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REPORT OF NORTH CAROLINA STATE UNIVERSITY

FOR THE PERIOD

JULY 1, 1973 TO JUNE 30, 1974

A. TITLE: A Grant to Strengthen the Capabilities of North Carolina State University in Special Problems of Tropical Soils (Grant AID/csd 2835)

B. GRANTEE: North Carolina State University

C. DIRECTOR: Dr. P. A. Sanchez

D. STATISTICAL SUMMARY:

1. Period of Grant: November 2, 1970 to November 2, 1975

2. Amount of Grant: \$500,000.00

3. Expenditures:

3.1 For report period: \$68,045.00

3.2 Accumulated: \$169,585.00

3.3 Anticipated for next year: \$123,000.00

E. NARRATIVE SUMMARY:

The competency of North Carolina State University as a center of expertise in soils of the tropics continues to be significantly and measurably strengthened through the financial support provided by the grant during its fourth year of operation. In addition to the previous efforts in the areas of teaching and research, the thrust of this year's activities have concentrated on utilizing this expertise in developing countries.

The principal activity of the year was to improve linkages with tropical soil scientists through 1) organizing and conducting a major

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Seminar on Tropical Soils Management with participation of about 250 soil scientists, 2) conducting a post-seminar tour through key areas of South America, and 3) publishing in book form the Review of Soils Research in Tropical Latin America in English and Spanish, and 4) formulating plans for establishing a Tropical Soils Network Center as the outreach arm of the Consortium.

F. GENERAL BACKGROUND AND PURPOSE OF THE GRANT:

A grant to strengthen the capabilities of North Carolina State University in special problems of tropical soils was approved on November 2, 1970 for a five-year period. Its purpose is to increase the capability of the Soil Science Department in becoming a center of expertise for training, research, and technical assistance in soils of the humid tropics. The subject matter emphasis is on soil fertility and management; the initial geographical emphasis is Latin America. Additional efforts which contribute to the broad objective of the grant is provided by two other AID-funded activities: The International Soil Fertility Evaluation and Improvement Program (ISFEIP), Contract AID/1a 646, and a research program entitled "Agronomic-Economic Research on Tropical Soils", Contract AID/csd 2806.

1. Objectives of the Grant

1.1 Objectives restated

- (1) To establish a senior faculty professorial position at North Carolina State University in tropical soils to coordinate efforts of other departmental research activities in the tropics and those of the other four cooperating universities.

- (2) To provide visiting professorships through which North Carolina State University will bring additional expertise and experience from the other cooperating institutions and from other sources.
- (3) To provide graduate research assistantships for students in tropical soils in North Carolina State University degree granting programs.
- (4) To provide (a) for travel of graduate students to tropical areas for training, (b) for support of such students while overseas, and (c) for travel and support of faculty to supervise them and to consult with cooperating institutions.
- (5) To provide graduate exchange assistantships so that students of the four cooperating institutions may have access to the strengths of North Carolina State University.
- (6) To modify existing soil courses and develop new courses in tropical soils for use by AID and the personnel involved in tropical soil and crop management and related activities in the less developed countries.
- (7) Strengthen library and other information services and provide support for the preparation of training materials on soil and crop management in the tropics.

2. Review of the Objectives

The activities during this report period remain consistent with these objectives. No modification of the original objectives is contemplated. As the program develops, however, more emphasis is given to the utilization aspects.

ACCOMPLISHMENTS

1. Staff Involvement

A large proportion of the faculty are involved in tropical soils studies. This policy permits that the increased expertise attained

through the grant is weaved throughout the fabric of the Department.

During this year, 22 professors and 21 graduate students were involved in various degrees in teaching, research, and technical assistance in tropical regions. This represents 40% of the Department's faculty and 50% of its graduate students. A complete list appears in Table 1.

Five faculty members and four graduate students are presently stationed overseas. They conduct research and technical assistance activities supported by the two AID contracts in Brazil, Peru, Panama, Costa Rica, and Guatemala.

Table 1. Soil Science Department staff involved in tropical soils teaching, research, and technical assistance programs.

Faculty

C. B. McCants, Professor and Department Head
 P. A. Sanchez, Associate Professor and Project Leader, Grant csd/2835 and Contract csd/2806, tropical soils teaching and research
 J. W. Fitts, Professor and Director, International Soil Fertility Evaluation and Improvement Program (ISFEIP) Contract la/646.
 W. V. Bartholomew, Professor, organic matter transformations
 S. W. Buol, Professor, soil genesis teaching and research
 R. B. Cate, Visiting Associate Professor, ISFEIP, (Guatemala)
 M. G. Cook, Professor and Coordinator, Academic Affairs
 F. R. Cox, Associate Professor, soil micronutrient research
 R. B. Daniels, Professor, soil geomorphology (USDA)
 J. W. Gilliam, Associate Professor, analytical services
 M. A. Granger, Research Associate, tropical soils
 A. H. Hunter, Visiting Associate Professor, ISFEIP, soil analysis
 E. J. Kamprath, Professor, soil fertility teaching and research
 G. S. Miner, Assistant Professor, soil fertility teaching and research
 J. J. Nicholaidis, Visiting Assistant Professor, ISFEIP (Costa Rica)
 D. D. Oelsligle, Visiting Assistant Professor, tropical soils research (Costa Rica)
 S. S. Portch, Visiting Assistant Professor, ISFEIP, (Panama)
 G. Uehara, Visiting Professor, tropical soils
 J. L. Walker, Visiting Associate Professor, ISFEIP (Guatemala)
 D. L. Waugh, Visiting Associate Professor, ISFEIP
 S. B. Weed, Professor, soil chemistry teaching and research
 A. G. Wollum, Associate Professor, soil microbiology teaching and research

Graduate Students in Tropical Soils

A. Alvarado (Costa Rica), soil genesis (Dr. Buol)
 J. M. Bingham (USA), soil genesis (Dr. Buol)
 E. Gonzales (Paraguay), soil fertility (Dr. Kamprath)
 L. F. Lepsch (Brazil), soil genesis (Dr. Buol)
 A. S. Lopes (Brazil), soil fertility (Dr. Cox)
 C. E. Lopez (Dominican Republic), soil fertility (Dr. Sanchez)
 J. Mendez-Lay (Panama), soil fertility (Dr. Kamprath)
 F. Munevar (Colombia), soil microbiology (Dr. Wollum)
 L. Mejia (Colombia), soil genesis (Dr. Buol)
 J. R. Paredes (Venezuela), soil genesis (Dr. Buol)
 R. A. Pope (USA), soil genesis (Dr. Buol)
 D. G. Rossiter (USA), soil management (Dr. Sanchez)

Table 1 (Cont'd).

J. G. Salinas (Bolivia), soil fertility (Dr. Sanchez)
S. M. Sertsu (Ethiopia), soil fertility (Dr. Sanchez)
C. E. Seubert (USA), soil fertility (Dr. Sanchez)
T. J. Smyth (USA), soil fertility (Dr. Sanchez)
F. T. Turner (USA), soil chemistry (Dr. Gilliam)
E. J. Tyler (USA), soil genesis (Dr. Buol)
J. H. Villachica (Peru), soil fertility (Dr. Sanchez)
M. K. Wade (USA), soil management (Dr. Sanchez)
R. S. Yost (USA), soil fertility (Dr. Kamprath)

Supporting Staff

Bertha Monar, Tropical Soils Program Secretary
Cathy Langley, Laboratory Technician III
Patrice Hill, Stenographer II

2. Teaching

In addition to the regularly scheduled fall semester course on "Characteristics and Management of Soils of the Tropics," a special graduate course on the "Chemistry, Physics, and Mineralogy of Oxide Systems," was taught during the spring semester by Dr. Goro Uehara. Most of the graduate student body and many faculty members attended.

The Soil Fertility Evaluation seminar was held for its ninth consecutive year under the sponsorship of ISFEIP. Lectures were given to over 20 participants from developing countries by faculty employed under the la/646 and csd/2806 contracts, the 211(d) grant, and state and federal appropriations for operations of the University.

Drs. S. W. Buol and S. B. Weed participated in the Tropical Soils Mineralogy Workshop held at the University of Hawaii as a Consortium effort to strengthening teaching of this subject matter.

3. Visiting Scientists

Dr. Goro Uehara of the University of Hawaii joined the Department as a Visiting Professor for the period of January 1 to August 31, 1974. Dr. Uehara taught the special course mentioned in the previous section and consulted intensively with faculty and graduate students on research programs in the tropics and in North Carolina. Also he initiated studies on the role of calcium silicate on Oxisols, Histosols, and on the effects of absorbed anions on cation retention in Oxisols in cooperation with faculty members and two graduate students. Dr. Uehara provided advise for new research projects and reviewed critically the manuscript of a Tropical Soils

Management book prepared by Dr. Sanchez. His presence in Raleigh resulted in very productive interchange of stimulating ideas with faculty and graduate students. His visits to our research stations in Peru and Brazil generated several new avenues of research, particularly in the area of soil physics.

Several scientists and administrators visited the Department during the year to discuss matters of mutual interest related to tropical soils. Their visits averaged about four days and usually involved seminar presentations. During this year, the following visited the Department on matters relevant to the 211(d) grant: Mr. Chau Van Hahn, Chief of Soil Chemistry Laboratory, Institute of Research, Saigon, Vietnam; Dr. Colin Andrew, Division of Tropical Pastures, CSIRO, Brisbane, Australia; Dr. George C. Naderman, Jr., Cornell-NCSU Brazil Project; Dr. Antonio Pinchinat, CATIE, Turrialba, Costa Rica; Dr. Egon Klamt, Soils Department, Universidad Federal de Rio Grande do Sul, Brazil; Dr. David Moore, Oregon State University; Mr. Eric Bettanay, Division of Land Resources, CSIRO, Perth, Australia; Dr. Robert C. T. Lee, Chairman, Joint Commission of Rural Reconstruction, Taipei, Taiwan; Dr. Arthur Niehoff, AID Consultant and Miss Milagros Miro, University of Puerto Rico. Of this list, Dr. Pinchinat's travel was partially supported by 211(d) funds.

4. Research

Two graduate students supported by the 211(d) grant obtained their degrees during the year. Dr. Michael A. Granger from Guyana completed his program in September, 1973 and joined the faculty in a post-doctoral position in charge of evaluating the fertility-capability soil

classification system. Dr. Fred T. Turner obtained his doctorate in January, 1974 after completing a dissertation on factors affecting the increase in phosphorus availability in flooded soils. Dr. Turner joined the faculty of Texas A&M University and is working on the chemistry of flooded soils at the Beaumont Station.

A third graduate student supported by 211(d) funds, Mr. Alfredo S. Lopes from Brazil, recently obtained full financial support from his country to continue his program at this University.

The 211(d) grant has been used to supplement research by faculty and graduate students in order to make their research efforts more meaningful to developing countries. During this year, 211(d) funds were used for: 1) Mr. Leonidas Mejia, a Colombian graduate student to travel to the Llanos Orientales to collect and ship samples for his thesis research, 2) shipping soil samples collected by Mr. Ramon Paredes in the Maracaibo Basin of Venezuela to Raleigh for his thesis research and 3) for Dr. R. B. Daniels to travel in Brazil and advise Mr. Igo Lepsch on his thesis research program.

Since all these projects are also partially supported by the Tropical Soils Research Contract, the research results appear in the annual report of that contract.

5. Participation in International Conferences and Study Trips

Faculty travel to tropical regions supports many of the grant's objectives. It increases the individual's experience in specific tropical areas and problems; it allows him to become personally acquainted

with personnel and on-going programs at different institutions, and it often provides consultation services to the host countries. A total of 14 professors and 5 graduate students visited 15 countries during this year, spending a total of 20 man-months away from the campus. Of these, 7 professors and 1 graduate student travelled under grant support. Faculty travel within the United States to coordinate activities among the Consortium Universities was also supported by grant funds.

A summary of travel activities follows:

Drs. Buol and Weed attended a Tropical Soil Mineralogy Workshop in Hawaii for the period of July 7-22, 1973.

Dr. Kamprath attended the "III Soils Colloquium: Phosphorus in Tropical Areas" sponsored by the Colombian Society of Soil Science in Bogota during the period of August 26 to 31, 1973. He presented a paper entitled, "Chemical aspects and mineral forms of phosphorus in tropical regions."

Dean Rigney, Dr. McCants, and Dr. Sanchez attended the Annual Review of the Consortium in Washington on November 8 to 9, 1973.

Dr. Sanchez attended the annual meeting of the American Society of Agronomy in Las Vegas from November 11 to 16, 1973, and chaired a joint session between Divisions A-6 (International agronomy) and Division S-4 (Soil fertility and plant nutrition).

Mr. Leonidas Mejia travelled to Bogota and the Llanos Orientales of Colombia from December 20, 1973 until January 7, 1974. He collected soil samples along a toposequence near Carimagua and shipped them to the United States for study.

Dr. Sanchez travelled to Cali, Colombia to confer with the CIAT staff about arrangements related to the Tropical Soils Management Seminar. He also spent part of his time in Peru consulting with Ministry officials in relation to the post-Seminar tour in that country. (January 15 to 23, 1974)

Dr. Kamprath attended a symposium on "Sulfur in an Australasian Agriculture" in Camberra, Australia as a U. S. representative sponsored by the National Science Foundation from February 6 to 26, 1974. Funds from the 211(d) grant were used to visit the Division of Tropical Agronomy (CSIRO) and the University of Queensland in Brisbane and to visit the Waite Agricultural Research Institute and CSIRO offices at Adelaide. Dr. Kamprath presented a seminar on "Exchangeable aluminum as a criterion for liming highly weathered soils" at Brisbane.

Drs. McCants, Sanchez, and Uehara attended the Seminar on Soils Management and the Development Process in Latin America in Cali, Colombia from February 10 to 14, 1974. Dr. Sanchez was the Seminar Chairman. Dr. McCants welcomed the group on behalf of the Consortium. Dr. Sanchez presented two papers on "The fertility-capability classification system" and "Effects of solar radiation on rice responses to nitrogen in Peru." Dr. Uehara presented a paper on "Management implications of soil mineralogy in Latin America." Other NCSU faculty members also attended with support from other funds: Drs. Oelsligle, Granger, Hunter, Waugh, Cate, Walker, and Portch. Drs. Sanchez, Uehara, and Oelsligle participated in the post-seminar tour from February 15 to 24, 1974.

Drs. Oelsigle and Sanchez participated in a multiple cropping conference sponsored by IICA and AID in Turrialba, Costa Rica during the period from February 25 to 28, 1974.

Dr. Daniels travelled to Sao Paulo and Brasilia, Brazil to advise Mr. Igo Lepsch on his field thesis research. Dr. Daniels and Dr. Buol proceeded to Brasilia to consult with the staff of the NCSU-Cornell research project from March 30 to April 13, 1974.

Dean J. A. Rigney attended a meeting of the Consortium Council of Deans in Washington on May 7, 1974.

Dr. Sanchez attended a briefing on agricultural drought situation in the Sahelian zone at AID, Washington on May 8, 1974.

Drs. McCants and Buol attended a conference on "Experimental Design to Predict Crop Productivity with Environmental and Economic Inputs" at the University of Hawaii from May 19 to 26, 1974.

Dr. Sanchez attended an international conference on "Land Use Systems for the American Humid Tropics" in Lima, Peru on June 10 to 15, 1974, sponsored by the Interamerican Institute of Agriculture Sciences. He presented a paper on "Soil management research in the Amazon Jungle of Peru."

Dr. Uehara was invited to the University of Florida in Gainesville to present a series of seminars on the Mineralogy, Chemistry, and Physics of Soils of the Tropics, and to discuss related matters with faculty and graduate students. He was there from June 24 to 28, 1974. All expenses were paid by the University of Florida.

6. Seminar on Soil Management and the Development Process in Tropical Latin America

At the November, 1972 meeting of the Consortium Executive Committee, it was decided that the second Consortium-sponsored Seminar be held at CIAT, Colombia in February, 1974. The Executive Committee assigned the responsibility of planning and organizing the Seminar to North Carolina State University.

The purpose of the Seminar was to gather the leading working tropical soil scientists from Latin America and discuss new and relevant advances related to the title of the seminar. An additional purpose was to explore the possibilities of expediting communications among soil scientists in the tropics through creating a research network in tropical soils.

Suggestions of appropriate speakers were received from our faculty as well as from Cornell University, AID, CIAT, IICA, the Colombian and Latin American Societies of Soil Science. A Steering Committee was then formed and consisted of Drs. J. M. Spain and F. Fernandez of CIAT; L. A. Leon, President of the Colombian and Latin American Societies of Soil Science; R. Pietri of the University of Puerto Rico; T. S. Gill of AID; and P. A. Sanchez, Chairman. The committee met at Cali in April, 1973 and in Las Vegas in November, 1973. The selection of the speakers and participants and commitments to attend were made during this period.

The seminar then became a joint effort of five co-sponsoring organizations: The University Consortium on Soils of the Tropics; CIAT; AID; the Colombian Society of Soil Science; and the Latin American Society of

Soil Science. A \$ 40,000 grant was requested by NCSU on behalf of the Consortium and was awarded by AID in November, 1973 (Grant AID/TA-G 1058). The host institution, CIAT, also budgeted special funds to support part of the Seminar.

Arrangements for the post-seminar tour to Carimagua, Colombia were made with CIAT and ICA. The CIAT soil scientists planted special demonstration plots to be ready at the time of the tour. Arrangements were also made with the Ministry of Agriculture in Peru and the Peruvian Society of Soil Science for visits to Lambayeque, Yurimaguas and La Molina in Peru. Arrangements were also made with the Empresa Brasileira do Pesquisas Agropecuarias and the Instituto Agronomico de Campinas for a 1000 km bus tour from Campinas to Brasilia. The excellent collaboration of these institutions in forward planning contributed substantially to the success of this tour to key areas of South America with relevant ongoing soil research projects.

In December, 1973, Dr. Elemer Bornemisza of the University of Costa Rica-IICA accepted the responsibility for serving as Editor of the seminar proceedings.

In January, 1974, it became apparent that the number of people intending to attend the Seminar and the post-Seminar tour was over twice of that originally planned. CIAT made considerable efforts in modifying a meeting room to accommodate over 200 people. Arrangements were also made to charter larger aircraft and buses for the post-seminar tour.

A total of 209 soil scientists from 26 countries participated in the Seminar. (Table 2). Of these only 40 were supported by the special AID grant. Over 80% of the participants, therefore, were supported by their own institutions or other international sources. The AID grant, therefore, served as "seed money" for this large undertaking.

Approximately 70 scientists participated in the Colombian portion of the tour and 35 in the entire tour including Peru and Brazil. Of these 10 were supported by the AID grant.

A total of 32 papers were presented and distributed in mimeographed form in Spanish and English. The topics were organized in sessions dealing with soil classification, soil-water relations, research networks in tropical soils, soil fertility, crop adaptation to soils, soil fertility evaluation and soil management systems.

The entire group participated in working sessions organized to discuss research priorities and the means for improving communications among tropical soil scientists. The working groups unanimously agreed that "some kind of a network is needed to fill important voids and help bring about a more effective overall program." The groups suggested that "an important beginning in tropical soil science coordination has already been brought about by this seminar. It recommended that the co-sponsors of the seminar pursue the subject further by 1) contacting interested individuals and institutions, and 2) taking advantage of existing resources available within the Tropical Soils Consortium."

Table 2. Number of speakers and participants to the Seminar on Soil Management and the Development Process in Tropical America.

Country	Total Attending	Financed by AID Grant
Belgium	1	0
Bolivia	1	1
Brazil	19	11
Colombia	79	1
Costa Rica	5	4
Chile	1	0
Ecuador	7	3
El Salvador	4	1
France	1	0
Germany	1	0
Guatemala	5	3
Guyana	1	0
Haiti	1	1
Honduras	2	1
Indonesia	1	0
Japan	1	0
Nicaragua	1	1
Nigeria	1	0
Panama	4	3
Peru	11	6

Table 2 (Cont'd)

Country	Total Attending	Financed by AID grant
Puerto Rico	6	0
Republic Dominicana	1	1
Tonga	1	0
Trinidad	1	1
USA	26	0
Venezuela	27	2
Total	209	40

Dr. Bornemisza is presently editing the manuscripts for formal publication. It is expected that 2000 copies of English and Spanish versions of the Proceedings will be available for distribution by February, 1975.

7. Directory of Tropical Soil Scientists

At the November, 1972 Executive Committee Meeting, North Carolina State University was assigned the responsibility of developing a directory of expertise in tropical soils. A format was developed at the April, 1973 Executive Committee Meeting and a set with 72 entries was distributed to the institutions at the November, 1973 meeting. It is important to emphasize that this list includes outstanding soil scientists from developing country institutions as well as U. S., European and Japanese ones. The responsibility of assembling this information in a computerized storage-retrieval system was assigned to Prairie View A&M University.

8. Arrangements for a Tropical Agronomy Field Course

The International Agronomy Committee of the American Society of Agronomy has for some time desired to conduct a field course in tropical agronomy for teachers in the U. S. Universities with no prior experience in the tropics. Dr. Sanchez canvassed the ASA membership through an article in the "Agronomy News." A substantial number of ASA members expressed their interest in participating in such a course at their own expense. At a joint meeting between the International Agronomy Committee and the Consortium to take responsibility of

conducting the course in either Puerto Rico or Hawaii. At the April, 1974 Executive Committee Meeting, the University of Hawaii was assigned full responsibility in planning and conducting the course on behalf of the Consortium in June, 1975.

9. Planning for Establishing a Tropical Soils Network Center

Considerable faculty time has been spent in developing the concept of a network center and preparing a concrete proposal to the Consortium and AID for establishing such a Center. Considerable time was also spent discussing these ideas with members of the other four Universities AID and representatives of developing countries. A proposal was developed in May, 1974 with four concrete objectives and mechanisms for achieving them. A summary of our concept of the Network Center follows. The objectives of the Center are: 1) to accelerate communications among tropical soil scientists on new advances in the field, 2) to conduct research on and promote the utilization of advances in soil science by farmers, 3) to serve as a focal point for AID and other donors seeking qualified scientists for specific functions and for developing countries requesting such assistance, and 4) to help identify additional research and training needs in tropical soils and find appropriate support to implement them.

9.1 Research Network

It is proposed that the first objective be accomplished by creating a research network in tropical soils. This actually involves formalizing many of the linkages already in existence between

the Consortium and other tropical soil scientists. The operation of the research network consists of several steps:

9.11 Linkages with other institutions active in the field will be made by formal agreements. These include international organizations such as IRRI, CIAT, CIMMYT, CIP, ICRISAT, IITA, ILRAD, ILCA, and FAO; regional institutions such as IICA, CATIE, WARDA, AVRDC; the national research, training, and extension institutions of tropical countries with meaningful involvement in soils and other institutions from developed countries active in the field such as IRAT, ORSTOM, TVA, and several American, European, Australian, and Japanese Universities. Each institution interested in joining the network would be requested to send a list of individual scientists who should receive the communications and will promise to make their new research results available for distribution. One person from each institution will be selected as the network representative for that institution or subdivision thereof,

9.12 The Center will receive new publications and select the most relevant ones for dissemination to interested recipients. For example, publications dealing with significant advances in the chemistry of Oxisols will be distributed to countries which have these soils and not those with desert climates. A limited number of the most important publications

will be translated into English, Spanish, and French. A complete list of abstracts of publications received will be published periodically.

9.13 The Center will publish a Tropical Soils Newsletter several times a year in a format akin to the "Agronomy News."

9.14 The Center will organize and sponsor several regional or worldwide conferences for key soil scientists to assemble and discuss relevant advances on specific topics related to tropical soils. Regional conferences in each of the major tropical regions (Africa, Asia, Latin America) will be held on the average of every three years per region. Worldwide conferences will deal with specific topics and will be scheduled as often as necessary.

9.15 The Center will be responsible for publishing the proceedings of such conferences and its distribution.

9.1 Utilization at the Farmer's Level

It is proposed that the second objective be accomplished by several activities aimed at developing realistic mechanisms for getting the information utilized by farmers.

9.21 The Center will request that cooperating institutions condense their research results into concrete recommendations to farmers. These will be circulated among the network.

9.22 Through study trips or other suitable mechanisms, the Center will request Consortium staff to identify successful utilization programs and the factors responsible for their success.

9.24 The Center will sponsor and conduct research on methodology for transferring the research information to farmers.

9.25 After this information has been obtained, the Center will promote actual utilization programs in one or two selected areas. These projects will draw on the resources of participating institutions. Outside support will be requested if appropriate.

9.3 Serving as a Focal Point

It is proposed that the third objective of the Center be accomplished by the following activities:

9.31 Compile and keep up to date, a Directory of Technical Expertise in Tropical Soils. This roster will be made available to individuals or institutions upon request. The Consortium staff will be requested to identify these scientists capable and interested in short or long-term assignments.

9.32 Assist AID and other donor agencies in implementing requests for technical assistance in tropical soils. The Center would facilitate and expedite such requests by identifying the institution or individual best qualified and available to provide such services. When appropriate, the Center staff may provide direct assistance.

9.33 Assist developing country institutions requesting technical assistance in tropical soils. The Center may facilitate and expedite such requests by directing them to the appropriate

funding agency and suggesting possible institutions or individuals among the network who might be interested in providing such assistance.

9.34 Assist in design and/or evaluation of new research training or utilization projects in the field or tropical soil science. The Center might help AID and other donors in evaluating proposed projects by identifying the appropriate individuals within or outside the Consortium.

9.35 Assist in the coordination of joint research projects conducted by Consortium institutions or others involved in the network. By facilitating communication at the planning stage, the Center may contribute to reducing wasteful duplication.

9.4 Research and Training Programs

The Center, through appropriate members of the Consortium and the network, may be instrumental in identifying new "bottlenecks" within the network mechanism. The fourth objective may be accomplished by the following activities:

9.41 Organize study groups composed of Consortium and/or network representatives to appraise and define serious void in training, research, or utilization aspects.

9.42 Identify on a continuous basis, the priority areas of research and other restrictions in tropical soils.

9.43 Identify promising young soil scientists associated with developing country institutions working in these priority areas

for graduate assistantships in Consortium institutions or elsewhere. The Center may support when appropriate, a limited number of these graduate programs. Thesis research will be conducted in developing countries.

9.44 Provide financial support for the initial research work of these scientists when they return to their home country after completing graduate work. Small research grants or "seed money" may be given to these scientists in response to project proposals in the priority areas identified by the Center. Such a follow-up program will strengthen linkages and permit highly qualified developing country professionals to become meaningful involved in the network.

9.45 Upgrade the undergraduate teaching program in soil science of developing country institutions through workshops conducted by Center personnel. These workshops will be run by the Consortium institutions and are designed to bring key soil science teachers up to date with subject matter and teaching techniques.

9.46 Organize and provide logistical support for short-term field courses in tropical soils (Institutes). Consortium and network staff will participate in the teaching. The purpose of these Institutes would be to upgrade the knowledge of developing country soil scientists who have been away from school several years.

Suitable simultaneous translations in Spanish and/or French will be available when appropriate.

9.47 Sponsor scientist exchange between developed and developing country institutions within the network. One-to-one exchanges will be arranged in a way that a competent but relatively young soil scientist from a developing country university may spend a semester or a year at a developed country university. The university in turn will send one of its scientists to the counterpart institution at the same time. In effect this would be a reciprocal sabbatical leave.

9.48 The Center may conduct specific research programs in developing countries with its own staff in areas or circumstances where such programs cannot be handled by Consortium or other network institutions.

9.49 The Center will establish a central soils characterization laboratory to serve as a control for other laboratories desiring this arrangement and to help characterize soils from tropical areas lacking sufficient facilities.

The Center will be governed by an Administrative Board and its activities coordinated by an Executive Committee, composed of members of the five institutions. The staff would consist of a Director, Administrative Assistant, and clerical staff located at one of the participating institutions. Two additional Associate Directors and appropriate clerical staff will be housed at other institutions.

The annual core budget for operating the Center is estimated at \$ 125,000. Outreach activities contemplated for the first two years are estimated to cost an additional \$ 400,000.

10. Impact of Grant-Supported Activities in Developing Institutional Capabilities

The above activities have strengthened demonstratively the Soil Science Department's expertise in soils of the tropics. The strategy of involving a major proportion of the faculty graduate students in tropical studies directly or indirectly insures a truly departmental effort. The new and modified courses plus the many seminars and informal discussions have increased the international atmosphere of the department. Study trips to new areas have substantially broadened the personal experience of the faculty and has reduced local biases caused by limited experience in one or two tropical regions. The increased emphasis on utilizing our capabilities adds a new dimension to the scope of the program.

11. Utilization of Institutional Resources in Development

Since its inception, the Soil Science Department has directly contributed to the development of soil science in the tropics through various means. A summary of such contributions related to the training of graduate students for tropical areas, the North Carolina State University Agricultural Mission to Peru (Contract AID/1a 510), the International Soil Fertility Evaluation and Improvement Program (Contract AID/1a 646), and the Tropical Soils Research Contract (Contract AID/csd 2806) have appeared in the previous annual reports. During the report period many activities were geared primarily to expand the utilization aspects of our program.

11.1 Actual Overseas Involvement

An estimation of the degree of the total involvement of the Department in tropical soil science is the actual time spent overseas by Soil Science Department faculty and graduate students.

Table 3 shows that the Department devoted approximately 10.8 man-years in overseas assignments related to tropical soil science. Of these, 9.1 man-years were contributed by the faculty and graduate students stationed in several developing countries, some of which also devoted considerable time to assistance in neighboring countries.

The campus-based staff spent a cumulative total of 1.7 man-years in 67 short-term visits to 15 countries by 14 professors and 5 graduate students. Most of these short visits provided support for on-going technical assistance and research projects. Many of them served to establish and strengthen linkages with local soil scientists and AID Missions as well as continuing contacts with former graduate students now occupying key positions in Latin America.

Table 3. Actual overseas involvement by North Carolina State University Soil Science Department Staff for the period of July 1, 1973 to June 30, 1974. Includes personnel on AID contracts 1a/646 and csd 2806.

Country	Campus-based Staff		Overseas Staff	Total
	trips	man-days	man-days	man-months
Brazil	12	188	730	30.6
Peru	10	104	730	27.8
Guatemala	6	37	730	25.6
Costa Rica	7	34	670	23.5
Panama	5	34	300	11.1
Colombia	12	84	0	2.8
El Salvador	2	4	60	2.1
Nicaragua	2	4	60	2.1
Ecuador	1	3	60	2.1
Hawaii	5	53	0	1.8
Indonesia	1	35	0	1.1
Australia	1	21	0	0.7
Bolivia	1	10	0	0.3
P. ay	1	3	0	0.1
Honduras	1	2	0	0.1
Total, trips	67			
Total, man-years		1.7	9.1	10.8

11.2 Publications

The following journal articles, bulletins, papers, and theses on tropical soils were published by the Soil Science Department Staff.

Those supported by the 211(d) grant are identified.

- Bartholomew, W. V. 1973. Nitrogeno del suelo en los tropicos. En Sanchez (Ed): "Un Resumen de Investigaciones Edafologicas en la America Tropical," North Carolina Agr. Exp. Sta. Tech. Bull. 219 (Spanish version):75-96.
- Bejarano, W., J. Lainez, and Sam Portch. 1974. Adequate use of fertilizers on perennial and annual crops. Seminar on Soil Management and the Development Process in Tropical America. (In English and Spanish). Mimeographed. 11 pp.
- Buol, S. W. 1973. Genesis, morfologia y clasificacion de suelos. En: Sanchez (Ed): "Un Resumen de Investigaciones Edafologicas en la America Latina Tropical," North Carolina Agr. Exp. Sta. Tech. Bull. 219 (Spanish version):1-42.
- Buol, S. W. 1973. Soil laboratory needs in tropical research. Agronomy Abstracts 1973:111.
- Buol, S. W., P. A. Sanchez, R. B. Cate, Jr., and M. A. Granger. 1974. Soil fertility-capability classification: A technical classification for fertility management. Seminar on Soil Management and the Development Process in Tropical America. (In English and Spanish). Mimeographed. 24 pp.
- Cline, M. G. and S. W. Buol. 1973. Soils of the Central Plateau of Brazil. Agronomy Mimeo 73-13, Department of Agronomy, Cornell University.
- Cox, F. R. 1973. Potasio. En: Sanchez (Ed): "Un Resumen de Investigaciones Edafologicas en la America Latina Tropical," North Carolina Agr. Exp. Sta. Tech. Bull. 219 (Spanish version):177-194.
- Cox, F. R. 1973. Micronutrients. En: Sanchez (Ed): "Un Resumen de Investigaciones Edafologicas en la America Latina Tropical," North Carolina Agr. Exp. Sta. Tech. Bull. 219 (Spanish version):199-215.
- Cordero, A. and G. S. Miner. 1974. A field research program for obtaining interpretation data. Seminar on Soil Management and the Development Process in Tropical America. In (English and Spanish). Mimeographed. 20 pp.

- Granger, M. A. 1973. Potassium characteristics, solution composition and mineral equilibria of selected soils from North Carolina and Guyana. Ph.D. Thesis, Soil Science Department, North Carolina State University. 162 pp. (Supported by 211(d) grant).
- Granger, M. A. and S. W. Buol. 1973. Application of a theoretical $K_2O-Al_2O_3-SiO_2-H_2O$ system to pedology. Agronomy Abstracts 1973:113. (Supported by 211(d) grant).
- Hunter, A. H. 1974. New techniques and equipment for routine soil-plant analytical procedures. Seminar on Soil Management and the Development Process in Tropical America. (In English and Spanish). Mimeographed. 15 pp.
- International Soil Fertility Evaluation and Improvement Program 1972. The evaluation and improvement of soil fertility in Latin America. Annual Report Contract la-646. Soil Science Department, North Carolina State University.
- Kamprath, E. J. 1973. Acidez del suelo y encalado. En: Sanchez (Ed): "Un Resumen de las Investigaciones Edafologicas en la America Latina Tropical," North Carolina Agr. Exp. Sta. Tech. Bull. 219. (Spanish version):137-150.
- Kamprath, E. J. 1973. Fosforo. En: Sanchez (Ed): "Un Resumen de las Investigaciones Edafologicas en la America Latina Tropical," North Carolina Agr. Exp. Sta. Tech. Bull. 219 (Spanish version): 195-198.
- Kamprath, E. J. 1973. Chemical aspects and mineral forms of soil phosphorus in tropical regions. Paper presented at the Third Soils Colloquium: Phosphorus in Tropical Zones, Colombian Society of Soil Science. 14 pp. (Supported by 211(d) grant).
- Lepsch, I. F. and S. W. Buol. 1974. Investigations in an Oxisol-Ultisol Toposequence in Sao Paulo State, Brazil, Soil Science Soc. Amer. Proc. 38(3):
- Lutz, J. F. 1973. Propiedades fisicas del suelo. En: Sanchez (Ed): "Un Resumen de las Investigaciones Edafologicas en la America Latina Tropical," North Carolina Agr. Exp. Sta. Tech. Bull. 219. (Spanish version):43-51.
- Palencia, J. A., J. L. Walker, and L. Estrada. 1974. A soil fertility evaluation program. Seminar on Soil Management and the Development Process in Tropical America (In English and Spanish). Mimeographed. 23 pp.

- Sanchez, P. A. 1973. Manejo de suelos bajo el sistema de roza. En: Sanchez (Ed): "Un Resumen de las Investigaciones Edafologicas en la America Latina Tropical," North Carolina Agr. Exp. Sta. Tech. Bull. 219 (Spanish version):51-74.
- Sanchez, P. A. 1973. Fertilizacion con nitrogeno. En: Sanchez (Ed): "Un Resumen de las Investigaciones Edafologicas en la America Latina Tropical," North Carolina Agr. Exp. Sta. Tech. Bull. 219 (Spanish version):97-134.
- Sanchez, P. A., G. E. Ramirez, and M. V. de Calderon. 1973. Rice responses to nitrogen under high solar radiation and intermittent flooding in Peru. *Agronomy Journal* 65:523-529. (Supported by 211(d) grant).
- Sanchez, P. A., A. Gavidia, G. E. Ramirez, R. Vergara, and F. Minguillo. 1973. Performance of sulfur-coated urea under intermittently flooded rice culture in Peru. *Soil Sci. Soc. Amer. Proc.* 37:789-792. (Supported by 211(d) grant).
- Sanchez, P. A. and S. W. Buol. 1974. Properties of some soils of the Upper Amazon Basin of Peru. *Soil Sci. Soc. Amer. Proc.* 38: 117-121.
- Sanchez, P. A., R. K. Perrin, and S. W. Buol. 1974. Concepts of program design for soils research and information transferral in developing countries. Paper presented at a workshop on "Experimental Design for Predicting Crop Productivity with Environmental and Economic Inputs." University of Hawaii. Mimeographed. 26 pp. (Supported by 211(d) grant).
- Soares, W. V., E. Zoborowsky, G. C. Naderman, E. Gonzalez, and R. S. Yost. 1974. Resultados preliminares de estudos com calcario e fosforo num Latosol Vermelho Escuro, textura argilosa, fase cerrado. Nota pervia. XIV Congresso Brasileiro de Ciencia do Solo. Santa Maria, Rio Grande do Sul.
- Soil Science Department. 1972. Agronomic-economic research on tropical soils. Annual Report. Contract AID/csd 2806. Soil Science Department, North Carolina State University. 43 pp.
- Turner, F. T. 1974. Increased phosphorus diffusion as an explanation for increased phosphorus availability in flooded rice soils. Ph.D. Thesis, Soil Science Department, North Carolina State University. 166 pp. (Supported by the 211(d) grant).

Waugh, D. L., R. B. Cate, Jr., and L. A. Nelson. 1973. Discontinuous models for rapid correlation, interpretation and utilization of soil analysis and fertilizer response data. Int. Soil Fertility Evaluation and Improvement Program Tech. Bull. No. 7 (In English and Spanish).

Waugh, D. L., R. B. Cate, Jr., L. A. Nelson, and A. Manzano. 1974. New concepts in biological and economical interpretation of fertilizer response. Seminar on Soil Management and the Development Process in Tropical America. (English and Spanish versions). Mimeographed. 25 pp.

11.3 Dissemination of Information

Substantial effort was made during the year in disseminating these and other publications in the most direct fashion to the individuals who could use it most. During the year, our mailing list of tropical soil scientists and institutions receiving these publications grew to 450 entries, distributed as follows: Latin America: 279, United States: 69, Asia: 25, Europe: 21, Africa: 16, plus 30 on campus. Funds from Contract AID/csd 2806 were used for mailing these publications.

In order to make our Review of Soils Research in Tropical Latin America more widely used, a Spanish version was prepared and printed at IICA-CIDIA, Turrialba, Costa Rica. The original English version was reprinted as Technical Bulletin 219 of the North Carolina Agriculture Experiment Station. Both are being distributed to our mailing list and to whomever requests it at no cost.

12. Other Resources for Grant-Related Activities

The Soil Science Department conducts extensive programs in four broad categories: (1) teaching, (2) research, (3) extension, and (4) international. Involved in these programs are 55 professional soil scientists (46 Ph.D., 7 M.S., and 2 B.S. degree holders) and

a supporting staff of 28 technicians and 15 secretaries, for a total full-time personnel input of 98. In addition, there are 42 graduate students working on projects within these categories. The approximate annual cost for salaries and fringe benefits for the faculty and staff is \$ 1.6 million. The annual cost for operation, other than salaries and fringe benefits, is \$ 750,000.

There is a thorough intermix of personnel activities among the four categories described above and only a small percentage are engaged totally in one category. The data in Table 1 shows that approximately 40 percent of the faculty in the department are involved in international programs that are directly related to the purpose of the 211(d) grant. Of the total cost of operating the department, approximately 30 percent is directed to activities related to the 211(d) grant; whereas the financial support from the grant is less than 3 percent of the total. These facts clearly illustrate that the University, through its Soil Science Department, has a solid base of expertise in soil science, is providing major support to sustain the base, and is involving a high percentage of the faculty in the department in 211(d) related activities. Funds provided by the 211(d) grant have been and will continue to be used to deepen, rather than broaden the base with emphasis on increasing the expertise of faculty interested and engaged in teaching, research, or extension programs related to tropical soils.

13. Next Year's Plan of Work

The process of further analyzing and modifying current courses offered by the department will continue to incorporate, where appropriate, subject matter relevant to tropical areas.

The following visiting scientists are expected to be in Raleigh for short-term assignments under 211(d) support: Dr. Luis E. Tergas, University of Florida, Ecuador Project; Mr. Marcelo N. Camargo, EMBRAPA, Brazil; Mr. Claude Charreau, IRAT, France; and Dr. Peter Nye of Oxford University.

Continued emphasis will be given to coordinate the activities sponsored by the 211(d) grant with those under the Tropical Soils Research Program and the Soil Fertility Evaluation and Improvement Program to insure that the expertise of the department in tropical soils is strengthened and its overall contribution to international soil science is advanced.

The main emphasis for the following year, however, will consist of developing a mechanism for implementing the function of the Tropical Soils Network Center in collaboration with the other Consortium Institutions.