suction pump that is being used to increase pressure in the 20 liter bottle of water to permit rinsing of 11 bottles or flasks in a tray at one time. Water pressure from bottle raised a few feet above the desk is insufficient to supply the amounts required for 11 spigots in the washing trough.

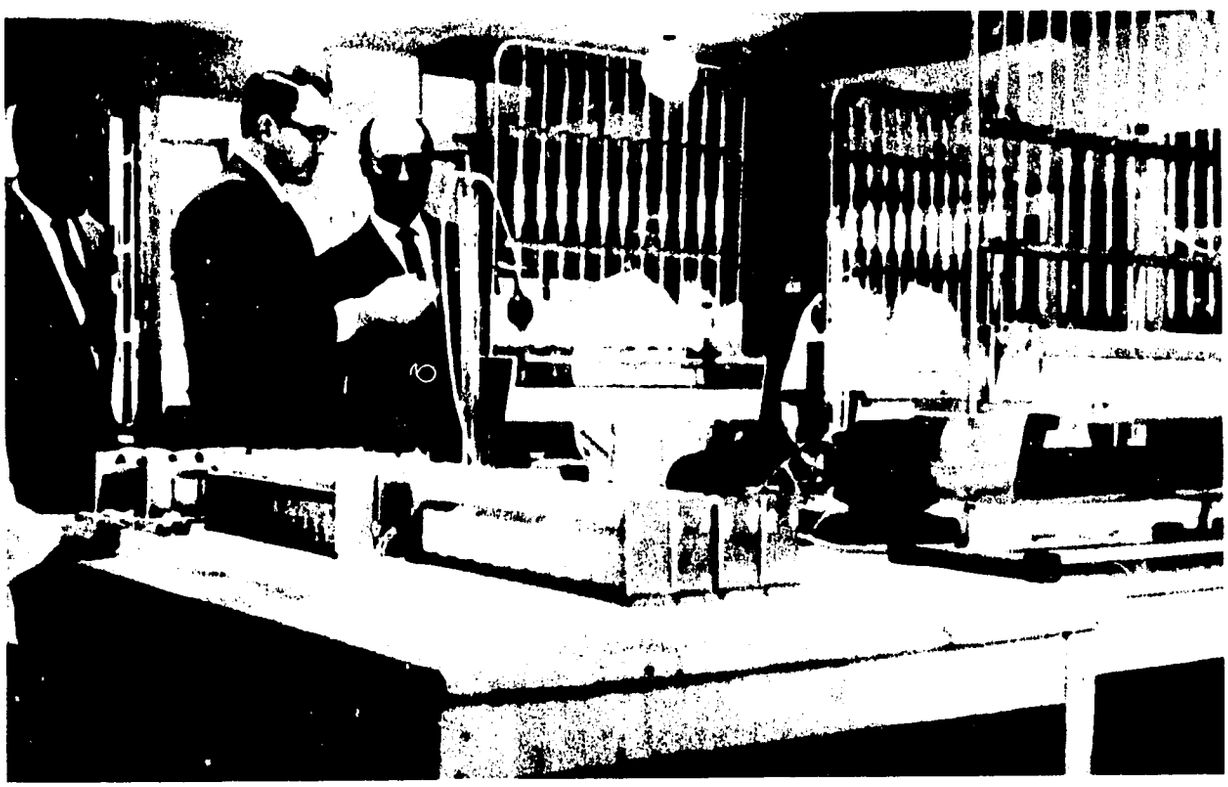


Photo 14. Quito Lab, Ecuador. Dr. Donovan Waugh explains the operation of the automatic dispensers that were installed by the International Soil Testing project in the Quito Lab to Minister of Agriculture and Livestock, José Aray Marín. Dispensers are equipped with 5, 25, and 50 ml plastic pipettes. Extraction trays with 125 ml plastic bottles are on the table in foreground. Filter trays are on the left of the table.

PRIMEIRO CADERNO DIARIO DE PERNAMBUCO — SEXTA-FEIRA, 7 DE JANEIRO DE 1966

Recife Terá 4.a Feira Mais Moderno Laboratório De Fertilidade De Solos Na América Do Sul

Explicando A Adubação —

Photo 15. Recife, Brazil. Photo of news article in Recife papers relative to the new soil testing laboratory in Recife, cooperatively established by the Brazilian Ministry of Agriculture and the International Soil Testing project.

Análise da terra
e sua adubação

O ESTADO DE S. PAULO ANO XI NUMERO 546 SAO PAULO, 29-9-1965 SUPLEMENTO AGRICOLA

Photo 16. Sao Paulo, Brazil. Full two pages of a Sao Paulo newspaper reporting the inauguration of the new Soil Testing Laboratory in Campinas. It is equipped with the multiple unit apparatus to permit rapid handling of samples.

Photo 17. Sao Paulo, Brazil. Front-page picture of preparing soil samples in the New Soil Testing Laboratory in Campinas. Note samples in cartons in a tray.

APPENDIX B - Soil Sampling, Photos 18-20

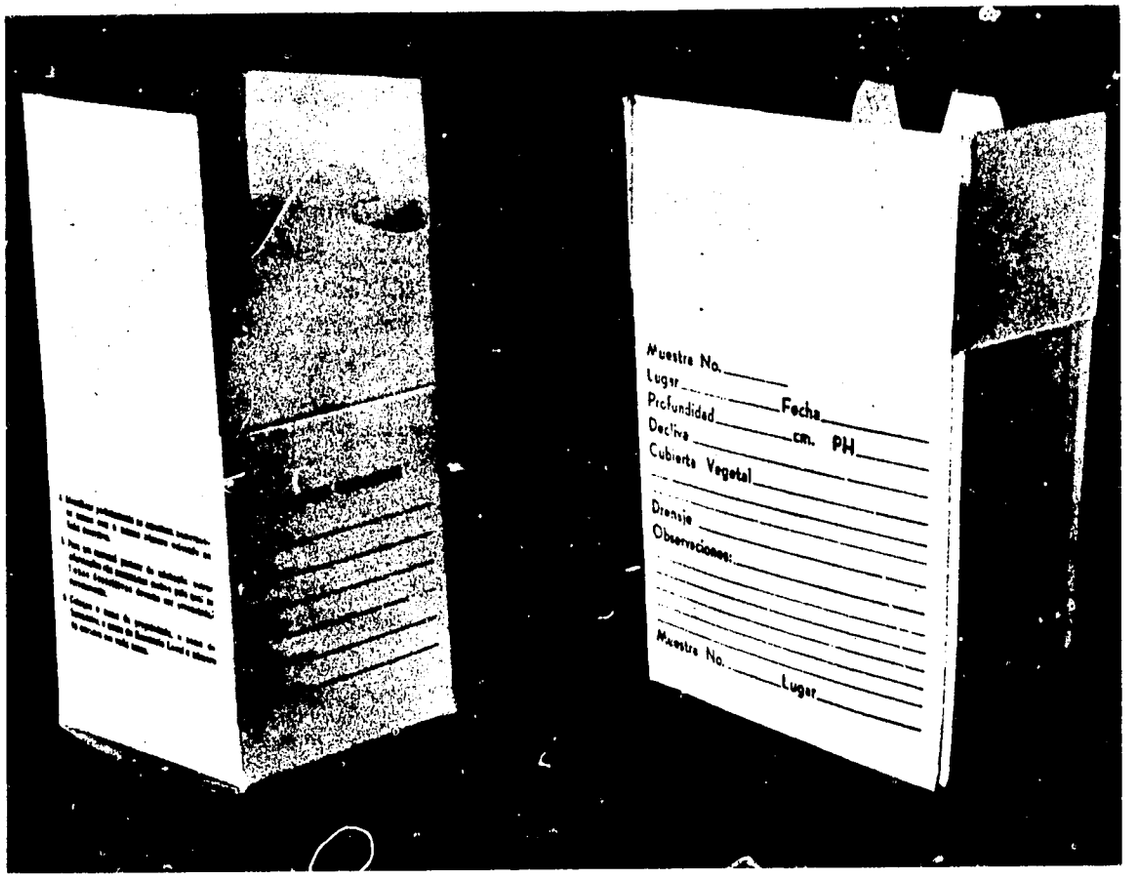


Photo 18. Soil cartons for submitting samples for testing. The square carton on the left is used in Brazil. The rectangular carton with one 2-inch side to coincide with extraction trays is used in Guatemala, Honduras and El Salvador.

Photo 19. Guatemala. Many fields in the rough terrain of Central America are small and irregular as shown here. Cultural practices are poor and the soils frequently are nutrient deficient.

Photo 20. Guatemala. A common practice throughout Middle America is the burning of crop residue to clear the land. Such practice not only destroys needed organic matter, but increases the problem of obtaining representative soil samples for testing.

APPENDIX C - Interpretation Studies, Photos 21-23

Photo 21. La Molina, Peru. Ing. José Estrada is examining corn plants in a fertilizer study designed to get data for interpreting soil test results.

Photo 22. La Molina, Peru. Treated and untreated plants in phosphorus study in the greenhouse.

Photo 23. La Molina, Peru. Soil fertility study with phosphorus and potassium to obtain data for use in interpreting soil test results.

APPENDIX D

Tech. Bul. No. 1, ISTP Series, Cover and two figures

Tech. Bul. No. 2, ISTP Series, Cover

Guide Sheet

JULY 1965 TECHNICAL BULLETIN NO. 1

A RAPID METHOD FOR CORRELATION OF SOIL TEST ANALYSES WITH PLANT RESPONSE DATA

UN MÉTODO RÁPIDO PARA CORRELACIÓN DE ANÁLISIS DE SUELO CON ENSAYOS DE FERTILIZANTES

UM MÉTODO RÁPIDO PARA CORRELAÇÃO DE ANÁLISES DE SOLO COM ENSAIOS DE ADUBAÇÃO

INTERNATIONAL Soil Testing

Illustration 1.

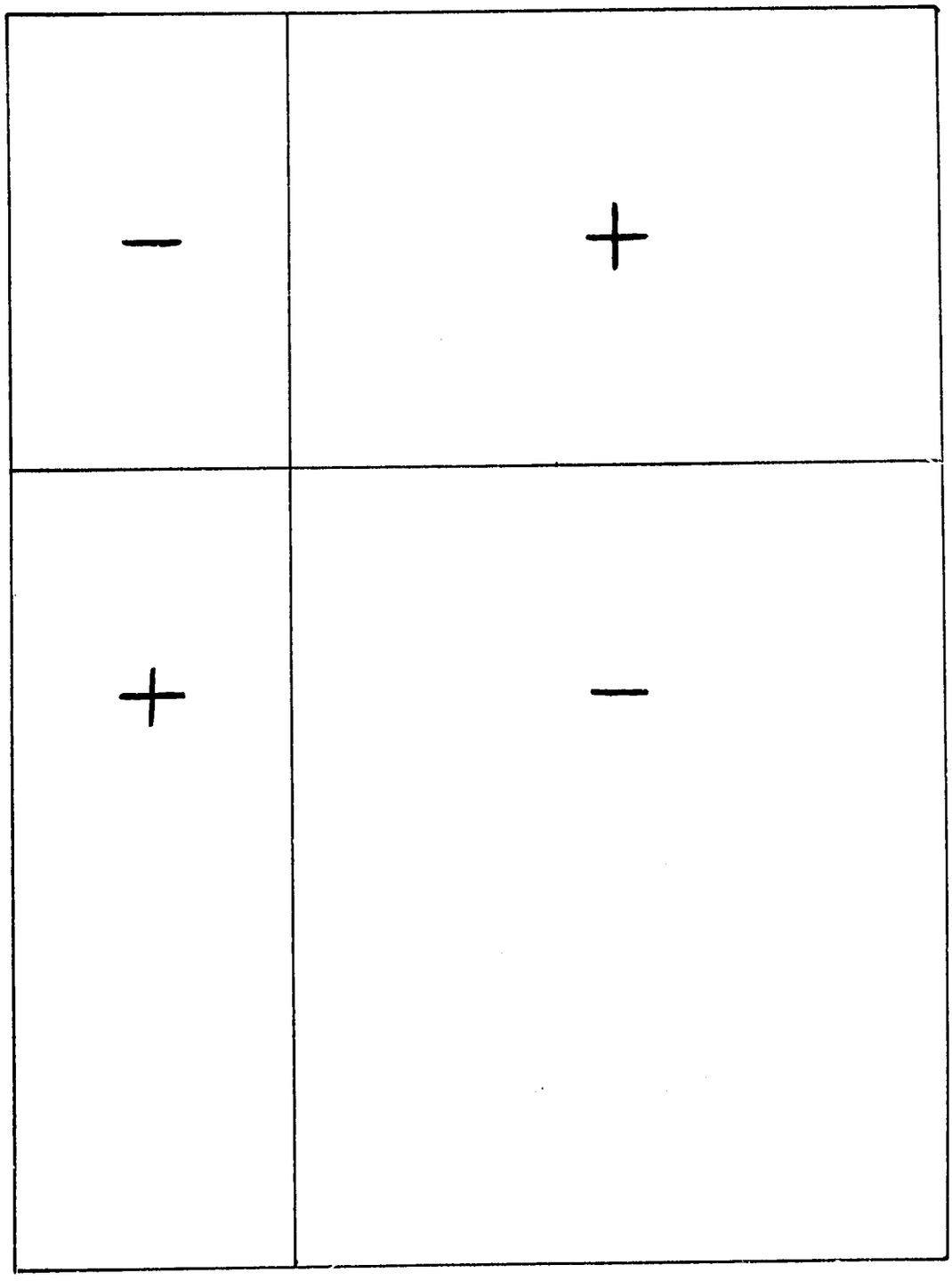


Fig. 1 – Format of clear plastic overlay which is used for finding critical soil test values.

Modelo de plástico transparente que sobrepuesto al gráfico se usa para determinar valores críticos de análisis de suelos.

Modelo de plastico transparente "overlay" usado para determinar valores críticos em análise de solos.

Illustration 2.

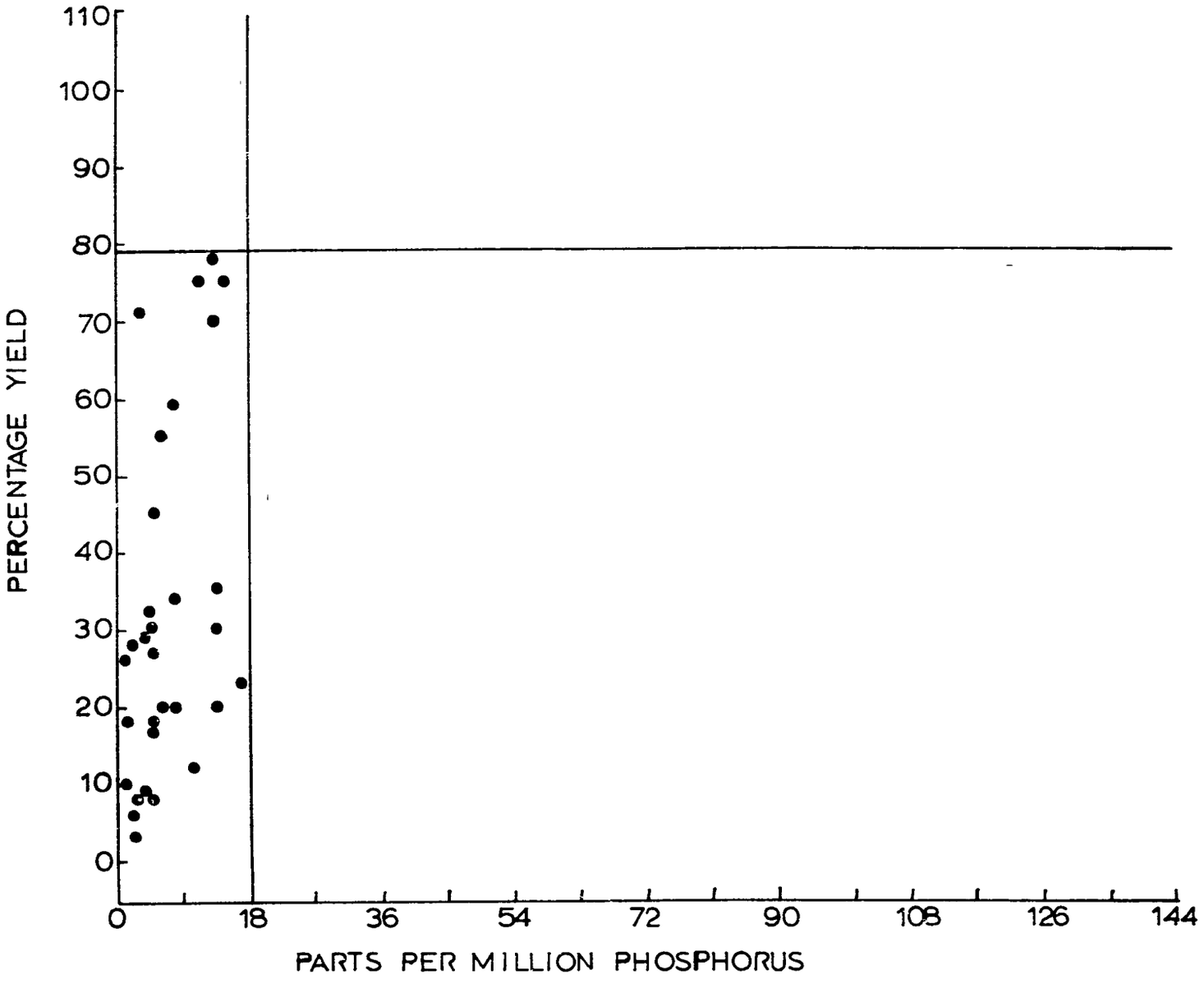


Fig.3–Scatter diagram of percentage yield vs. soil test values for North Carolina Method.

Distribución gráfica del porcentaje de rendimiento vs. valores del análisis de suelo por el método de North Carolina.

Illustration 3. Gráfico mostrando produção relativa versus análise do solo pelo método

DEC, 1965 TECHNICAL BULLETIN NO. 2

EVALUATION OF SOIL FERTILITY IN LATIN AMERICA: SOIL TESTING-PLANT ANALYSES 1965

INTERNATIONAL SOIL TESTING

Illustration 4.

GUIDE SHEET FOR (CROP) _____

SOIL TESTING LABORATORY (NAME, COUNTRY) _____

GUIDE SHEET PREPARED (DATE) _____

REVIEW BEFORE (DATE) _____

ELEMENT			POTASSIUM (K)			NOTES
	CHANGES OF GETTING A PROFITABLE RESPONSE ARE		GOOD 80/100	AVERAGE 50/100	POOR 10/100	
		SOIL TEST VALUE IS	LOW	MEDIUM	HIGH	
PHOSPHORUS (P)	GOOD 80/100	LOW				
	AVERAGE 50/100	MEDIUM				
	POOR 10/100	HIGH				

Illustration 5. - Outline for guide sheets used in Guatemala, Honduras and El Salvador.

APPENDIX E - Reports by Hunter, Walker and Waugh

A SOIL FERTILITY AND MANAGEMENT SERVICE PROGRAM

A. H. Hunter

WHAT IS IT?

A Soil Fertility and Management Service program is an analytical and educational program for increasing agricultural production. This is accomplished by means of analyzing soil and plant tissue samples for farmers. The information thus gained along with all other information available from research concerning plant nutrition and management practices is utilized to make recommendations to farmers for the proper use of fertilizers, soil amendments or other crop nutritional materials and practices.

WHY IS IT NEEDED?

1. It makes possible a direct link between soil fertility and crop nutrition research, the Extension Service, and the farmer. This not only facilitates the flow of research information to the farmer but also effectively brings the farmers problems to the attention of research people.
2. By giving every farmer the opportunity of taking advantage of the service, it furnishes reliable information to the farmer for fertilizer use, soil management and crop nutritional practices that he cannot easily obtain in any other way.
3. It is a service which interprets research results to farmers in a way and at a level that they can understand and put into practice.
4. Until this type of service is provided to farmers, only a small proportion of the information gained from research is actually being put to practical use for increasing agricultural production. This

means that full value is not being obtained from each research dollar.

5. Information concerning insects, disease and weed control, new varieties etc., is of limited value until soil fertility, soil management and plant nutritional practices are capable of giving high production.

6. All research concerned with soil chemistry, fertility, physics, classification, etc., often requires routine analysis of soils and plants such as would be performed in the service program. Having a system established for such routine analysis will provide the most inexpensive and effective way of getting this required work done.

7. Legitimate fertilizer industries welcome and support this type of program because it better assures an economical response to the plant nutrients and soil amendments used. This encourages fertilizer use and aids industry to better plan their expansion programs. The program also helps to eliminate or minimize operators whose only purpose is to exploit farmers.

8. Since this type of program will reach and aid a large percentage of the farmers, it will win their support for all research programs supported by public funds because they become increasingly aware of the benefits of such information.

HOW DOES IT WORK?

It is a program of cooperation between the farmer, the Extension Service, the research person and the service program director.

Farmers, commercial company representatives, and extension agents collect soil or plant tissue samples which are representative of the area

or crop on which information is desired.

The sample accompanied by other pertinent information concerning the site is submitted to the laboratory for the various analysis needed. The sample is properly prepared and chemically analyzed in the laboratory.

The results are recorded,and these, together with the other information which accompanied the sample, are submitted to a trained agronomist or placed on I.B.M. sheets for processing for the purpose of obtaining recommendations.

The recommendations are sent to the farmer, extension agent and other interested agencies.

The extension agent reviews the recommendations with the farmer to make certain that he understands what they mean and how to use them.

The extension agent follows the farmer's progress to determine the results obtained.

The results and/or problems are reported to the director of the service program. Each of the above mentioned steps is an important phase of the service program and one step poorly executed will result in loss of education, accuracy and effectiveness of the program.

HOW MANY SAMPLES MUST BE ANALYZED?

The success of the service program depends to a very large extent on the number of samples which can be analyzed, and on the length of time required from the time the sample is taken until the recommendations are in the hands of farmers. Farmers, like most everyone else, don't ask a question until they are ready for the answer. This means that when the sample is taken in the field

the farmer is usually ready to use the information to be gained from it and he cannot or will not wait long for the results.

For this reason, the facilities should be established to have a capacity of at least 100 samples per day at the start. Fortunately, a program which is capable of doing 100 samples per day can, with a few modification and a few more personnel, be capable of doing up to 1,000 samples per day.

Of course another important reason for having large capacity is that the service program cannot be fully effective without being capable of helping a large segment of the agricultural population.

WHAT GOES INTO THE INTERPRETATION OF RESULTS AND MAKING OF RECOMMENDATIONS?

The recommendations are,of course, the end product of all the important steps which precede it. The recommendations can hardly be better than the sample or the accuracy of the laboratory analysis. However, much more than this is involved in arriving at proper recommendations. They are a product of the interpretation of all the available information concerning the sample, soil, crop, location, weather, etc. The interpretation process is entirely dependent upon the research information available concerning the particular soils, plants and the factors governing nutritional chemical reactions within the soils and plants and the growth or yield responses. Without research information as a foundation, the results of chemical analysis of the samples become only unintelligible numbers so far as making recommendations are concerned.

Research then, both local and non-local, forms the foundation for an effective service program. It is for this reason that close cooperation must be maintained between the director of the service program and all related research programs.

WHAT PERSONNEL, FACILITIES AND EQUIPMENT ARE NEEDED TO OPERATE A SERVICE PROGRAM?

Personnel

I. Director of service program. This person should have a good background in soil chemistry and fertility. It would be his responsibility to direct and coordinate all phases of the program.

A. Director of laboratory. This person should have good training in chemistry and analytical procedures and would be responsible for all of the work connected with the analysis of the samples.

1. Two laboratory technicians. These people would need some knowledge of chemistry and should be capable of readily adopting to analytical procedures. Under the direction of the laboratory director they would be responsible for doing the analytical procedures.

2. Three laboratory helpers. These persons need not have any technical training. They would be responsible for preparing the samples, washing glassware and other chores around the laboratory.

3. One typist. This person would require mainly typing skill and would be responsible for the secretarial work, typing and mailing of reports.

This number of people should be able to analyze between 100 and 300 samples daily.

Facilities

The following rooms, offices and laboratories are needed for proper functioning of the program.

1. A plant sample drying, preparation and storage room. Approximately 10 to 15 sq. meters.
2. A soil sample drying, preparation and storage room. Approximately 15 to 20 sq. meters.
3. Office space for director of program, director of laboratory, secretarial functions, etc. Approximately 25 to 35 sq. meters.
4. A laboratory room for analysis of soil and plant samples. Approximately 90 to 120 sq. meters.
5. A small chemical, glassware and general storage room. Approximately 10 to 15 sq. meters.

Total space requirements - 150 to 205 sq. meters.

Equipment

The following major items of equipment are required for preparation and analysis of soil and plant samples.

		Approximate Cost U.S. $
1.	Sample shaking machine	350.00
2.	Spectrophotometer	400.00
3.	pH meter	350.00
4.	Flame photometer	1,000.00
5.	Magnetic stirrers - two	100.00
6.	Wiley stainless laboratory mill	300.00
7.	Top loading analytical balance	800.00
8.	Muffle furnace	200.00

9.	Large centrifuge	900.00
10.	Multiple dispensing equipment and trays	400.00
11.	Vaccum pumps - two	100.00
12.	Large drying oven	250.00
13.	Water still or ion exchange demineralizer	350.00
14.	Soil crusher and screen	200.00
15.	Soil drying cabinet	250.00
	T O T A L	5,950.00

The above named items of equipment constitute the major pieces of equipment needed for establishing a service laboratory but the initial cost must also include such items as glassware, chemicals, forms for recording and reporting results, small items of equipment and tools, sample containers, etc. It is estimated that the initial cost of all these items would be about $7,000.00.

Annual Operating Budget

The annual operating budget must include salaries, monies for replacement of expendable materials, such as chemicals, glassware, report forms, postage, etc., and monies for repair of laboratory and equipment and replacement of equipment.

The cost of operation of a service program on a per sample basis,of course, varies with the number of samples processed and the efficiency of operation of the laboratory. However, as a rule it is possible for a laboratory that is processing from 100 to 200 samples per day, doing the normal routine analysis, to do so at a cost of between $1.50 and $2.00 per sample.

The financing of service programs now in operation in other countries is done in various ways which may be classed in 3 major categories:

1. The service program processes all submitted samples with all desired analysis free of charge. In this case the government must budget to the service program the total cost of operating the program.

2. The service program processes at a nominal usually below cost fee, all submitted samples with the routine analysis. If other analysis are desired these are charged at a rate sufficient to cover cost. In this case, the government must provide a budget to the service program in an amount which will make up the difference between cost of operation and the nominal fees collected from the farmers.

3. The service program processes all samples submitted with all desired analyses and charges the farmer sufficient to pay for the total operation of the laboratory,making it a self sustaining program. In this case the government must budget funds for the establishment of the service program and provide legal procedures for the collection and use of the fees directly by the program.

There are no doubt good arguments for each mode of operation. However, in general the first two types provide more incentive for use of the service by all classes of farmers.

The low income farmers who are doing the poorest job of farm management and land use are probably the ones who will need the most encouragement for making use of the service program.

OTHER COMMENTS

It is suggested that since this program should be so closely connected with the work of the extension service and since it is a program concerned primarily with the direct and immediate improvement of farming practices for

higher more economical yields, that it should be under the direction of a section of the Ministry of Agriculture. It is also suggested that since the director of the program should be closely connected with the work of the Agronomy Department of the University, that it would be good for the director to hold a joint appointment with the Ministry of Agriculture and the University Agronomy Department. This type of appointment will aid in maintaining close cooperation between research and the utilization of information for improving crop production.

With a program administered in this manner, it would make little difference whether the laboratory facilities be established in available space at the Ministry or at the University. It is also possible that many of the required items of equipment may be available either at the University or the Ministry.

The multiple dispensing equipment, as well as some trays,flasks and other related items which are not available through regular supply houses, will be furnished by the North Carolina State University and AID International Soil Testing Project Contract. Also furnished under this contract will be assistance as desired in planning and establishing the laboratory and analytical procedures; also assistance in establishing all the other phases of the service program and providing training for the directors of the program and the laboratory.

The need for a soil fertility and management service program is great. The benefits of such a program for increasing agriculture production and improving farm management practices have been proven many times by the successful service programs already established throughout various parts of the world. It is hoped that all agencies and establishments who have a responsibility to agriculture will give this program their full support.

REPORT AND RECOMMENDATIONS TO THE MINISTER OF AGRICULTURE FOR ESTABLISHING A GUATEMALAN SOIL TESTING-SOIL FERTILITY NATIONAL PROGRAM

J. L. Walker

INTRODUCTION

The Problem:

The economic strength of Guatemala lies in its agriculture; the economic progress of the Republic is indetachable from the agricultural progress. Unfortunately, the proportion of the agricultural development as related to the demographic development is very low. Obviously, in order to improve the economic conditions, it is necessary that agricultural production be greatly increased; but, can this be accomplished with soils already nutritionally deficient?

How to Tackle it:

The most important tool for balancing the agricultural production in relation to the demographic expansion, and finally surpass the latter, is by putting into practice the data obtained from agricultural research studies. Research in this field should provide the answers to questions such as, which are the most economical agricultural products; where to plant them; and how to cultivate them in order to obtain the greatest yields at the least possible cost.

The rapidity in getting the vital answers to these questions will greatly depend on the amount of existing cooperation in the work that is being done, and the one that will be conducted, among and within the various dependencies of the Government--especially within the Ministry of Agriculture--and the governmental and private agencies, both local and international.

A National Soil Testing-Soil Fertility Program, duly conceived, organized and executed, and capable of furnishing the necessary information relative to

obtaining high yields at high return levels, can be very useful in the solution of problems encountered in agricultural production.

The International Soil Testing Project, sponsored by North Carolina State University and the Agency for International Development, was created as an international cooperative program for research and education, to provide technical and educational assistance relative to soil fertility and plant nutrition, which is required in establishing the Soil Fertility-Soil Analyses National Programs in the cooperating countries.

The five objectives of the International Soil Testing Project are the following:

1) Cooperate in obtaining specific information in regard to fertilizer requirements and forms and types of plant nutrients required for the various soils, crops and climatic conditions to be encountered in Latin American countries, and use it in the most effective possible way in incrementing the agricultural output;
2) Assist the Governments and dependencies in developing and improving their soil analyses service for better plant nutrition, fertilizer trials, and demonstration programs;
3) Assist each region in developing adequate sampling and soil analyses standards, and in the interpretation of results;
4) Cooperate in developing research programs relative to analyses and evaluation of soils where most needed; and
5) Compile and compare data relative to soil analyses and soil fertility of countries having similar climate and soil conditions with results obtained from local soils analyses and with the ecological and climatic studies of soils, and presenting the results of these correlations in a comprehensive report designed to furnish information readily applicable

in order to increment crop production.

To get a reasonably clear picture of the soil fertility and plant tissue analyses programs that are being conducted at present, and in order to determine the phases that need strengthening, the International Soil Testing Project conducted a meticulous survey in various countries of Latin America during the period 1964-65. Agricultural entities and soil analyses laboratories--private, governmental and international--were interviewed. Unofficially, services, plans and achievements on agricultural research were discussed with several scientists, technicians and administrators from private as well as State organizations, local and international. A summary was prepared from the information obtained during this period of study, and an outline was made in respect to general needs. Finally, during the months of March and April of the current year, informal conferences were held in each of the countries participating in the study, to discuss with local scientists and technicians the findings and to see if general guides could be established and put into practice, with the purpose of initiating an immediate cooperative work before the year was over, and, consequently, establishing a National Soil Testing-Soil Fertility Program in each of the countries of Central America. As an outcome of the technical conference held in "La Aurora", the following recommendations were submitted to the Minister of Agriculture for his consideration:

Recommendations

SEVEN RECOMMENDATIONS FOR THE ESTABLISHMENT OF THE NATIONAL PROGRAM IN GUATEMALA

1. That an Advisory Committee be officially appointed by the Ministry of Agriculture for the Guatemalan Soil Testing-Soil Fertility National Program to coordinate the programs among the various dependencies of the Ministry and with other interested organizations, private as well as international. The specific and official functions of this group will be as follows:

A. Ascertain the coordination and continued operations of the National Program in reference;

B. Eliminate the expensive duplication of efforts among the Government agencies and others by encouraging cooperative research and mutual exchange of information;

C. Keep the various agencies of the Ministry informed on national and international developments related to the program;

D. Make recommendations to the Ministry of Agriculture in regard to:

1. The determination of policies required
2. The necessary changes in the actual program
3. The new areas to be surveyed, and
4. The improvement on distribution of information

E. Coordinate the National and Regional Programs' efforts to insure the most rapid progress in obtaining the necessary data needed in planning a rapid expansion of the national production at the lowest possible cost.

II. That the National Soil Testing-Soil Fertility Program research work be coordinated among the Research Divisions of the Ministry, the Universities, Schools of Agriculture, and International Agricultural Organizations, with the participation of interested private international companies, especially concerned in research activities related to crop response.

III. That in view of the dire need of basic information on nutritional status of the Guatemalan soils at present, a priority program be initiated to get representative soil samples. The Soil Fertility and Plant Nutrition Department of the Dirección General de Investigación y Control, in cooperation with the Dirección de Desarrollo and the Dirección General de Recursos Naturales Renovables,

be entrusted with the principal responsibilities of the Soil Sampling Program. However, to ascertain a rapid coverage of the nation's most important agricultural areas and obtain these vital basic data on soil fertility, the three principal dependencies responsible for obtaining the samples, should not only coordinate their efforts in that respect, but should also plan collateral sampling programs using any possible aid offered by the Faculty of Agronomy and School of Agriculture personnel; students from private or international organizations, including agronomists from fertilizer companies; farmers cooperatives; military civic action associations; and missionary groups.

IV. That one of the laboratories of the Ministry of Agriculture be in charge of the analyses of farmers' samples, and that this laboratory be kept well informed of the latest methodology and research through the cooperation and coordination with the Research Departments of the Ministry, the University and the Schools of Agriculture, as well as with international organizations, private and governmental. (Several private laboratories have expressed keen interest in coordinating their efforts with the National Program.) The actual method used to analyze farmers' samples is unsatisfactory and it was recommended that a better method be used, and at the same time, that the service laboratory of the Ministry of Agriculture be modernized in order to be able to analyze 300 samples daily, to be certain that the fertilizer recommendations are sent to the farmers within 10 days after receipt of the sample.

V. That the interpretation of the laboratory analytical results and the fertilizer recommendations be the paramount responsibility of the Soil Analyses Laboratory in the Ministry of Agriculture and that, with the cooperation of trained people from other private and public organizations, standard guides be established to be followed in making the recommendations.

VI. That the Soil Fertility and Plant Nutrition Department of the Ministry, in cooperation with the Extension Service agronomists, be responsible for formulating the recommendations relative to the use of plant nutrients and other soil amendments, and that, with the assistance of scientists conducting research studies on plant nutrients and successful local producers, the basis for making the recommendations be established and revised in conferences held annually.

VII. That educational programs for farmers, intended to ascertain their comprehension of the fertilizer recommendations, and also ascertain that they are using appropriate methods to improve their crops, be the main responsibility of the Extension Division in collaboration with the Soil Fertility-Plant Nutrition Department personnel. Also, as the need arises, the collaboration of private companies, agricultural schools and international organizations, should be requested.

TWELVE STEPS TO ENDORSE THE NATIONAL PROGRAM

The scientists and technicians, who recently met in Guatemala, made specific recommendations to the International Soil Testing Project in respect to their desire to support each of the seven steps outlined above. The International Soil Testing Project is pleased to be able to make the following contributions, which have been already discussed at the conference, as part of the initial support to the Guatemalan Soil Fertility-Soil Testing National Program:

1. To furnish the basic equipment (not electronic) of multiple dispensers to the Soil Analyses Laboratory of the Ministry, and to assist in planning and designing the modifications needed to modernize the laboratory, so as to enable it to have a capacity of analyzing 100 samples per day.

2. To provide the services of a Control Laboratory to be located at N. C. State University and designated to test new methods and equipment in relation to soil analyses, and to conduct analyses with the purpose of establishing national control samples as well as to investigate soil analyses problems in the Republic of Guatemala.
3. To furnish control samples from the United States, in addition to data related to these samples, so that the laboratories would be able to initiate their soil sample analyses on a uniform basis;also assist in the collection and establishment of the national control samples.
4. To provide technical information on how to conduct laboratory and greenhouse studies; also, on how to make correlation studies with greenhouse and field trials in a simple and technical way, in order to establish a solid scientific base for making fertilizer recommendations that will result in maximum agricultural yields at a minimum cost.
5. To undertake the mineralogical characterization of a limited number of important agricultural soils with the aim of using this information in formulating guides for the use of fertilizers.
6. To furnish upon request all the information and detailed instructions on procedures to be used on analytical soil tests to all the laboratories, governmental and private.
7. To assist in the formulation of guides for the interpretation of laboratory results and making fertilizer recommendations for the various soils and crops.
8. To conduct short courses on methods and programs of soil testing-soil fertility for laboratory technicians, agronomists and administrators, with the purpose of strengthening the National Program as rapidly as possible. These courses will be offered at the N. C. Soil Testing

Laboratory and at N. C. State University and will be conducted largely in Spanish to prevent any delay that might occur if the participants were requested to learn English.

9. To publish and disseminate information on how to correlate the laboratory data.
10. To assist in the preparation of information sheets which should accompany the soil samples, and in the preparation of guides which will help improve and establish uniformity in the soil sampling methods.
11. To assist in arranging presentations designed to explain the objectives of the National Program to the farmers.
12. To assist in organizing programs on selected areas intended to produce a maximum impact in relation to soil sampling and soil analyses and, consequently, demonstrating the efficiency and yields of the Guatemalan Soil Fertility-Soil Testing National Program.

Conclusion

INITIATION OF THE GUATEMALAN SOIL FERTILITY-SOIL ANALYSES NATIONAL PROGRAM

Eight Steps to Initiate the National Program:

1. Appoint the Advisory Committee.
2. Increase the capacity of the Soil Testing Laboratory of the Ministry of Agriculture in order to process--efficiently and rapidly--all the samples submitted.
3. Sample soils representative of those areas which are of utmost importance to the economy of the Republic.
4. Initiate research studies of these soils to establish which properties are limiting their productivity.

5. Develop guides for the interpretation of the results obtained from the soil analyses and make recommendations for all the important crops.
6. Initiate an educational program on how to obtain representative samples.
7. Develop an educational program aimed at assisting the farmers in the interpretation of the results obtained from the analyses; how to obtain recommended fertilizers and how to apply them adequately; and advise them on the use of improved seeds and pesticides.
8. Give adequate training to personnel of the Ministry in relation to methods and means of operating a soil testing-soil analyses program, thus insuring a maximum production at a minimu cost.

Naturally, many of these steps will be overlapped. During the National Program's first year, a detailed sampling of the principal soils should be continued in order to insure an adequate supply of basic information which will become an asset in the field of agricultural production. At the same time, as soon as the success of the National Program spreads throughout the rural areas, a greater amount of samples will be submitted to the laboratory of the Ministry.

The National Program should be adequate to meet this demand. To achieve this the following factors should be considered:

1. Basic research for obtaining information relative to factors involved in the improvement of crop yields at a minimum cost.
2. Adequate service facilities (Extension and Laboratory) to ascertain that the farmers get the necessary information required and thus receive the benefit from the facts revealed by means of basic research.
3. Educate the farmer on how to ask what they need and make possible for them to receive the benefit of getting recommendations suggested by the Guatemalan Soil Testing-Soil Fertility National Program which in return will contribute to the increment of the agricultural production of the Republic.

A Feasibility Study for

A ROUTINE SOIL TESTING SERVICE IN PERU

Operated by the Divisions of SIPA

D. L. Waugh

Introduction

Whether or not anything is worth borrowing money to purchase depends on its potential to return more than it costs to use the loan. Fertilizer is one item which has been shown time and time again to be a good investment for the farmer who uses it properly. Yet, fertilizers used indiscriminately cannot be expected to reach their potentials. Careless recommendations can only result in disappointing returns and defeat the purpose of investment risks (loans) to purchase the fertilizer in the first place. It is the responsibility of the lending agencies to make sure the loans for fertilizer are being well spent, not only for the protection of the lending agency, but more importantly, in order to be fair to the farmer who takes out a loan in good faith that such a venture will help him. Thus, a soil testing program is the insurance policy which should underwrite every fertilizer loan.[1/]

Guidelines for putting a good routine soil analysis service into operation are presented in this report. While the program would require funds to get it started, it could readily become self-supporting if a charge is made for analysis. On the basis of the estimates given in Table 3, a charge of $1.20 per sample would

1/ Attention is directed to the two previous publications concerning the importance of and the need for a soil testing program on which to build sound soil fertility practices. These publications were put out by the International Soil Testing Project after the first phase of the study in Peru and are titled: 1) The Fertilizer Requirements of Countries of Latin America, and 2) Soil Testing as a Guide to Increasing Crop Production through Better Use of Fertilizer and Lime.

cover total costs, and perhaps operate at a slight profit, once the sample number gets up to the 100,000 sample-a-year range. Since one sample can represent from 1 to 5 hectares, depending on field conditions, the cost per hectare would range from $0.25 to $1.20. Fertilizer costs in Peru are relatively high, ranging from $40 to $120 per hectare. When considering the potential for better fertilizer responses from good recommendations, soil testing must be considered in high priority.

Design of the Program

In order to provide the type of service necessary for a modern soil testing program, it is essential that research,extension and "fomento" or service be available to be combined with soil laboratory facilities. SIPA, with its interest in these important phases of an agriculture program, can assume full responsibility for routine analysis service for Peru. In so doing, the other soils laboratories in the country would be released from this routine operation and could concentrate on carrying out new programs of laboratory, greenhouse and field research basic to the understanding of soil chemistry and soil fertility in Peru. The various Universities could resume their role in research and education, and SIPA could strengthen its role of service to agriculture. By following the suggestions herein set forth it is believed that a good soil testing service could be put into effect quickly.

The question which must be answered first is how many soil analysis labs are needed, and where they are needed, now and in the future. Several criteria must be considered; proximity of the service to the farmers, speed of the service, accuracy of the analyses and interpretations, and cost of the service to the farmer, to SIPA, or to both.

The problem of proximity to the soil testing service for the farmers being served is difficult to handle, especially in a large country where the farmers are bunched in little groups and these groups widely scattered. The distribution of the SIPA Extension Service offices clearly illustrate this problem. There are over 200 extension agencies and sub-agencies widely distributed in Peru. Yet, probably only about one-fourth of the farmers served by these agencies are within walking distance for the closest one. Nevertheless, these agencies are the only center of help for the farmers in the outlying areas, and each agency should be strengthened to provide the necessary services in soil testing. It is obvious, of course, that every sub-agency cannot be equipped to do the relatively complicated soil analyses required for a good routine procedure in soil testing. But each agency must play an active role in order to provide service to these farmers.

The SIPA Extension-Fomento Offices

A very effective system of farmer service could be established by setting up each agency and sub-agency as a field office for soil testing. The make-up of the field office would be extremely simple:

- a supply of soil sampling materials (tubes, spades, sample cartons or bags, and information sheets).
- a hand-made rack to air-dry samples if need be.
- a small, hand-operated sample preparing device to mix, crush, sieve and sub-sample 200 g. soil.
- a supply of 200 g. size sample cartons and 5, 10 and 20-box shipping cartons to be used in sending the samples on to the analysis center.
- a hand-made storage rack in which the remaining portion of each sample is stored for future checks or reference if necessary.

The staff of the field office would be the extension agent and perhaps a helper to assist in sample preparation. The agent would be given field training required to do this job well. It would be his responsibility to arrange soil sampling drives involving a small group of farmers, each of which could assist in taking the samples under the supervision of the agent. After each farm is properly sampled, the agent would take the samples to the field office, prepare them for analysis and shipping, and send them to the analysis lab. Upon arrival of the results back to the extension agent, he again meets with the groups of farmers, explains the results, offers suggestions on proper use of seeds, fertilizers, insecticides, weed control, etc. In this way, one extension agent can help a large number of farmers, providing a very important service to those who need it most.

The Analysis Labs of SIPA

The problem of decentralization of Lima must be considered in the soil testing service. However, this decentralization will have to be accomplished by means of the large number of extension field offices. It is, after all, at these field offices that the vital part of soil testing is really done--getting the samples, and returning to the farmer with the helpful answers he needs. As far as the farmer is concerned, the field office is his soil testing service, not the analysis lab. This concept is essential to a successful soil testing program in Peru, simply because on the basis of the other considerations required for the analysis lab center, the superiority of one lab at La Molina is evident. The following is a rather detailed discussion of these other considerations, based on a unit-number of samples arbitrarily set at 100,000. Efficiency of a routine service lab increases markedly up to large numbers. It is not possible to state exactly what this point is, but 100,000 samples per year is probably a reasonable guess based on United States labs.

Cost of Analysis per Sample

A large factor in the recommendation that only one lab be used for the analysis work is the low cost of regularly scheduled air transportation of small samples for all parts of Peru to Lima, (Table 1). On a per sample basis (200 g.) the cost of air shipment is much lower than the high fixed costs of a suitable physical plant, proper equipment, and trained staff members. This is true at a volume of 100,000 samples per year, and is even more obvious at low volumes (see Table 2). Furthermore, whereas it appears as though enough technicians are available at the La Molina lab to operate at high capacity, there just are not enough to operate several laboratories without draining away scientists badly needed to carry out certain basic research essential to soil fertility knowledge. Use of one central lab would results in most analyses per technician.

Added to these factors is the plan adopted by the International Soil Testing Project to program data processing techniques for the purpose of printing out fertilizer recommendations on a standard form. Since the program would be designed to "fit" all countries cooperating in the project, Lima could become the processing center for several other countries in addition to Peru. Such a system would add greatly to the efficiency of the soil testing program and also provide the punched cards necessary to run almost any kind of data analysis in the future concerning soil fertility and use of fertilizers in Peru and Latin America as a whole.

Speed of Completing the Analysis

Modern techniques in laboratory analysis of soil make rapid determinations possible in a system designed for large capacity. One central analysis laboratory can employ these to the fullest extent. Furthermore, there is the problem of rush periods which would be relieved considerably by sending all samples to a central lab. This is because there is a continual process of planting going on when the country as a whole is considered. On the other hand, area labs would experience

definite rush periods during the planting season of the local area. Uniform flow of samples to the laboratory helps tremendously in achieving low cost and quick analyses.

In an attempt to give some idea of the length of time which might be expected as necessary for soil testing with this system, an outline of predicted time requirements is given in Table 3. There will certainly be times when the requirements will be greater than this, but the average time required should be about 10 days to two weeks. The big unknown in this estimate would be the time required to get the samples from the sub-station to an airport or other direct-line transportation to Lima. This kind of problem, of course, would be experienced even with a large number of labs. In effect, the trip to Lima represents only 1/2 to 2 days, and this amount of time can easily be lost in a system of less efficient analysis laboratories.

Accuracy of the Analyses and Fertilizer Recommendations

Quality control is, without question, much easier to maintain with a well organized large analysis center than with several smaller ones. Then, too, the IBM data processing technique offers considerable advantages in accuracy of reporting the results and making recommendations.

Projections in the Future

The system of field offices and analysis center outlined above would be easily modified to meet future needs. The field offices could be added or dropped or altered as the need arises, without affecting the overall program. As the number of samples rises beyond 100,000 samples per year, additional analysis labs could be established at strategic locations, or the La Molina lab could easily be reinforced to handle more samples simply by adding more technicians to the basic plant. Most equipment runs better and lasts longer under steady use than under intermittent use.

The proposed field-office analysis-lab system is perfectly suited for close coordination with Plan Costa: It would promote close contact with the farmers, provide accuracy in the recommendations, and be available at a cost which the farmer would find insignificant compared to the costs of fertilizers. Few programs that SIPA or any other organization might put into effect would have the impact of a well coordinated soil testing-fertilizer loan program.

Total Use of the SIPA Routine Soil Testing Service

Other governmental programs in Peru are in need of a soil testing service. The high capacity laboratory at La Molina could serve to provide such routine analyses in addition to farmer samples. This total use of a soil testing service would make maximum use of both equipment and technical resources of Peru, and provide valuable data for the country as a whole.

Table 1. Costs of shipping soil samples from various outlying areas of Peru to Lima and regularity of scheduled transportation. (Only a few examples are given: Low to High)

Shipping from	cost of shipping soil* 1 Kg.	200 g.	Number of trips weekly*
	S/.	S/.	
Air Freight			
Chiclayo	5.45	1.09	7
Tumbes	7.95	1.59	1
Tarapoto	5.50	1.10	3
Arequipa	5.80	1.16	7
Pucalipa	5.10	1.02	5
Tingo María	4.30	0.84	4
Cusco	6.25	1.25	7
Iberia	10.00	2.00	4
Quitos	7.55	1.51	5
Satipo	5.15	1.03	1
Collective			
Huanacayo	1.00	0.20	7
Chiclayo	0.30	0.06	3
Arequipa	0.80	0.16	5

* Actual figures given by various companies

Table 2. Minimum days required to complete soil testing of farmers' samples (farmer to labs to farmer) using the extension-lab analysis-lab system.

Operation	minimum days required
Take samples, carry to Ext. Lab	1
Prepare sample for analysis at Ext. Lab	1
Ship from Ext. Lab to Analysis Lab	1
Completion of Analyses and reports	3
Return shipping of reports to Ext. Lab	2
Deliver report to farmer	2
Total days -	10

Comment: Taking the samples at the farms should be an efficient process, since the agent can plan it to be convenient. Once he has collected a group of samples on a drive, they can be prepared before another drive is started, and sent out directly. If the samples are very wet they would have to be dried, thereby adding at least 2 more days in the Ext. Lab. The rest of the schedule depends mostly on coordination of the shipping days with working days at the analysis lab, and would fluctuate considerably.

Table 3. Present and Projected Costs in Operating a Routine Soil Testing Service in Perú

Items INCLUDED in Routine Soil Testing Service	Present SIPA Program La Molina	Projected Program for the Next 4 Years			
	1965	1966	1967	1968	1969
Projected Number of Samples to be analyzed	2,000	25,000	50,000	75,000	100,000
Expenses: (U.S. $)	$	$	$	$	$
1. Equipment (5-Yr. Depr.)	1,000	2,000	2,000	2,000	2,000
2. Building (20-Yr. Depr.)	400	400	400	400	400
3. Materials, supplies	500	5,000	7,000	9,000	11,000
4. Reagents	750	5,000	10,000	15,000	20,000
5. Staff La Molina*					
Director, Dept. Soils	1,500	3,000	3,000	3,000	3,000
Lab Director	2,600	5,000	5,000	5,000	5,000
Chemists	2,000	8,000	12,000	16,000	20,000
Analytical Aids	2,800	10,500	10,500	10,500	10,500
Helpers	1,000	1,000	1,000	1,000	1,000
6. Field Offices**					
Equipment (10-Yr. Depr.)	---	1,000	2,000	3,000	4,000
Sample Preparation	---	2,500	5,000	7,500	10,000
7. Transportation of Samples and Mailing of Reports	---	4,000	6,000	8,000	10,000
8. IBM Recommendations	---	4,000	6,000	7,000	8,000
Total Expenses	12,400	51,000	70,000	90,000	105,000
Cost per Sample	6.20	2.10	1.40	1.20	1.05
Estimated Income	7,500	30,000	60,000	90,000	120,000
Profit From Soil Testing	-4,900	-21,000	-10,000	----	15,000

* Part-time Departmental Director; Number of chemists increases by one person per year, from 1 in 1965 to 5 in 1969; remainder of staff need not increase

**These Extension-Fomento offices would take samples and budget for this cost, as they make farmer visits in their present and projected programs.

Table 4. Summary of New Money Needed in the Period 1966-1970 to Develop Soil Testing Program in Perú to a Capacity of 100,000 Samples per Year.

Item of Operation	1966	1967	1968	1969	1970
Projected Number of Samples to be Analyzed	25,000	50,000	75,000	100,000	100,000
Expenses: (U.S. $)	$	$	$	$	$
1. Field Offices*					
Remodel Room for Soils Work	10,000	10,000	10,000	10,000	----
Train Agents and Helpers	1,000	1,000	1,000	1,000	1,000
Prepare Samples for Shipping	2,500	5,000	7,500	10,000	10,000
2. La Molina Analysis Center					
Remodel, Equip.	10,000	----	----	----	----
Personnel at Lab Center	27,000	31,000	35,000	40,000	40,000
Supplies, Reagents, Maintenance	10,000	17,000	24,000	31,000	31,000
3. Initial Design and Charges for shipping cartons, information sheets	1,000	----	----	----	----
4. Sample Transportation to La Molina	4,000	6,000	8,000	10,000	10,000
5. IBM Report Processing and Mailing	6,000	6,000	7,000	8,000	8,000
Total Expenses in Projected Plan	71,500	76,000	92,500	110,000	100,000
Projected Income from Soil Testing	30,000	60,000	90,000	120,000	120,000
Annual Appropriation Required to Balance the Budget **	41,000	16,000	2,500	- 10,000	- 20,000

* The Projected cost per field office would be $200; if 50 were developed yearly, 4 years would complete the program.

** Figures for 1969 and 1970 indicate a budget surplus from soil testing if the charge of $1.20 per sample were continued.

CONFERENCE OF THE WORLD SOIL MAP PROJECT OF FAO

Donovan L. Waugh

With the overlapping of the AID agricultural programs and related activities in Rio during the week of July 12 to 16, I had the privilege of representing the International Soil Testing Project at the FAO World Soil Map Conference in Rio. The purpose of the representation at the conference was to coordinate plans of fertility evaluation through the soil testing effort with the soil classification effort in Latin America. Representatives from most of the South American nations were present, in some cases with two representatives. Countries not represented included Ecuador, Bolivia, and Colombia.

The first four days of the conference were devoted almost exclusively to discussions of the "Third Draft of the Soil Map of South America". The detailed legend was carefully reviewed by the soil classification representative from each country, followed by discussions to coordinate the various units of classification as closely as possible. A number of tentative changes were made in the legend, and each representative was asked to submit a list of changes he felt were necessary in his own area to make the map correspond to the prescribed limits of each soil group shown on the map. In this way it was hoped that the "corrected" copy of the third draft could be completed and published within the span of a year.

The last day of the conference related specifically to the subject with which our project is directly concerned, namely, the discussion of approximating the productivity of land units. Several schemes were presented which showed possibilities for evaluating first the existing productivity under present conditions and then the potential productivity if all the factors which are readily changeable were properly taken into account. The proper use of fertilizer was proclaimed as the greatest

single factor which can be put into use to improve the productivity of the various soil groups. The need to assign priority of development to high potential new areas was discussed, as the importance of colonization increases throughout Latin America.

Finally, as a representative of International Soil Testing, I presented our ideas concerning the importance of soil testing as a tool to evaluate and re-evaluate the year to year fertility of soil after it is in production. Comparisons were made between soil classification and soil testing as means of predicting fertilizer needs. The outcome of the discussion was a motion on the part of FAO to include close coordination with soil testing as necessary and essential to the effective use of the mapping units. I pledged the support of International Soil Testing in the planning of research studies and field trials, which will be needed to effectively correlate methods of soil analyses and interpret these analyses, such that the mapping units can become an important part of the basis for interpretation and recommendation of fertilizers. In this manner it is hoped that reference information can be established which will enable comparisons to be made of soil analytical data, not only from one part of a country to another, but across country boundaries.

APPENDIX F - Maps

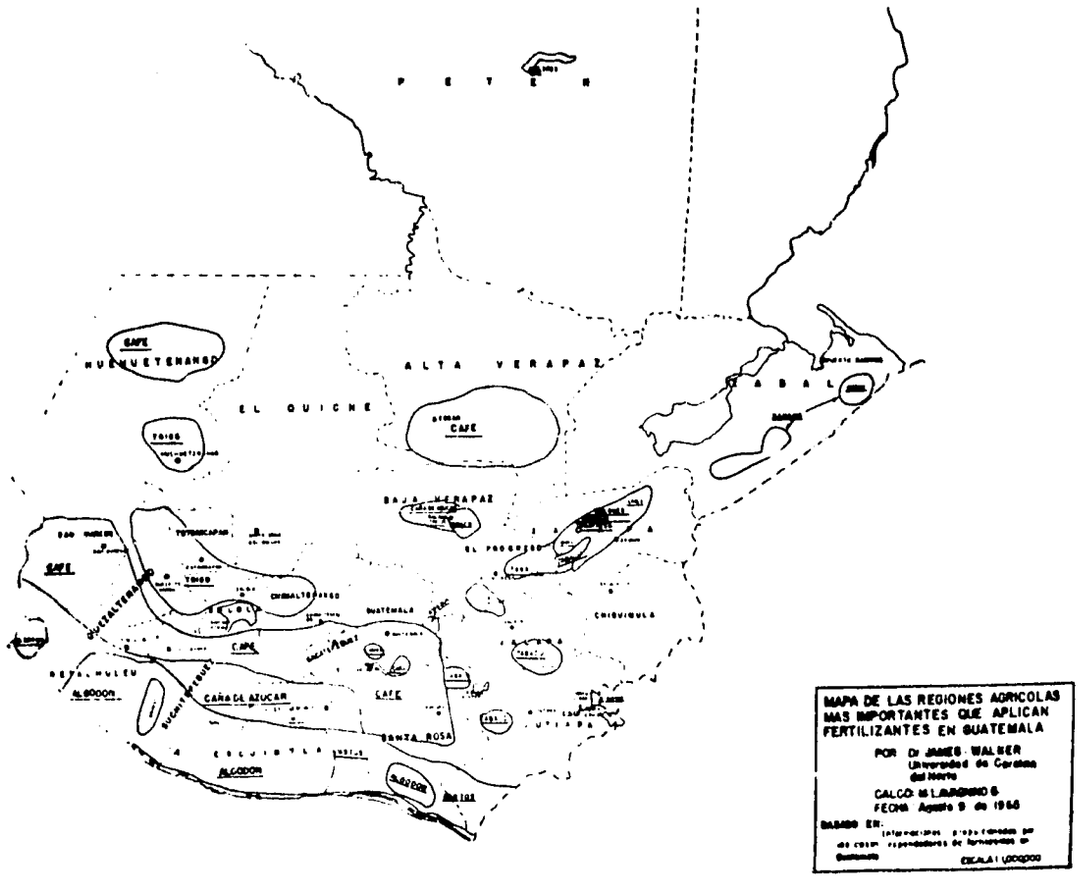
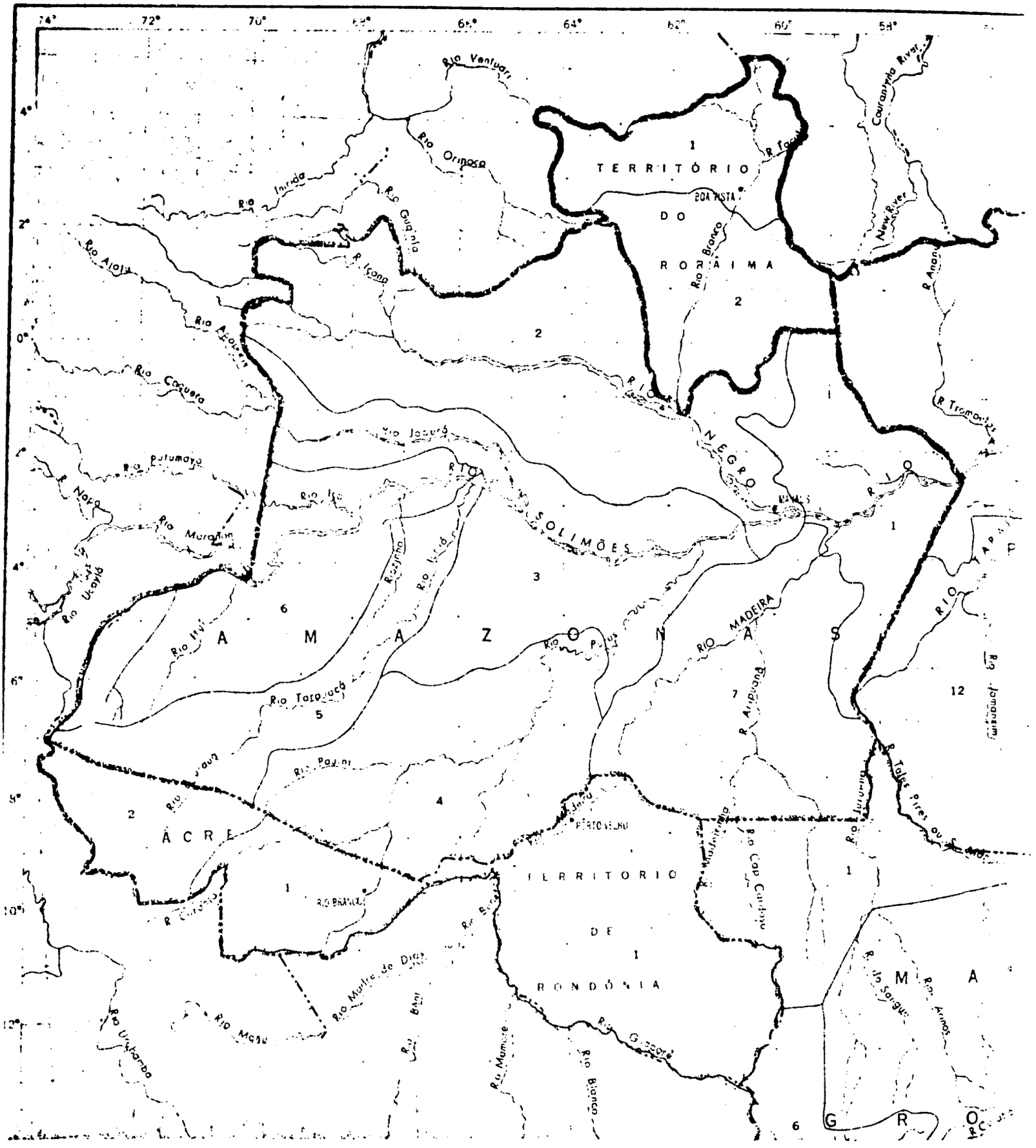


Photo 24. Guatemala. A general map showing the more important crop producing areas where the use of fertilizers is likely to be most important to the country.


TERRITÓRIO
DO
RORAIMA
BOA VISTA
Rio Branco
Rio Ventuari
Rio Orinoco
Rio Inirida
Rio Guainia
R. Icana
Rio Atabapo
Rio Cababuri
Rio Caquetá
Rio Japurá
Rio Putumayo
Rio Naro
Rio Muratim
Rio Uaupés
Rio Tiquié
Rio Isié
Rio Tarauacá
Rio Purus
Rio Jutaí
Rio Paumari
Rio Jurua
R. Curanja
Rio Madre de Dios
Rio Manu
Rio Urubamba
Rio Beni
Rio Mamoré
Rio Guaporé
Rio Branco
Rio Cap Cardoso
Rio Madeira
R. Aripuanã
Rio Jurumã
Rio Jamanxim
R. Tapajós
Rio Xingu
R. Anauá
R. Tromai
Courantyne River
New River
R. Icana
Rio Negro
Rio Solimões
MANAUS
PORTO VELHO
RIO BRANCO
AMAZONAS
ACRE
TERRITÓRIO
DE
RONDÔNIA
AMAPÁ
GRO
1
2
3
4
5
6
7
12

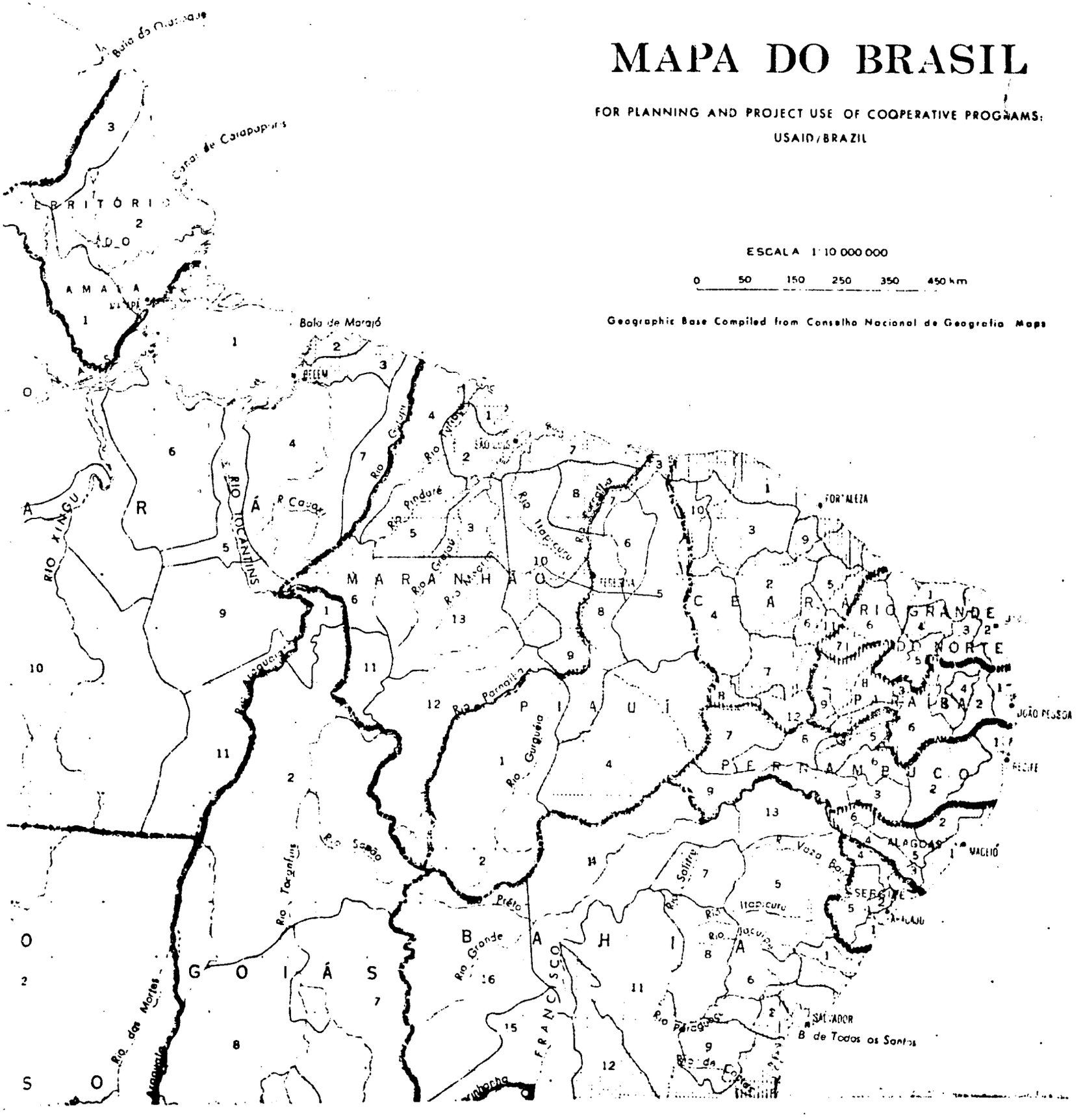
MAPA DO BRASIL

FOR PLANNING AND PROJECT USE OF COOPERATIVE PROGRAMS:
USAID/BRAZIL

ESCALA 1:10 000 000

0 50 150 250 350 450 km

Geographic Base Compiled from Conselho Nacional de Geografia Maps



GUANABARA

1. Alto Madeira

ACRE

1. Alto Purus
2. Alto Aurus

AMAZONAS

1. Médio Amazonas
2. Rio Negro
3. Solimões-Tefé
4. Rio Purus
5. Rio Juruá
6. Solimões-Javari
7. Rio Madeira

RORAIMA

1. Alto do Rio Branco
2. Catrimani

PARÁ

1. Marajó e Ilhas
C - 2. Salgado
C - 3. Bragantina
4. Guajarina
5. Tocantina
6. Jacundá-Pacajá
7. Gurupi
8. Baixo Amazonas
9. Itacaiúnas
10. Rio Xingu
11. Planalto
12. Tapajós

AMAPÁ

1. Macapá
2. Amapá-Macapá
3. Oiapoque

MARANHÃO

C - 1. Litoral Norte
C - 2. Baixada
B - 3. Baixo Mearim
4. Gurupi
C - 5. Pindaré
6. Tocantins
C - 7. Litoral Nordeste
B - 8. Baixo Parnaíba
B - 9. Médio Parnaíba
B -10. Itapecuru
11. Carolina
12. Alto Parnaíba
13. Alto Mearim

PIAUÍ

1. Alto Parnaíba
2. Planalto
C - 3. Litoral
A - 4. Sertão
5. Ibiapaba
6. Carnaubeira
B - 7. Baixo Parnaíba
B - 8. Médio Parnaíba

PARAÍBA

C - 1. Litoral e Mata
A - 2. Agreste e Caatinga Litorânea
A - 3. Seridó
B - 4. Brejo
A - 5. Borborema Oriental
A - 6. Borborema Central
B - 7. Sertão Alto
A - 8. Sertão de Piranhas
A - 9. Sertão do Oeste

PERNAMBUCO

C - 1. Litoral e Mata
A - 2. Agreste
A - 3. Sertão de Mozoró
C - 4. Triunfo
A - 5. Sertão Alto ou Alto Pajeú
A - 6. Sertão do Alto Mozoró
C - 7. Araripe
A - 8. Sertão Central
A - 9. Sertão do São Francisco

ALAGÔAS

C - 1. Litoral
C - 2. Mata
B - 3. Baixo São Francisco
A - 4. Sertão do São Francisco
A - 5. Sertaneja
A - 6. Serrana

SERGIPE

B - 1. Litoral
B - 2. Central
B - 3. Baixo São Francisco
A - 4. Sertão do São Francisco
A - 5. Oeste

CEARÁ

C - 1. Litoral
B - 2. Sertão Central
B - 3. Sertão Centro-Norte
B - 4. Sertão do Sudoeste
B - 5. Sertão do Baixo Jaguaribe
A - 6. Sertão do Médio Jaguaribe
A - 7. Sertão do Salgado e Alto Jaguaribe

C - 8. Araripe
B - 9. Baturité
C -10. Ibiapaba
A - 11. Pereiro
A -12. Cariri

RIO GRANDE DO NORTE

C - 1. Baixeiras ou Litoral e Salinas
C - 2. Litoral
A - 3. Agreste
A - 4. Centro-Norte
A - 5. Seridó
A - 6. Chapada do Apodi
A - 7. Serrana

BAHIA

B - 1. Litoral Norte
B - 2. Recôncavo
B - 3. Cacaueira
C - 4. Extremo Sul
B - 5. Nordeste
A - 6. Feira de Santana
A - 7. Senhor do Bonfim
B - 8. Encosta da Chapada Diamantina
B - 9. Jequié
C -10. Conquista
A -11. Chapada Diamantina
B -12. Serra Geral
13. Sertão do São Francisco
14. Baixo-Médio São Francisco
15. Médio São Francisco
16. Barreiras

MINAS GERAIS

B - 1. Médio-Baixo Jequitinhonha
B - 2. Médio Jequitinhonha
C - 3. Mucuri
B - 4. Rio Doce
B - 5. Mata
B - 6. Itacambira
C - 7. Alto Jequitinhonha
C - 8. Metalúrgica
C - 9. Campos da Mantiqueira
B -10. Sul
B -11. Oeste
12. Alto Médio São Francisco
B -13. Montes Claros
14. Alto São Francisco
15. Urucuia
B -16. Paranaíba-Rio Grande (Alto Paranaíba)
B -17. Triângulo

ESPÍRITO SANTO

C - 1. Norte
B - 2. Baixo Rio Doce
C - 3. Vitória
C - 4. Itabemirim
C - 5. Serrana do Centro
C - 6. Serrana do Sul

GUANABARA

C - 1. Baixada Carioca

RIO DE JANEIRO

C - 1. Baixada de Goitacases
C - 2. Baixada do Rio São João
C - 3. Baixada de Araruama
C - 4. Baixada da Guanabara
C - 5. Baixada do Rio Guandu
C - 6. Litoral da Baía da Ilha Grande
B - 7. Macaé
B - 8. Cantagalo
C - 9. Alto da Serra
C -10. Resende

SÃO PAULO

C - 1. Litoral de São Sebastião
C - 2. Médio Paraíba
C - 3. Alto Paraíba
C - 4. Mantiqueira
C - 5. Litoral de Santos
C - 6. Baixada de Ribeira
B - 7. São José do Rio Pardo
C - 8. Bragança
C - 9. São Paulo
C -10. Paranapiacaba
C -11. Alto Ribeira
C -12. Piracununga
B -13. Rio Claro
B -14. Piracicaba
C -15. Campos Gerais
A -16. Itaporanga
B -17. Franca
B -18. Ribeirão Preto
B -19. Araraquara
B -20. São Carlos e Jaú
C -21. Botucatu
A -22. Piraju
B -23. Barretos
A -24. Rio Preto
A -25. Catanduva
B -26. Bauru
B -27. Araçatuba
A -28. Marília
A -29. Assis
B -30. Presidente Prudente
B -31. Pereira Barreto
B -32. Andradina
B -33. Presidente Venceslau

PARANÁ

C - 1. Litoral
C - 2. Alto Ribeira
C - 3. Castro
C - 4. Curitiba
B - 5. Campos Gerais
B - 6. Tomazina
C - 7. Alto Ivaí
B - 8. Iratí
B - 9. Oeste
A -10. Norte
C -11. Campos do Oeste

SANTA CATARINA

C - 1. Litoral de São Francisco
C - 2. Bacia do Itajaí
C - 3. Florianópolis
C - 4. Laguna
C - 5. Canoinhas
A - 6. Rio do Peixe
A - 7. Oeste
C - 8. Campos de Lajes

RIO GRANDE DO SUL

C - 1. Litoral
B - 2. Depressão Central
B - 3. Missões
B - 4. Campanha
B - 5. Serra do Sudeste
C - 6. Encosta do Sudeste
A - 7. Alto Uruguai
C - 8. Campos de Cima da Serra
B - 9. Planalto Médio
A -10. Encosta Inferior do Nordeste
A -11. Encosta Superior do Nordeste

MATO GROSSO

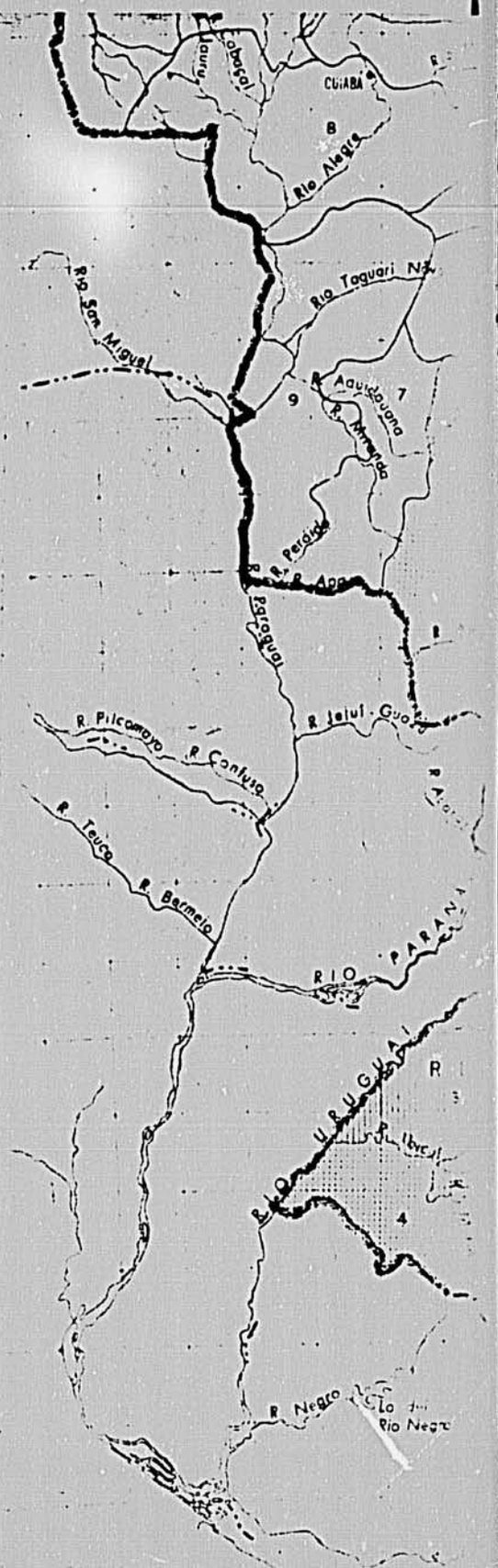
1. Aripuanã
2. Chapada
3. Pozoreu (Leste)
B - 4. Campo Grande
5. Rio Pardo (Sudeste)
6. Encosta Norte
7. Encosta Sul
8. Baixada Norte
9. Baixada Sul

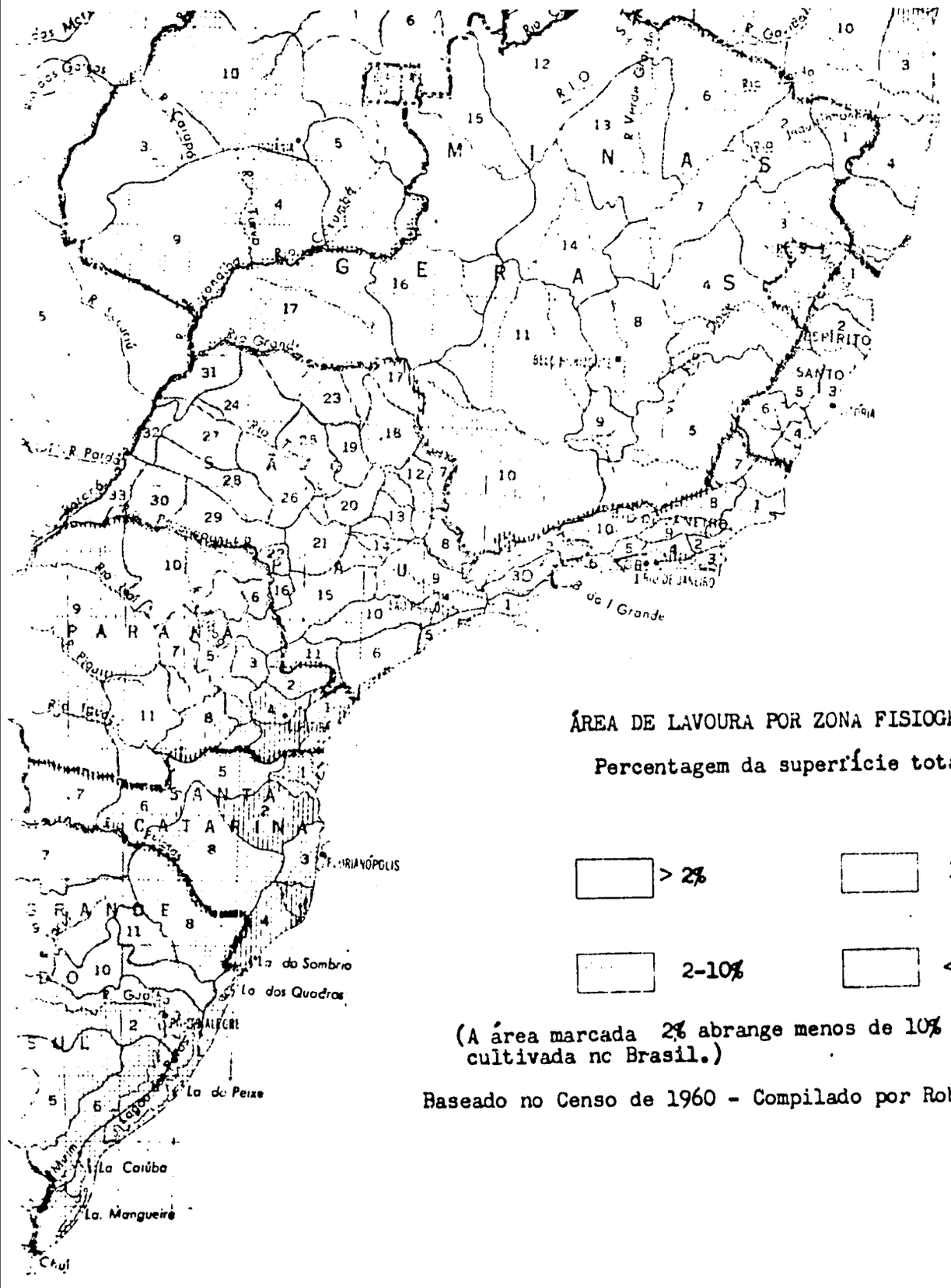
GOIÁS

1. Araguaia-Tocantins
2. Norte Goiano
3. Alto Araguaia
B - 4. Meia Ponte
B - 5. Ipameri
6. Planalto
7. Paraná
8. Alto Tocantins
B - 9. Rio Verde
B -10. Mato Grosso de Goiás

DISTRITO FEDERAL

1. Planalto





ÁREA DE LAVOURA POR ZONA FISIOGRÁFICA

Percentagem da superfície total

> 2%

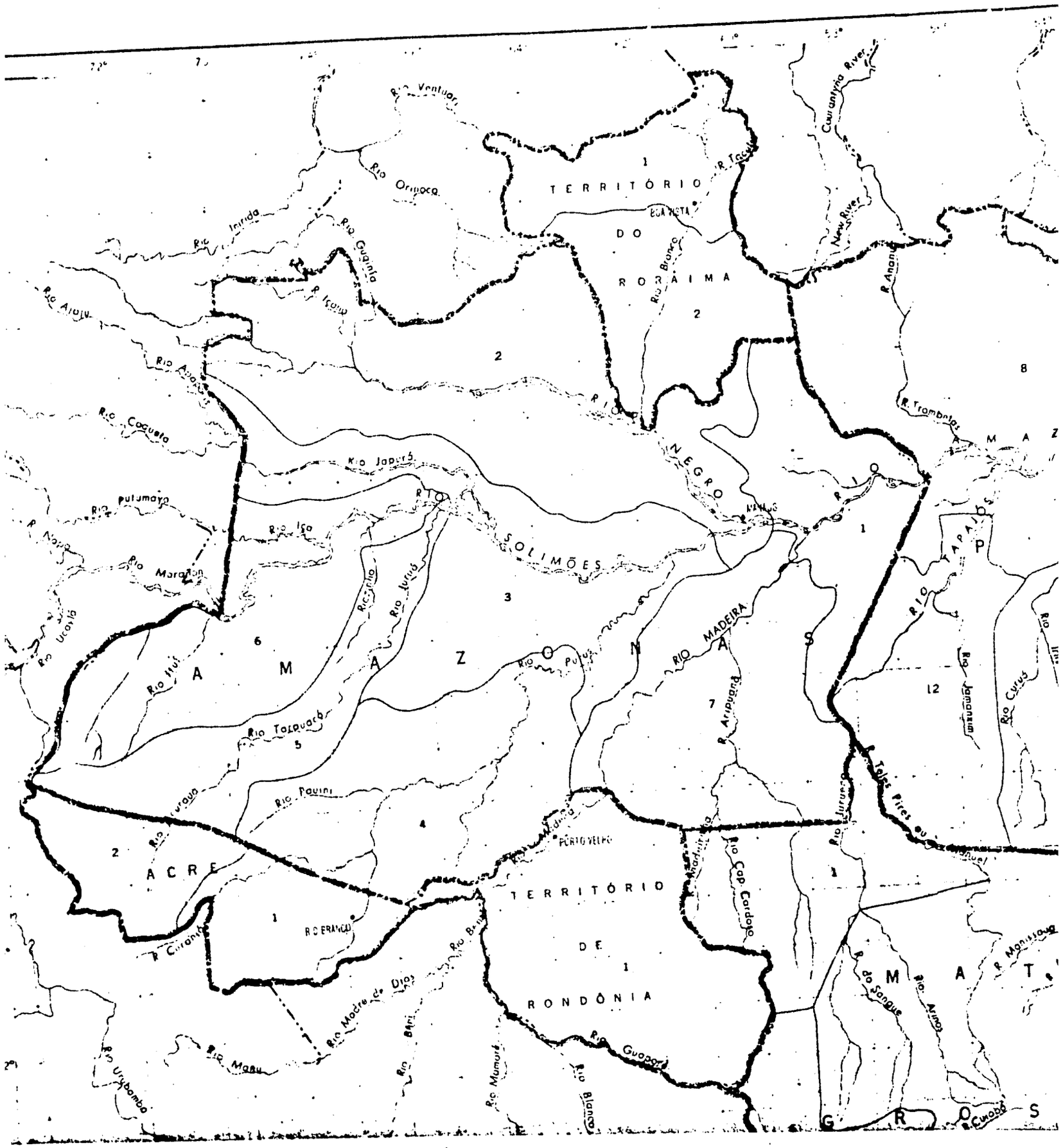
10-20%

2-10%

< 20%

(A área marcada 2% abrange menos de 10% do total de terra cultivada nc Brasil.)

Baseado no Censo de 1960 - Compilado por Robert Cate, NC - ARD


TERRITÓRIO DO RORAIMA
BOA VISTA
Rio Branco
Rio Ventuari
Rio Orinoco
Rio Inirida
Rio Guainia
Rio Isana
Rio Aiaiu
Rio Apaporis
Rio Caquetá
Rio Japurá
Rio Putumayo
Rio Isa
Rio Marañon
Rio Ucayali
Rio Negro
Rio Solimões
Rio Jurua
Rio Purus
Rio Madeira
Rio Aripuanã
Rio Tapajós
Rio Curuá
Rio Jamanxim
Rio Tapajós ou Teles Pires
Rio Juruena
Rio Cap. Cardoso
Rio Madeira
Rio Abunã
Rio Mamoré
Rio Guaporé
Rio Blanco
Rio Mamoré
Rio Baní
Rio Madre de Dios
Rio Mabu
Rio Urubamba
Rio Curanja
Rio Tarauacá
Rio Paumi
Rio Iuruá
Rio Xingu
Rio do Sangue
Rio Arinos
Rio Manissaua
Rio Cuiabá
Rio Trombetas
Rio Anauni
Courantyne River
New River
PORTO VELHO
RIO BRANCO
MANAUS
TERRITÓRIO DE RONDÔNIA
ACRE
AMAZONAS
MATO GROSSO
1
2
3
4
5
6
7
8
12

MAPA DO BRASIL

FOR PLANNING AND PROJECT USE OF COOPERATIVE PROGRAMS:
USAID/BRAZIL

ESCALA 1:10 000 000

0 50 150 250 350 450 km

Geographic Base Compiled from Conselho Nacional de Geografia Maps

RONDÔNIA

1. Alto Madeira

ACRE

1. Alto Purus
2. Alto Juruá

AMAZONAS

1. Médio Amazonas
2. Rio Negro
3. Solimões-Tefé
4. Rio Purus
5. Rio Juruá
6. Solimões-Javari
7. Rio Madeira

RORAIMA

1. Alto do Rio Branco
2. Catrimani

PARÁ

1. Marajó e Ilhas
C - 2. Salgado
C - 3. Bragantina
4. Guajarina
5. Tocantina
6. Jacundá-Pacajá
7. Gurupi
8. Baixo Amazonas
9. Itacaiúnas
10. Rio Xingu
11. Planalto
12. Tapajós

AMAPÁ

1. Mazagão
2. Amapá-Macapá
3. Oiapoque

MARANHÃO

C - 1. Litoral Norte
C - 2. Baixada
B - 3. Baixo Mearim
4. Gurupi
C - 5. Pindaré
6. Tocantins
C - 7. Litoral Nordeste
B - 8. Baixo Parnaíba
B - 9. Médio Parnaíba
B -10. Itapecuru
11. Carolina
12. Alto Parnaíba
13. Alto Mearim

PIAUÍ

1. Alto Parnaíba
2. Planalto
C - 3. Litoral
A - 4. Sertão
5. Ibiapaba
6. Carnaubeira
B - 7. Baixo Parnaíba
B - 8. Médio Parnaíba

PARAÍBA

C - 1. Litoral e Mata
A - 2. Agreste e Caatinga Litorânea
A - 3. Seridó
B - 4. Brejo
A - 5. Borborema Oriental
A - 6. Borborema Central
B - 7. Sertão Alto
A - 8. Sertão de Piranhas
A - 9. Sertão do Oeste

PERNAMBUCO

C - 1. Litoral e Mata
A - 2. Agreste
A - 3. Sertão do Moxotó
C - 4. Triunfo
A - 5. Sertão Alto ou Alto Pajeú
A - 6. Sertão do Alto Moxotó
C - 7. Araripe
A - 8. Sertão Central
A - 9. Sertão do São Francisco

ALAGÔAS

C - 1. Litoral
C - 2. Mata
B - 3. Baixo São Francisco
A - 4. Sertão do São Francisco
A - 5. Sertanejo
A - 6. Serrana

SERGIPE

B - 1. Litoral
B - 2. Central
B - 3. Baixo São Francisco
A - 4. Sertão do São Francisco
A - 5. Oeste

CEARÁ

C - 1. Litoral
B - 2. Sertão Central
B - 3. Sertão Centro-Norte
B - 4. Sertão do Sudoeste
B - 5. Sertão do Baixo Jaguaribe
A - 6. Sertão do Médio Jaguaribe
A - 7. Sertão do Salgado e Alto Jaguaribe

C - 8. Araripe
B - 9. Baturité
C -10. Ibiapaba
A - 11. Pereiro
A -12. Cariri

RIO GRANDE DO NORTE

C - 1. Salineiras ou Litoral e Salinas
C - 2. Litoral
A - 3. Agreste
A - 4. Centro-Norte
A - 5. Seridó
A - 6. Chapada do Apodi
A - 7. Serrana

BAHIA

B - 1. Litoral Norte
B - 2. Recôncavo
B - 3. Cacaueira
C - 4. Extremo Sul
B - 5. Nordeste
A - 6. Feira de Santana
A - 7. Senhor do Bonfim
B - 8. Encosta da Chapada Diamantina
B - 9. Jequié
C -10. Conquista
A -11. Chapada Diamantina
B -12. Serra Geral
13. Sertão do São Francisco
14. Baixo-Médio São Francisco
15. Médio São Francisco
16. Barreiras

MINAS GERAIS

B - 1. Médio-Baixo Jequitinhonha
B - 2. Médio Jequitinhonha
C - 3. Mucuri
B - 4. Rio Doce
B - 5. Mata
B - 6. Itacambira
C - 7. Alto Jequitinhonha
C - 8. Metalúrgica
C - 9. Campos da Mantiqueira
B -10. Sul
B -11. Oeste
12. Alto Médio São Francisco
B -13. Montes Claros
14. Alto São Francisco
15. Urucuia
B -16. Paranaíba-Rio Grande (Alto Paranaíba)
B -17. Triângulo

ESPÍRITO SANTO

C - 1. Norte
B - 2. Baixo Rio Doce
C - 3. Vitória
C - 4. Itapemirim
C - 5. Serrana do Centro
C - 6. Serrana do Sul

GUANABARA

C - 1. Baixada Carioca

RIO DE JANEIRO

A 1. Baixada de Goitacazes
C - 2. Baixada do Rio São João
C - 3. Baixada de Araruama
C - 4. Baixada da Guanabara
C - 5. Baixada do Rio Guandu
C - 6. Litoral da Baía da Ilha Grande
B - 7. Mariaé
B - 8. Cantagalo
C - 9. Alto da Serra
C -10. Resende

SÃO PAULO

C - 1. Litoral de São Sebastião
C - 2. Médio Paraíba
C - 3. Alto Paraíba
C - 4. Mantiqueira
C - 5. Litoral de Santos
C - 6. Baixada do Ribeira
B - 7. São José do Rio Pardo
C - 8. Bragança
C - 9. São Paulo
C -10. Paranapiacaba
C -11. Alto Ribeira
C -12. Piracicununga
B -13. Rio Claro
B -14. Piracicaba
C -15. Campos Gerais
A -16. Itaporanga
B -17. Franca
B -18. Ribeirão Preto
B -19. Araraquara
B -20. São Carlos e Jaú
C -21. Botucatu
A -22. Piraju
B -23. Barretos
A -24. Rio Preto
A -25. Catanduva
B -26. Baurú
B -27. Araçatuba
A 28. Marília
A -29. Assis
B -30. Presidente Prudente
B -31. Pereira Barreto
B -32. Andradina
B -33. Presidente Venceslau

PARANÁ

C - 1. Litoral
C - 2. Alto Ribeira
C - 3. Castro
C - 4. Curitiba
B - 5. Campos Gerais
B - 6. Tomazina
C - 7. Alto Ivaí
B - 8. Irati
B - 9. Oeste
A -10. Norte
C -11. Campos do Oeste

SANTA CATARINA

C - 1. Litoral de São Francisco
C - 2. Bacia do Itajaí
C - 3. Florianópolis
C - 4. Laguna
C - 5. Canoinhas
A - 6. Rio do Peixe
A - 7. Oeste
C - 8. Campos de Lajes

RIO GRANDE DO SUL

C - 1. Litoral
B - 2. Depressão Central
B - 3. Missões
B - 4. Campanha
B - 5. Serra do Sudeste
C - 6. Encosta do Sudeste
A - 7. Alto Uruguai
C - 8. Campos de Cima da Serra
B - 9. Planalto Médio
A -10. Encosta Inferior do Nordeste
A -11. Encosta Superior do Nordeste

MATO GROSSO

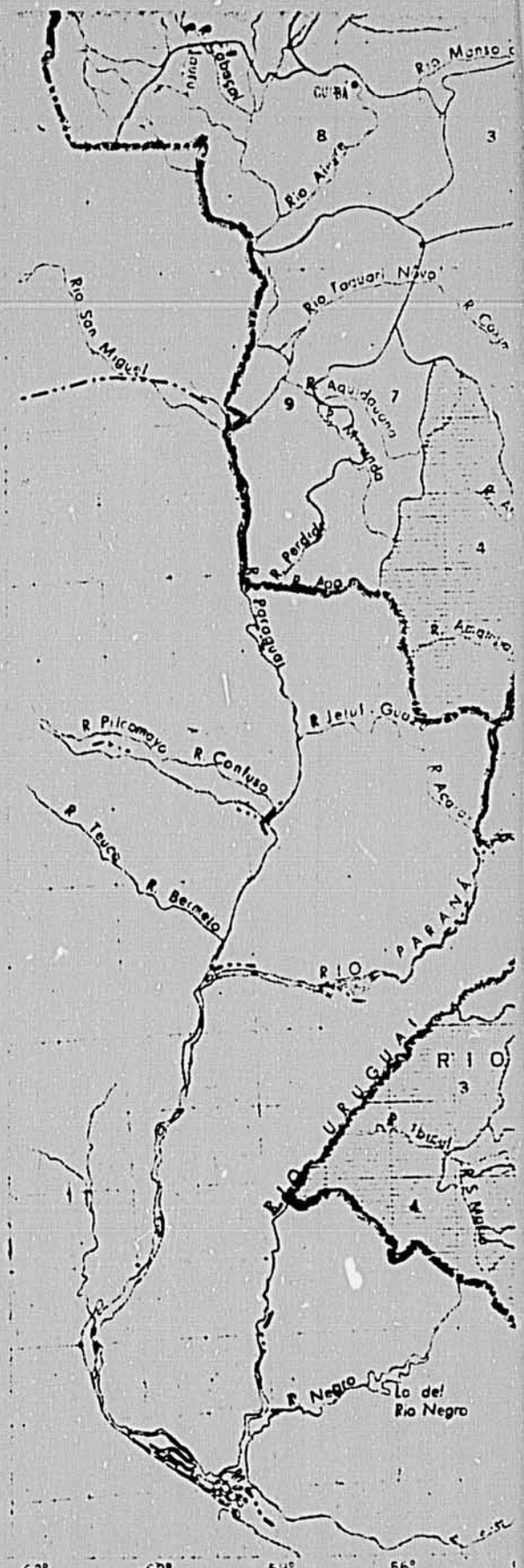
1. Aripuanã
2. Chapada
3. Paxoreu (Leste)
B - 4. Campo Grande
5. Rio Pardo (Sudeste)
6. Encosta Norte
7. Encosta Sul
8. Baixada Norte
9. Baixada Sul

GOIÁS

1. Araguaia-Tocantins
2. Norte Goiano
3. Alto Araguaia
B - 4. Meia Ponte
B - 5. Ipameri
6. Planalto
7. Paraná
8. Alto Tocantins
B - 9. Rio Verde
B -10. Mato Grosso de Goiás

DISTRITO FEDERAL

1. Planalto



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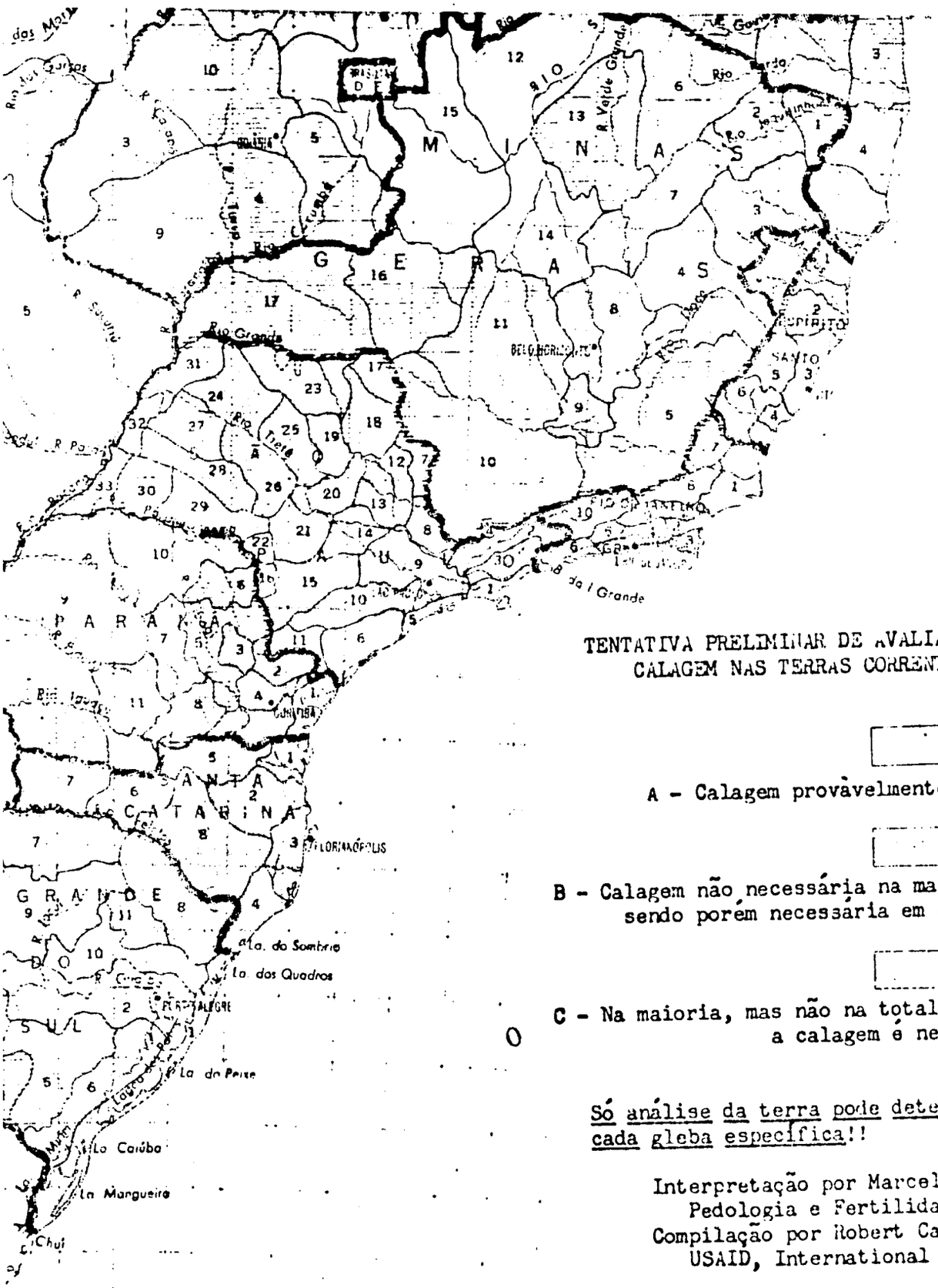

TENTATIVA PRELIMINAR DE AVALIAÇÃO DA NECESSIDADE DE CALAGEM NAS TERRAS CORRENTEMENTE CULTIVADAS

A - Calagem provàvelmente não necessária.

B - Calagem não necessária na maioria das glebas cultivadas, sendo porém necessária em parte das áreas cultivadas.

C - Na maioria, mas não na totalidade das glebas cultivadas a calagem é necessária.

<u>Só análise da terra pode determinar as necessidades para cada gleba específica</u>!!

Interpretação por Marcelo Camargo, Divisão de Pedologia e Fertilidade do Solo, M.A.
Compilação por Robert Cate, North Carolina State
USAID, International Soil Testing Project