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Staff Changes

The following staff changes and staff assignments were made in 1969: Mrs. Frances Lamm left the project and was replaced by Mrs. Raquel Chavez as bilingual secretary.

Robert B. Cate, Jr. returned to Raleigh from Recife, Brazil the first of January to concentrate his efforts upon the economic interpretation of soil analyses in respect to fertilizer use. The program in Brazil is under the leadership of Carlos P. Bickford, who headquarters in Rio de Janeiro.

Donovan L. Waugh moved his headquarters from Lima, Peru to La Paz, Bolivia in June. This was necessitated by the political situation in Peru. Dr. Waugh continued to serve the three-country region of Bolivia, Ecuador and Peru.

Home Leave

James L. Walker and family waited until late in 1968 to start their home leave. This carried over into 1969, and a few weeks of the new year were spent in the United States.

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INTRODUCTION

The need for increased quantities and improved quality of food has been accorded considerable attention in recent years as the world population has increased and as the widespread evidence of hunger and malnutrition has become generally known. The general atmosphere of concern about food and nutrition has generated discussion and debate on the capabilities of our land resources to produce the needed crops and of the technical inputs necessary to achieve the needed and desired production. In such an atmosphere of concern was the current project conceived and inaugurated.

Of primary concern at the start of the project was a documentation of fertility needs for the numerous soil zones in Latin America and West Africa. Along with the project objectives was an assigned responsibility to aid and implement the establishment of soil fertility analyses services in those countries cooperating in the project. Such services were to be efficient and accurate and were to serve to guide farmers in the proper use of fertilizer, lime and other soil amendments.

Documentation of soil fertility conditions and of fertilizer needs requires research and testing. An initial survey of the countries in which the project operated revealed that neither research nor testing activities were adequate to provide the information needed on fertilization and fertilizer needs of the soil. Consequently it became necessary to sponsor and implement both research and soil testing programs in the cooperating countries.

Initial project efforts were directed toward the establishment of laboratories to make soil fertility analyses and of compiling and evaluating the available research data on soil fertility and testing methods applicable to fertility evaluation programs in Latin America. Later efforts were directed

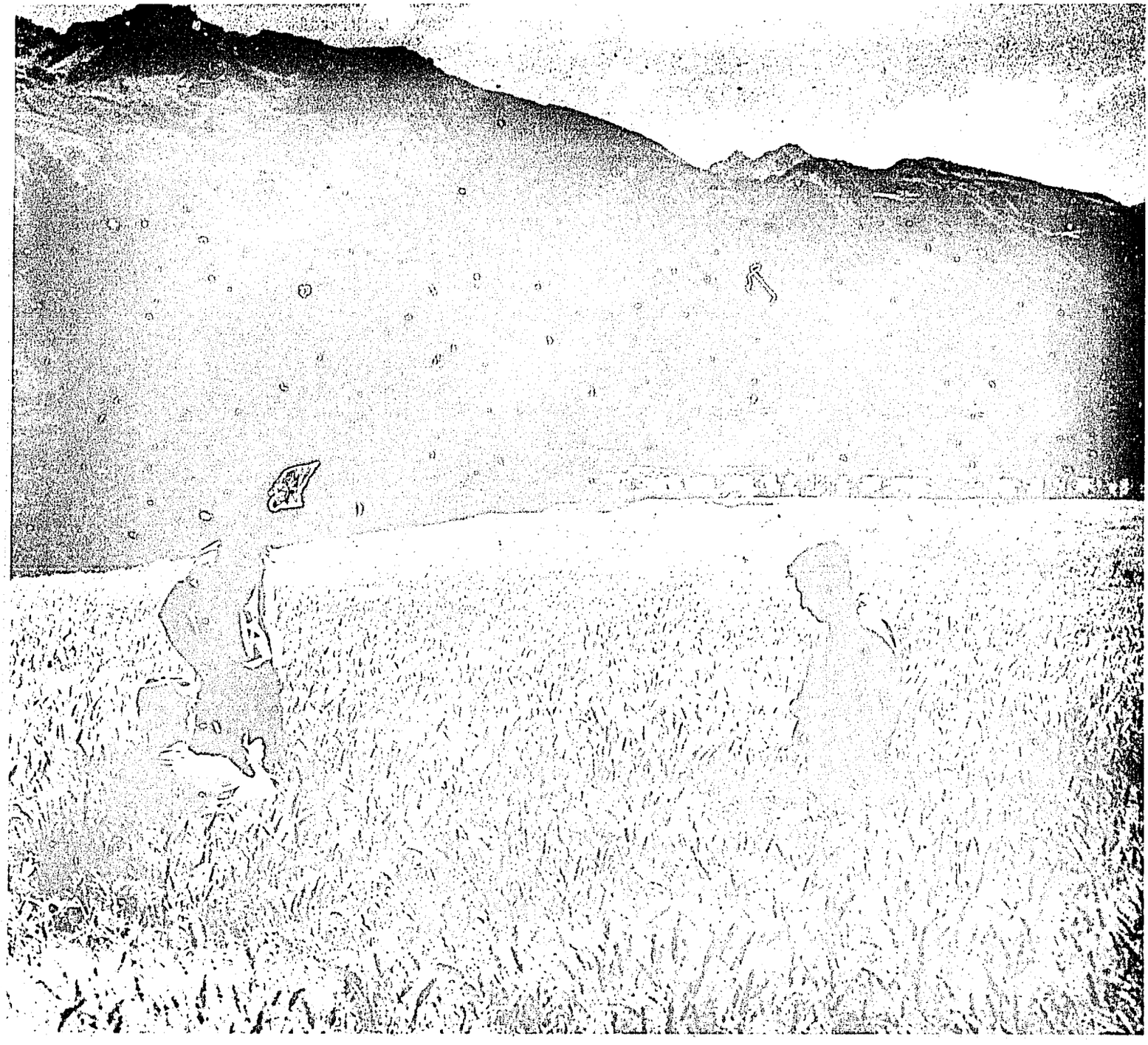
Potato fertility experiments at the
Santa Catalina Station, INIAP, Ecuador.

toward the establishment of supporting research and of expanding the use and support of the local programs through educational processes. Impact educational programs to improve the efficient production of important crops were sponsored in which soil fertility analyses were employed to provide proper information on needs for fertilizer and lime. Reconnaissance soil sampling surveys were encouraged to provide fertility information on soils not currently used for agriculture production or which, for other reasons, were not represented among the samples analyzed by the testing laboratories.

The activities and accomplishments of the project in the course of a single year can be best evaluated against the background of the project aims

and objectives and in the light of previous project accomplishments. An outline of the 1969 activities will be presented and evaluated in this manner.

A new production outlook in very old agriculture. Wheat fertility studies in Bolivia.

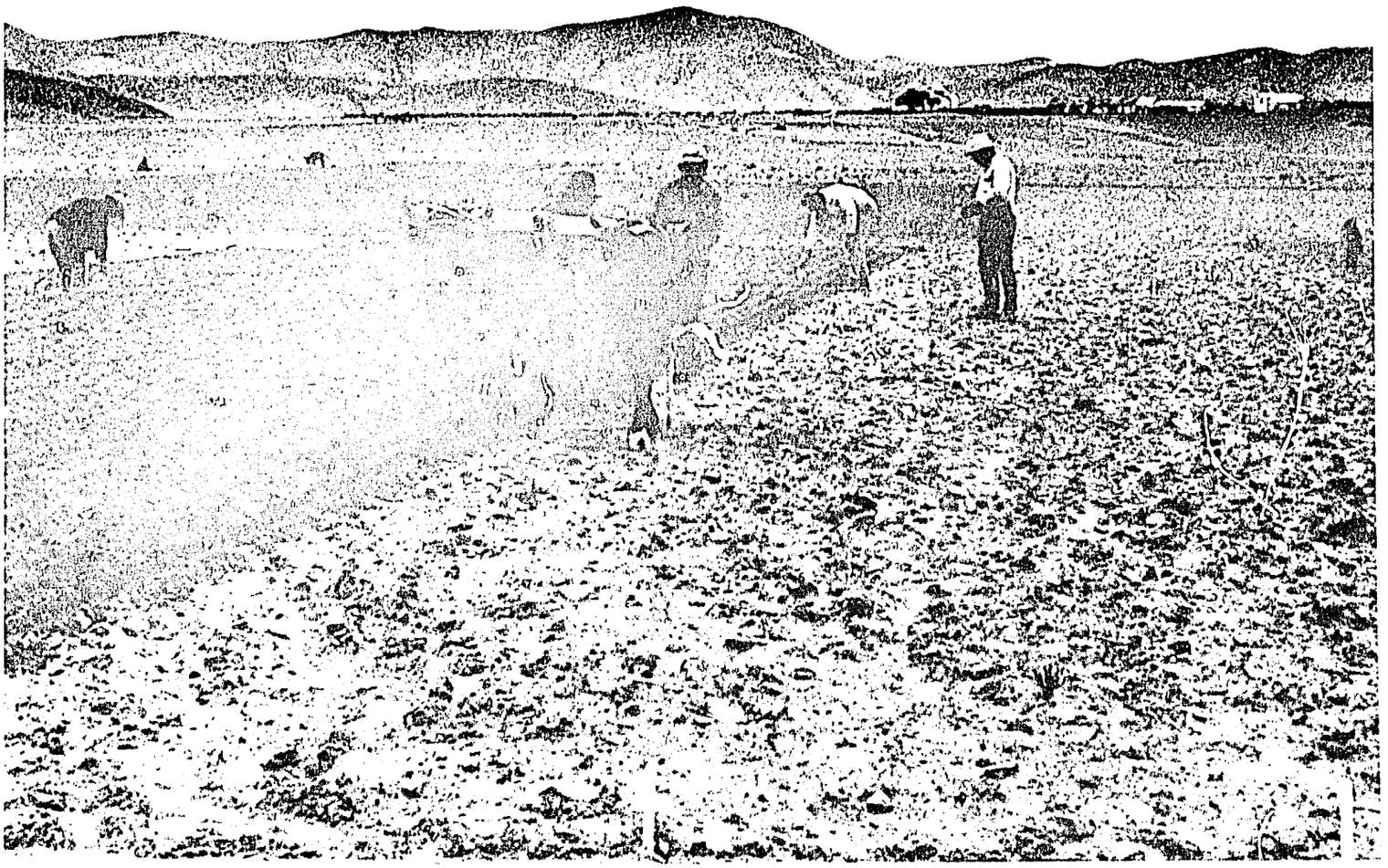


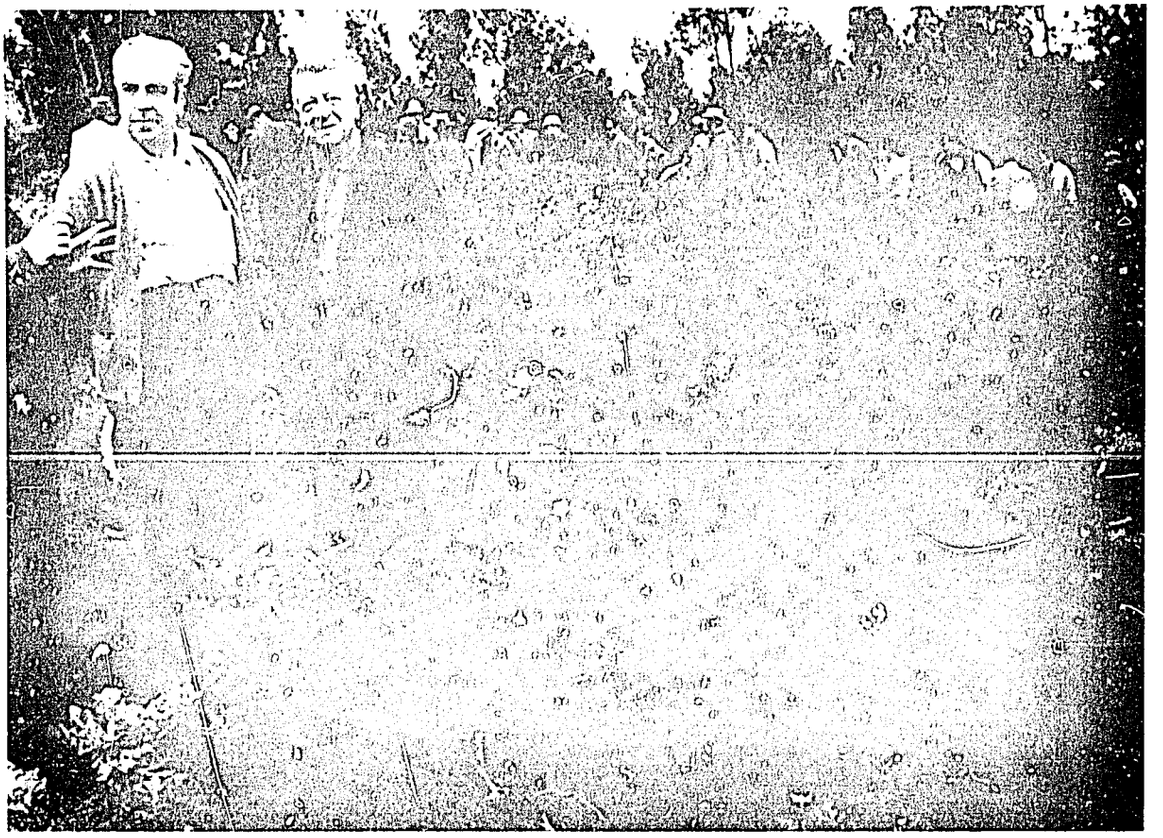
Summaries of past project activities appear in annual reports and bulletins. Country achievements in the development of soil fertility analyses systems and programs have been marked. Such achievements are

An efficient system for receiving soil samples
and preparing them for analyses. Recife, Brazil.

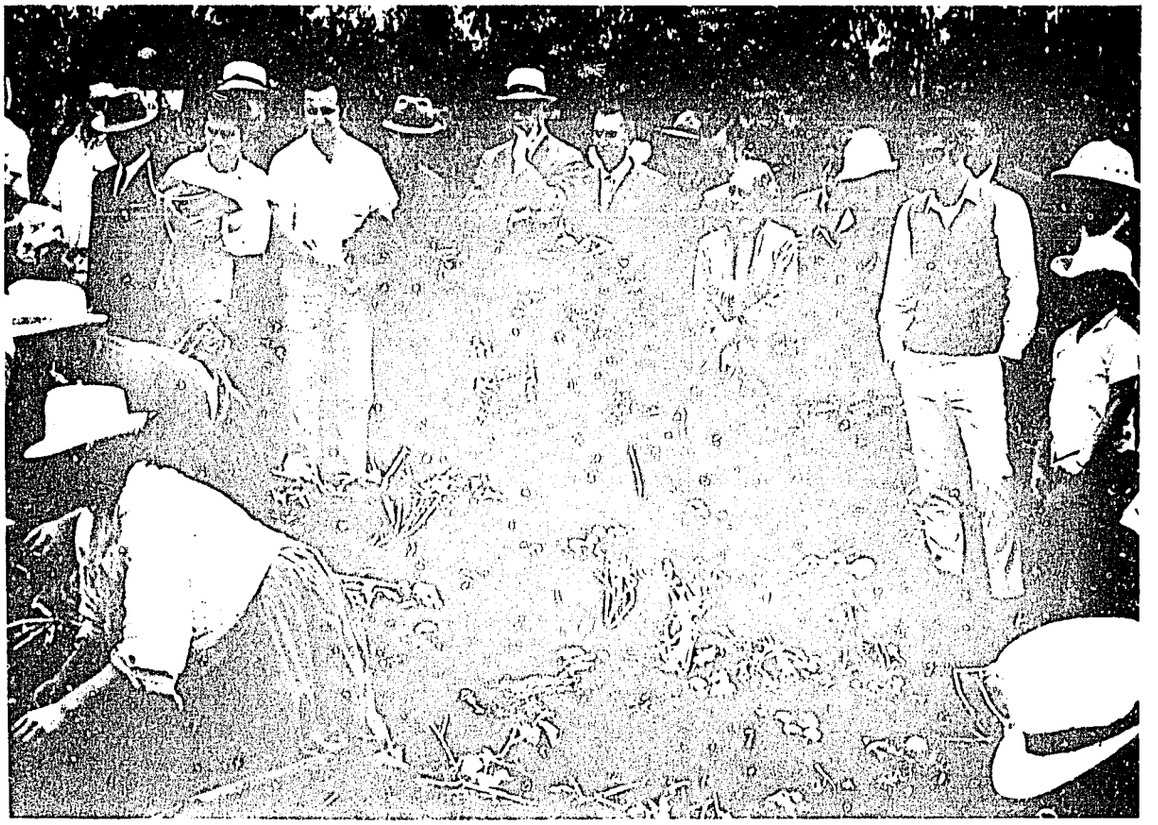
reflected in the numbers of laboratories which have been established for soil fertility analyses, in the services these programs have given to agriculture, in the extent of research conducted in support of the program, in the numbers and competence of the professional and technical people associated with the soil fertility research and service systems, in the extent to which the program services are known to and favorably accepted by the farmers and agribusiness communities of the countries, and in the resultant quantity and excellence of soil fertility information accruing relative to the soils in the cooperating countries.

Modern experimentation with the use of ancient motive power.





Potato experiments in Ecuador have shown the need for adequate and balanced soil fertility and have demonstrated fertility conditions and rates of fertilizer additions which can be profitable.



INCREASES IN FERTILITY ANALYSES SERVICES

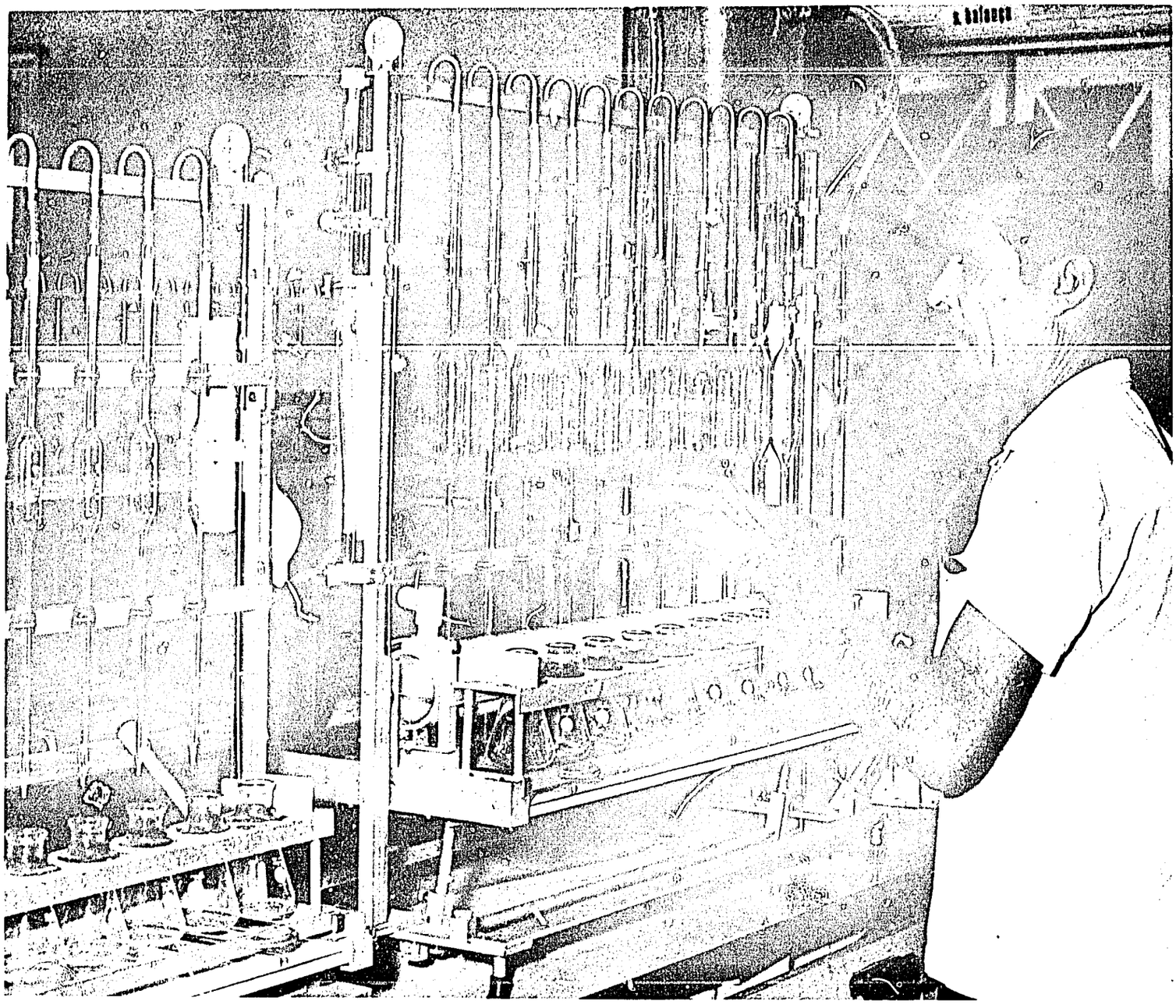
One of the very good barometers of achievement in the Soil Fertility Analyses and Improvement Program is the relative numbers of samples analyzed by each of the several country services each year. In general the programs have improved and the services have increased. If the services are utilized

Table 1. Use changes in soil fertility analyses services

Country	Approximate number of samples tested			
	1965	1967	1968	1969*
Brazil	20,000	50,000	100,000	140,000
Bolivia	0	0	1,200	5,000
Paraguay	500	1,500	2,000	2,500
Peru	1,900	9,000	11,000	12,000
Colombia	890	6,202	7,800	
Venezuela	0	2,500	4,000	6,600
Ecuador	1,050	1,460	3,755	4,000
Panama	800	10,000	7,500	3,100
Costa Rica	250	3,000	4,500	
Nicaragua	1,330	4,651	5,122	7,000
Honduras	1,572	3,159	3,116	3,500
El Salvador	1,878	3,559	4,529	10,400
Guatemala	1,753	6,808	8,231	10,500

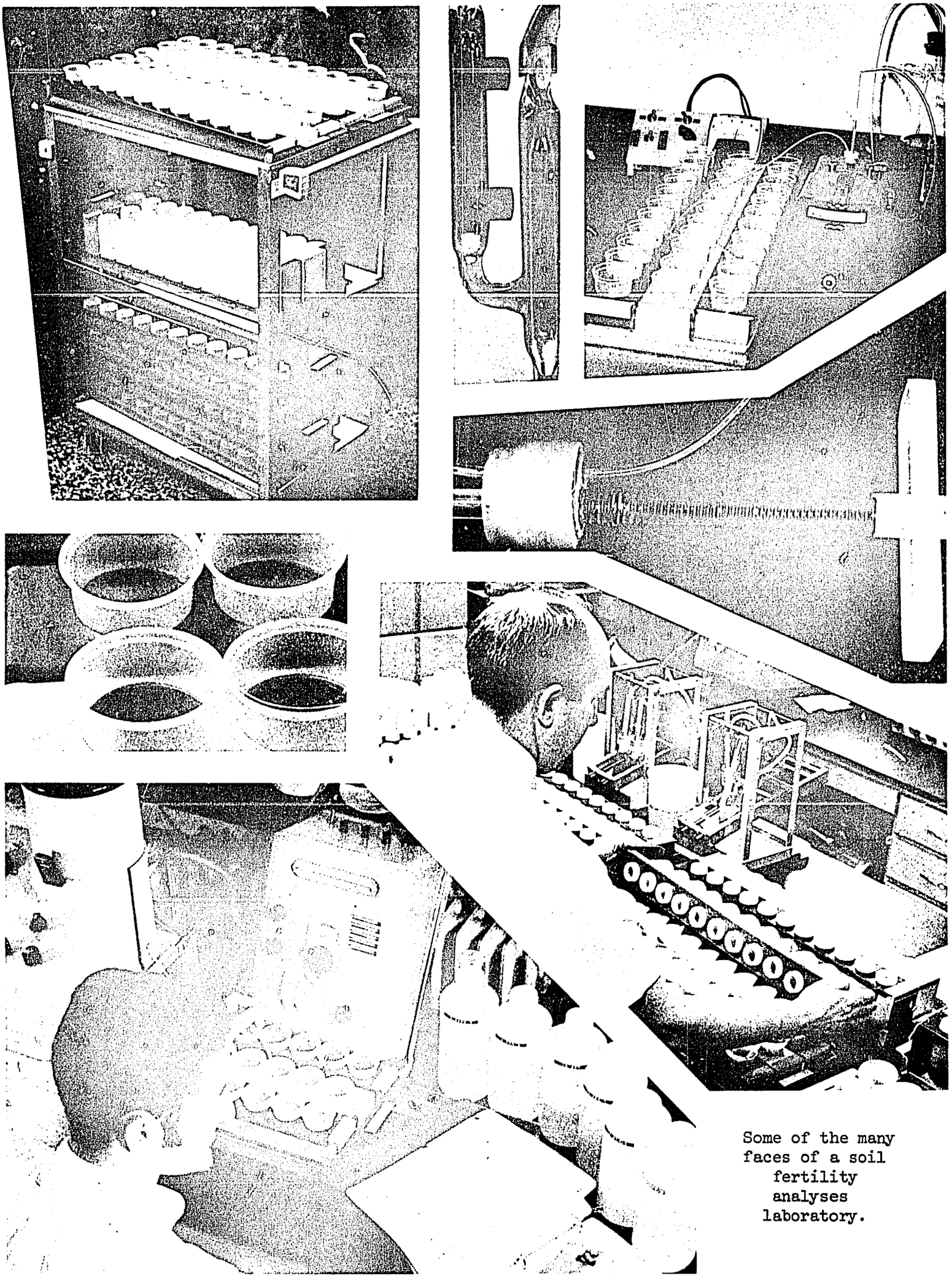
*Estimated in most instances from incomplete results.

as they should be, the numbers of soil samples analyzed each year will bear a direct relationship to the quantities of fertilizer used. This is because



Multiple unit equipment in soil fertility laboratories have imparted both speed and accuracy to analyses processes.

fertilizer analyses are made for the purpose of ascertaining the fertility status of particular fields and to supply critical information for determining fertilizer and lime needs for the production of specific crops on these field sites.



Some of the many faces of a soil fertility analyses laboratory.

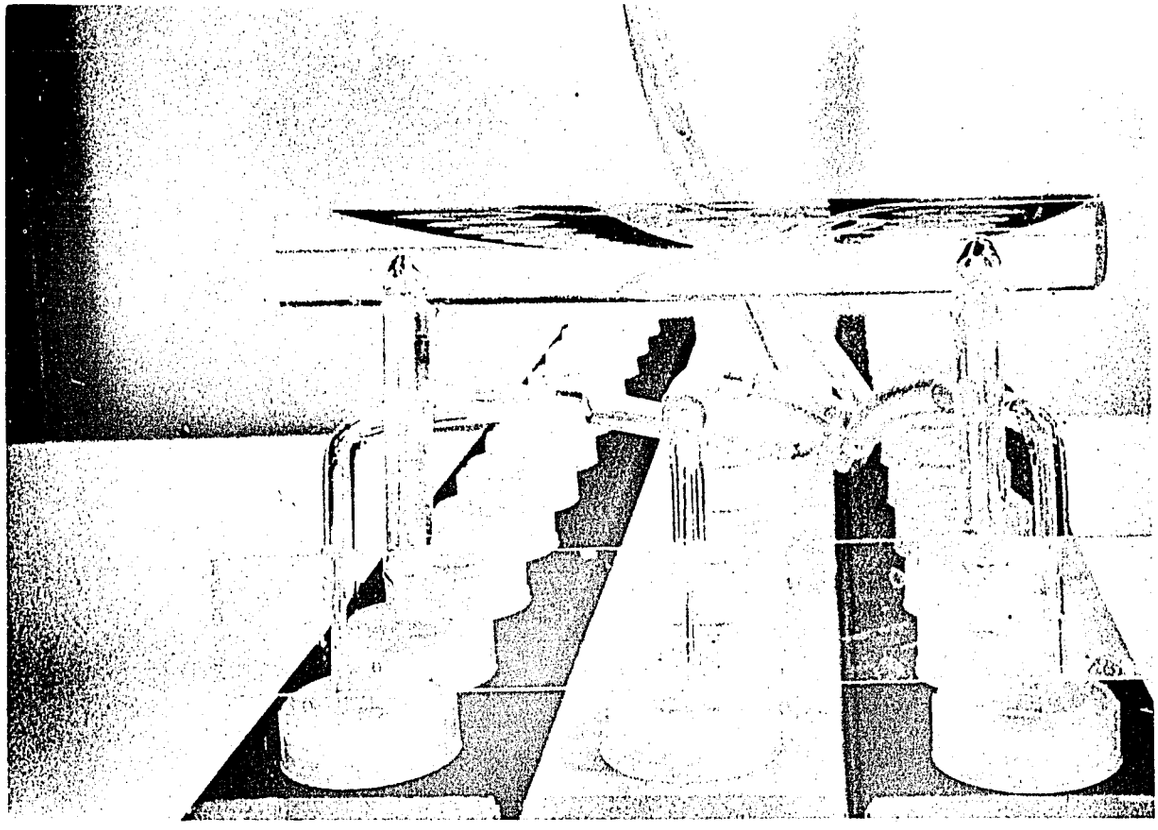
IMPROVING THE LABORATORIES

Apparatus and Laboratory Organization

Developing the analytical methods, the automated apparatus and equipment and the laboratory organization to assure accurate and efficient soil testing services in the cooperating countries has been of major concern.

One important adaptation has been the design and production of an automatic diluting unit to handle three samples simultaneously. In effect it can take up measured aliquots from three separate samples at one stroke of the control lever and automatically dilute these samples with the appropriate chemicals in preparation for element analyses. This will be an important time saver n laboratory operations. It further adds to the effectiveness of the multiple unit concept and procedure.

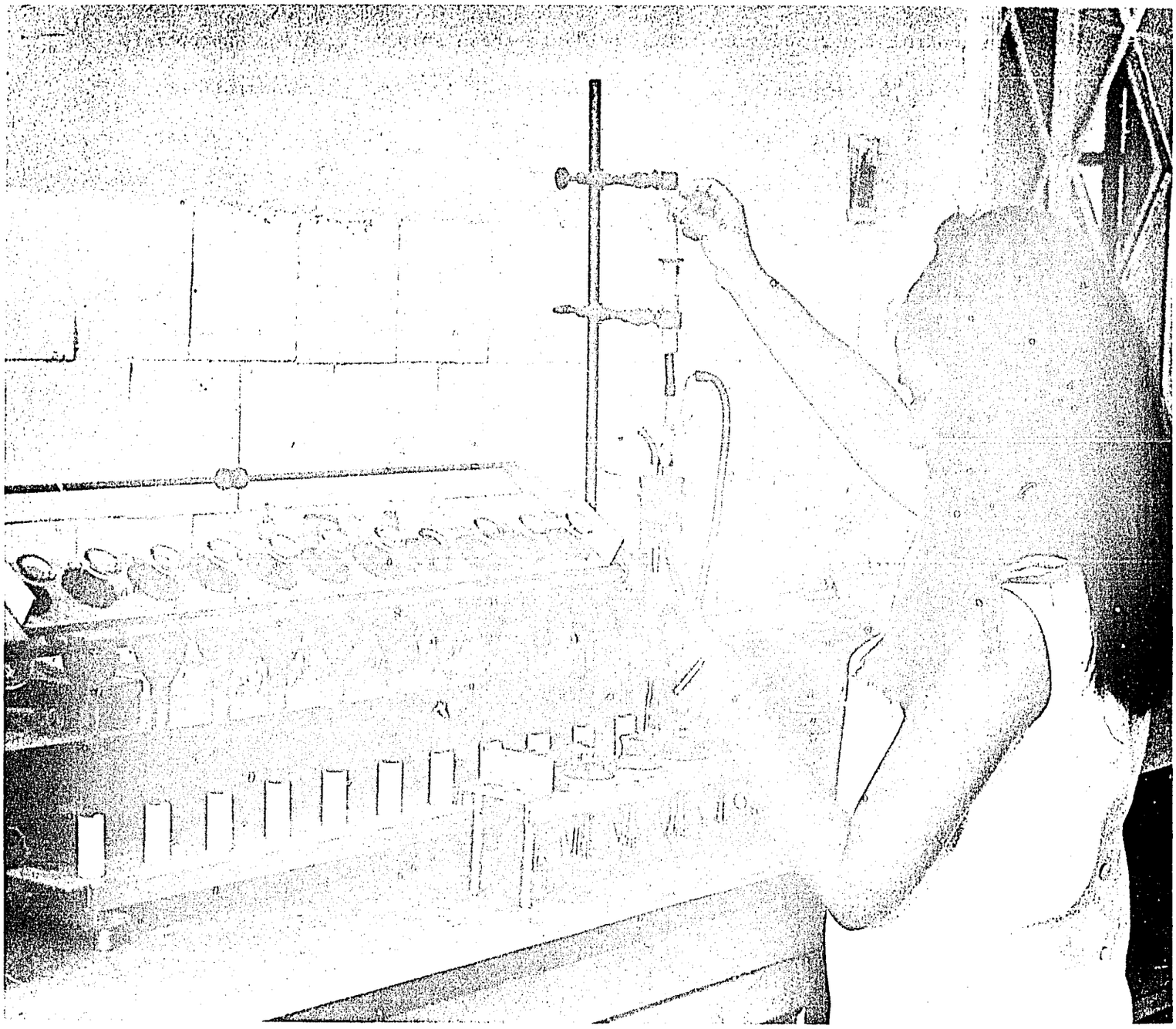
Now handle 3 samples when previously only 1 was transferred.



Analytical Procedures

Several soils in Peru were found in which plants derive a considerable portion of potassium from nonexchangeable forms. Thus an analysis of exchangeable potassium may indicate the soil is below the critical level

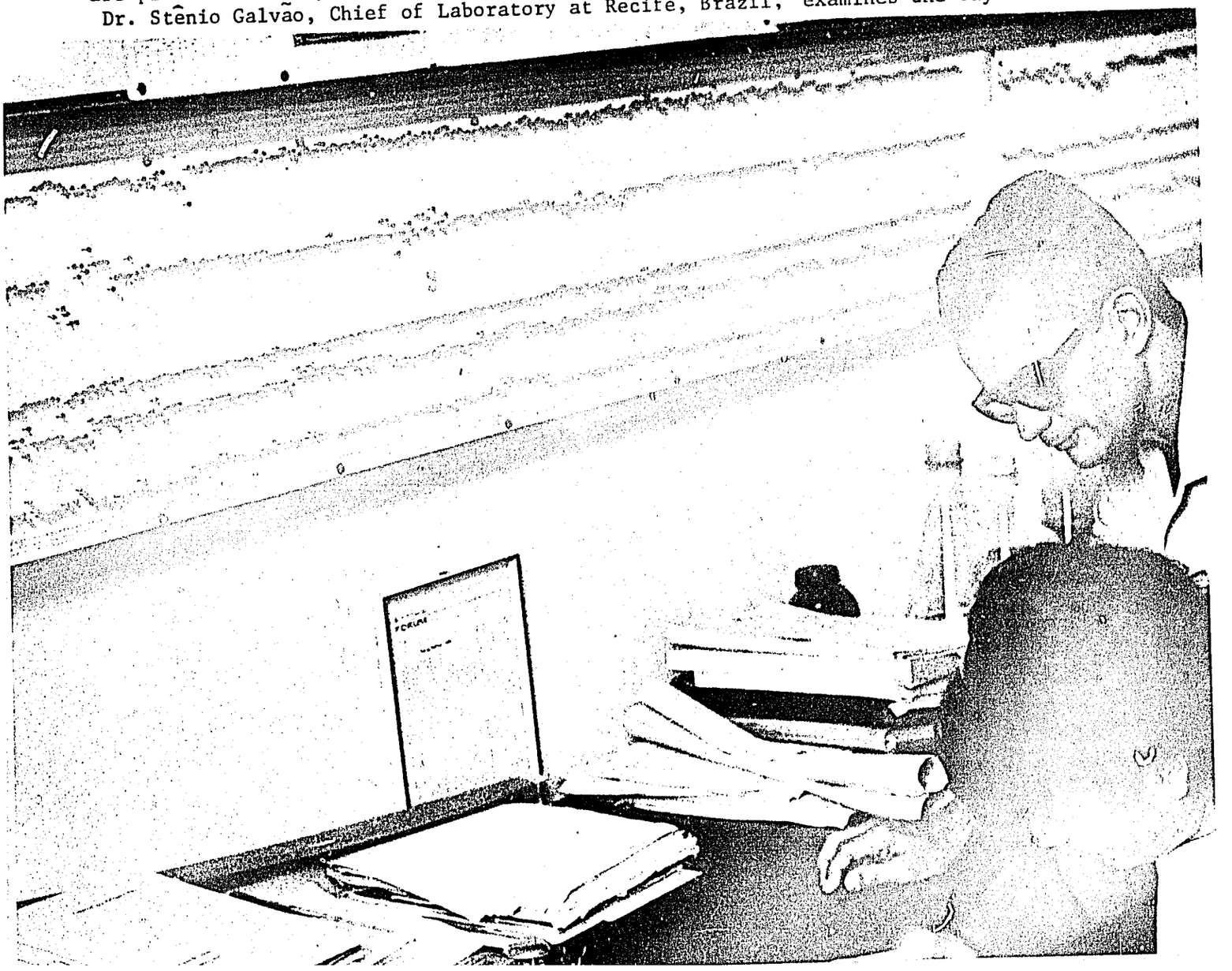
Multiple unit procedures are now employed in all analytical processes except preparing the samples for analysis and making the final readings on nutrient quantities in the soil.

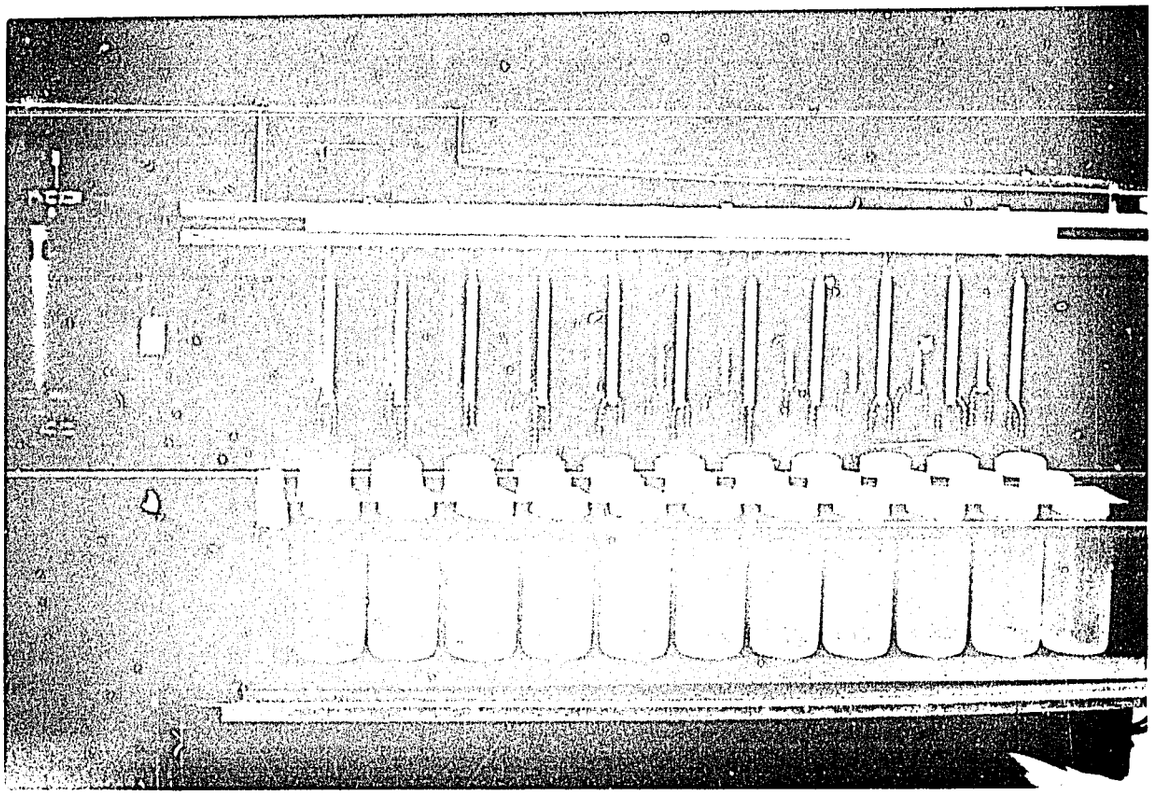


when the plant is actually obtaining potassium from other sources. Several studies were made in Peru with some of these soils to see if a better procedure for predicting the critical level could be found. The sulfuric acid procedure suggested by Dr. A. H. Hunter proved to be the most satisfactory.

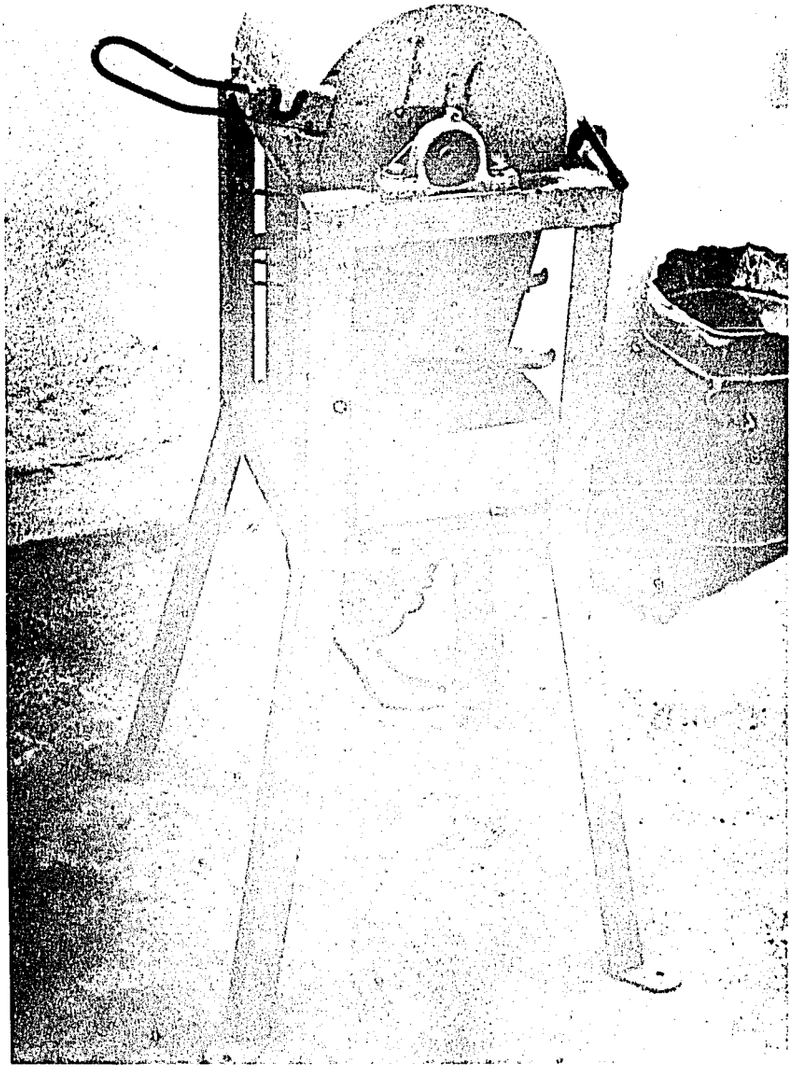
Searching for an extractant for the micronutrients zinc and manganese results in an improved procedure for phosphorus. The Olsen sodium bicarbonate

Quality control procedures in laboratory operations. Here control sample results are plotted each day to quickly ascertain analytical problems and diagnose the causes. Dr. Stênio Galvão, Chief of Laboratory at Recife, Brazil, examines the day's results





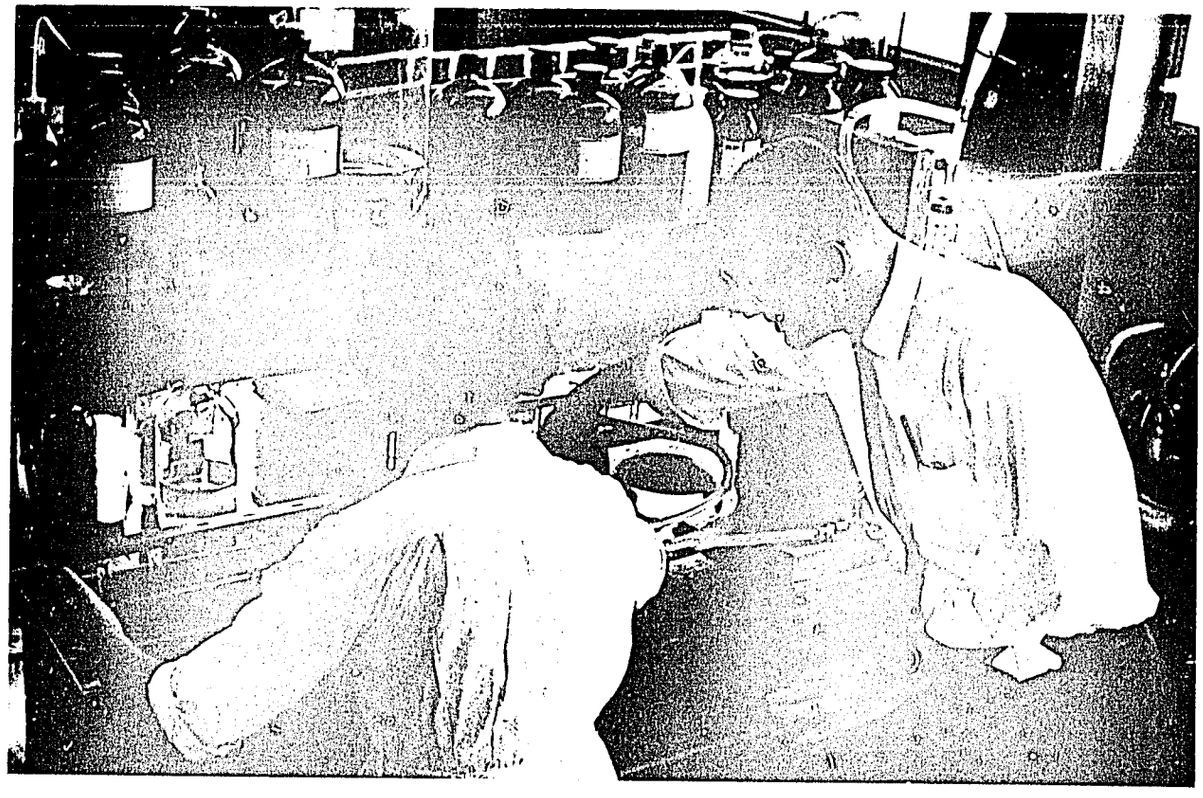
Multiple unit stirrer handles 33 samples at one time.



Soil grinding unit developed in Peru to handle several samples at one time.

With semi-automated equipment the operator changes samples in the colorimeter with one hand and records the readings with the other.

Semi-automated equipment developed and in operation in Peru.



SUMMARY OF RESULTS OF LIME - N P K - Mg Mn Zn STUDY

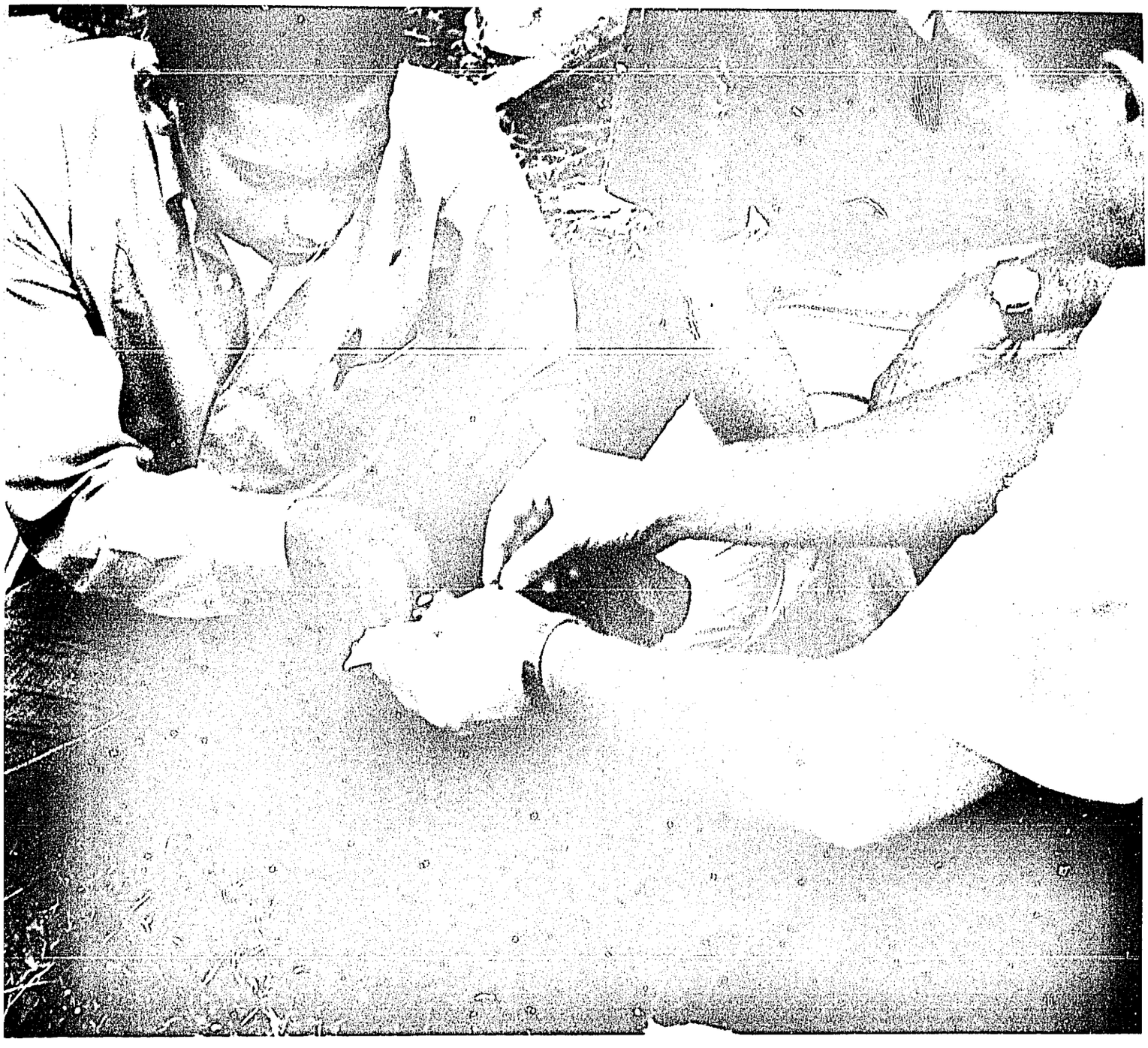
Soil Analysis

	pH	M.O Ton/ha	Al me/100	P ppm	K ppm	Ca + + me/100	Mg + + me/100	Zn ppm	Mn ppm	% Sat. Al
Soil 1	4.0	50	5.8	2.0	85	0.27	0.30	7.15	6.91	91.12%
Soil 2	4.0	58.5	3.0	2.5	75	0.52	0.22	10.48	10.71	77. %
Soil 3	5.3	51.5	2.2	4.5	235	1.4	0.87	10.43	3.13	48.87%
Soil 4	4.0	67.5	3.3	2.0	100	0.45	0.33	9.37	7.25	80.39%

Yields and Treatments

Treatment	g. per pot of dry matter: sorghum			
	Soil - Number			
	1	2	3	4
Check-no fertilizer, no lime	0.29	0.48	4.85	0.72
No lime + N P K	0.25	3.53	21.24	0.16
1.0 x lime + N P K	15.96	15.86	20.51	12.08
1.0 x lime + N P K + Mg Mn Zn	19.36	23.92	23.16	14.39
1.5 x lime + N P K	10.23	10.72	17.06	15.95
1.5 x lime + N P K + Mg Mn Zn	20.37	20.55	20.17	18.42

Data are from study by Manuel Villavicencio at La Molina, Peru, under the direction of Dr. D. L. Waugh. Crop was sorghum.



Exploring with tissue testing procedures and other diagnostic techniques has been part of the project research.

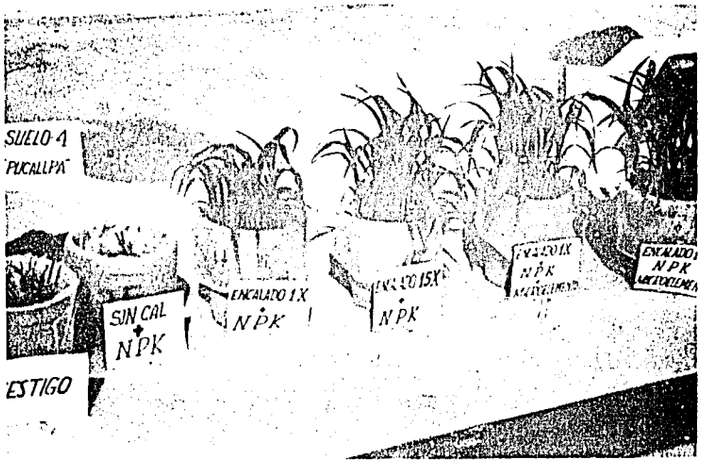
extractant, as used in Peru, was modofied by adding 0.01 M EDTA and the soil to solution ratio narrowed to 5 ml soil to 25 ml extractant. The result was better correlation for phosphorus and a good procedure for extracting zinc and manganese.

ATTAINING EFFICIENCY IN CORRELATION RESEARCH

The correlation of laboratory test results with plant growth responses to the addition of fertility elements forms the basis for predicting the need for fertilizer. Both greenhouse and field response data are used for this purpose. Greenhouse response data are more accurate indicators of the levels of plant nutrients in soils because weather and other crop limiting factors can be controlled. However, field response data are necessary to evaluate actual field needs and to refine and test optimum rates of fertilizer.

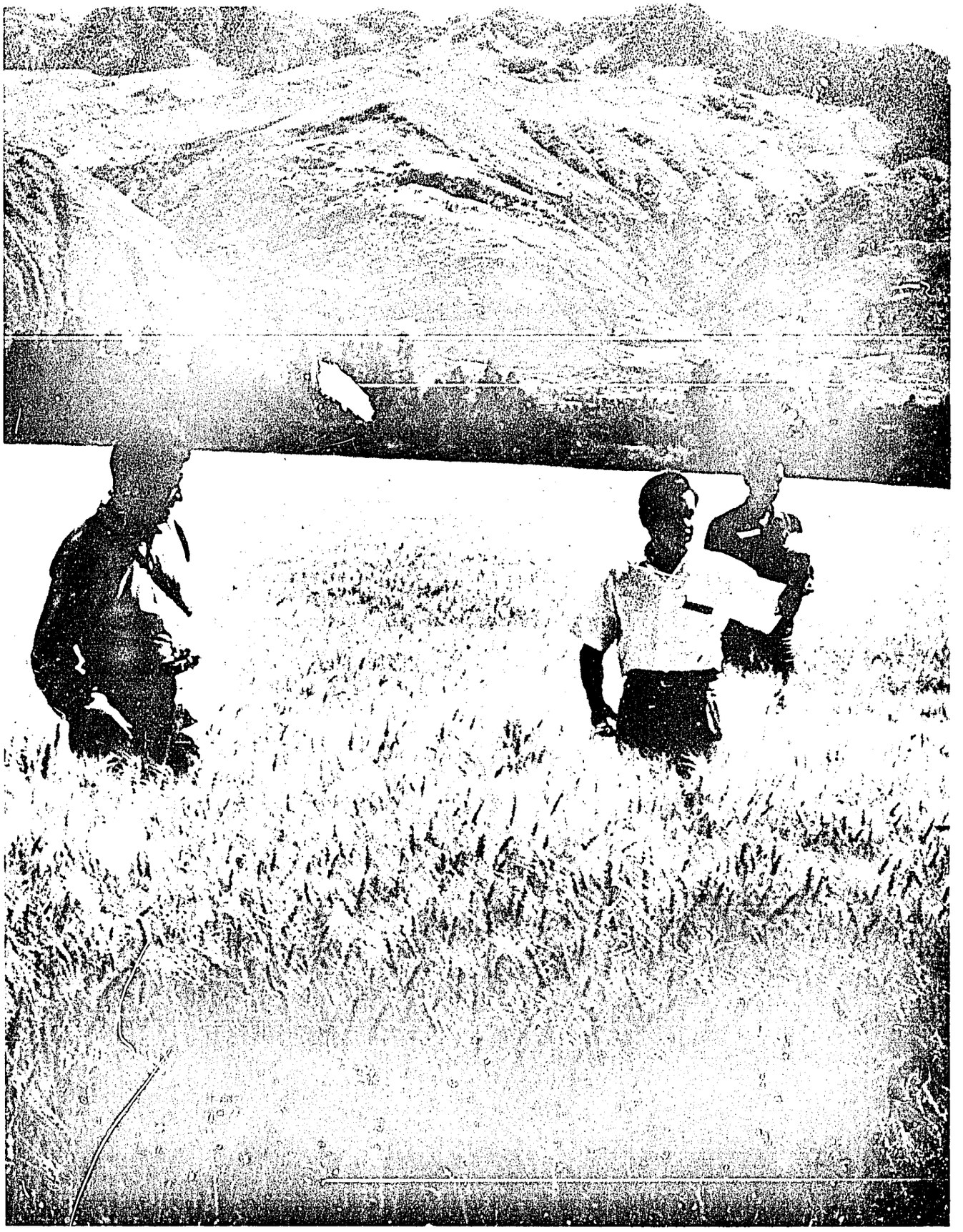
Soil fertility evaluation programs are based upon the accumulated results of research. The basic research employed has come from a wide spectrum of studies in many countries. The adaptive research results have come and must continue to come from local areas or from similar soil and climatic regions. Most of the research sponsored and/or conducted by the Soil Fertility Evaluation Program has been of the adaptive type.

The project has proposed a systematic approach to the adaptive research program for the purpose of obtaining the necessary soil test-fertilizer response correlation data. This approach is designed to make the most effective use of the limited research capacities of most of the cooperating countries. Such an approach advocates the taking of soil samples from a large number of prospective field experimental sites followed by soil fertility analyses to determine the range and geographical distributions of fertility problems. If a soil fertility evaluation service has been in operation for sufficient time, the summarized results from laboratory analyses can supply such information. Following a survey of soil fertility needs and geographical distribution patterns, soils are selected for greenhouse or shadehouse testing. Here the soils are tested and evaluated for nutrient deficiencies by crop response



to the addition of fertility elements. Tentative critical levels of nutrient elements are established and fertilizer needs for particular soils are estimated. In this phase, similar experiences in other geographical areas are most helpful. From these soil samplings and greenhouse data, field experimental sites are selected and appropriate experimental designs are outlined.

Several marked advantages accrue from such a research approach. First, experimental sites can be selected which best represent the fertility variations existant in a country or area under investigation. Second, the experimental design for each site can be made to investigate the fertility conditions at the site. This generally reduces the number of plots in the experiment and assures that the treatments cover the range of fertility conditions which need investigation. Third, survey or preliminary studies in the laboratory and in the greenhouse can



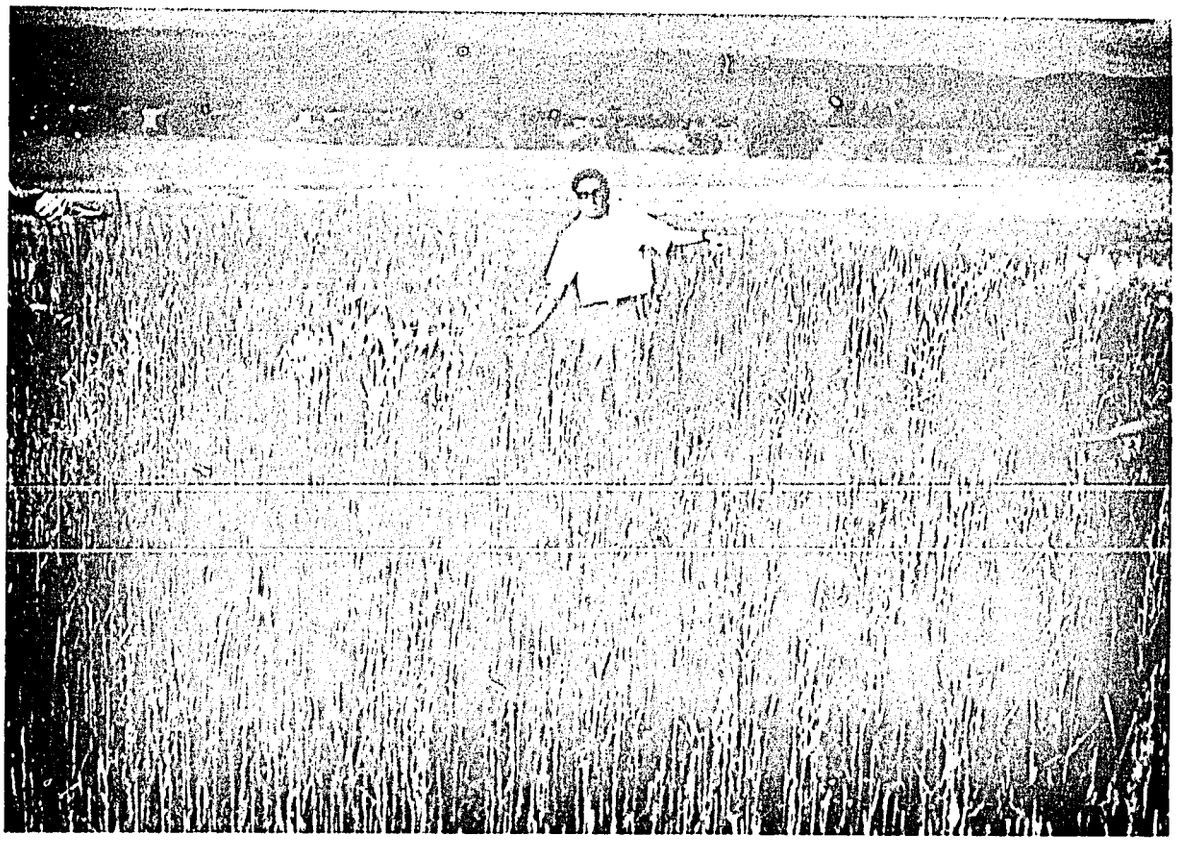
Under high fertility the improved selections of wheat show to advantage.

conducting greenhouse studies, correlation data and experience in Peru were used to estimate the fertility and lime needs in Bolivia using the analyses of the Bolivian soil. In every one of the 17 field trials of the first year, the soil fertility guide data from Peru gave accurate appraisals of the fertility needs in Bolivia. This would be expected inasmuch as the upland areas of the two countries are similar. The fertility conditions and nutrient addition ranges needing investigations were properly evaluated from the soil fertility analyses and were adequately considered and investigated in the designs of the field experiments.

Soil Fertility-Crop Variety Experiments

Bolivia. Bolivia is a wheat-importing country and considerable effort has been made to increase the wheat yields. Testing new varieties, including the dwarf Mexican wheat, had met with little success and very little or no differences were found between varieties without fertilizer. All yields were low in their field experiments. The seventeen soil fertility trials conducted through the Soil Fertility Evaluation Program quickly pointed out their problem in testing varieties; it was a lack of soil fertility. During the 1968-69 wheat season, eight cooperative field studies were undertaken between the wheat breeders and the Soil Fertility Evaluation Program. Soil samples were taken from the sites selected and were analyzed. The fertilizer treatments were based on the information gained from the analyses. Ten wheat varieties were included in the study. One part of the study was the standard variety testing procedure; the other was the varieties fertilized according to soil tests. Some very startling results were obtained in the trials. In the standard procedures, yields were low--ranging generally from five to ten

In Bolivia the improved selections of wheat did not yield appreciably better than the older selections until soil fertility had been made near optimum.



When fertility is made high then the genetic potentials of crop varieties become evident. All crop variety selections should be evaluated under high fertility. Low and mediocre fertility levels always result in low and mediocre yields regardles of the crop selection cultivated.

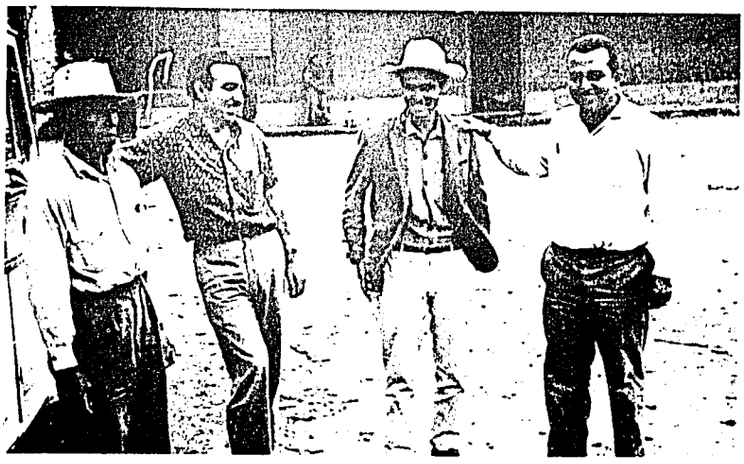
bushels per acre--and no differences were noted in varieties. Where fertilized, the yields generally were in excess of 30 bushels per acre (usually 40 to 50 bushels per acre), and considerable differences were noted between varieties. All of the trials were conducted under dry-farming conditions (no irrigation) and, where moisture was limiting, the improved Bolivian variety Coposu appeared to be as good as any and perhaps a little superior. Where moisture was more adequate, the Mexican dwarf wheats were superior. The trials have created much interest in the use of improved varieties, together with the fertilizer practices needed for each field.

Fertility Studies by the Potted Plant Technique

Guatemala. Potted plant studies involving about 400 pots were conducted in Guatemala to obtain information on additional important cultivated soils in relation to phosphorus, potassium and sulfur. Both potassium and sulfur deficiencies are more widespread than was originally anticipated. The critical level for potassium was also found to be somewhat higher than previous studies for certain soil conditions.

El Salvador. Potted plant studies confirmed previous data in that the critical level was found to be 18 ppm for phosphorus with the North Carolina Mehlich extractant. With the additional data, a good cross section of the cultivated soils has been tested for El Salvador.

Cooperative scientists in El Salvador also conducted some studies on a cooling technique recommended by Dr. Walker for potted plant studies in a greenhouse. The pots are placed on a sand table which is kept moist but below saturation. The evaporation from the sand cools the atmosphere around the plants. It may also reduce transpiration from the plant.



Soil fertility analysis and improvement programs require professional and technical personnel. Some of the individuals assigned to the program in El Salvador. Ing. Molina on the right.

High population densities and high intensity agriculture in the upland areas of Central America will require that more attention be given to soil fertility.

Vegetable culture is also very responsive to fertility.

Current experimentation includes fertilizer response studies with all food crops.

Soil Acidity Studies

Liming acid soils is a big problem in the tropical regions and additional research is always welcome.

El Salvador. Not many studies have been made to date relative to liming acid soils in Central America; this is especially true in respect to field trials. Using the project approach of measuring neutral salt exchangeable acidity as a guide to liming, potted plant studies were conducted on selected acid soils. The predicted rates were found to be accurate. The next step was to further test the procedure in field trials. Corn was used as the test crop. Field observations indicate the predicted rate of liming to be the best treatment. Some good responses are apparent but the yield data are not available as yet.

Peru. Two students conducted some potted plant studies on liming acid soils. They observed that the liming factor of two is high for their soils which have more than 5 me/100 g of exchangeable acidity. The higher rate of liming induced manganese deficiency.

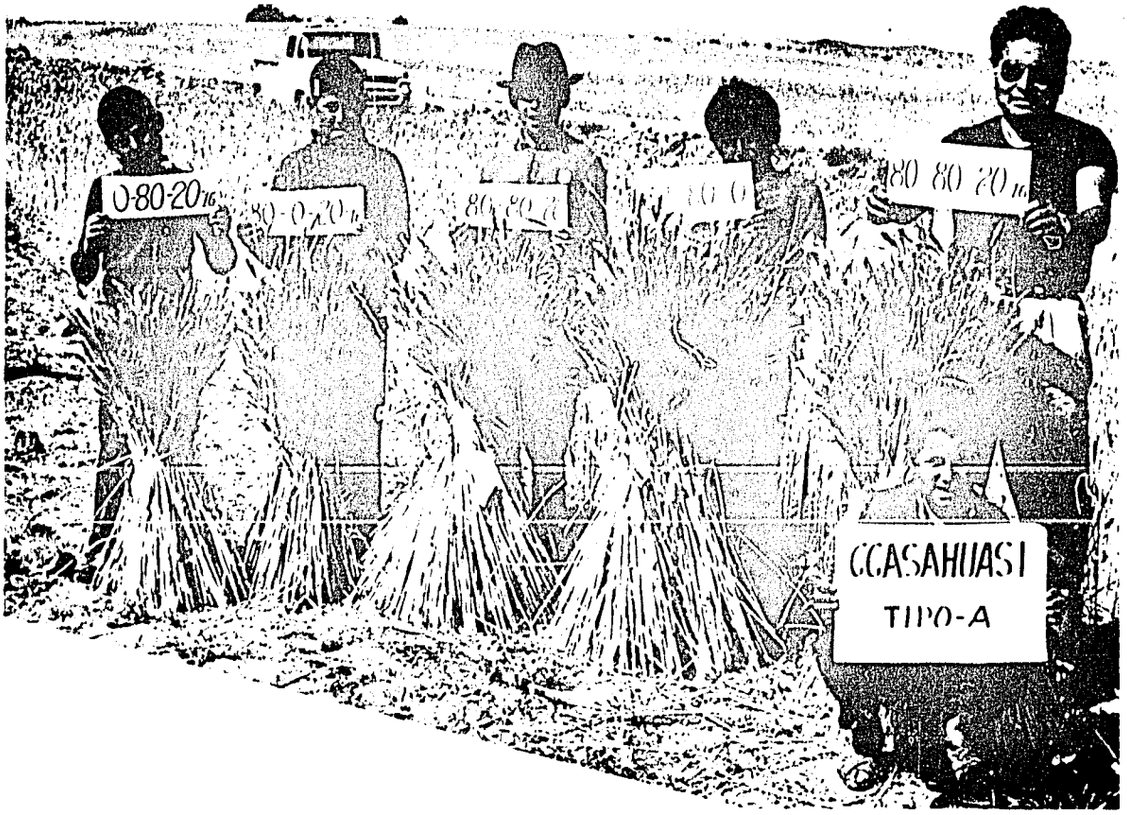
Field Correlation Trials

Ecuador. In Ecuador approximately 50 simple field trials on fertilizer use were attempted with rice. These were all located along the coast in the vicinity of Guayaquil. No data is available as yet from these trials.

Potassium-Magnesium Interaction Potato Studies

Peru. In the central coastal region of Peru, the soil tests indicated several fields were on the borderline of needing either potassium or magnesium and, in some cases, both. Many of these fields were not yielding as good as expected. Using soil tests as a guide, five replicated field studies were

Potato culture is very important in the highland areas of Central and South America and banana culture extensive in the humid and tropical lowlands. Both crops require good soil fertility.



Wheat culture has always been important in many parts of the World. In Bolivia above and Paraguay below; attention to soil fertility is making the culture of wheat more profitable to local farmers.

undertaken with potassium and magnesium using potatoes as the test crop. Observations of the experiments were made from time to time and leaves taken for foliar analyses. Responses to potassium and magnesium were obtained at all five sites which verified the soil test results. The increases at all sites from the potassium and magnesium were as large as obtained from phosphorus, and was also as large as the response obtained to nitrogen on two of the fields. An interaction was found to exist between the potassium and magnesium. The data are currently being analyzed statistically to ascertain the extent of the interaction. The foliar analyses indicated the potassium-magnesium balance was very critical in these soils. The best yields were obtained when the magnesium content was relatively high in relation to potassium.

Some Appraisals of Methodology

Some important aspects of the value and use of soil analyses can be seen from a consideration of an extensive body of field experimental data from Peru on the response of potatoes to fertilizer elements.* Samples from the plot areas have provided a means of evaluating soil fertility analyses methods, for establishing meaningful critical levels of the major plant nutrients in the soils, and for appraising the usefulness and accuracy of fertilizer response information. Much of the potato experimentation was conducted before the establishment of a soil testing service in Peru. Consequently many of the experimental plots were not selected on the basis of prior soil analyses and greenhouse tests. The experimental sites, however,

*Ministry of Agriculture of Peru and the University Agraria, La Molina, in cooperation with AID and North Carolina State University.

Table 4. Relationship between soil fertility analyses and response of potatoes in the field to the addition of phosphorus.

Sample No.	Yield* Complete Treatment Tons/ha	% Yield - P Complete Treatment	Soil Analyses** Method No. 1 P ppm	Method No. 3 P ppm
1	21.6	90	44	18
3	14.0	81	29	10
4	24.1	99	42	11
5	16.3	82	30	10
8	17.8	79	17	8
9	19.4	86	34	11
10	42.3	25	9	4
11	27.4	99	39	11
12	29.4	79	26	9
15	24.6	74	8	4
16	20.4	88	50	20
18	30.8	116	50	21
24	26.8	71	14	7
27	25.7	83	19	8
33	19.0	60	12	5
36	36.9	43	6	4
42	19.8	105	50	8
54	14.2	96	50	15
57	16.8	72	16	7
60	19.8	56	13	7
63	10.1	87	20	11
75	13.0	53	15	3
83	16.1	71	11	5
87	36.0	74	18	4
91	15.4	83	30	12
95	17.6	29	15	7
99	16.3	55	10	5
107	22.6	79	46	18
111	12.9	92	16	7
115	22.1	85	30	12
119	16.7	114	50	20
129	27.8	62	5	6
136	17.5	68	9	7
140	31.9	30	12	4
152	43.6	38	14	5
156	33.6	62	11	6
160	12.3	58	10	7
164	54.5	88	15	8
172	35.8	65	6	4
176	20.8	37	10	5
180	34.8	80	12	9
186	10.7	103	12	15
187	39.3	86	28	17
188	56.8	106	44	16
189	26.8	73	23	7
190	46.1	53	11	5
192	27.0	84	35	13
201	49.6	61	8	4
203	22.8	93	34	13

represent a wide variety of soil and climatic conditions and soil samples from the sites have been effectively used to correlate fertility analyses with the need for fertilizer in the field for profitable potato culture.

These results illustrate two important aspects of the approach followed by the International Soil Fertility Evaluation and Improvement Program. The first is that adapted standard methods of analyses generally give good results when they are properly correlated with fertilizer response results. In some instances any one of several methods would be equally useful and accurate. The second is that a single critical level using relative response information (percentage yield or percentage increase in yield) is the most useful and meaningful method of evaluating and tabulating response data.

Table 4 shows the primary results of the field responses of potatoes to phosphorus at a wide selection of experimental sites in Peru. Also shown are the laboratory results for available phosphorus from two modifications of the Olsen bicarbonate procedure*. The critical levels for the two procedures by the use of the Cate-Nelson technique were 15 and 7 ppm respectively. In 43 out of the 49 instances the two methods agreed. In the 7 instances where there was not complete agreement, 4 samples were within 1 ppm of agreeing.

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*Yield complete was yield of potatoes in metric tons/ha when all needed fertility elements had been applied.

**Method No. 1 was by the use of 0.5M $NaHCO_3$ at pH 8.5 (Olsen). Soil: solution ratio was 1:20 and shaking time one-half hour. Ascorbic acid was used as a reducing agent and charcoal was employed to remove interfering colored substances.

Method No. 3 also employed 0.5M $NaHCO_3$. The soil:solution ratio was 1:5 and the shaking time 15 minutes. The extracting solution in this case contained 0.01 EDTA. A flocculate was used to expedite filtration.

With Method No. 1 the critical level was fixed at $\leq$ 15 ppm and in No. 3 at $\leq$ 7 ppm of extractable phosphorus.

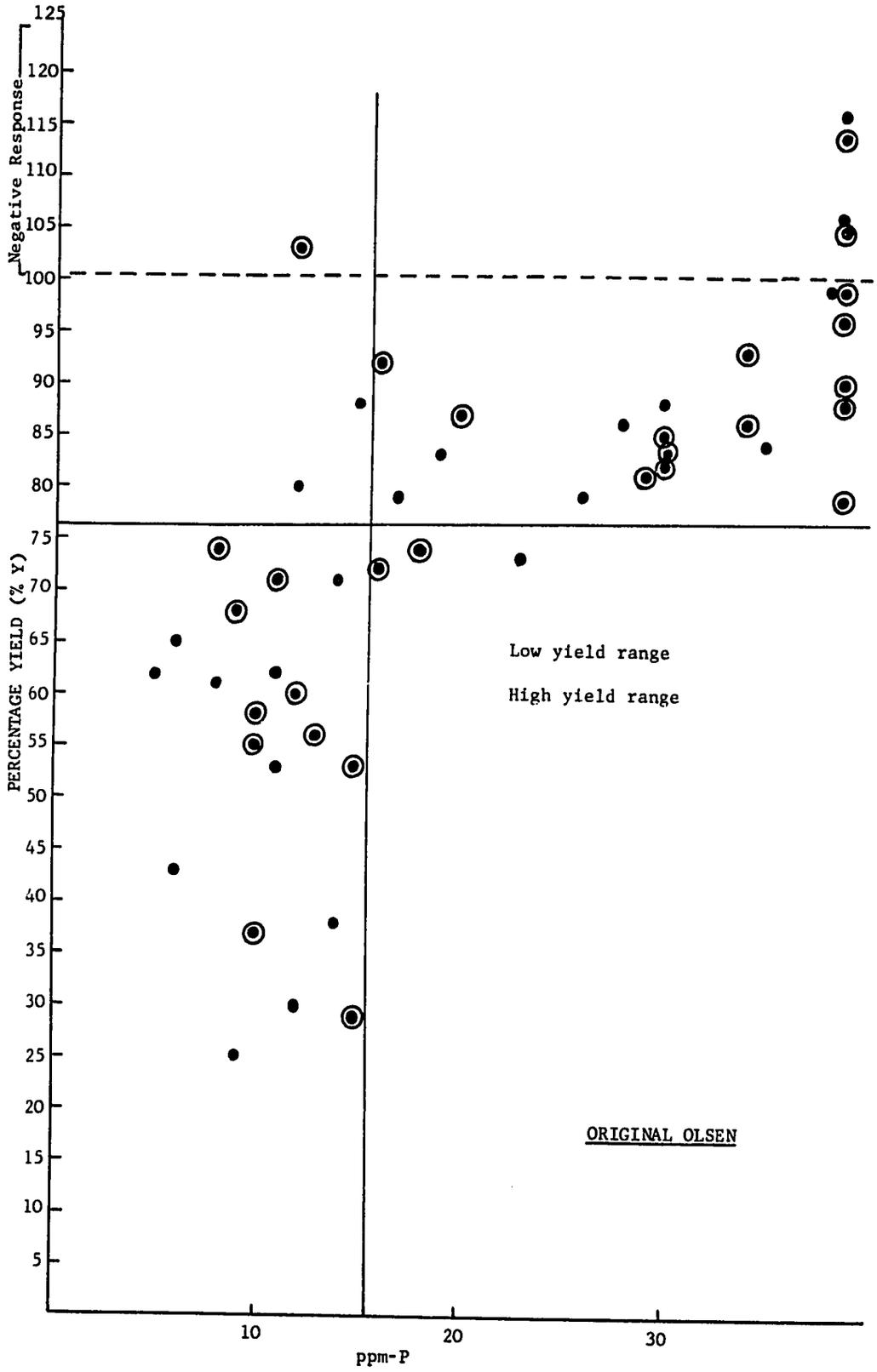


Figure 1. Extractable phosphorus in relation to relative yield of potatoes. (Field experiments and original Olsen Method)

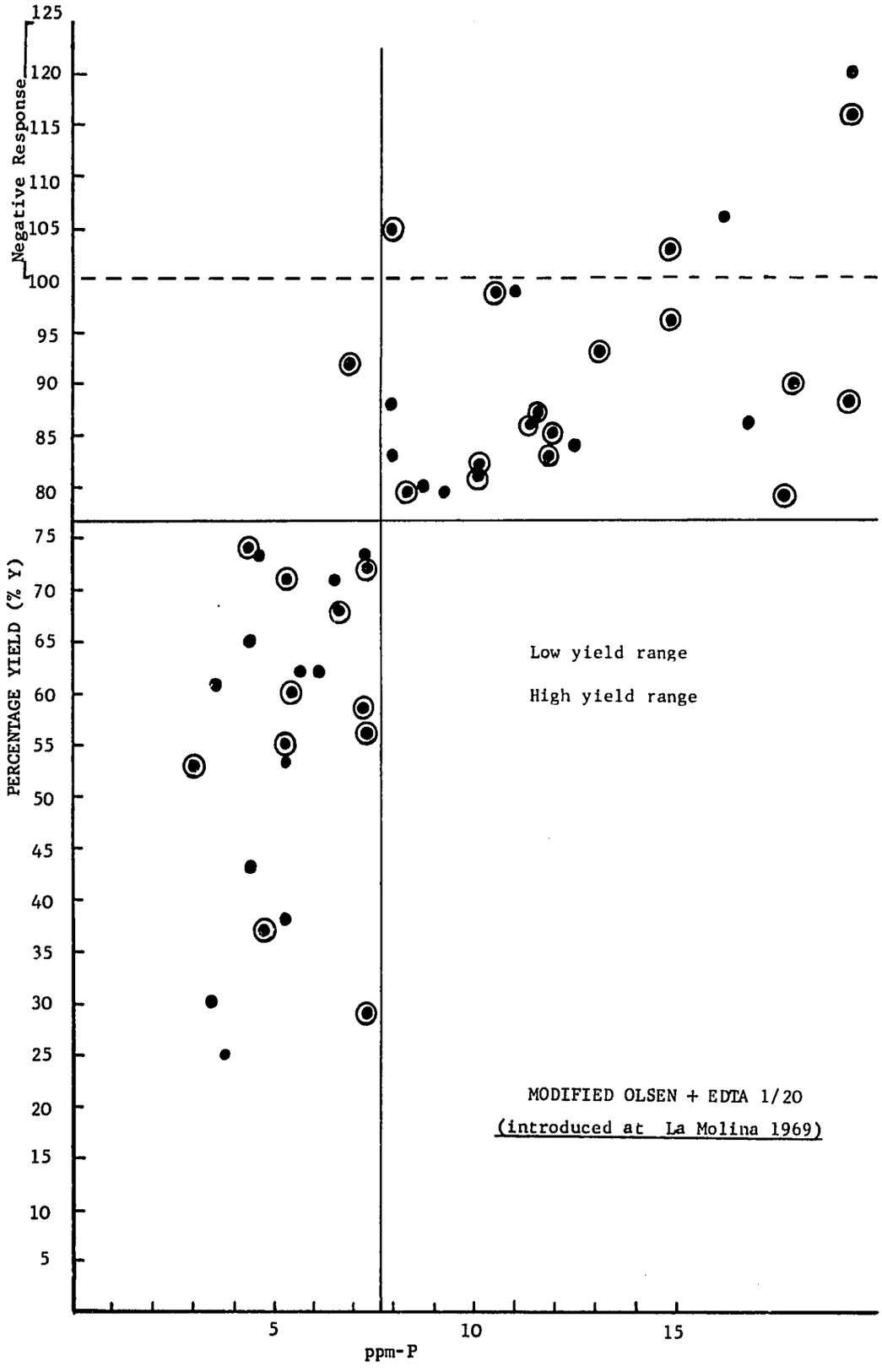


Figure 2. Extractable phosphorus in relation to relative yield of potatoes. (Field experiments and modified Olsen method)

In only two instances were the laboratory results sufficiently divergent to be of concern. These and other laboratory results indicate that a good soil fertility analyses system for phosphorus should indicate when phosphorus is low with an accuracy of 90-95 per cent probability. This means that the soil analyses can diagnose the need for the element and that when field factors other than phosphorus are not critically limiting to crop growth yield responses to the application of phosphorus can be expected. In field situations yield controlling factors other than fertility are often limiting such that the incidence to the response to phosphorus among soils low in the nutrient element may not always be 100 per cent.

The data in Table 4 also illustrate the second important aspect of soil fertility analysis. This is that when phosphorus is below the critical level in the soil some growth response can be expected. These responses can be expected at low as well as at high yield potentials. In other words, when factors other than phosphorus limit yield, the addition of phosphorus can generally be expected to produce a significant increase in the growth of the crop.

Consider again the potato data in Table 4. The yields range from 10.1 to 56.8 tons/ha. A separation of the sites into two groups, e.g., those 22 and below and those 23 and above, reveals that the relative responses to phosphorus are similar (Figures 1 & 2). In other words, the soil analyses reveal the need for the element in the soil and the probability of obtaining a response to fertilization with phosphorus. Soil analyses does not indicate the expected yield nor the absolute magnitude of response which can be expected unless other yield controlling factors are known and are made optimum.

COUNTRY PROGRESS

Brazil

Brazil is a very large country with diverse soil and climatic conditions but its economy is based largely on agricultural products. Increases in agricultural production have come about largely from bringing more land into cultivation. In recent years, however, much more attention has been given to improved cultural practices including the proper use of fertilizers and lime. During 1970 Brazilian farmers will spend over $170 million for fertilizers and lime, and this investment will more than triple during the next five years. This amount of fertilizer and lime, if applied in proper proportions and if used where needed, can have a profound effect upon increased yields as well as upon the unit cost of production.

The Soil Fertility Evaluation Project has made excellent progress in Brazil and there is much interest in the project among the Brazilian scientists and farmers. Currently there are 20 soil testing laboratories equipped with multiple unit apparatus that was designed and constructed in the Ministry of Agriculture. The laboratories are using similar analytical procedures which permit the ready exchange of data. Interpretation of laboratory results are similar in the various laboratories; likewise, similar guide sheets for fertilizer suggestions have been prepared.

The Government's goal of expanding soil fertility analyses to several times the current volume can be attained insofar as the capacities of the laboratories to handle the samples are concerned. Another 10 or 12 laboratories will be similarly equipped with the Abreu-Vettori apparatus.

A number of correlation studies are under way with both potted plant and field trials. Likewise, considerable data is being obtained in respect to liming acid soils.

Twenty-one persons have attended the soil fertility evaluation seminars in Raleigh, and these people are serving in providing stimulation and leadership on conducting the program in Brazil.

The individuals and laboratories concerned with fertility research and fertility analyses have good working relationships. Indications of their cooperative efforts are found in the Minutes of their technical meeting shown below.

SUMMARY MINUTES
FOURTH ANNUAL MEETING OF THE BRAZILIAN NATIONAL PROGRAM OF RAPID FERTILITY ANALYSES, AT EPFS, RIO DE JANEIRO, BRAZIL
SEPTEMBER 9-11, 1969

Report of Committee on Fertilizer and Lime

After the discussion held during this meeting the attending members have decided to:

1. Recommend that the use of correction factor of exchangeable Al be changed to 2.0, keeping the values 0 to 0.3 me low and higher than 0.3 me high.

2. For Ca + Mg from 0 to 2.0 me low, to complete the value to 2.0 me.

These values are suggested when there is an absence of more complete data which would justify modifying them.

The Committee also suggests that research work should be done in an attempt to correlate the method of the $M = \frac{Al}{Ca + Mg + K + Al}$ factor and the SMP method used in Rio Grande do Sul.

They further suggest that the liming materials used in soil acidity correction should be previously analyzed as to their relative power of total neutralization (PRNT), according to studies being made in Rio Grande do Sul.

3. The recommendations for the use of fertilizers should follow the third approximation (3a. approximaçao) of Cate and Vettori, as long as there are no studies which would justify alterations.

4. To suggest to the Pedology and Soil Fertility Group (EPFS), through the International Soil Testing Project, that effective action should be initiated with the state or regional extension services, with the

purpose of organizing plans for the recuperation of soil fertility through long-term financing of amendments and phosphate and potassium fertilizers, together with reasonable agricultural methods as is being done in Rio Grande do Sul with good results.

5. To suggest that the fertility laboratories make agreements with the government services responsible for the regulations which control the commerce of fertilizers and related products for agricultural use, with the purpose of prohibiting abuses and fraud in commercializing these products.

6. To suggest that emphasis be given to the exchange of samples between the various laboratories of this group in order to verify the uniformity of the results.

Signed: Albert E. Ludwick
Gonçalo Evangelista de França
Francisco José M. Holanda
José F. Patella
Walter C. Stamato
Dejair Lopes de Almeida
Alfredo Scheid Lopes, Relator

Report of Committee on Research

At 10:00 o'clock in the morning, the members of the Committee responsible for the research recommendations had their meeting and decided to suggest the following items to be discussed by the plenary assembly:

1. To recommend that the description of identification of soil units be made, in which the tests are carried out, according to the principles used by the Pedology and Soil Fertility group (EPFS).

2. Whenever possible, to group the results of research by taxonomic units of the soil.

3. To study methods of soil sample: size, area, number, profundity, periodicity and location of the samples.

4. To study methods and processes in order to increase efficiency of the chemical analyses.

5. To suggest studies to establish the minimum need of nutrient elements for plant growth on Cerrado soils.

6. To carry on research on the problem related to phosphorus fixation, based on the patterns established by the third approximation, and in comparison with other methods which may be suggested by any laboratory belonging to the national system of soil testing.

7. To intensify the studies on methods of determination of soil liming, recording data of correlation between the various methods.

8. To recommend that the research be done on size, watering, number of plants and type of receptacle in pot trials.

9. To suggest, until there is enough data on carrying out pot trial experiments, two liters of soil and ten plants in each receptable, using sorghum or millet as plant indicators.

10. To recommend that the central coordination (EPFS) send sorghum or millet seeds, whenever possible, to the various labs.

11. To recommend an evaluation of the residual outcome of tests with fertilizers conducted in pots.

12. To recommend studies related to the elevation of soil fertility and its maintenance.

13. To recommend field studies with the purpose of determining liming factor.

14. To suggest the use of one experimental design for field work, when experiments are held on a national basis, for determining the critical levels for phosphorus and potassium.

15. To suggest the use of other methods of soil fertility evaluation.

16. To suggest the summaries of experiments, partially or totally concluded, be sent to the central coordination (EPFS) before the annual meetings.

17. To suggest that schools and institutions of agriculture conduct negotiations with groups such as the Rondon Project, CNP, etc., in order to give the students an opportunity to carry on research work during vacation and/or school periods, with the purpose of diffusing throughout the country the importance of the researcher.

18. To recognize that the assistance of foreign technicians is valuable, but will not assure continuity of research work as needed by the country. It is important that the international help be especially given on a post-graduate level, offering much more attractive scholarships than the present ones, which demonstrate the firm purpose of the agencies in strengthening and stimulating the formation of highly skilled personnel.

Signed: José Mário Braga
Emo Ruy de Miranda
Moacyr de O. Camponet do Brasil
Adolfo Barrento de Castro
Emilson França de Queirós

Report of Committee on Publications and Promotion

After examining the problems of publication and promotion on scientific and extension levels, the Committee considering:

1. the importance of soil correction and fertilizing for farming and cattle raising development in the country;

2. the importance of immediate publication of research results as a basic factor to its improvement; and

3. the need of getting the research results to the farmers,

Suggests:

a. to motivate the political and administrative areas, and the credit organizations towards the importance of soil correlation and fertilizing;

b. to alert the public authorities, especially the National Research Council, about the serious problem of the difficulties in publishing works of scientific research;

c. to immediately disseminate the research data to the extension personnel for prompt indication to the farmers. This must be done independent of data publication in scientific magazines;

d. to provide training to the extension personnel through courses and/or periods of professional practice;

e. to cooperate with the extension personnel participating in courses given to the farmers;

f. to cooperate in the preparation of slides, maps, and other material to be used by promotion and extension services;

g. to cooperate in the installation of fields for soil correction and fertilizing demonstrations.

Singed: Raul Edgard Kalckmann
Guarany Carlos Gomes
Paulo Augusto da Eira
Abeilard Fernando de Castro

Report of Committee on Coordination with the Extension Services and Verification of Results

The Committee for studies of coordination with the extension services approved the following suggestions:

1. To follow the suggestions made by the Committee in the meeting held in 1968, which has not been done up to now

2. To emphasize the following items:

   a. to communicate with the extension services of the area putting its analysis laboratories and its technicians at the disposal of the referred extension services;

   b. to put adequate material for sample collection at the disposal of the extension services;

   c. to send the results of the soil testing, made by the farmers, to the local extension offices, providing the contacts between laboratory ⟶ Extension Service ⟶ farmer;

   d. training of field extension personnel in the interpretation of soil test results, in order to enable them to correctly change the original recommendations whenever necessary, according to the real needs of the area and the farmer;

   e. to intensify through publications and D.M. the fertilizing recommendations made by the laboratory;

   f. to publicize the research work of the sector, in order to inform the extension services;

   g. to study a general plan for improving soil fertility, and have all organizations meeting together in this study.

Signed: Braz Victor
Humberto Bohnen
Moacyr de O. Camponet do Brasil
Gladys Ferreira de Souza
Hélio Ramos
Antônio Batista Valentim Varella

Report of Committee of Analysis Methods in General and Nitrogen Recommendations in Particular

Resolutions:

1. Following the normal practice, organic matter will become one of the routine procedures in all participating laboratories for indirect evaluation of nitrogen, each organization being responsible for establishing its own scale for interpretation and method, and for sending them to EPFS for standardization. As for the method itself, to be included in the routine of the laboratories involved, EPFS will be in charge of that.

The Committee suggests that an attempt at calibration must be made using a method of utilizable nitrogen. The method presented by Pavageau could be used for this purpose as well as any other similar method.

2. In order to avoid increase of work for the laboratories, it is reccommended that the separate determination of magnesium be processed only in cases of areas known as deficient of this element.

3. To keep the present methods used for phosphorus and potassium using the North Carolina extractant. It is suggested, however, that the calibrations to be made with potassium must be checked also with the ratio $\frac{K}{Ca + Mg}$.

4. The determinations for pH and Al will be kept without change, following the methods presently used.

5. Each laboratory will send to EPFS reports on the analytical methods used.

6. To develop a correlation center for data gathered throughout Brazil.

Signed: Moacyr Pavageau, Relator
Raphael Minotti Bloise
José Ferreira Mendes
Geraldo de Assis Guimarães
Eung No Park

After the reports were submitted and discussed, the plenary assembly came to the following conclusions:

1. Recommendations on Fertilizers and Liming

Item 5 will read as follows:

"That EPFS emphasize with the organizations responsible for the control of the commerce of fertilizers and correctives, the need of intensifying the analysis of these products in order to avoid fraud."

2. Research

Items: 6) read "ISTP Technical Bulletin 3" instead of "third approximation."

13) read "experimental plan" instead of "experimental delineation." (This distinction is not applicable in English.)

9) cancel this item.

3. Publications and Promotion

Completely approved.

4. Coordination with the Extension Services and Verification of Results

Completely approved.

5. Analysis Methods in General and Nitrogen Recommendations in Particular

Items: 1) will read as follows: "To study the possibility of using methods for evaluation of N."

6) will read as follows: "To suggest the remittance of data relating to field work to EPFS, and data relating to soil testing to the farmers."

The discussions about the reports submitted were quite interesting. The members of the Publications and Promotion Committee came up with two propositions:

1. Emo Ruy de Miranda - "Address an official letter to Banco do Brasil requesting larger support for fertilizer financing."

2. Ady Raul de Silva (National Research Council) - " An amount should be withdrawn from the financial funds of each research project to take care of publishing their results either on technical-scientific and extension levels."

Professor Braga, speaking for the members who participated in the last symposium on Soil Testing held in North Carolina, proposed the development of a central organization to combine the activities of the various laboratories, serving as a reference and coordination service. Submitted to other members for discussion, Vettori declared that such an organization would be unnecessary due to the fact that its activities would normally be performed by EPFS.

Robert Cate, speaking for Dr. Fitts, introduced Dr. William L. Rodgers, Chief of ARDO (USAID). Following, he gave to the members attending the meeting an idea of the plans for the international project, stating that it is getting close to the end of the first stage, as it was forseen for five years. The project, however, is being reorganized by USAID. He also stated that the projects carried on in Latin America proved to be quite worthy. The time is coming when methods will have to be sharpened, due to the significant development of soil testing in these countries.

In conclusion he said that a statistical and economic analysis is being made about the various laboratories in Brazil He emphasized the need of exchanging data throughout the world.

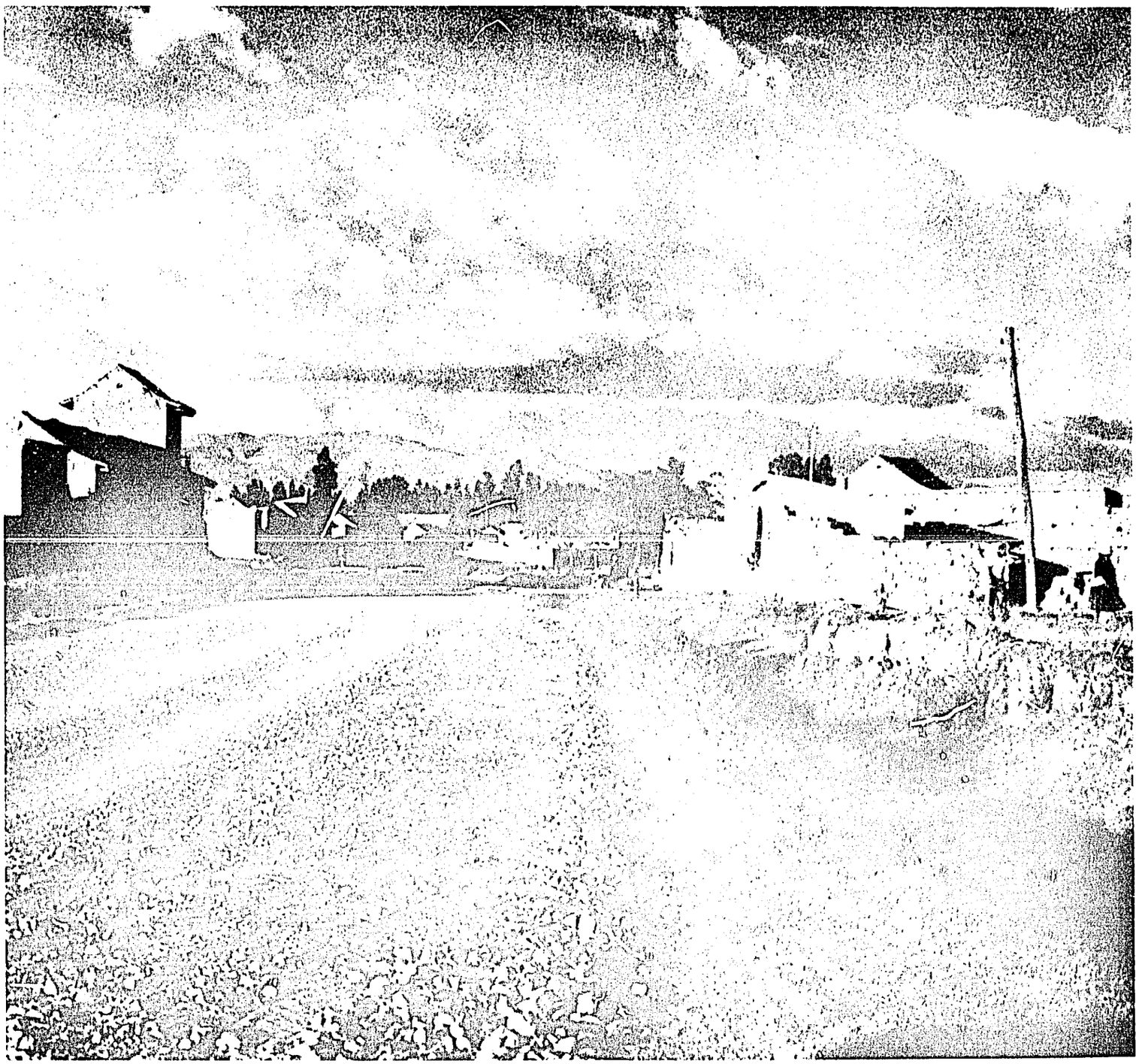
In closing, the Director of EPFS made a brief salutation to all members attending the meeting, hoping to see them in the near future. He expressed his thanks for the cooperation of all organizations in attending the meeting and submitting excellent reports. He said that this meeting proved to be one of the best of the National Program for Rapid Soil Fertility Analyses, which pleased him very much. The Director requested from everyone working with fertility a better and larger cooperation in order to enable Brazil to continue to lead in the best and largest agricultural and livestock production in Latin America.

Improved fertility could make the labor more rewarding.

Bolivia

Bolivia has a good soil fertility analysis laboratory located in Santa Cruz. The laboratory was established cooperatively with the British AID Mission. For the immediate future, the laboratory should be able to handle

Improvement in soil fertility should make crop production more efficient and profitable and delightful countries more prosperous and beautiful.



the country's needs for fertility analyses as well as the service requirements for soil survey.

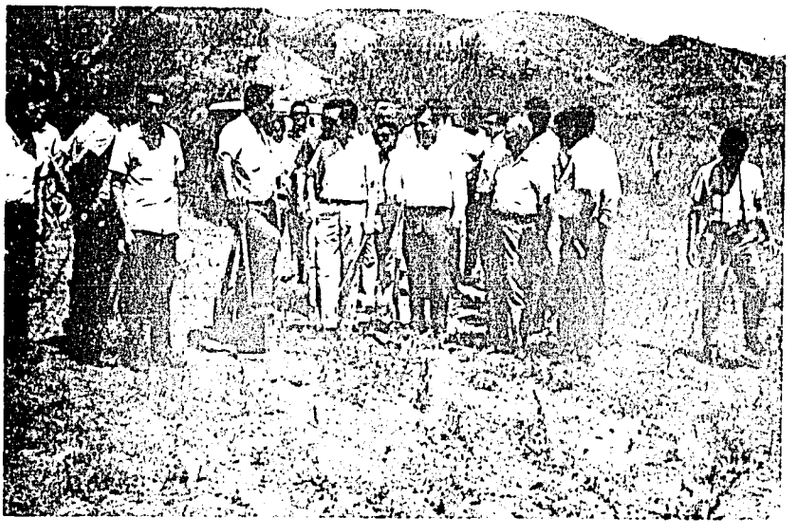
The success of the wheat program in Bolivia has generated interest in establishing similar programs with corn and potatoes. Two participants were selected and attended the 1969 seminar in Raleigh to prepare them to assume leadership in these two new programs. A total of five persons from Bolivia have attended soil fertility evaluation seminars in Raleigh. This training in soil fertility and familiarity with the International Program has had a marked influence upon the success of the wheat program.

During the year 30 field trials have been established on fertility needs of potatoes, 35 on the fertility needs of wheat, 5 on the needs of corn, 2 on quinua, 2 on rice and 1 each on bananas and citrus. Data from this number of field trials should provide much valuable information on the fertilizer needs of the soils of the country and of the relationships between the fertility needs and soil fertility analyses data from the laboratory.

A new and unique approach was taken in Bolivia to acquaint farmers with the proper use of fertilizers and new varieties in the production of wheat. Each farmer entering the demonstration was given four bags of fertilizer, but the combination of the bags of fertilizer was determined from a soil analysis. Only three fertilizers were used: 15-15-15; 13-39-0; and 46-0-0. If the soil tests showed the soil to be low in phosphorus and potassium, then the farmer was supplied with two bags of 15-15-15, one bag of 13-39-0 and one bag of 46-0-0 for an area of 6,000 square meters but, if his field needed only nitrogen (high in P and K), then four bags of 46-0-0 were given to the farmer to apply on an area 12,000 square meters in size. The farmer was given either Coposu wheat or one of the new Mexican dwarf wheats.

Field experiments serve to provide correlation data, and refine recommendations as well as serve as demonstrations for educational work. They are expensive to set out and maintain. Advance preparation including analyses of the site soils make them most efficient and useful.

Wheat experiments in Bolivia.



Soil sampling excursion in Nicaragua.

Shadehouse pot trials in Brazil.

The initial cost of the fertilizer was borne by Y.P.F.B., the National Oil Co. of Bolivia, by establishing a fund for such purposes. The farmer participating had to agree not only to having his field sampled and tested, but he also had to buy the improved varieties of wheat at a price slightly higher than the regular market. This impressed upon the farmer the importance of the seed and was a deterrent in his feeding or eating it. Likewise, he had to agree to pay for the fertilizer so that the fund could be maintained and additional demonstrations conducted in the future. The farmer was protected, however, in that the yield of his new wheat with proper fertilization had to be sufficiently above that of his regular practices to pay the costs; otherwise, he paid nothing. Any profit above cost of fertilizer and improved seed was his.

A farmer could select only one area of 6,000 to 12,000 square meters, depending upon the soil tests, or he could take two or three areas. Meetings were held in the villages to present the program and to ascertain interest. Approximately 500 farmers indicated a desire to participate in the fertilizer trials and were successful in establishing their plots.

Local communities were organized so that neighbors helped mix the bags of fertilizer and spread it before seeding. This was done to impress upon the farmers that fertilizers are different. Visits were made to all of the demonstrations by the local agricultural leaders. Several meetings were also held and a few tours were conducted.

Except in the regions where drought was extremely severe and no wheat produced, the demonstrations were highly successful. The yield of the properly fertilized improved varieties was several fold that of the local varieties grown with the customary practices. Much interest was created in improved

practices, including the proper use of fertilizer. The seed supply of improved wheat varieties is being increased and approximately $5,000,000 worth of fertilizer will be imported for use in the 1969-70 crop season.

Colombia

Dr. E. J. Kamprath reviewed the Soil Fertility Evaluation Program in Colombia during March and noted that much progress is being made under the leadership of Gildardo Marin. They have an active Advisory Committee which meets regularly to discuss the program and offers suggestions for future activities. The number of samples tested for farmers increased from 843 in 1965 to 7,314 in 1968. Summaries of the results have been prepared on a regional basis, and these have shown the wide variability that exists in their soil conditions in respect to fertility.

A group of three Colombian soil scientists went to Lima, Peru to observe the laboratory facilities developed by the project there, and to become better acquainted with the overall Peruvian approach to the Soil Fertility Evaluation Program.

Three Colombians were also on the North Carolina State University campus for a special AID-sponsored program which lasted two weeks. During this period they became familiar with several aspects of the International Soil Testing Project. Also Colombia has sent three people to the seminar programs of the project at Raleigh. Dr. Kamprath's report for Colombia appears in the appendix of this report.

Ecuador

Interest continues to mount in Ecuador in respect to the Soil Fertility Evaluation Program. There is close cooperation between the Ministry of

Agriculture Laboratory in Quito and the laboratory operated by the Fertisa Fertilizer Company in Guayaquil. A good start has been made in conducting correlation studies and the results have encouraged the research workers to increase their efforts. Some interesting work is underway with banana production in which soil tests are used as a source of information for fertilizer application.

Six persons have participated in the soil fertility seminars in Raleigh. These people are assuming responsibilities for the conduct of the fertility programs within the country.

Peru

The Soil Fertility Evaluation and Improvement Program in Peru continues to operate and to give service. Dr. Waugh, who was formerly in Peru, is now located in La Paz, Bolivia. However, he still has responsibilities for the Peruvian program.

Many studies conducted in cooperation with the Ministry of Agriculture and with the Agrarian University have been valuable in calibrating soil test procedures and in evaluating program operations. These studies will be brought together and summarized at a later date.

Venezuela

Dr. C. B. McCants reviewed the program in Venezuela in March 1969 and reported that, "The program is moving forward at a slow but steady pace. Significant developments are unfolding, which indicate that the groundwork laid during the early years of the program is beginning to yield measurable and beneficial results." A copy of Dr. McCants' report for Venezuela is in the appendix.

Panama and Costa Rica

No contacts were made with either Panama or Costa Rica during the first six months of 1969 due to local conditions. However, the Director of the Soil Testing Program in Panama has reported that the program is continuing in the manner developed by the Soil Fertility Evaluation Project. He urgently requested continued cooperative endeavors in conducting their program.

Nicaragua, Honduras, El Salvador and Guatemala

These four countries are under the leadership of Dr. J. L. Walker for the Soil Fertility Evaluation Project. Dr. Walker has prepared a detailed progress report for this region which fully outlines activities, accomplishments and needs. Some interesting items from Dr. Walker's report are reproduced here.

Fertility made this difference in Guatemala.

Ratios of $N/P_2O_5/K_2O$ in fertilizers used in Central America from 1964 through 1968.					
COUNTRY	1964	1965	1966	1967	1968
Guatemala	1/0.67/0.17	1/0.69/0.25	1/0.69/0.25	1/0.72/0.22	1/0.72/0.22
El Salvador	1/0.32/0.32	1/0.42/0.39	1/0.40/0.40	1/0.40/0.40	1/0.40/0.40
Honduras	1/0.15/0.69	1/0.05/0.40	1/0.13/0.67	1/0.18/0.70	1/0.16/0.63
Nicaragua	1/0.61/0.22	1/0.88/0.23	1/0.67/0.21	1/0.72/0.32	1/0.76/0.32
Costa Rica	1/0.65/0.48	1/0.32/0.45	1/0.36/0.45	1/0.34/0.49	1/0.33/0.47
Panama	1/0.17/0.11	1/0.17/0.13	1/0.36/0.29	1/0.40/0.20	1/0.38/0.25
REGION	1/0.42/0.32	1/0.42/0.32	1/0.44/0.38	1/0.45/0.41	1/0.45/0.41
North Carolina			1/0.98/1.12		

Fertilizer use would be much more efficient and profitable if the proper balance of plant nutrient elements were applied in the fertilizer.

Ratios of $N/P_2O_5/K_2O$ needed in fertilizers as determined by soil fertility analyses.	
COUNTRY	FERTILIZER NEED RATIO $N - P_2O_5 - K_2O$
GUATEMALA	1/1.65/0.82
EL SALVADOR	1/1.28/0.58
HONDURAS	1/1.30/1.00
NICARAGUA	1/1.55/1.30

FERTILIZER RECOMMENDATIONS

Making fertilizer recommendations to farmers is the culminating technical part of a soil fertility evaluation and improvement program. In the making of useful and practical fertilizer and soil management recommendations account is taken of the fertility status of the soil as shown by the soil analysis, the crop to be grown, the past cropping history of the farmer's field, the yield potential of the crop and its concomitant need for fertilizer elements, the climatic features of the area and their probable influence on crop growth and on fertility needs, the capacity or ability of the farmer to use good soil and crop management practices, and the probable economic implications of the cost of fertilizer in relation to the value of the expected increase in yield.

Soil analyses to determine fertility needs and economic considerations of fertilizer use are considered of prime importance in making fertilizer recommendations.

The importance of climatic conditions and the impact of soil management factors are largely reflected in and can be adequately evaluated by field experiments of yield potentials. Considerable effort has been made in the project to generate fertilizer response information and to assemble, evaluate, and compile such data into usable form. Economic considerations of the interpretation procedures have been given particular attention.

Table 5. Example of recommendation form used in Peru

Potatoes

Soils pH 6-4 or lower:

Phosphorus (P) Analysis

Potassium (K) Analysis	0-6 ppm	7-14 ppm	15^+ ppm
0-160	160-200 Kg/Ha P_2O_5 / 120-160 Kg/Ha K_2O	100-120 Kg/Ha P_2O_5 / 120-160 Kg/Ha K_2O	20- 40 Kg/Ha P_2O_5 / 120-160 Kg/Ha K_2O
165-300	160-200 Kg/Ha P_2O_5 / 80-100 Kg/Ha K_2O	100-120 Kg/Ha P_2O_5 / 80-100 Kg/Ha K_2O	20- 40 Kg/Ha P_2O_5 / 80-100 Kg/Ha K_2O
305-380	160-200 Kg/Ha P_2O_5 / 20- 40 Kg/Ha K_2O	100-120 Kg/Ha P_2O_5 / 20- 40 Kg/Ha K_2O	20- 40 Kg/Ha P_2O_5 / 20- 40 Kg/Ha K_2O
385^+	160-200 Kg/Ha P_2O_5 / 0 Kg/Ha K_2O	100-120 Kg/Ha P_2O_5 / 0 Kg/Ha K_2O	20- 40 Kg/Ha P_2O_5 / 0 Kg/Ha K_2O

Soils pH 6.5 or higher:

Potassium (K) Analysis			
0-220	160-200 Kg/Ha P_2O_5 / 160-200 Kg/Ha K_2O	100-120 Kg/Ha P_2O_5 / 160-200 Kg/Ha K_2O	20- 40 Kg/Ha P_2O_5 / 160-200 Kg/Ha K_2O
225-280	160-200 Kg/Ha P_2O_5 / 100-120 Kg/Ha K_2O	100-120 Kg/Ha P_2O_5 / 100-120 Kg/Ha K_2O	20- 40 Kg/Ha P_2O_5 / 100-120 Kg/Ha K_2O
285-350	160-200 Kg/Ha P_2O_5 / 20- 40 Kg/Ha K_2O	100-120 Kg/Ha P_2O_5 / 20- 40 Kg/Ha K_2O	20- 40 Kg/Ha P_2O_5 / 20- 40 Kg/Ha K_2O
355^+	160-200 Kg/Ha P_2O_5 / 0 Kg/Ha K_2O	100-120 Kg/Ha P_2O_5 / 0 Kg/Ha K_2O	20- 40 Kg/Ha P_2O_5 / 0 Kg/Ha K_2O

Table 6. Example of recommendation form used in Bolivia.
Rotation wheat, potatoes, corn

I. Soils low in Phosphorus: 0-6 ppm P.

Analysis of Potassium K (ppm)	Wheat	Potatoes	Corn
0-125	(40 - 60 - 34) 4 bags 17-17-17 1 bag 13-52- 0	Min. 120-120-100 Max. 150-150-125 8 bags 17-17-17 2 bags 0- 0-60 2 bags 13-52- 0 ——— 2 bags 46- 0- 0 sidedress	Min. 80- 80- 80 Max. 100-100-100 6 bags 17-17-17 1 bag 13-52- 0 1 bag 0- 0-60 ——— 2 bags 46- 0- 0 sidedress
130-250	(53 - 69 - 17) 2 bags 17-17-17 2 bags 13-52- 0 1 bag 46- 0- 0	Min. 120-120- 50 Max. 150-150- 75 8 bags 17-17-17 3 bags 13-52- 0 ——— 2 bags 46- 0- 0 sidedress	Min. 80- 80- 40 Max. 100-100- 60 6 bags 17-17-17 1 bag 13-52- 0 ——— 2 bags 46- 0- 0 sidedress
255	(65 - 78 - 0) 3 bags 13-52- 0 2 bags 46- 0- 0	Min. 120-120- 0 Max. 150-150- 30 4 bags 17-17-17 4 bags 13-52- 0 ——— 3 bags 46- 0- 0 sidedress	Min. 80- 80- 0 Max. 100-100- 20 2 bags 17-17-17 3 bags 13-52- 0 ——— 2 bags 46- 0- 0 sidedress

Similar table used for soils medium and high in phosphorus.

Statistical Analyses of Correlation Data

A standard correlation form has been prepared to collect data from pot and field trials. The form is reproduced in Figure 3 . The data included in the figure illustrate the use of the form. Cooperating institutions have been requested to fill in these forms for all of their experiments. In return, cooperators will receive statistical analyses, possibly with a wide range of model functions, although a modified (square root) quadratic seems to give consistently the best results of all curvilinear models, but usually not so good a fit as is obtained by the Cate-Nelson critical level procedure. Also, we plan to reproduce the filled-in standard forms and the computer analyses for distribution to all cooperators. Thus each lab will gradually amass a file of statistically analyzed correlation studies performed all over the world, cross-referenced by crop, soil extractant, soil type, etc.

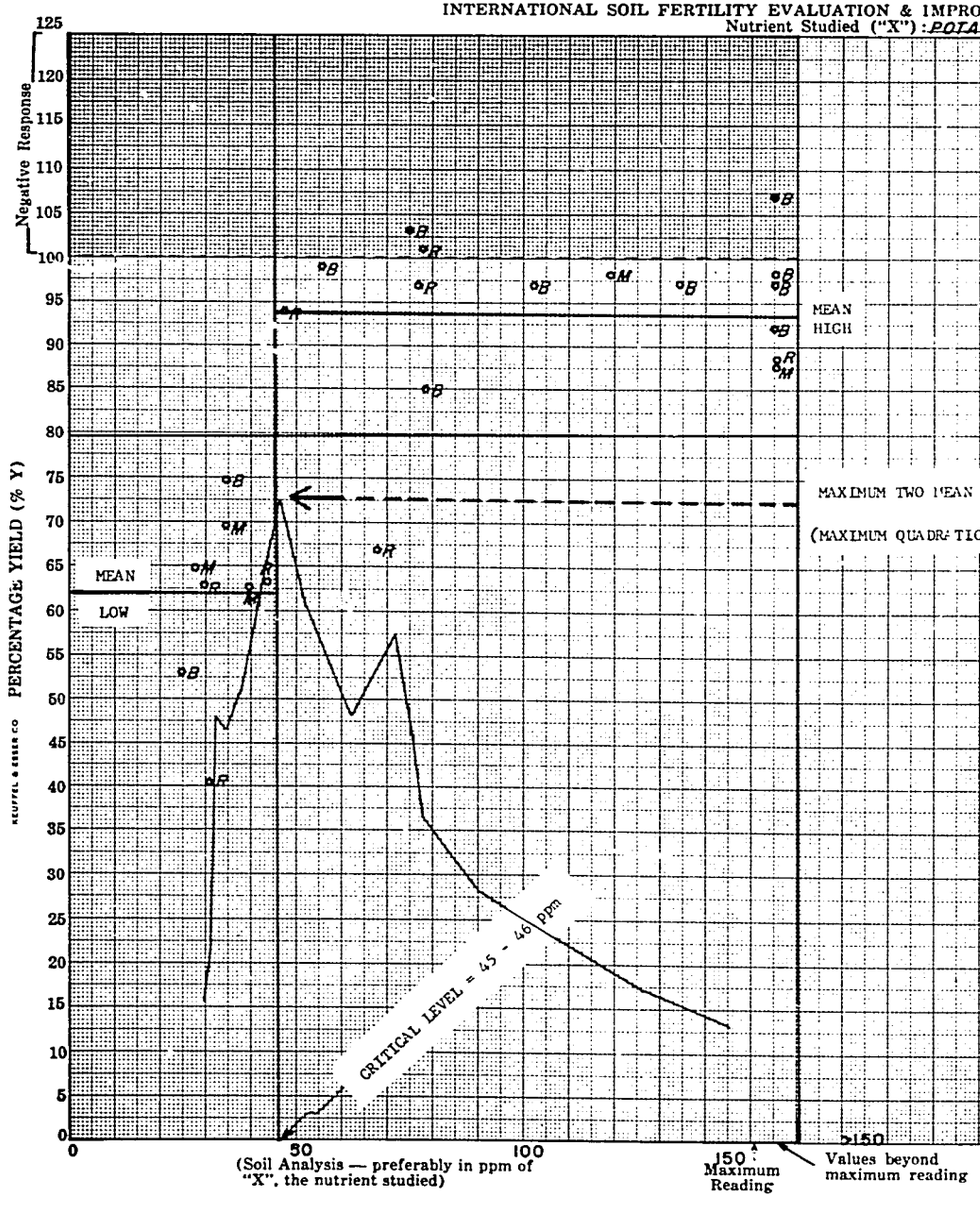
One aspect of the statistical analyses will be a mathematical version of the graphical technique presented in Technical Bulletin No. 1 of the International Soil Testing Series to find the Cate-Nelson critical level. A computer program has been written which determines the C-N level precisely, i.e., by locating the level of soil nutrient which divides the data into two populations such that the coefficient of determination (R^2) of the means of the two populations is maximized. The result is the same as that obtained by the original C-N method, but it permits additional statistical interpretation. The jagged line in Figure 3 is an example of the application of the new method, which is now being readied for publication.

Fertilizer Recommendations

Preliminary Report No. 3 of the International Soil Testing Series has been published giving the gist of our suggested system for basing recom-

INTERNATIONAL SOIL FERTILITY EVALUATION & IMPROVEMENT — STANDARD CORRELATION FORM*

Nutrient Studied ("X"): POTASSIUM - K



BASIC DATA TABLE

PERCENTAGE YIELD (% Y) = $\frac{\text{YIELD OF COMPLETE MINUS "X"}}{\text{YIELD OF COMPLETE TREATMENT}} \times 100$

SAMPLE NO.	YIELD COMPLETE MINUS "X"	YIELD COMPLETE TREATMENT	% Y	SOIL ANALYSIS		SAMPLE NO.	YIELD COMPLETE MINUS "X"	YIELD COMPLETE TREATMENT	% Y	SOIL ANALYSIS
C-1	659	875	75	34		FT-8	1131	1166	97	77
C-4	842	1560	54	26		FT-9	1176	1165	86	>150
C-5	3220	3320	97	134		FT-10	654	1045	63	30
C-5a	1115	1138	98	>150		FT-10a	1423	1450	98	118
C-6	2255	2325	97	>150						
C-7	1288	1982	65	28						
C-8	1257	1878	67	68						
C-9	2214	2515	88	>150						
C-10	2779	2750	101	78						
C-12	1998	2150	92	>150						
C-13	3042	3142	99	56						
C-15	1113	1082	103	75						
C-5a	1551	1544	107	>150						
C-7	6[illegible]	822	70	35						
C-14	2404	2827	85	78						
C-16	2543	2621	97	102						
FT-2	979	1042	94	48						
FT-3	674	1644	41	31						
FT-4	856	1337	64	44						
FT-6	847	1345	63	40						

1. Extraction Method (including reagents, normality, time of shaking soil-solution ratio and whether measurement by weight or volume): HNO3 - 0.05N, 1:10, percolation measured by weight
2. Crop (and variety, if known): Cotton
3. Country and Locations: Brazil - São Paulo
4. Climate: mild tropical
5. Classification of Soils: Latosols (Oxisols) - Baurú (B), Terra Roxa (R), Terra Roxa Misturada (M)
6. Type of Trial (pot, microplot, field, etc.): Field
7. Number of Replications: 4
8. Units of Yield Measurement: Kilos of seed cotton
9. Levels of Nutrients in "Complete": 100 kg/ha $N, P_2O_5, K_2O + S + Zn$
10. Method of Application of Nutrients: band at planting (2/3 N topdressing)
11. Details on Liming, (if any): Dolomitic lime to raise pH to 6.0
12. Code Used in Graph, (if any): Letters to indicate kind of soil (see 5)
13. Other Comments:
14. Persons and Agencies Responsible: (see 16)
15. Dates of Trials: 1958-59 & 1959-60 seasons (see dash line in table)
16. Literature Reference (if published): "Determination of Potassium Deficient Areas for Cotton, L. M. M. de Freitas, A. C. McClung, & F. Pimentel Gomes, Potash Review, Mar 1966.

*For further details, see Technical Bulletins No. 1 and No. 3 of the International Soil Testing Series. To obtain additional assistance, please contact: International Soil Fertility Evaluation & Improvement, P. O. Box 5907, Raleigh, N. C. 27607

Figure 3. A statistical method for determining a critical level of soil available phosphorus and an evaluation of the utility of the two population concepts in making fertilizer recommendations.

mendations on the minimization of unit costs. A more refined discussion of the approach is currently being reviewed for publication. The essence of the method is that we can combine simplified response functions (based on the C-N split) with existing input cost studies to provide approximate guidelines for economic fertilizer recommendations, using optimum input ratios for maximum efficiency (the "expansion path" concept). These guidelines, together with soil test summaries and crop acreage data, will permit us to make realistic estimates of the economically justified fertilizer needs of much of Latin America.

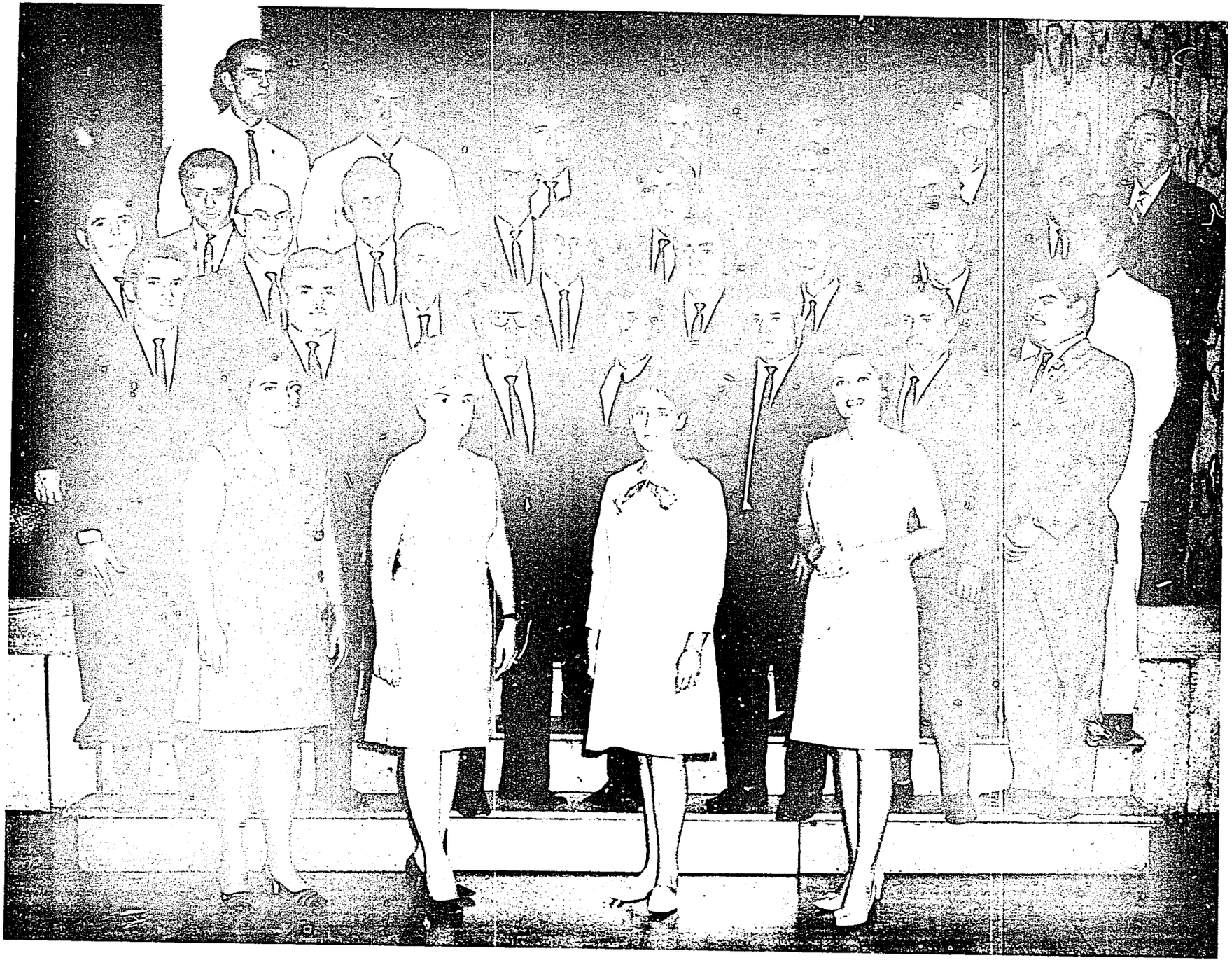
Since climate and other noncontrollable production factors vary yield and modify the responses obtained from the addition of fertilizer and fluctuating markets alter the margin of profit which can be realized from the use of fertilizers, recommendations made to farmers must reflect this expected variability and take into account the element of probability. It follows, therefore, that considerable data and experience should eventually be employed to formulate fertilizer use practices and recommendation suggestions to farmers.

A day with a County Agent (Mr. W. D. "Bill" Lewis, Wilson Co., N.C.).

FERTILITY EVALUATION AND IMPROVEMENT SEMINAR

The seven-week seminar, June 9 to July 25, was the fifth seminar of this type conducted by the project. Twenty-six participants representing nine countries took part in this year's program. The countries represented included: Brazil, 8; Bolivia, 2; Ecuador, 3; Colombia, 1; Nicaragua, 1; Honduras, 2; El Salvador, 3; Guatemala, 3; and Dominican Republic, 3. This was the first seminar in which representatives from the Dominican Republic

Seminar participants examine soil fertility and crop production problems in the field.



SOIL FERTILITY EVALUATION SEMINAR

North Carolina State University

June 9 - July 25, 1969

Group Photograph

FRONT ROW (left to right)

Name	Country
Reina Matamoros de Salinas	Honduras
Dotty Goodson	U. S. A.
Maria Elisa Erdmenger	U. S. A.
Frances Lamm	U. S. A.

SECOND ROW (left to right)

Luis Rafael Pérez Alvarez	El Salvador
Julio César Brolo Luna	Guatemala
Fernando Gravina Munhoz	Brazil
José Antonio Díaz Solís	Dominican Republic
Ramón Salinas Orellana	Honduras
Alfonso Altamirano Calderon	Ecuador
Víctor Manuel Rosales	El Salvador

THIRD ROW (left to right)

Jose Alberto González Spillari	Guatemala
J. W. Fitts	U. S. A.
Raul Arthur Riggenbach	Brazil
Wálter Humberto Carrera Murillo	Bolivia
Benedicto Campos Nolasco	El Salvador
José Ferreira Méndes	Brazil

THIRD ROW (continued--left to right)

Name	Country
Emo Ruy de Miranda	Brazil
Rafael Ajuria	Honduras

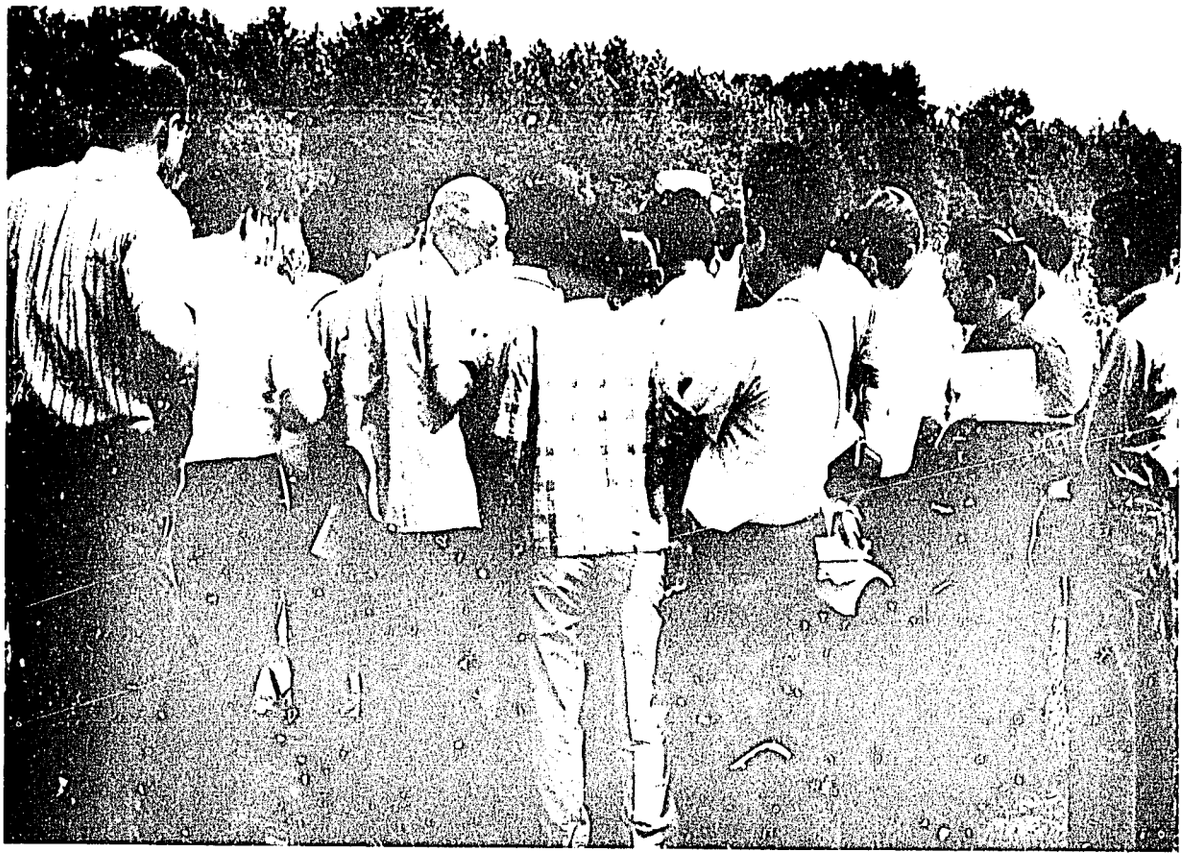
FOURTH ROW (left to right)

César Parreño Herrera	Ecuador
Emmanuel de Souza Cruz	Brazil
Francisco Dalaney Fermín Acosta	Dominican Republic
Rosendo Guzmán Bravo	Nicaragua
Fernando Arturo Valdéz Flores	Dominican Republic
Luis Alberto Estrada Ligorría	Guatemala
José Hiriam Tobón Cardona	Colombia

FIFTH ROW (left to right)

Alfredo Scheid Lopes	Brazil
Lucio Adolfo Zuleta Leaños	Bolivia
José Mário Braga	Brazil
Dejair Lopes de Almeida	Brazil
R. B. Cate, Jr.	U. S. A.
W. V. Bartholomew	U. S. A.
A. H. Hunter	U. S. A.

Seminar participants observe soil fertility and crop production experiments and problems at a number of locations. Here they examine peach production and fertility problems above and corn production below.

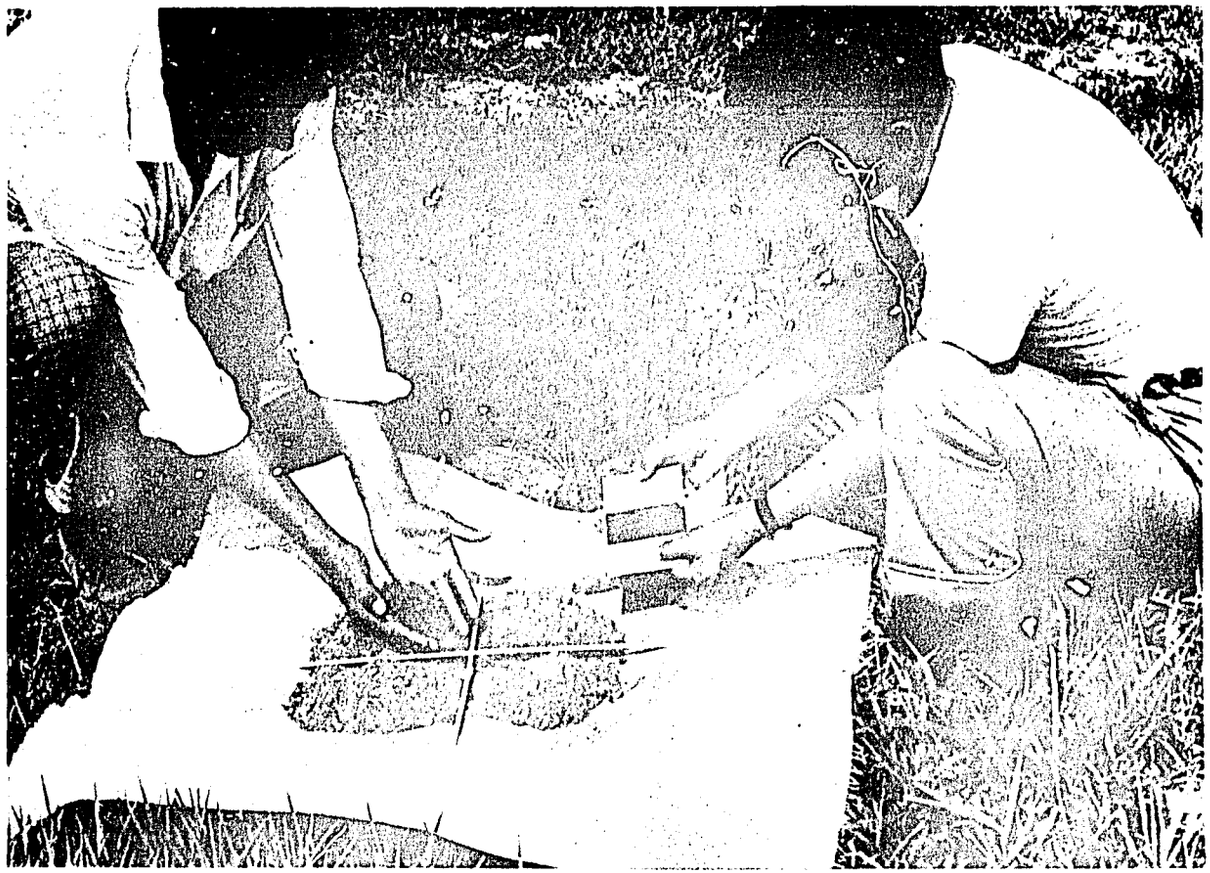


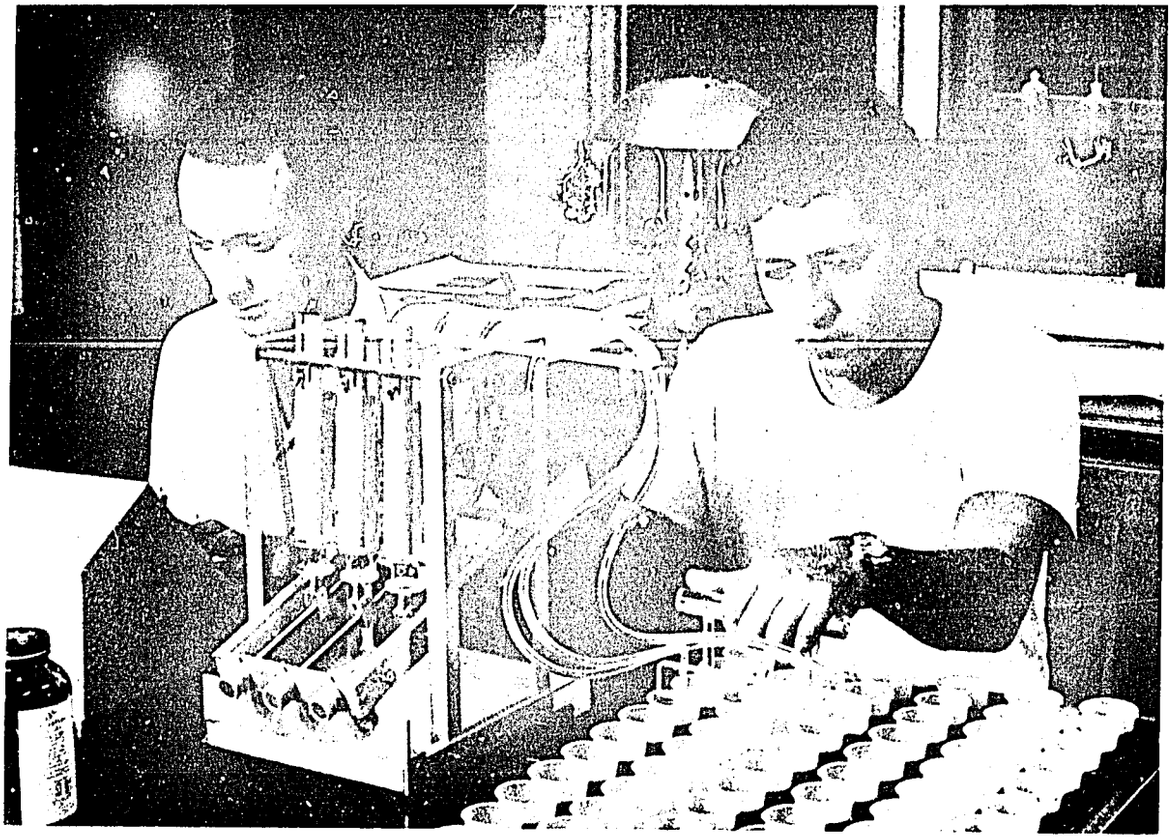
Corn production on new land.

Soil sampling problems in low lying areas.

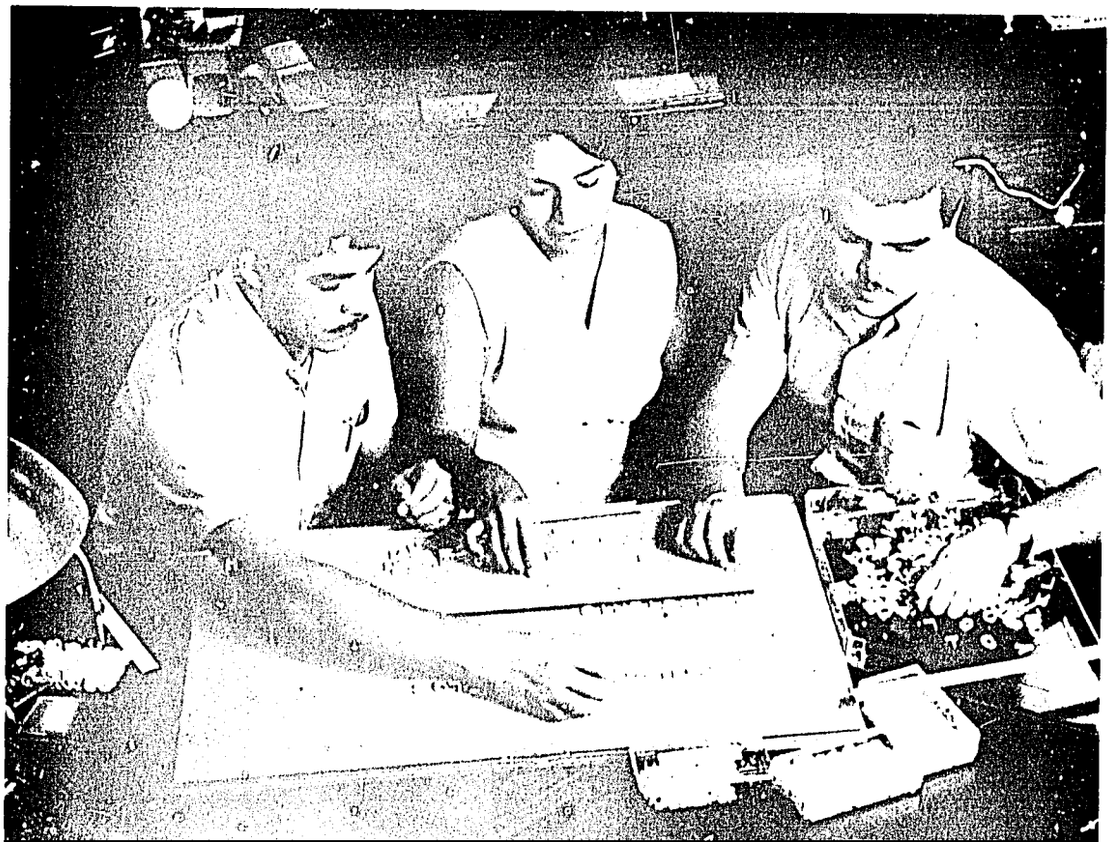
Observing tobacco culture.

Soil sampling techniques and demonstations were part of the seminar experience. Above Sres. Munhoz, Campos, González, Valdéz, Lopes, and Almeida. Below Sres. Zuleta and Carrera divide a sample.

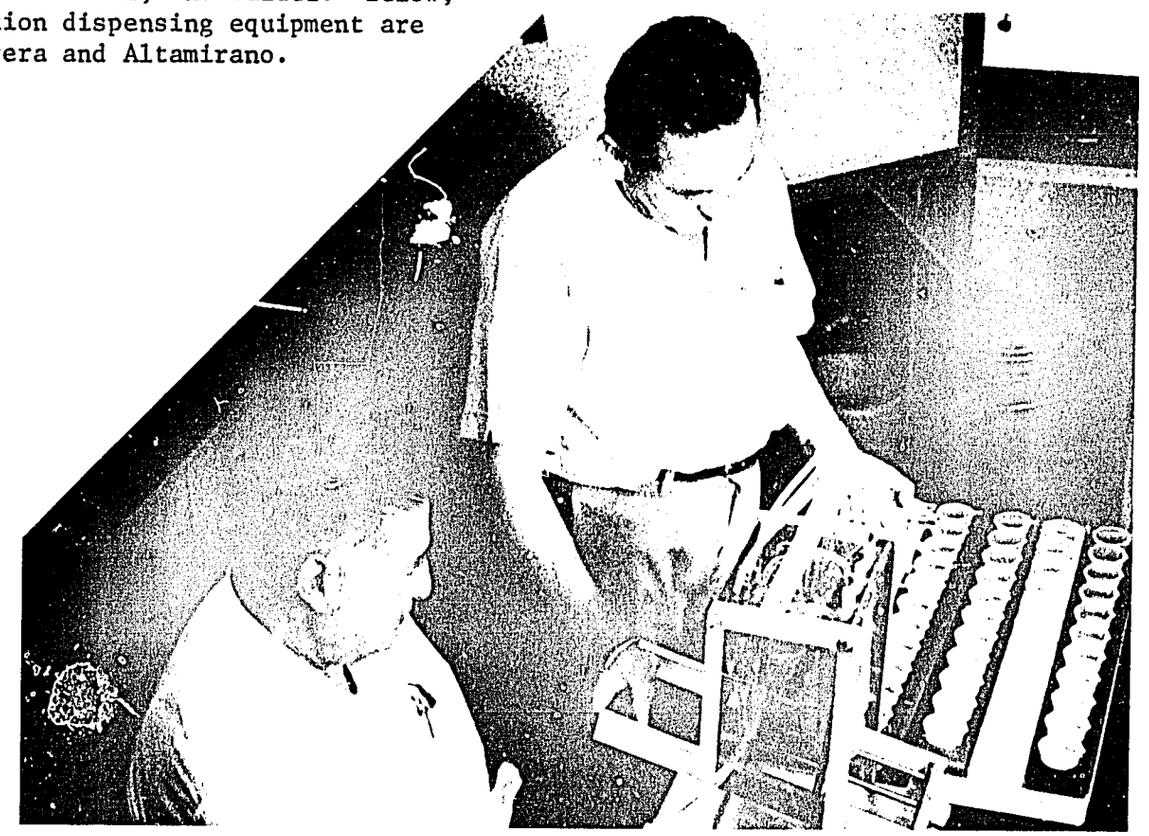


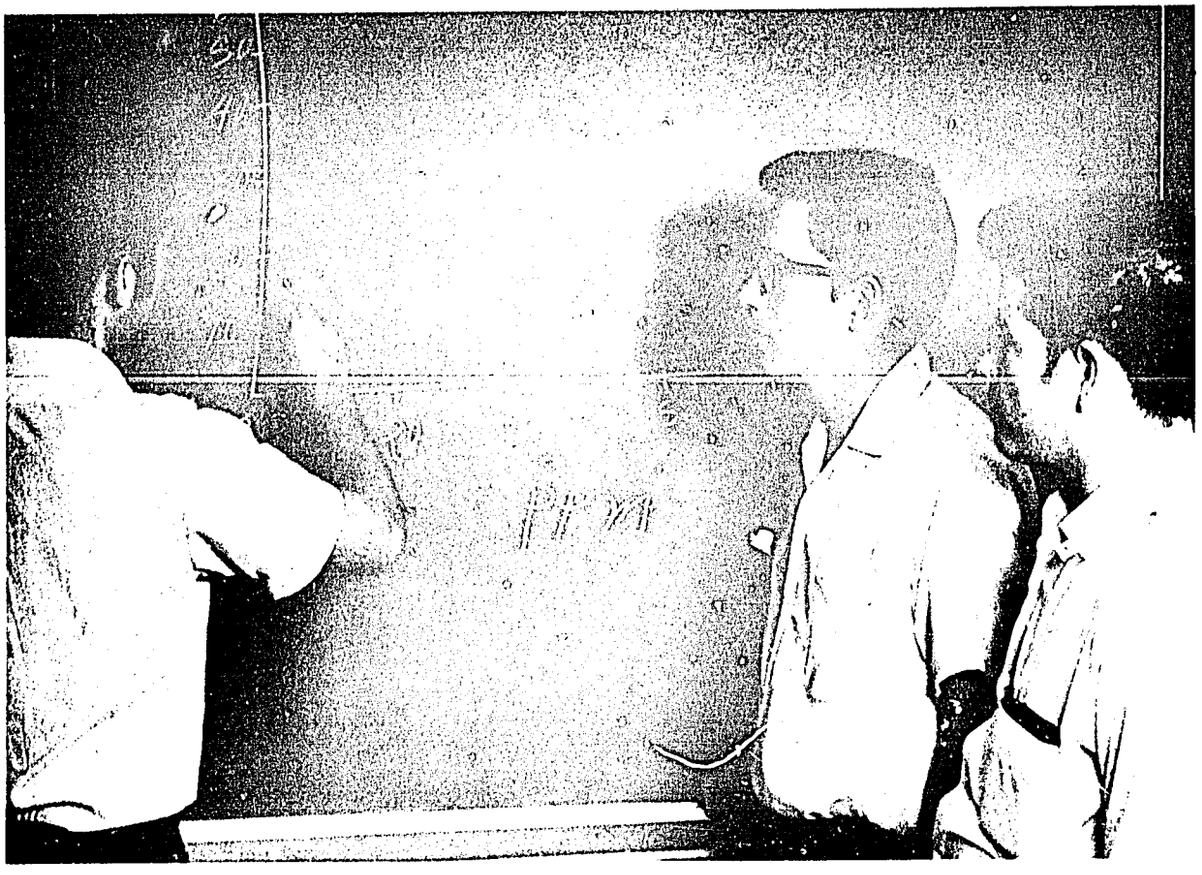


Above, Sres. Tobón and Guzmán try out multiple unit laboratory equipment. Below, Sr. Rosales, Sra. de Salinas, and Sr. Brolo start construction of a visual aid.

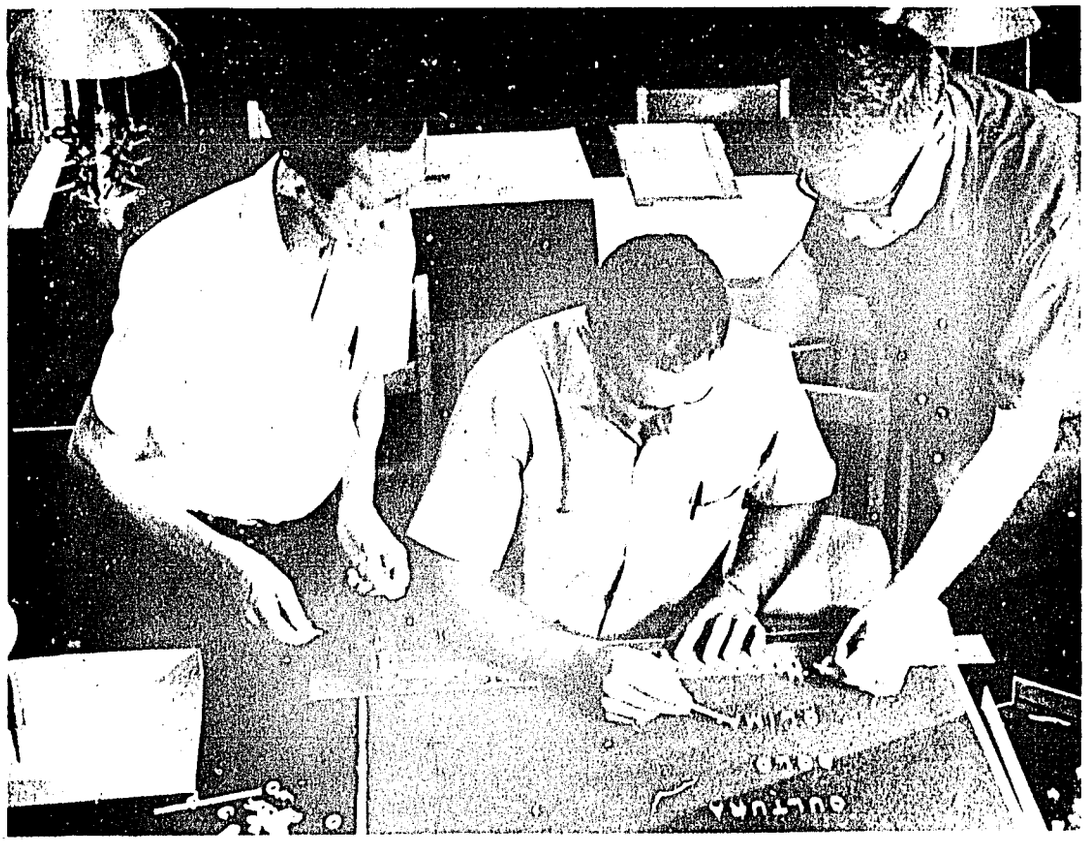


Above, Sres. Campos, González, and Valdéz. Below, working with solution dispensing equipment are Sres. Herrera and Altamirano.

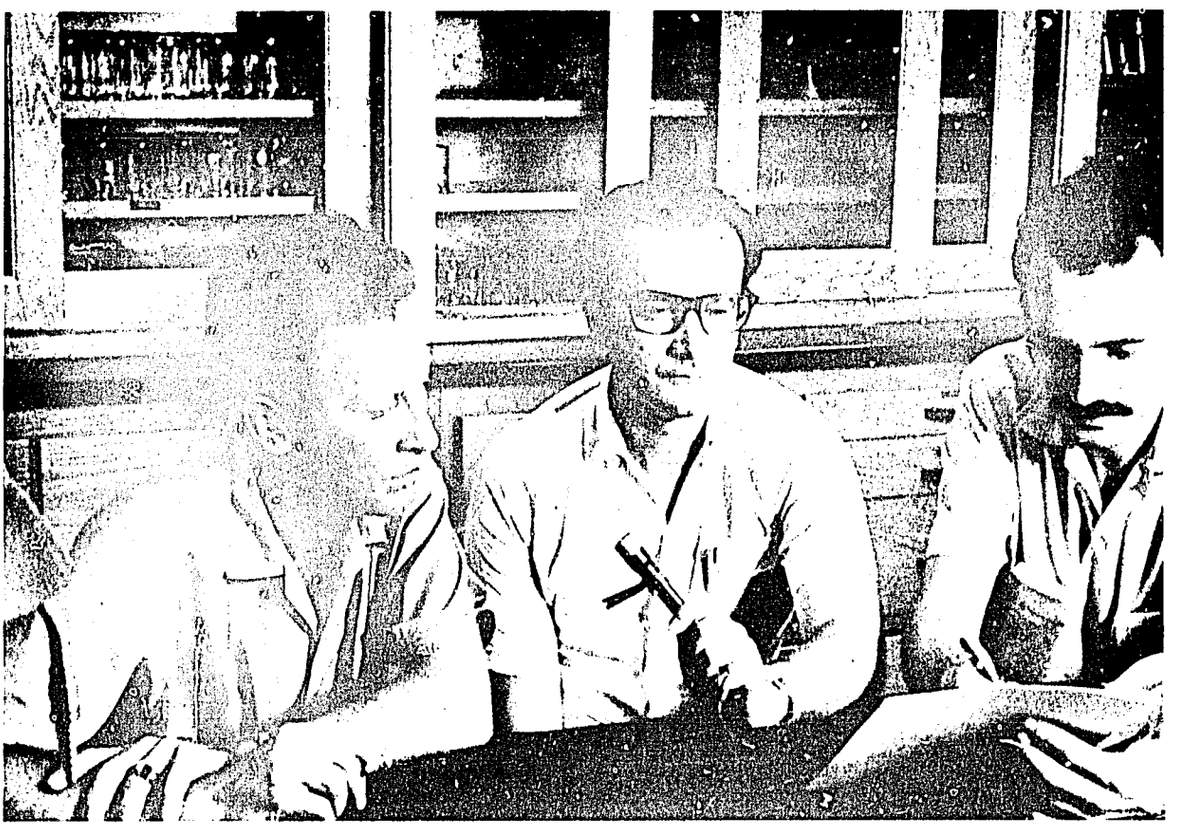




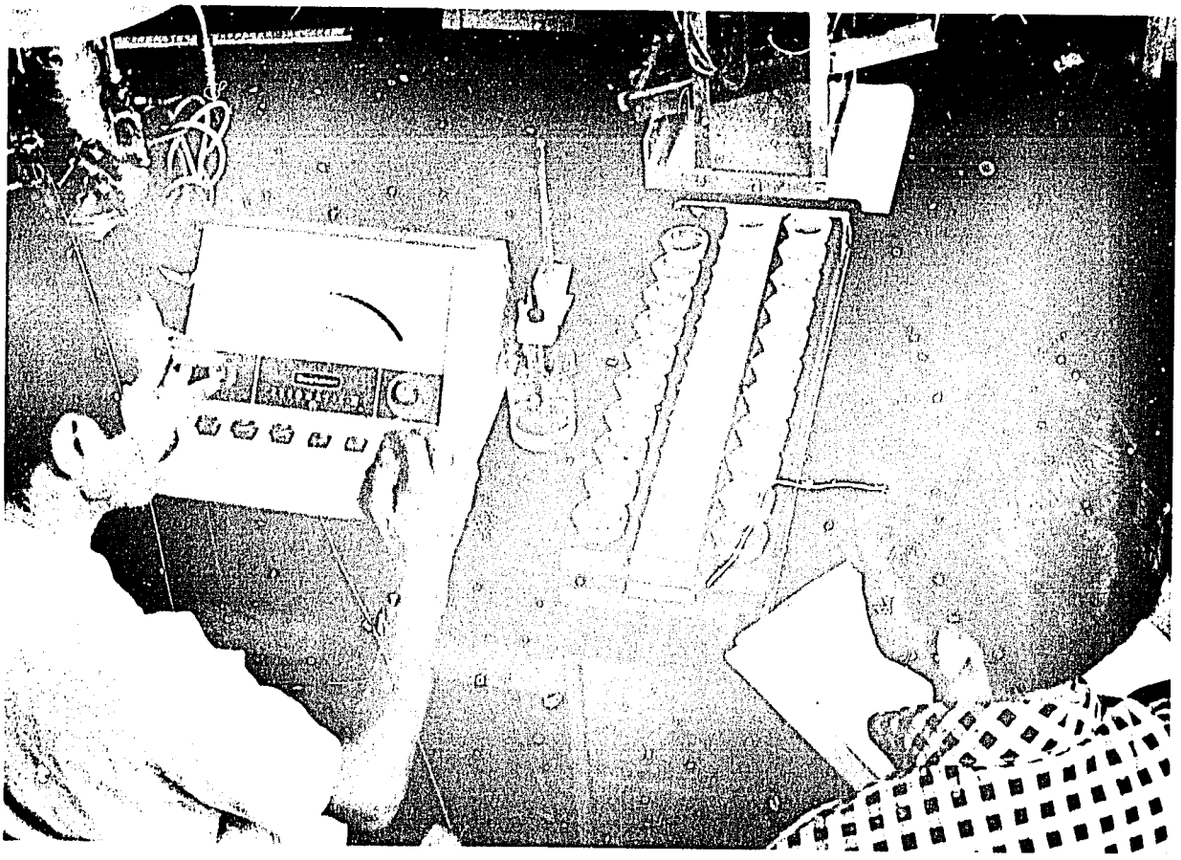
Above, plotting fertilizer response data are Sres. Pérez, Estrada, and Salinas. Sres. Méndes, Lopes, and Braga arrange plastic letters in the compilation of a visual aid.

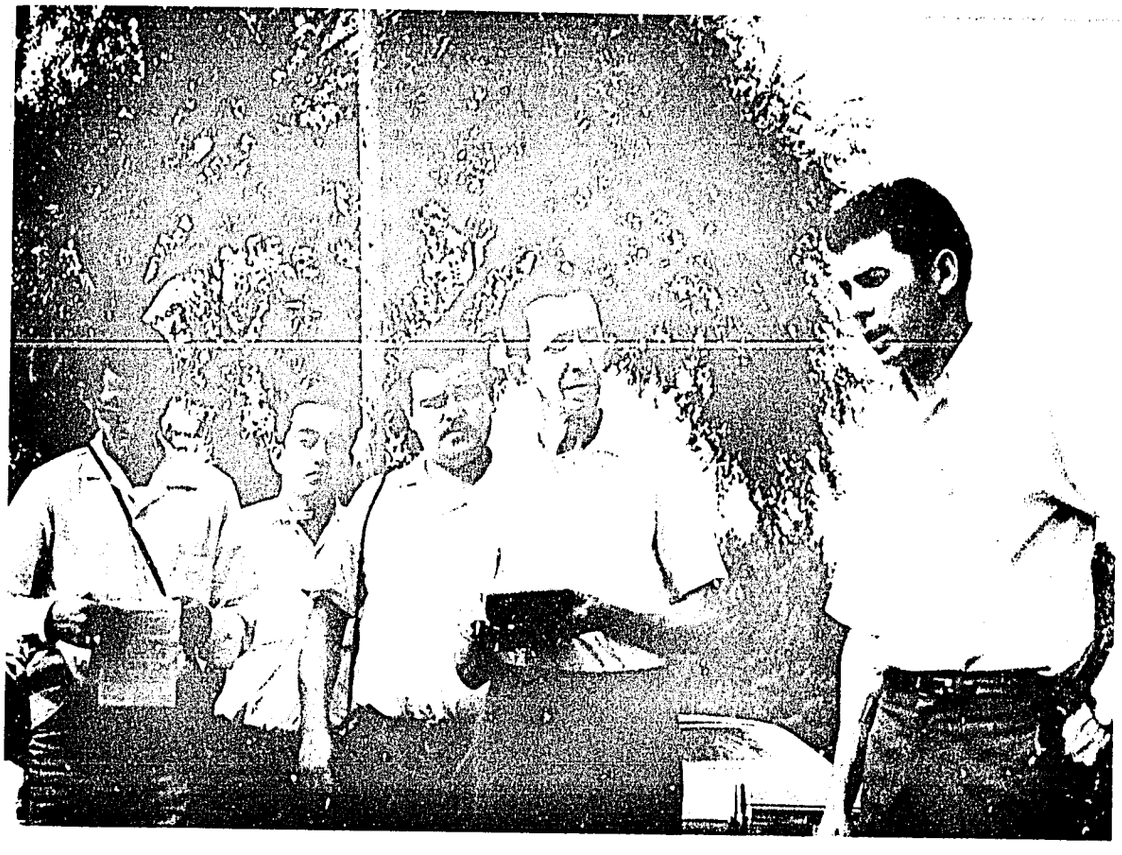


Dr. Hunter demonstrates a phase of tissue testing above to Sres. Salinas, Estrada, and Pérez. Below, a script for tape recording is discussed among Sres. Miranda, Munhoz, and Almeida.



Dr. Cummings demonstrates soil properties on the Sandhills Station above to Sres. Almeida, Rosales, Miranda, Munhoz, and Ajuria. Below, Sres. Riggenbach and Souza Cruz calibrate the pH Meter.





Sr. Ajuria translates for Sres. Fermín, Campos, Brolo, and Méndes.

Sres. Zuleta, Carrera, and Solís prepare samples for analyses.

The plant sap is pressed out of the tissue and into the indicator paper to measure nutrient availability to plants from the soil.

Soluble plant nutrients in the tissue are measured noting the color intensity in a test solution. Such techniques are useful in diagnosing nutrient deficiencies in soils. Tissue testing procedures also are helpful in determining fertilizer treatments for perennial crops.

Sra. Salinas above notes the heavy straw residue left from a high yield of wheat. Below, Dr. Cummings discusses soil properties in the Sandhills of North Carolina.

FERTILITY SUMMARIES AND VARIATION PATTERNS

Assembling, summarizing and evaluating soil fertility data which have accrued from the cooperating projects continues as a major function of the project. Some recent segments of data are reported herein. A comprehensive summary of soil fertility data will be compiled separately.

The 1968 Annual Report summarizes a number of preliminary surveys of soil fertility as revealed by test data. Included here are data from areas not extensively covered in the 1968 report.

Professor Raul Edgard Kalckmann and Fernando Gravina Munhoz of the Department of Soil Science and Chemistry respectively, of the Federal University of Paraná, have reported on soil fertility analyses from Paraná. The system of classifying the results of analyses are shown below:

	Low	Medium	High
pH	<5.0	5.0-6.0	>6.0
Al (me/100 g)	<0.5	0.5-1.5	>1.5
Ca + Mg (me/100 g)	<2.0	2.0-4.0	>4.0
P (ppm)	<4	4-9	>9
K (ppm)	<30	30-60	>60

A summary of analyses results by micro-region is shown in Tables 7 & 8. The data serve to show the distribution patterns within the state of the soils low and/or high in particular fertility elements. They also demonstrate the extent of heterogenity in fertility in micro-regions within the

Table 7. Summary of soil fertility analyses results from the State of Paraná, Brazil (Ca, Mg, P and K).

Micro-Region	Number of samples	Ca + Mg me/100g			P ppm			K ppm		
		Low <2.0	Med.	High >4.0	Low <4	Med.	High >9	Low <30	Med.	High >60
1	600	76	143	381	200	130	270	77	178	345
2	26	12	10	4	12	9	5	5	16	5
3	51	5	15	31	25	16	10	0	11	40
4	88	16	29	43	56	28	4	2	28	58
5	347	59	187	101	214	79	54	30	130	187
6	1,044	191	464	389	236	385	423	136	339	569
7	21	3	13	5	8	10	3	7	9	5
8	71	27	19	25	68	3	0	8	21	42
9	158	42	39	77	89	47	22	17	25	116
10	30	9	7	14	15	13	2	0	6	24
11	33	0	6	27	15	9	9	3	1	29
12	92	4	11	77	22	49	21	7	11	74
13	44	12	3	29	15	17	12	4	11	29
14	446	64	102	280	295	97	54	127	110	209
15	298	60	77	161	198	64	36	92	56	150
16	347	56	197	94	110	133	104	182	98	67
17	232	24	38	170	142	56	34	10	42	180
18	407	51	183	173	108	154	145	208	120	79
19	184	49	52	83	133	28	23	34	53	97
20	23	11	9	3	16	3	4	7	7	9
21	711	61	85	565	505	131	75	27	140	544
22	514	22	49	443	264	155	95	13	54	447
23	210	50	86	74	185	12	3	18	79	113
24	185	43	77	65	59	75	51	5	44	136
TOTAL	6,162									

Table 8. A summary of soil fertility analyses results from the State of Paraná, Brazil (pH and Al).

Micro-Region	Number of samples	pH			Al m/100 g		
		Low <5	Med.	High >6	Low <0.5	Med.	High >1.5
1	600	236	309	55	177	132	291
2	26	12	14	-	9	8	9
3	51	16	20	15	25	7	19
4	88	40	43	5	19	19	50
5	347	185	158	4	67	109	171
6	1,044	449	575	20	294	522	228
7	21	4	17	0	9	10	2
8	71	42	24	5	14	8	49
9	158	97	55	6	33	22	103
10	30	18	8	4	5	7	18
11	33	7	15	11	18	8	7
12	92	7	43	42	73	7	12
13	44	15	11	18	28	1	15
14	446	104	196	146	273	93	80
15	298	61	106	131	211	59	28
16	347	37	142	168	316	27	4
17	232	67	81	84	144	28	60
18	407	56	109	242	334	55	18
19	184	61	87	36	89	50	45
20	23	12	9	2	5	2	16
21	711	166	292	253	469	101	141
22	514	104	225	185	363	75	76
23	210	64	136	10	40	112	58
24	185	126	50	9	36	9	140
TOTAL	6,162						

POTASSIUM IN SOIL SAMPLES

STATE OF PARANA, BRAZIL

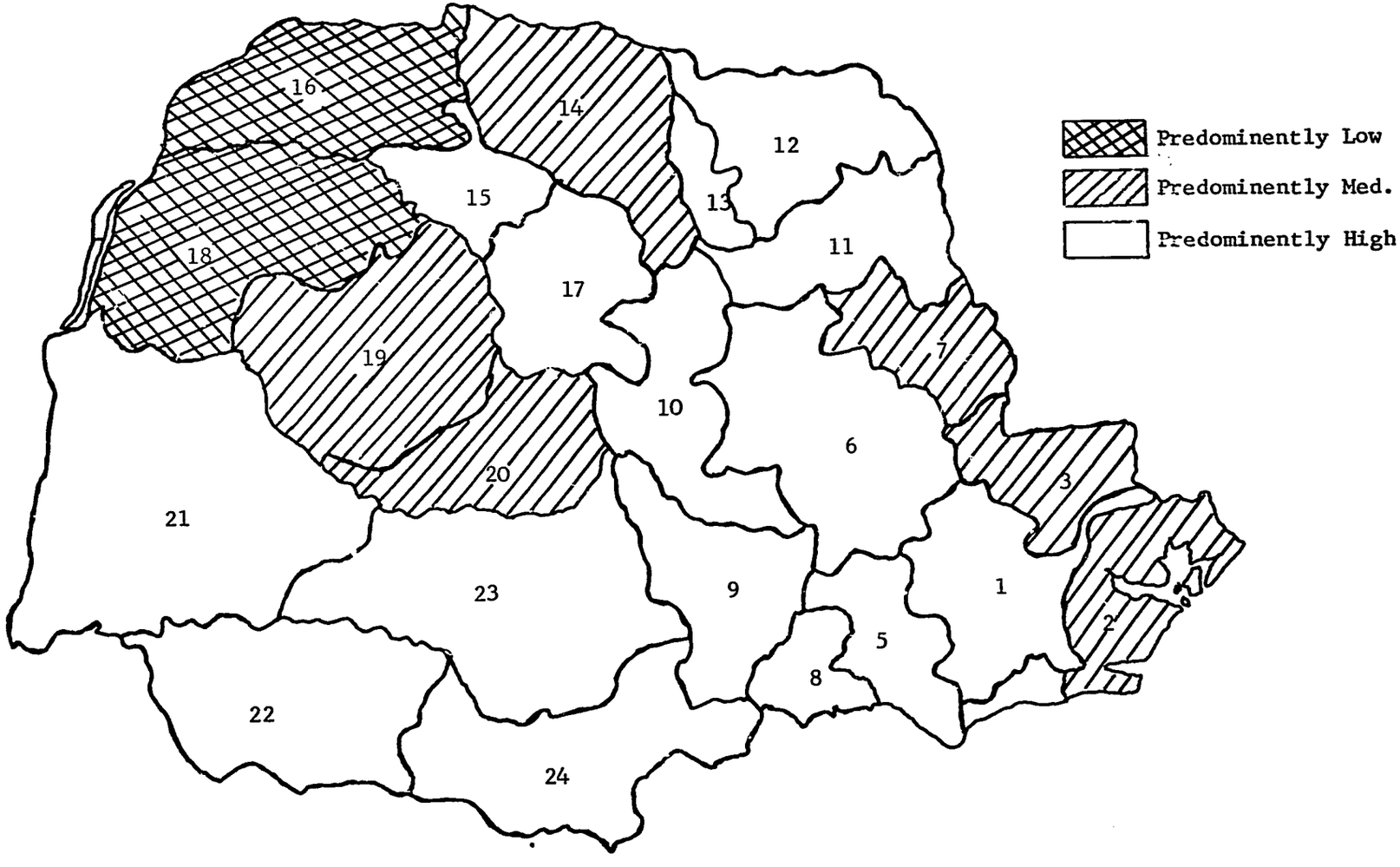


Table 9. Soil fertility analyses summaries - Nicaragua. Data summarized by Agr. Ramiro Montes V., Jefe Dept. Quimica, Centro Experimental Agropecuario, Ministry of Agriculture, Nicaragua, with the cooperation of Dr. James L. Walker, Regional Director, International Soil Fertility Evaluation and Improvement Program and AID.

Region and State	Per cent of samples in each of the following categories								
	Low P			Med. P			High P		
	Low K	Med. K	High K	Low K	Med. K	High K	Low K	Med. K	High K
Pacific States	5.9	20.4	29.3	0.7	4.8	11.1	1.0	6.4	20.7
Carnazo	11.3	22.3	46.1	0.3	3.1	7.4	0.3	1.8	7.4
Chinandega	7.8	21.2	25.7	0.7	11.3	11.7	1.5	9.1	11.1
Granada	4.8	27.1	29.9	0.8	5.8	13.1	1.5	3.8	13.3
León	4.7	19.9	21.7	1.1	4.6	10.9	0.8	13.2	23.1
Managua	5.3	22.0	36.3	0.3	2.1	13.2	0.7	2.3	17.8
Masaya	2.6	19.0	42.7	0.7	1.4	9.8	0.2	1.8	21.8
Rivas	6.9	6.9	2.8	1.4	5.0	5.2	1.6	15.0	55.2
Central States	15.0	28.3	6.3	1.7	9.7	5.0	2.0	13.7	18.2
Boaco	22.6	26.4	4.6	2.2	6.2	7.3	3.0	16.8	10.9
Chontales	37.9	28.3	6.0	1.6	6.6	2.4	2.4	2.2	6.2
Estelí	4.1	21.1	6.5	1.0	10.0	6.2	4.2	21.2	25.7
Jinotoga	10.6	37.6	6.7	3.2	13.2	4.7	0.5	9.6	13.9
Madriz	8.1	22.3	8.4	2.0	7.3	6.6	0.9	14.5	29.9
Matagalpa	11.4	28.8	7.2	7.2	0.4	12.0	4.6	1.5	13.2
Nueva Segovia	20.0	36.2	3.6	2.6	10.2	4.0	1.8	12.4	9.2
Atlantic States									
Rio San Juan	67.7	23.3	2.0	0.0	2.0	1.0	0.0	3.0	1.0
Zelaya	80.0	17.6	0.9	0.5	0.6	0.0	0.2	0.0	0.2

Table 10. Summary by agrarian zone of soil test results for P and K from farmer samples analyzed in Peru[1/].

Agrarian Zone	Number Samples	Samples Low in P		Samples high in P	
		Low K	High K	Low K	High K
		(No.)	(No.)	(No.)	(No.)
I.	273	18	86	43	126
II.	1,601	240	605	137	619
III.	1,024	179	382	123	340
IV.	2,315	190	729	188	208
V.	548	36	294	16	202
VI.	375	4	248	2	121
VII.	1,576	20	1,052	11	493
VIII.	192	104	46	11	31
IX.	146	46	37	33	30
X.	1,101	245	269	213	374
XI.	1,424	370	399	236	419
XII.	95	2	22	8	63
Total Peru	10,670				

1/ Does not include research samples and soil mapping and classification samples analyzed at La Molina, results of which are to be summarized by soil type.

Table 11. Soil fertility analyses summaries - Honduras. Data summarized by Ing. Agr. Vladimiro Castellanos, Jefe, Depto. Suelos, Direccion General de Agricultura y Ganaderia, Ministerio de Recursos Naturales, Honduras, with the cooperation of Dr. James L. Walker, Regional Director, International Soil Fertility Evaluation and Improvement Program, AID, and Dr. A. N. Plant, Potash Research Association.

Region and State	Per cent of samples in each of the following categories								
	Low P			Med. P			High P		
	Low K	Med. K	High K	Low K	Med. K	High K	Low K	Med. K	High K
Northern Caribbean	37.0	6.1	15.0	3.0	0.8	4.5	7.3	3.0	23.3
Santa Bárbara	52.8	5.6	22.2	0.9	- -	3.7	0.9	0.9	13.0
Yoro	25.7	4.0	16.2	8.1	- -	2.7	10.8	5.4	27.0
Olancho	38.0	7.4	16.3	2.1	1.2	5.4	5.2	2.3	22.1
Colón	56.4	5.1	7.7	5.1	- -	5.1	10.3	2.6	7.7
Atlántida	14.7	2.9	11.8	2.9	- -	5.9	32.4	5.9	23.5
Cortés	29.9	4.6	9.3	4.2	1.0	3.1	9.8	4.6	33.5
Central	25.1	11.2	40.6	0.8	0.4	3.0	1.3	1.0	16.6
Copán	53.8	2.6	7.7	2.6	- -	- -	7.7	5.1	20.5
Ocotepeque	13.8	20.7	34.5	- -	3.4	3.4	- -	- -	24.2
Lempira	- -	40.0	60.0	- -	- -	- -	- -	- -	- -
Intibucá	32.1	17.9	28.6	- -	- -	- -	7.1	- -	14.3
La Paz	43.1	14.6	36.7	1.6	- -	1.6	- -	- -	2.4
Comayagua	18.2	6.1	46.9	0.6	- -	3.3	- -	0.6	24.3
Francisco Morazán	20.6	11.1	44.3	0.6	0.3	3.9	1.5	1.5	16.2
Southern Pacific	12.5	4.5	19.0	0.7	0.4	4.4	3.3	2.4	52.8
Valle	17.1	4.3	7.9	0.7	0.7	3.6	1.4	1.4	62.9
Choluteca	9.7	3.7	15.2	0.5	0.3	4.1	3.8	2.6	60.1
El Paraíso	22.3	7.8	41.3	1.4	0.4	6.3	1.9	1.9	16.7

Table 12. Relationship of levels of P and K in soil samples to the incidence o soil acidity.

Region and State	Per cent of samples low P	K	Categories in pH range <6.0	>7.3
Country wide	54.9	17.1	14.2	4.4
Pacific States	55.4	7.6	3.5	5.5
Carnazo	79.8	11.9	5.7	0.9
Chinandega	54.7	10.1	1.9	3.0
Granada	61.7	7.0	6.7	4.0
León	46.4	6.5	0.3	5.6
Managua	63.6	6.2	4.1	10.0
Masaya	64.3	3.5	4.0	3.7
Rivas	16.6	9.9	3.6	2.2
Central States	49.7	18.8	16.4	3.8
Boaca	53.5	27.7	21.2	1.1
Chontales	72.1	41.7	40.2	4.4
Estelí	31.6	9.3	4.4	3.6
Jinotoga	54.9	14.3	21.0	1.7
Madriz	38.8	11.0	5.8	7.3
Metagalpa	47.5	13.6	8.7	3.4
Nueva Segovia	59.9	24.4	26.2	3.1
Atlantic States	97.7	78.9	82.2	0.4
Rio San Juan	92.9	67.7	49.5	3.0
Zelaya	98.5	80.7	88.0	0

Data summarized by Ing. Ramiro Montes V., Head of the Chemistry Department, Agricultural Research Center, Ministry of Agriculture and Livestock, Nicaragua, C. A.

Table 13. Nicaragua - Soil test summary by zones and states.*

ZONE	CROPS	STATE	NO. OF SAMPLES	DEFICIENCY CORRECTION OF P OR K NEEDED			
				LOW P LOW K	LOW P ADEQUATE K	ADEQUATE P LOW K	ADEQUATE P ADEQUATE K
PACIFIC (SOUTH)	CORN, RICE, PASTURES, SUGARCANE	RIVAS	450	21.8%	7.6%	14.6%	56.0%
	CORN, RICE, FRUITS	CARAZO	310	35.5%	53.2%	1.9%	9.4%
	COTTON, RICE, CORN	GRANADA	435	40.0%	38.2%	6.6%	15.2%
	CORN, COTTON, VEGETABLES	MASAYA	521	22.4%	52.8%	1.9%	22.9%
PACIFIC (NORTH)	COTTON, CORN, VEGETABLES	MANAGUA	1277	23.7%	53.7%	2.6%	20.0%
	COTTON, PASTURES	LEON	461	28.6%	27.1%	19.1%	25.2%
	COTTON, CORN, SESAME	CHINANDEGA	1123	24.0%	56.9%	5.7%	13.4%
TOTALS			4577	26.3%	45.6%	6.5%	21.6%
CENTRAL (SOUTH NORTHERN)	CORN, PASTURES	CHONTALES	559	74.8%	7.3%	7.3%	10.6%
	CORN, SORGHUM, VEGETABLES	BOACO	236	53.8%	14.8%	21.2%	10.2%
	CORN, BEANS, COFFEE	MATAGALPA	1302	53.5%	13.4%	16.1%	17.0%
	CORN, BEANS, SORGHUM	ESTELI	876	36.4%	11.9%	26.7%	25.0%
	CORN	JINOTEGA	334	63.1%	11.1%	10.5%	15.3%
	CORN, BEANS	MADRIZ	663	37.0%	17.1%	16.6%	29.3%
	CORN, BEANS, RICE	NUEVA SEGOVIA	846	67.0%	9.0%	13.6%	10.4%
TOTALS							
ATLANTIC (SOUTH NORTHERN)	PASTURES, RICE, CORN	RIO SAN JUAN	65	90.8%	6.1%	4.6%	1.5%
	FRUITS, RICE, CORN	ZELAYA	315	98.7%	1.0%	0.0%	0.3%
	??	COMARCA DE EL CABO	0	?	?	?	?
TOTALS							

* Results of soil analysis - February 1969 - 9,773 samples, by Ing. Ramiro Montes V., Head of Chemistry Department, Agricultural Research Center, and Dr. James L. Walker, Regional Director, International Soil Testing Project, "La Calera" - Ministry of Agriculture and Livestock, Nicaragua, C. A.

Table 14. SOIL FERTILITY ANALYSES SUMMARY, GUATEMALA

REGION AND STATE	SAMPLES	% PK DD	% PK DM	% PK DA	% PK MD	% PK MM	% PK MA	% PK AD	% PK AM	% PK AA
TOTAL	6497	14.5	31.0	19.8	1.4	3.0	0.8	3.8	21.7	4.0
CENTRAL REGION	1067	1.3	26.0	52.9	5.1	1.2	1.2	0.2	7.5	4.6
Guatemala	423	2.8	53.6	27.0		2.3			10.3	4.0
Chimaltenango	463		10.1	79.0	4.9		2.1	0.2	3.8	0.8
Sacatepéquez	138		4.3	56.5	22.5		0.7		8.0	8.0
El Progreso	43	4.6	18.6	9.3		7.0		2.3	16.3	41.9
WESTERN REGION	2811	13.9	35.4	16.6	0.7	4.3	0.8	7.0	18.7	2.6
Huehuetenango	381	37.5	35.2	7.1	0.5	1.6	1.3	2.1	11.1	3.7
Quezaltenango	981	5.6	20.6	24.5	0.9	5.2	1.3	17.3	20.4	4.3
Retalhuleu	374	13.6	50.5	7.0		6.7		0.5	21.1	0.5
San Marcos	394	15.2	24.1	11.2	1.0	4.3	0.8	4.0	37.3	2.0
Totonicapán	86	2.3	39.5	32.6		4.7		1.2	18.6	1.2
Sololá	156	14.1	69.9	5.7	1.9	4.5			3.2	0.6
Suchitepéquez	439	12.9	53.1	20.9	0.2	2.5	0.2		8.7	1.4
EASTERN REGION	463	17.7	40.6	10.8	0.6	1.7	1.7	1.5	19.7	5.6
Chiquimula	125	38.4	39.2		1.6	2.4		0.8	16.0	1.6
Jalapa	94	20.2	38.3	36.2			2.2	1.0	1.0	1.0
Jutiapa	111	8.1	50.5	7.2		0.9	2.7	0.9	20.7	9.0
Zacapa	133	4.5	35.3	6.0	0.8	3.0	2.3	3.0	35.3	9.8
CARIBBEAN REGION	635	54.8	20.3	5.0	2.5	1.9		5.8	7.6	2.1
Alta Verapaz	140	55.0	16.4	6.4	7.4	2.8		10.0	1.4	0.7
Baja Verapaz	62	6.4	47.0	18.0	3.2	3.2		3.2	14.0	5.0
Izabal	289	58.5	14.2	3.8	1.0	1.7		7.3	10.4	3.1
Petén	100	89.0	9.0	1.0	1.0					
Quiché	44	20.4	61.3			2.3			15.9	
PACIFIC REGION	1521	7.2	28.0	11.5		2.5	0.5	0.3	43.7	6.4
Santa Rosa	319	8.2	33.5	37.6		1.9	2.2	0.3	6.3	10.0
Escuintla	1202	6.9	26.5	4.6		2.7		0.2	53.7	5.4

Compiled by Ing. Agr. Jorge A. González S. and Jaime T. Wyld of the Department of Soils, Division of Research and Extension, Ministry of Agriculture, Guatemala, and Dr. James L. Walker, Regional Director, Soil Fertility Evaluation and Improvement Program, N.C.S.U/AID.

Table 15. Summary by province of soil test results for P and K from farmer samples analyzed at Ministry of Agriculture and Fertisa laboratories, Ecuador[1/].

Province	Number Samples	Number of Samples			
		Low - P		High - P	
		Low K	High K	Low K	High K
Sierra					
Carchi	467	145	196	27	99
Imbabura	387	144	183	9	51
Pichincha	1,297	517	406	62	309
Cotopaxi	252	93	92	13	54
Chimborazo	153	48	51	6	48
Azuay	68	30	20	5	13
Tunqurahua	110	49	61	8	52
Others	42	--	--	-	—
Coast					
Esmeraldas	173	31	48	8	86
Manabi	233	3	51	4	175
Los Rios	329	106	74	58	91
Guayas	1,372	515	239	160	458
El Oro	416	67	143	75	131
Oriente (Selva)					
as group	78	58	17	1	2
Total Ecuador	5,377	-	-	-	-

1/ Summary does not include 4,000 samples analyzed by the Universidad Central, Quito, and 1,000 sub-samples analyzed by Fertisa, which are under study for summary by soil classification.

Table 16. Summary by department of soil test results for P and K from farmer samples analyzed at Santa Cruz, Bolivia[1/].

Department in Bolivia	Number Samples	Samples low in P		Samples high in P	
		Low K	High K	Low K	High K
La Paz	124	25	20	22	57
Cochabamba	1,421	712	422	103	184
Potosi	594	119	280	31	164
Chuquisaca	449	101	201	19	128
Santa Cruz (Vallegrande)	23	5	8	4	6
Tarija	544	217	218	23	86
T o t a l	3,155				

1/ Does not include soil analysis from soil survey carried out by Mr. Cochrane, British Tropical Mission. Also does not include several hundred farmer samples from Santa Cruz area.

only a relatively few of the total farmers and crop producers of the Latin American countries so far have made use of the service. Use patterns tend to be somewhat spotty and may reflect the influence of a good agricultural leader, a successful farmer, a persuasive fertilizer company representative or the incidence of the culture of a particular crop. In summarizing the current collection of data, the frequent unequal and biased distribution of samples needs to be considered and proper evaluations made.

The unadjusted summaries, on the other hand, are likely to closely reflect the fertility status of the soil areas where fertilizers are currently used and the fertility needs for the production of particular crops. Table 17 shows some of the fertilizer use patterns among crops for Guatemala. Part of the difference among crops can be associated with the kinds of land areas used for the particular crops and part with the need of the crop for fertility or because of the conventional fertilizer use traditions of the cropping area. Cotton is grown largely in the coastal areas on the Pacific side of the country. Bananas are grown extensively on the Caribbean lowlands. Wheat culture is largely confined to the central highlands. Coffee is grown largely in the intermediate upland areas and potatoes in the highland valleys.

The planning of fertilizer production and distribution systems for present consumption patterns probably can be guided very well by the soil fertility data which is now available in many countries. However, when expansions in fertilizer use are contemplated, additional kinds of soil may be fertilized and then some adjustments in recommended fertilizer rates and ratios may be in order. To properly evaluate the fertility status of the agricultural soils of any unit area within a country, the data obtained from soil fertility analyses summaries should be scrutinized and if found nonrepresentative should be supplemented with information from systematic sampling studies. These sampling studies should fill in the gaps and omissions usually found in summary information.

Another feature of soil fertility analyses summaries is that large numbers of samples do not provide a degree of accuracy commensurate with

the labor involved in processing large numbers. There appears to be a tendency for soil samples to come to the laboratories from the same general areas season after season. In other words, use patterns tend to be repeated. Summaries for successive years appear quite similar. Some reasonable minimum number of observations is likely to provide a needed appraisal of soil fertility. Experience to date does not permit a definition of that minimum number. Each

Table 17. Average yields and areas planted of the principal crops of Guatemala in 1967 and 1968.

Crop	Area planted acres	% of area fertilized	Average yield	Soil samples analyzed No/1000 acres
Rice	33,500	20	16 CWT/A	27.0
Corn	1,720,000	45	9 CWT/A	2.4
Wheat	111,000	80	7 CWT/A	8.7
Beans	263,000	10	6 CWT/A	0.9
Potatoes	9,500	85	36 CWT/A	11.5
Cotton	221,000	75		2.0
Sesame	6,000	40	13 CWT/A	
Bananas	47,500	85	55 CWT/A	4.7
Cacao	6,000	50	3.5 CWT/A	
Coffee	442,000	85	5.5 CWT/A	6.8
Sugar cane	75,500	60	25 Tons/A	5.1
Rubber	5,000	5	9.5 CWT/A	
Tobacco	8,500	80	9.5 CWT/A	

Table 18. Guatemala - Soil test summary by crops.

	Total Samples	Phosphorous Only			Potash Only			Both Phosphorous and Potash			Phosphorous Deficient & Potash Adequate	Nitrogen	
		Deficient	Medium	Adequate	Deficient	Medium	Adequate	Deficient	Medium	Adequate		Deficient	Adequate
CROPS PROVIDING MAJOR SOURCE OF HUMAN NUTRITION IN GUATEMALA	2368 (57.5%)	1947 (82%)	127 (5.5%)	298 (12.5%)	123 (5%)	311 (13%)	1938 (82%)	116 (5%)	11 (0.5%)	241 (10%)	1153 (49%)	2366 (100%)	
Beans, dried	68	56(82.5%)	4	8	1(1.5%)	5	62	1	0	7	51(75%)	68	
Corn	1183	969(82%)	57	157	30(2.5%)	122	1031	30	6	110	870(73.5%)	1182	1
Fruit	318	230(72.5%)	26	66	11(3.5%)	22	289	9	0	66	195(61.5%)	318	
Pasture (meat, milk)	134	110(82%)	11	13	25(18.5%)	28	81	25	1	10	60(45%)	134	
Potato	31	23(74%)	3	5	0(0%)	3	28	0	0	3	22(71%)	30	
Rice	255	234(92%)	5	16	54(21%)	105	96	49	1	12	81(32%)	255	
Vegetables	107	84(78.5%)	7	16	0(0%)	8	99	0	1	16	77(72%)	107	
Wheat	272	241(88.5%)	14	17	2(1%)	18	252	2	2	17	223(82%)	271	1
CROPS PROVIDING MAJOR SOURCE OF EXTERNAL REVENUE FOR GUATEMALA	1182(29%)	960(81%)	71(6%)	151(13%)	111(9.5%)	274(23%)	797(67.5%)	102(8.5%)	26(2%)	101(8.5%)	655(55.5%)	1179(99.75%)	
Bananas	63	46(73%)	2	15	16(25.5%)	27	20	15	0	12	7(11%)	63	
Coffee	852	692(81%)	61	99	91(10.5%)	215	546	84	25	54	459(54%)	849	3
Cotton	123	90(73%)	4	29	1(1%)	12	110	1	1	29	78(63.5%)	123	
Essential Oils	36	36(100%)	0	0	0(0%)	4	32	0	0	0	32(89%)	36	
Sugar Cane	108	96(89%)	4	8	3(3%)	16	89	2	0	6	79(73%)	108	

Data from the records of the Department of Soils, General Directorate for Agricultural Research and Extension, National Soil Fertility and Analysis Program, Ministry of Agriculture. Compiled by Ing. Jorge A. Gonzalez, Head, National Soil Fertility Program, Soils Department, D.G.I.E.A., Ministry of Agriculture, and Dr. James L. Walker, Regional Director, International Soil Fertility Evaluation and Improvement Program, N.C.S.U.-AID.

laboratory should examine the variation patterns shown by their samples and determine the best methods of selecting samples to be included in summaries.

Some general fertility patterns are emerging as the summary data are assembled. These are reflected in the ranges of incidence among soil sample analyses of levels of phosphorus, potassium, and of the degrees of soil acidity as measured by pH and exchangeable aluminum. Cardinal features of the data from most areas are the ranges and variations in soil fertility existing within rather small local areas. An overall survey of phosphorus and potassium levels is shown in Table 20.

In the highland areas, the mountains and intermittent valleys, occur a wide spectrum of soil conditions. Diverse soil parent materials mixed and transported by erosion agents have resulted in heterogenous patterns of fertility and productive capacities. These variable fertility conditions are reflected in the results of soil analyses.

High pH in soils is generally found in the more arid regions, the Pacific coastal areas of much of Central and South America, the arid regions of Argentina, Paraguay, and Bolivia, and in the Northeast region of Brazil. Here also occurs saline soils and the soil problems associated with arid regions and a lack of water. Soil properties and landscape features which permit and/or influence the installation and operation of irrigation facilities as well as soil internal drainage properties assume a degree of importance in such soils along with fertility and other productivity factors.

Table 19. A comparison in fertility distribution of summaries made in June 1968 from Nicaragua with the combined summary made in February 1969.

Total No. of Samples	Percent of samples when:			
	P low K adequate	P adequate K low	P low K low	P adequate K adequate
4000	42.9	1.9	15.0	40.2
9773	40.6	2.0	12.0	45.4

Soil acidity has been found high in the high rainfall region east of the Andes in South America and in the Caribbean lowland soils of Central America. Relatively high levels of soil acidity are found in the soils of the coastal areas of eastern Brazil.

Table 20. Some general ranges in phosphorus and potassium fertility for broad geographic areas of Central and South America.

Region	Needing Phosphate %	Needing Potash %
Coastal area (east) Brazil	50-75	30-40
East slope of Andes and interior Brazil	75-100	50-75
Andean range (Sierra)	50-75	25-50
Pacific Coastal soils South America	30-60	0-30
Central America Caribbean Coast	75-100	40-60
Central America Altiplano range (mountains)	40-60	20-35
Central America Pacific Coast	40-60	0-30

Table 21. Fertility variations among samples analyzed by the Federal Soils Laboratory in Brazilia, CEPTAB-D.P.E.

Potassium and phosphorus analyses			
P low K low	P low K high	P high K low	P high K high
57.8%	29.7%	10.1%	2.4%

Acidity and needs for lime	
	Distribution within 1861 samples
pH range	No. of samples
3.5-4.5	381
4.6-5.0	549
5.1-5.5	516
5.6-6.9	424
7.0-7.8	10

r. Gonzalez (above) and Sr. Miranda (below) ponder the results of some tissue testing methods.

REPORT SUPPLEMENT

This supplement contains some semi-detailed reports of project activities in Colombia and Venezuela. These reports resulted from research consultation activities in those countries. They contained more detail than could be logically included in the general body of the Annual Report. However, they are included with the Report to expedite dissemination of the information to all interested parties and to assure the preservation of the reports in available and usable form. In general, these reports are self explanatory and need no preface to account for the origin or to amplify the contents of the reports.

SOIL FERTILITY EVALUATION PROGRAM IN COLOMBIA

Eugene J. Kamprath

As part of the ISTP-AID project, a trip was made to Colombia, South America, on March 7 to March 22, 1969 to work with the soil fertility evaluation program of the Instituto Colombiano Agropecuario. Meetings were held at Tibaitata and Palmira with personnel of ICA, the Rural Development Group-AID in Bogota, the Soils Section at the Instituto Geografico Augustin Codazzi in Bogota, the soils group at the Instituto Investigaciones Tecnologicas in Bogota, members of the University of Nebraska-AID party in Colombia, and members of the Rockefeller Foundation, the Ford Foundation and CIAT.

Meetings

1. Rural Development Group-AID. A meeting was held with Dr. James McDermott, Development Officer, and Mr. James Bleidner, Assistant Rural Development Officer. The activities of the International Soil Testing Project were discussed. The Rural Development group indicated their areas of interest in the current agricultural problems of Colombia. They are particularly interested in the fertilizer industry of Colombia and economic evaluation of fertilizer response data. Dr. McDermott arranged a meeting with the group of economists on a USDA/PASA working with the Oficina Planamiento Sector Agropecuaria Ministerio de Agricultura, who are especially interested in the fertilizer industry of Colombia.
2. Soils Section of ICA, Tibaitata. Discussions were held with Dr. Manzano., Dr. Leon, Gilberto Rodriguez, Rodrigo Lora, and Dr. Ken Frank of the University of Nebraska-AID on soil fertility problems and

current research. Micronutrient studies are being conducted in the greenhouse with three soils from the Llanos. Spinach was used as the test crop. No response was obtained with additions of zinc, copper, or manganese. Without the addition of boron there was hardly any growth. Growth was also reduced when magnesium was not added. Discussions were held as to the rates of boron and magnesium that should be used in field studies. Laboratory studies with mineral soils indicated that the addition of equivalent amounts of lime at 1.5 to 2 times the milliequivalents of exchangeable aluminum was sufficient to neutralize 80 to 90 per cent of the exchangeable aluminum.

3. Soils Section of ICA, Palmira. Meetings were held with Gildardo Marin, Jairo Gomez, Jose Tobon, and Dr. Alfredo Leon. Various aspects of the soil testing program in Colombia were discussed. Considerable time was devoted to reviewing and revising the fertilizer recommendation guide sheets. A bulletin on soil sampling is being prepared by Mr. Tobon and Marin. A discussion was held as to the material to be included and ways in which the material could be presented.

   Mr. Tobon is visiting the various regional offices of ICA. At these meetings he holds a discussion on the interpretation of soil test results and also demonstrates the proper method for taking soil samples. Suggestions were made as to techniques and materials to use at these meetings.

4. Meeting with the Subcommittee on Analytical Procedures of the Advisory Soil Testing Committee. A meeting was held with members of the Subcommittee, Dr. Arturo McCormick, Francisco Silva, Miss Melba Lopez, Mr. Galiano and Dr. Alfredo Leon. It was decided that a bulletin on analytical procedures for soil tests be prepared by the Subcommittee.

All laboratories making soil tests would be encouraged to follow the suggested methods.

5. Meeting with Economists on a USDA/PASA assigned to Oficina Planamiento, Sector Agropecuaria, Ministerio de Agricultura. A meeting was held with Wade Gregory, Larry Boone and Robin Henning, economists, who are working with the planning office of the Ministerio de Agricultura. They are interested in economic returns obtained with the use of fertilizer. They are also interested in making a study of the fertilizer industry in Colombia. A discussion was had on the use of soil test summaries for determining the ratios and grades of fertilizers needed and the relative need for a particular ratio and grade.

6. Seminar presented at Tibaitata. A seminar was presented to graduate students and faculty at Tibaitata. The topic discussed was, "The adsorption and availability of sulfates in soils."

7. Other Meetings. Discussions were held with Dr. U. J. Grant, Director of CIAT, Dr. James Spain of CIAT, Dr. James Plaxico of the Ford Foundation, and Dr. Robert Waugh of the Rockefeller Foundation.

Soil Fertility Evaluation Program

Present Status. The number of soil samples has increased each year since the laboratory started analyzing farmer samples (Table 1). A considerable effort is being made in follow-up program on soil tests. This educational program is being aimed at the agricultural extension agents. Meetings are being held at the various regional ICA offices. A bulletin on taking soil samples has been prepared. Bulletins will be prepared on the interpretation of soil tests and fertilizer application.

Table 1. Number of soil samples tested by the Soil Testing Laboratory at Palmira.

Year	Number of farmer samples
1965	843
1966	1983
1967	5190
1968	7314

A comprehensive report was prepared by Gildardo Marin for ICA outlining in detail the present operation and personnel of the Soil Testing Laboratory and projecting the needs for the future. This report is an excellent guide which can be used as the basis for future expansion of the Soil Testing Laboratory as the need arises.

Fertilizer Ratios Needed and Relative Amounts

The relative distribution of the various fertilizer ratios needed in four of the main agricultural areas of Colombia are shown in Table 2. Four ratios, 1-1-1, 1-4-4, 1-2-1, and 1-3-1 would take care of 88 per cent of the fertilizer needs of the Cauca Valle. In the Mountain region the ratios 1-1-1, 1-4-4, 1-2-1, and 1-3-1 would take care of 87 per cent of the needs. The ratios 1-1-1, 1-4-4, and 1-1-2 and 1-2-1 would provide 78 per cent of the needs for the Valle del Alto Magdalena. In the Sabana de Bogota 79 per cent of the needs would be met with the ratios 1-1-1, 1-4-4, 1-2-1, and 1-3-1. As the soil testing program expands, information on the relative distribution of fertilizer ratios needed to provide the recommended plant nutrients will be of great value in the manufacture of mixed fertilizers for the various agricultural regions.

Table 2. The percentage distribution of fertilizer ratios which are needed in Colombia based on soil test summaries.

Soil Test Level P_2O_5	K_2O	Fertilizer Ratio	Grades Available	Percent of Samples: Valle del Alto Magdalene	Cauca Valle	Mountains	Sabana de Bogota
H	H	1-1-1	14-14-14	22	33	10	30
L	L	1-4-4	5-20-20	23	10	30	12
M	M	1-2-2	10-20-20	4	6	4	3
L	M	1-2-1	12-24-12	5	13	22	9
L	H	1-3-1 or 1-3-0	10-30-10	6	16	18	13
M	L	1-1-2	- - -	16	1	5	6
M	H	1-2-1	12-24-12	11	16	7	15
H	L	1-1-4	- - -	7	1	4	5
H	M	1-1-2	- - -	6	4	4	7
				100	100	100	100

Advisory Soil Testing Committee

Through the efforts of Mr. Gildardo Marin, an Advisory Soil Testing Committee was formed. Each year this committee reviews the program of the Soil Testing Laboratory and makes suggestions as to ways in which the program can be improved and expanded. A number of subcommittees have been established to look at specific areas such as methods of analyses. The Committee would recommend to the Government the most appropriate fertilizer grades for the various regions as determined by soil test summaries.

At a meeting in February 1969, the Committee made the following suggestions:

1. Consideration be given to establishment of a pilot lab at Tibaitata.
2. Preparation of minimum requirements for operation of a soil testing laboratory.
3. Prepare additional publications on soil analysis and soils in general.
4. To organize short courses on soil testing and soil fertility for people giving technical assistance.
5. To expand soil correlation studies on soil tests for potassium and response to potassium fertilization.
6. To increase research on need for liming as determined by exchangeable aluminum measurements.
7. To print a handbook on use of fertilizer.
8. To increase research on the economic response of potatoes to fertilizers.

Table 3. Advisory Soil Testing Committee.

Area Represented	Representative	Organization
Fertilizer Industry	Regulo Perdomo	Abocal
Soil Laboratories	Francisco Silva Mojica	Instituto Geografico "Augustin Codazzi"
Fomento Agricola	Josue Lopez J.	Rice Federation
Sociedad de Agricultores	Luis Rodriguez C.	Sociedad de Agricultores de Colombia
Reforma Agraria	Ernesto Velez Koppel	Incora
Ministerio de Agricultura	Jose Vicente Vergara	Ministerio de Agricultura
Desarrollo Tecnologico	Arturo McCormick	Instituto de Investigaciones Tecnologicas
Instituto Colombiano Agropecuario	Alfredo Leon S.	ICA - Palmira
Instituto Colombiano Agropecuario	Gildardo Marin M.	ICA - Palmira

PROGRESS REPORT ON THE NATIONAL SOIL FERTILITY EVALUATION AND IMPROVEMENT PROGRAM IN VENEZUELA

C. B. McCants
March, 1969

During the period February 22-March 8, 1969, discussions were held in Venezuela with people involved directly or indirectly in the National Soil Fertility Evaluation and Improvement Program for Venezuela. This program was initiated in 1966 with the assistance of the International Soil Testing Project. Among the people visited were Dr. George Casas, Director of Investigations, MAC; Dr. Luis Medina MAC; Mrs. Pola Ortiz, MAC; Mr. Rafael Gonzalez, Soil Section MAC-CIA; Dr. Juan Comerma, Soil Section, MAC-CIA; Mr. Angel Chirinos, Soil Section, MAC-CIA; Dr. Carlostadio Sanchez, University of Oriente; Mr. Atilio Castillo, Manager of Fertilizer Operations, Instituto Venezolana Petroquimica; and Mr. Francisco Codecido, Soils Extension Agent.

The Program is moving forward at a slow but steady pace. Significant developments are unfolding which indicate that the ground work laid during the early years of the Program is beginning to yield measurable and beneficial results. Notable among these developments are: (1) initiation of a pilot soil fertility evaluation and improvement program in the State of Yaracuy, (2) appointment of a leader for the program in Yaracuy, (3) close-working relationships among several organizations with agricultural interests and activities in Yaracuy, (4) construction of a laboratory for analysis of soil samples for fertility evaluation, and (5) official recognition of the program and establishment of the organization for implementation (copy appended).

In July 1968, the State of Yaracuy was selected as the site for the pilot project on the use of soil testing as a guide to efficient use of fertilizers. This area was selected because of the availability of recent soil survey information, extensive data on correlation of soil test values with crop response to fertilizer in this state, and intensive agricultural development programs in the area. Mr. Francisco Codecido, Soils Extension Specialist, was appointed to coordinate the Program. He is commended highly for the leadership he has given to the Program and the progress that has been made. Three meetings have been held for organization and for training of the active participants in the Program. Included at these meetings were formal presentations on obtaining representative soil samples, method of analysis, and interpretation of the results.

Approximately 375 soil samples have been obtained from the 1600-2000 hectares of land involved in the project and they will be analyzed in the laboratory at Maracay. Analyses to be performed and the corresponding method are: P (Olsen); K (Olsen); Ca (sodium acetate); pH (1:2.5); organic matter (Wakely-Black); soluble salts (1:5 extract); and texture (feel). In the analytical procedures one control sample will be included with each 10 field samples. Results of the analysis are to be sent to Mr. Codecido and to the local extension agent. They will make the fertility recommendations using a guide sheet prepared jointly by research, extension, and IVP personnel. Plans have also been made to conduct a number of simple on-the-farm tests to demonstrate response of corn to rates of the major nutrients and to obtain additional data for correlation studies. The crop to be grown in the pilot project is corn.

New facilities are being constructed at Maracay for exclusive use in analyzing soils for fertilizer recommendations. These facilities include a room for soil preparation and storage, laboratory for analysis, and an office.

The building is located near to the laboratory and offices of the persons conducting research on soil fertility evaluation. It is the present plan that the new laboratory will be the primary source within the Ministry of Agriculture for the analysis of soil samples for fertilizer recommendations for several years.

Additional subprofessional help has been provided for the soil fertility research program. This assistance will be used to increase the number of field and laboratory experiments conducted to obtain data for correlation purposes.

Mr. Chirinos, who is in charge of the analytical laboratory, stated that the information and experiences obtained at the seminars sponsored by the Internationa Soil Testing Project at North Carolina State University in the summer of 1968 have been quite valuable to him in the laboratory. The major obstacle in implementing the ideas have been in getting equipment repaired. For example, he noted that a part on the stirrer provided by ISTP had broken and that he has been unable to find anyone interested in repairing it. Mr. Chirinos' opinion is that this is going to be an increasing problem. He believes that it maybe more effective to arrange for a technician to construct the equipment in Venezuela with locally available parts but using the basic designs developed by ISTP.

Dr. Casas and others in the central administration of the Ministry of Agriculture expect that the new political administration will give full support to the current soil fertility programs and add additional strength to them. They believe that the recognition which the Program has achieved already plus the anticipated benefits developed from the Yaracuy project will stimulate further interest and support.

RECOMMENDATIONS

1. Dr. Arvel Hunter can be of considerable assistance to Mr. Chirinos in the organization of the new laboratory facilities so that maximum efficiency in soil analysis can be obtained. It is recommended that arrangements be made for Dr. Hunter to go to Venezuela as soon as it is considered desirable by Mr. Chirinos and to work with Mr. Chirinos on this matter.

2. All indicators suggest that the Yaracuy project should prove to be quite successful. Considerable publicity should be given to the project and arrangements made for administrative officials in the Ministry of Agriculture to visit the area and to observe the project.

3. It is appropriate to begin the plans for another project similar to the one in progress. There are many excellent locations where this can be done and where it would make a significant contribution to the agricultural programs of the country. Action should be taken immediately to initiate soil fertility evaluation and improvement projects in these areas.

4. The correlation data available provide acceptable guides for the interpretation of the soil analysis but considerable improvement in these guidelines is desirable. Additional data from greenhouse, laboratory, and field experiments are needed and it is suggested that these studies be continued and expanded. Special attention needs to be given to potassium. Soils tested so far indicate the reserve of soil potassium is quite high. It is not known how long this will last or the influence of high calcium levels in these soils on the long-term availability of potassium.

5. The contribution of the ISTP to the National Soil Fertility Evaluation and Improvement Program in Venezuela has been significant. This contribution has been primarily in providing guidelines for local action and technical information on procedures. It is recommended that this type of

support be continued and at the same general level as in the past. With the present local support and interest, the principal factor needed to enable the Venezuelan program to reach its desired level is -- time. With the demonstrated interest of all segments of the agricultural industry in the Program, with the continued support on a consultation basis by ISTP, and with adequate time, five years or more, fertilizer recommendations based on soil analysis will be a significant contributory element in the crop production industry of Venezuela.

APPENDIX A

Republic of Venezuela. Ministry of Agriculture and Breeding. Directorate of Investigation. N° 009 Caracas, January 17, 1969. 158° and 110°.

By disposition of the President of the Republic and in accordance with the provisions specified in Article 26, 2nd Ordinal of the Organic Statute of the Ministries:

Inasmuch as the rational utilization of fertilizers constitute one of the effective elements for the increment of productivity of the agricultural crops and for soil conservation in the country;

Inasmuch as it is important for the development of the agricultural sector to increment the use of those inputs in the regions destined for agricultural production;

Inasmuch as it is necessary to coordinate programs related with the investigation, experimentation, extension, and development of the commercial activities regarding the fertility problems, soil analysis, and effective use of fertilizers in the country:

RESOLVE UPON:

Article 1°. - An Advisory Committee of the National Program of Soil Fertility and Fertilizers is created herein, and it is subject to the dispositions of this Resolution.

Article 2°. - Said Committee will be integrated by the persons named below:

a) Director of Investigations of the Ministry of Agriculture and Breeding.

b) Director of Extension of the Ministry of Agriculture and Breeding.

c) Director of Hydraulic Works of the Ministry of Public Works.

d) Sales Manager of the Venezuelan Institute of Petroquimica.

e) Dean of the Agronomy Faculty of the Venezuelan Central University.

f) Dean of the Agronomy Faculty of the University of Zulia.

g) Director of the Agronomy School of the University of the Centro-Occidental Region.

h) Director of the Agronomy School of the University of Oriente.

i) Advisor to the Directorate of Investigation of the Ministry of Agriculture and Breeding, who will also act as Secretary.

Article 3°. - The Advisory Committee of the National Program of Soil Fertility and Fertilizers, will have the following responsibilities:

a) Set the action policy for the development of the National Program of Soil Fertility and Fertilizers.

b) Become acquainted and consider the reports and programs prepared in a cooperative manner among the International Advisor of said Program and the Venezuelan specialists who participate in it, and make the necessary suggestions so that the Program may develop in a satisfactory form.

Article 4°. - The Director of Investigation shall be the Coordinator of the Advisory Committee and his attributions are herein specified as follows:

a) To convoke a meeting and preside the Committee's meetings.

b) Sign jointly with the Secretary all correspondence emanating from the Committee.

c) Coordinate the activities of the Committee and make the necessary arrangements for the good operation of the program with the Organisms which participate in it.

d) Any other attribution which might be designated by the Advisory Committee

In the absence of the Coordinator, functions will be executed by the member of the Committee that he will so assign.

Article 5°. - The Secretary of the Committee will have the following responsibilities:

a) Sign jointly with the Coordinator all correspondence emanating from the Committee.

b) Keep records and files of the minutes taken during each of the meetings of the Committee.

d) Any other responsibility that the Coordinator of the Committee wishes to designate.

Article 6°. - The Committee will meet quarterly and will be convoked by the Coordinator.

Article 7°. - The International Advisor for the National Program for Soil Fertility and Fertilizer might be present and shall have the right to speak but not to vote.

Article 8°. - The Committee will inform, at least once a year, of its activities and operations to the Ministry of Agriculture and Breeding.

Communicate and publish,
By the National Executive,

Alejandro M. Osorio
Minister of Agriculture and Breeding

A PROGRESS REPORT ON THE INTERNATIONAL SOIL FERTILITY EVALUATION AND IMPROVEMENT PROGRAM IN VENEZUELA

C. B. McCants
December 1969

The period December 2-18, inclusive, was spent in Venezuela to review the status of and make recommendations pertaining to The Soil Fertility Evaluation and Improvement Program in that country, hereafter referred to as the "National Program". This program was initiated in 1966 in cooperation with The International Soil Fertility Evaluation and Improvement Program, hereafter referred to as the"International Program". Semi-annual trips have been made to Venezuela since the program started to review its progress and to make appropriate recommendations. During the recent trip, visits were made to and discussions held with: University of Zulia, staff of the Department of Soils; Ministry of Agriculture (Caracas), Dr. Francisco Morillo and Dr. Luis Medina; Ministry of Agriculture (Maracay), staff of the Section of Soils.

In the State of Zulia, of which Maracaibo is the capital, the national government has initiated or is in the process of initiating several projects in the program of the National Agrarian Institute. In these projects a farm family is assigned an area, generally about 10 hectares, is provided housing in the project village, and receives general supervision on land and crop management from a project supervisor. Visits were made to several of these areas that are in either the active or the advanced planning phase. The indications are that the fertilizer practices employed are adapted

from general recommendations in use throughout the country with little or no consideration given to the unique properties of soils in the individual projects. General observations suggest that there is a wide variability in the residual fertility level among the soils and thus a justifiable need to tailor fertilization practices to the specific sites. It is quite probable that under the present system neither the analysis nor the rates of fertilizer applied are the most economical for the individual locations.

The personnel in the Department of Soils at the University of Zulia are interested in initiating research which will provide a scientific basis for fertilization and other soil management practices in the Maracaibo area, including the Agrarian Institute projects. They have adequate professional training to perform this type of research--the principle limitation is inadequate facilities for research in soil fertility, limited funds, and lack of time due to the extensive responsibilities for classroom teaching. An active soil fertility research program in this area, which will encompass the principles of soil testing, is needed and is considered essential to an orderly economic growth. The Department of Soils at the University of Zulia is capable of contributing to the solution of this problem and concerted efforts should be made to provide the resources which will enable them to begin an active soil fertility research program in the near future.

In discussions with Dr. Morillo and Dr. Medina, the effects of the impending revision in the objectives and activities of the International Program on its participation in the National Program were reviewed. The substance of the presentation was the same as that included in a letter of November 21, 1969 from Dr. J. W. Fitts, Director of the International Program to Dr. Morillo. In this correspondence it was stated that publications, analytical methods, and related information would continue to be available to Venezuela but that

no funds could be provided for travel by project personnel to that country. Dr. Morillo indicated that he understood the situation which made this decision necessary and expressed sincere appreciation for the interest and contribution of the International Program to the National Program. He was optimistic that funds will be obtained by the Venezuelan Government to support continued personnel assistance by the International Program.

A meeting of the Advisory Committee for the National Program was held in the offices of the Ministry of Agriculture in Caracas. The discussions indicated some differences of opinion among the groups represented on the specific roles of the various organizations involved in the National Program. Members of the Committee expressed confidence in the potential contributions that the Program can make to Venezuelan agriculture and to the economy in general. It does not appear that this Committee has functioned as effectively as was anticipated at the time it was conceived--namely, to provide general program direction, to coordinate activities, and to solicit support at the highest administrative levels of public and private agencies. Deficiencies which have arisen in the activities of the Committee occurred as a result of pressures from the many other duties of its members and not from the lack of their enthusiasm for the Program.

The Section of Soils, Center of Investigations, Ministry of Agriculture at Maracay continues to provide the major leadership and the most active support for the National Program. The principle areas of current activities that are related to the Program are: (1) operation of a modern laboratory for soil analyses, (2) experimentation (field and greenhouse) to provide data for the interpretation of soil analysis, (3) assist in the preparation of guide sheets for making fertilizer recommendations based on soil analysis, (4) conduct training sessions for extension personnel in the fundamentals of

soil fertility evaluation and in interpretation of soil analysis. A new laboratory has recently been completed and many of the items of equipment used and general procedures employed were developed and have been promoted by the International Program. This laboratory is under the direction of Mr. Angel Chirinos, a capable and dedicated chemist. (He was a participant in the Seminar conducted at North Carolina State University by the International Program in the summer of 1968). The laboratory analyzed over 6500 samples in 1969 for nutritional and other characterization studies whereas approximately 2500 samples were analyzed in 1968. The capacity of the laboratory for analysis is several times its current output and it is anticipated that the number of samples analyzed in 1970 will increase substantially above that in other years.

The Extension Division of the Ministry of Agriculture has assumed an increasing role in the National Program. Under the able and dedicated leadership of Mr. Francisco Codecido, Soils Extension Specialist, a pilot soil testing-fertilization program was initiated in 1969 in certain of the National Agrarian Institute projects in the State of Yaracuy. Other organizations that cooperated in the program were: Banco Agricola y Pecuario, National Agrarian Institute, and Venezuelan Petrochemical Institute, which operates the national fertilizer industry. There were 21 extension agents associated with the project. A total of 335 soil samples were obtained from fields to be planted in corn and were analyzed in the laboratory in Maracay. Recommendations for fertilization were made by personnel in the Extension Division using the soil analyses and the guide sheets which were prepared in cooperation with the research personnel in the Section of Soils. A number of on-farm tests were established in the area involving variations in rate of fertilization. Throughout the area, rainfall was abnormally low and the yield of corn averaged only about 1800 kg/ha. Nevertheless,

Mr. Codecido and his associates consider that the project served several useful purposes--notable among them was the experience provided the extension personnel and the introduction of the concept of soil testing to farmers, bankers, and other people associated with agriculture.

Plans are being developed to continue the project in Yaracuy, in which corn will be grown, and to initiate new projects with other crops in other areas of the country. The administrative personnel in the National Agrarian Institute are quite interested in utilizing the principles and opportunities provided by soil testing in the management of the programs which it operates.

The present educational efforts on the use of soil testing as a guide to usage of fertilizer is directed almost exclusively to small farmers and apparently very limited efforts are either in progress or planned to point out its value and encourage its use by the larger and more productive operators. This course of action is dictated partly by the extreme shortage of extension personnel qualified to work in this area and partly to the policy of the national government to concentrate extention efforts on the smaller farmers. It is doubtful, however, if the National Program will have the desired total economic effect nor will it receive the necessary general public support until it becomes more involved with and demonstrates its potential contribution to the economy of crop production by the larger farmers.

Following are the major contributions that the International Soil Fertility Evaluation and Improvement Project has made to the National Program in Venezuela.

1. Encouraged and assisted in the establishment and organization of the National Program.
2. Focused attention on the importance of soil fertility and the correct use of fertilizers in the economical production of crops.

3. Brought together for the purpose of discussion and planning such public and private agencies as the research and extension divisions in the Ministry of Agriculture, the fertilizer industry, the Universities, and commodity producers' organizations.
4. Oriented a significant portion of the soil fertility research programs t· ·d studies on relationships of soil fertility properties to plant response to fertilizers.
5. Aided in establishing a modern laboratory for performing soil analysis to provide a guide for fertilizer recommendations.
6. Provided specialized training for research personnel in the principles and practices of soil fertility evaluation.

The following recommendations are suggested to enable the National Program to more effectively accomplish its objectives:

1. Continue the correlation studies on the relationships between soil nutrient content and plant response to fertilizers.
2. Prepare and publish all data that relate to the interpretation of soil analysis for fertilizer recommendations.
3. Periodically review and when appropriate, revise the guide sheet for making fertilizer recommendations based on soil analysis.
4. Increase the technical training program in soil fertility for personnel in the Extension Division.
5. Increase the educational program and cooperative work on the use of soil testing with the larger farmers and with the various crop producers' organizations.

PUBLICATIONS

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1. 1965 - English
2. 1966 - English
3. 1967 - English
4. 1968 - English

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1. A Rapid Method for Correlation of Soil Test Analyses with Plant Response Data. Cate, Robert B., Jr., and Nelson, Larry A. Tech. Bul. No. 1 of the International Soil Testing Series.

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2. Evaluation of Soil Fertility in Latin America: Soil Testing- Plant Analyses 1965. Fitts, J. W., Cate, R. B., Jr., Hunter, A. H., Walker, J. L., and Waugh, D. L. Tech. Bul. No. 2 of the International Soil Testing Series.

   December 1965 - English
   December 1965 - Spanish
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3. Soil Test Interpretation Studies: Laboratory and Potted Plant. Waugh, D. L., and Fitts, J. W. Tech. Bul. No. 3 of the International Soil Testing Series.

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Preliminary Report Series

1. Economic Returns from Fertilizer Use - Based on Soil Test Information. Cate, Robert B., and Vettori, Leandro. Preliminary Report No. 1 of the International Soil Testing Series.

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

December 1968 - English
December 1968 - Spanish

3. Minimization of Unit Costs as a Basis for Making Fertilizer Recommendations. Cate, Robert B., Jr. Preliminary Report No. 3 of the International Soil Fertility Evaluation and Improvement Series.

August 1969 - English
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Other Related Publications

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

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2. La Fertilización del Trigo y su Relación con el Análisis de Suelos. Manzano, A., Carrera, W., and Waugh, D. Ministerio de Agricultura, Programa Nacional de Fertilización y Conservación de Suelos. Bolivia. Special Bulletin No. 1.

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