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FINAL REPORT

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NORTH CAROLINA STATE UNIVERSITY

AT RALEIGH

FINAL REPORT - PROJECT AID/csd-287

JUNE 30, 1970

On June 25,1963, North Carolina State University entered into a contractual agreement with the Agency for International Development of the United States Government to undertake a program to assess the fertilizer requirements of countries in Latin America and possibly part of West Africa. The objectives of the program as states in the contract were as follows:

A. To document the fertilizer and soil fertility requirements for increased crop production in the countries of Latin America and West Africa.

B. To help cooperating governments and agencies develop and maintain improved soil-testing services and fertilizer trial and demonstration programs.

C. To promote in each region the standardization of methods of soil samples, analysis and the interpretation of results.

D. To assist and encourage these countries to provide the necessary fertilizer (NPK) lime and soil amendments (minor elements) for increased crop production.

E. The research needs to attain these objectives are as follows:

1. Identify the nitrogen, phosphorus, potash, minor nutrient, acidity and salinity status of the arable soils of each country and present the data and their interpretations in comprehensive reports, including maps.

2. Relate all data on nutrient status and requirements of soil

to existing soil, climatic and ecological surveys.

3. To relate all data and information from (1) and (2) above to result from field experiments designed to measure the response of crops to fertilizers and management.

---- project was divided into two parts; the first part involved a survey of soil sampling procedures, methods of analysis and interpretation and recommendations made from the analyses. It was hoped that summaries of this information could be used in conjunction with soil maps showing major soil associations and types to serve as indicators of the locations where various fertilizer elements would be most needed.

The results of the survey as reported in Technical Bulletin No. 2 indicated that very little fertilizer was being used in Latin America in 1964 and very few soil samples were being tested. Therefore, it was impossible to document the fertilizer and soil fertility requirements of Latin America by this approach. A survey made in five countries of West Africa also indicated that there was little or no information available and essentially no soil testing was being done for farmers. In light of these results, a decision was made to discontinue work with West Africa and to concentrate initially on objectives B, C and D in Latin America.

The first step undertaken in the new approach was to establish competent soil testing laboratories in fourteen cooperating Latin American countries. This involved the design of relatively simple and inexpensive multiple unit apparatus and in assisting at least one laboratory in each of the fourteen countries to develop a capacity for testing more than 100

samples per day. In some countries, more than one laboratory was established, and in Brazil they constructed their own multiple unit apparatus to equip 21 laboratories. The laboratory phase of the project included training operators to perform the analyses, the use of control samples to assure accuracy, and the training of laboratory directors in the interpretation of the analytic results. The impact of this program of the soil testing programs in Latin America is indicated in the following data. The samples tested for farmers in 1965 in the fourteen cooperating countries totaled only 32,662, but this total increased to 223,641 by 1969. Only two laboratories tested more than 2,000 samples in the year 1965, but by 1969, 25 laboratories were testing over 2,000 samples per year and two of the laboratories tested more than 25,000 samples in that year.

One of the greatest weaknesses in soil testing around the world is the scarcity of correlation data for predicting plant response to fertilizer application from soil test information. There was little reason to expect that the correlations between soil test and plant response that had been developed in the United States would hold for Latin America. The lack of fertilizer response data in Latin America meant that it was necessary to obtain data quickly for this region and to devise simple and rapid techniques for interpreting the data. Therefore, new laboratory and greenhouse techniques were designed, tested and introduced by the project into laboratories and collaborative field studies were instigated in the cooperating countries. The countries that have been particularly active in providing correlation data include Brazil, Paraguay, Bolivia, Peru, Ecuador, Venezuela,

Panama, El Salvador and Guatemala. Much of the correlation data obtained from these laboratories has been published in the annual reports of 1967, 1968 and 1969 and in the special bulletin series which was initiated to publish data within countries.

By 1967, some of the cooperating countries were beginning to get a sufficient number of soil samples analyzed within certain regions to start summarizing the results as anticipated in objectives A and E of the initial project. The question immediately arose, however, as to how these data could best be analyzed and summarized for the respective countries. The initial summaries pointed up two important characteristics. First, there are wide variations in the fertility of the samples from the cultivated soils of almost every region. Thus, a general recommendation usually fits less than 25% of the fields. Secondly, past management usually has had such a large effect on the level of nutrients in the soil or upon soil properties such as acidity that conditions which might have existed in the virgin soil have been largely masked. This means that no reliable relation could be established between major soil types and the soil fertility analyses made on samples taken from the plow zone of cultivated fields.

Maps of soil test data have been prepared to show the percentage of soil samples within a political division that fall below the critical level of the nutrient in question. This type of map has been prepared for Peru, Panama and Northeast Brazil and has been included in the annual reports. Maps have also been prepared for Guatemala, Salvador, Honduras and

Nicaragua showing the percentage of soil samples that were l , medium, or high in phosphorus and potassium in each of the major regions of the country. Two-way summary tables showing the percentage of samples that are low, medium and high for phosphorus and potassium have also been prepared for Guatemala, El Salvador, Honduras and Nicaragua. Reports including these summaries have been prepared for local distribution and copies were submitted to the USAID Missions and to AID/Washington.

A new graphical procedure was developed for separating soils into two basic categories; namely, those which responded to a given fertilizer element and those which were non-responsive. The recommendations for fertilizer application for soils in the responsive category are based on the nutrient requirements to achieve a given magnitude of crop production. These constants are known reasonably well for most crops. The procedure is extremely simple to use by soils laboratories and it is highly prized by practitioners in Latin America and in other parts of the world.

The success of this project to date is indicated by the great interest within cooperating countries and by the impact that it has had upon the soil fertility evaluation programs in Latin America. The use of fertilizer has increased markedly in almost all of the cooperating countries as farmers learn which nutrients are needed and which will give economic returns. The countries that have cooperated in the program have invested several times as much money and staff time in these activities as that furnished by AID through this contract.

In the course of the activities during the past seven years, many

basic questions have been raised with respect to soil properties, analytical procedures and economic analyses that will require more intensive research effort. Therefore, these activities will continue in the future under two closely coordinated projects, one of which will continue the technical assistance aspects of the present program and the second will undertake a more concerted effort in resolving the basic research questions. Both of these projects will continue to use the data coming from cooperating laboratories and they will reinforce each other in the development of more efficient systems of fertilizer use in the years ahead.

In the International Soil Testing (and soil fertility evaluation) series, five technical bulletins were published in the three languages English, Spanish and Portuguese. These include:

Tech. Bul. No. 1	Robert B. Cate, Jr. and Larry A. Nelson. A Rapid Method for Correlation of Soil Test Analyses with Plant Response Data. July 1965.
Tech. Bul. No. 2	J.W. Fitts, R.B. Cate, Jr. A.H. Hunter, J.L. Walker and D.L. Waugh. Evaluation of Soil Fertility in Latin America: Soil Testing-Plant Analyses 1965. Dec. 1965.
Tech. Bul. No. 3	D.L. Waugh and J.W. Fitts. Soil Test Interpretation Studies: Laboratory and Potted Plant. Dec. 1966.
Tech. Bul. No. 4	E. J. Kamprath. Soil Acidity and Response to Liming Oct. 1967.
Tech. Bul. No. 5	A. H. Hunter and J.W. Fitts. Soil Test Interpretation Studies: Field Trials. Nov. 1969.

A special series was established to publish local data which would be of interest to other areas as well as to the local people. One bul-

letin was published in this series:

Special Bul. No. 1	A. Manzano, W. Carrera y D.L. Waugh. La Fertilización del Trigo y su Relación con el Analisis de Suelos. 1969.

The Special Bulletin was published only in Spanish.

Ocassionally it is desirable to release information in order to introduce new concepts and techniques before sufficient data is available to warrant publication of a technical bulletin. A preliminary report permits dissemination of a concept which usually results in discussion and a broader testing before the final report is prepared. These preliminary reports have been prepared in English, Spanish and Portuguese. These include:

Preliminary Report No. 1	Robert B. Cate, Jr. and Leandro Vettori. Economic Returns from Fertilizer Use - Based on Soil Test Information. May 1968.
Preliminary Report No. 2	Donovan L. Waugh and Robert B. Cate, Jr. Systematic Forms for Manual or Mechanized Data Collection Processing and Reporting for Use in Soil Fertility Evaluation and Improvement Programs. Dec. 1968.
Preliminary Report No. 3	Robert B. Cate, Jr. Minimization of Unit Costs as a Basis for Making Fertilizer Recommendations. Aug. 1969

Well illustrated Annual Reports were published for 1965, 1966, 1967, 1968 and 1969. The Annual Reports which were published only in English and with a limited distribution (500 copies) present a fairly complete summary of activities of the project for these years.