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REPORT OF NORTH CAROLINA STATE UNIVERSITY  
FOR THE PERIOD  
SEPTEMBER 1, 1971 TO JUNE 30, 1972

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: Drs. P. A. Sanchez and C. B. McCants

D. STATISTICAL SUMMARY

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

2. Amount of Grant: \$500,000

3. Expenditures

3.1 For report period: \$36,900

3.2 Accumulated: \$48,330

3.3 Anticipated for next year: \$117,950

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 second year of operation. Some specific manifestations of these improvements are:

- (1) A clearer definition of the objectives and commitment of an expanded teaching and research program in soils of the tropics which involves additional faculty and graduate students
- (2) The development of a graduate-level course, "Characteristics and Management of Soils of the Tropics"
- (3) Increased on-site experience by 10 faculty members and 3 graduate students in 14 tropical regions of Latin America, Africa, and Asia
- (4) Initiation of field research programs in three sites in Latin America

(5) Initiation of a visiting scientist program

(6) Active involvement in the planning and teaching of a Tropical Soils Institute sponsored by the Consortium

#### F. DETAILED REPORT

1. 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 awarded 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 and research in soils of the humid tropics. The subject matter emphasis is on soil fertility and management; the initial geographical emphasis is Latin America. Additional financial support in the subject matter area is provided by two other AID-funded activities: The International Soil Fertility Evaluation and Improvement Program (Contract AID/1a 646) and a project on "Agronomic-Economic Research on Tropical Soils" (Contract AID/CSD 2806).

#### 2. Objectives of the Grant

##### 2.1 Objectives restated

- (1) To establish a senior faculty professional 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 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

2.2 Review of objectives: The activities during this report period remain consistent with these objectives. No modification of the original objectives is contemplated. The only part of the program not yet in operation is that of exchange graduate assistantships; this delay is due to the absence of such requests.

### 3. Accomplishments

3.1 Organization and personnel involved: The teaching and research activities in tropical soils became more sharply focused during this report period. Improving expertise in this area is listed in two of the 10 principle goals of the Soil Science Department for the next decade. Shortly after the arrival of a full-time professor of tropical soils on August 15, 1971, all activities supported by the 211(d) grant and by the research contract were placed under his responsibility as project leader.

The procedure employed to implement the grant's objective consists of direct faculty and graduate student involvement in tropical soil studies. In this manner, increased competence in this area is woven throughout the fabric of the department and is not limited to selected faculty members. Presently 19 professors are involved to

various degrees in teaching, research and services in tropical regions (Table 3.1). Five of these are stationed in tropical areas of Latin America.

Four graduate students are presently supported by 211(d) funds. Nine other graduate students, who are supported by other sources, are also fully involved in tropical soils studies.

A brochure describing graduate study opportunities in the tropics was published and distributed in June 1972.

The faculty and graduate students involved in this program meet periodically to interchange ideas, travel reports and research results in order to keep informed of the program's overall activities.

3.2 Teaching: A new graduate-level course entitled "Characteristics and Management of Soils of the Tropics" (SSC 501) was developed during the year and approved by the University administration. It will be taught each fall semester by Dr. P. A. Sanchez. The course applies the principles of soil science to tropical environments with emphasis on (1) geographical occurrence and morphological soil properties in major tropical regions, (2) fertility problems in tropical areas, and (3) soil management systems such as flooded rice culture, shifting cultivation, extensive pasture production and plantation crops.

The following courses have been modified to incorporate additional material relevant to the tropics as a result of the professors' travel and experience gained under grant sponsorship:

- SSC 200 Introductory Soils
- SSC 452 Soil Classification
- SSC 541 Soil Fertility
- SSC 551 Soil Genesis and Classification
- SSC 553 Soil Mineralogy

Table 3.1. Soil Science Department staff involved in tropical soils teaching, research, and technical assistance programs

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Faculty

- C. B. McCants, Professor and Department Head  
P. A. Sanchez, Assistant 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, Contract 1a/646  
W. V. Bartholomew, Professor; organic matter transformations  
S. W. Buoi, Professor; soil genesis teaching and research  
R. B. Cate, Visiting Associate Professor; soil fertility evaluation (Brazil)  
M. G. Cook, Professor; Coordinator, Academic Affairs  
F. R. Cox, Associate Professor; soil micronutrient research  
J. F. Doggett, Visiting Associate Professor; soil fertility extension (Peru)  
J. W. Gilliam, Associate Professor; analytical services  
A. H. Hunter, Visiting Associate Professor; soil fertility evaluation  
E. J. Kamprath, Professor; soil fertility teaching and research  
J. F. Lutz, Professor; soil physics teaching and research  
G. S. Miner, Visiting Assistant Professor; soil fertility evaluation (Costa Rica)  
R. E. McCollum, Associate Professor; soil fertility research  
D. D. Oelsligle, Visiting Assistant Professor; tropical soils research (Costa Rica)  
S. S. Portch, Visiting Assistant Professor; soil fertility evaluation (Panama)  
J. L. Walker, Visiting Associate Professor; soil fertility evaluation (Guatemala)  
S. B. Weed, Professor; soil chemistry teaching and research  
A. G. Wollum, Associate Professor; soil microbiology teaching and research

Graduate students in tropical soils supported by 211(d) funds

- S. T. Benavides (Colombia); soil genesis  
M. A. Granger (Guyana); soil genesis  
A. S. Lopes (Brazil); soil micronutrients  
F. T. Turner (USA); soil chemistry

Graduate students in tropical soils supported by other funds

- A. Alvarado (Costa Rica); soil genesis  
E. Gonzalez (Paraguay); soil fertility  
I. Lepsch (Brazil); soil genesis  
A. Manzano (Bolivia); soil fertility evaluation  
J. Mendez (Panama); soil fertility  
F. Munevar (Colombia); soil microbiology  
C. E. Seubert (USA); soil fertility  
E. J. Tyler (USA); soil genesis  
S. Villagarcia (Peru); soil fertility  
R. S. Yost (USA); soil fertility
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Three faculty members have been actively involved in development and preparation for instruction in the Tropical Soils Institute which will be offered by the Consortium in Puerto Rico in July-August 1972. Dr. S. W. Buol will lecture for two weeks on soil classification; Dr. E. J. Kamprath will lecture and act as discussion leader for three weeks on soil chemistry and fertility; Dr. P. A. Sanchez will be the leader of the soil management section and will teach and lead discussion for four weeks.

3.3 Visiting scientists and seminars: Dr. John K. Coulter, Tropical Soils Advisor of the Rothamsted Experiment Station, spent two weeks at Raleigh actively consulting with the faculty and graduate students. During this period he presented four seminars on tropical soil management, consulted with Dr. Sanchez on the contents of the tropical soils course and had extensive discussions with the faculty involved in tropical soils programs. Dr. Coulter's visit, although short, had a significant impact on the department's tropical soils program by providing ideas for implementing new programs and revising existing programs.

Visitors from tropical regions commonly spend a few days consulting and usually give seminars in the department. During this year, Dr. John L. Nickel of IITA, Nigeria; Dr. J. P. Watson of the University of Rhodesia and Dr. J. D. Colwell of CSIRO, Australia presented special seminars.

Approximately one-third of the departmental seminars given this year by faculty and graduate students dealt with soils of the tropics.

3.4 Research: There are currently three students on doctoral programs and one on a Master's degree program funded by the 211(d) grant

(Table 3.1). The nature of Mr. Granger and Mr. Turner's program was described in the previous annual report.

Mr. Servio Benavides is a Ph. D. candidate from Colombia. The objective of his work is to characterize the soils of the upper Amazon jungle of Colombia, an area with almost total lack of information on soils and a great development potential for the near future. Several representative profiles have been collected and analyzed to obtain an accurate classification and determine their productive potential. This research is under the direction of Dr. S. W. Buol.

Mr. Alfredo S. Lopes is an M. S. candidate from Minas Gerais, Brazil. He will conduct a survey of zinc deficiencies in the Camp Cerrado soils and perform field studies on Zn fertilization at Brasilia. His research is under the direction of Dr. F. R. Cox.

3.5 International travel: 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 acquainted with personnel and on-going programs at different institutions, and it often provides consultation services to the host countries. A total of 10 professors and 3 graduate students spent time in 14 countries of Latin America, Africa and Asia during this year, spending a total of 18 man-months away from the campus. Of these, 6 professors and 2 graduate students traveled to 10 countries under grant support. Travel within the United States to coordinate activities among the Consortium universities was also supported by grant funds.

A summary of travel activities completely supported by the grant follows:

Dr. M. G. Cook was in Hawaii from July 9-25, 1971 to attend the teaching workshop sponsored by the Consortium. Information gathered in this trip was the basis of substantial modification of two courses which he teaches.

Dr. S. W. Buol and Mr. M. A. Granger traveled to Guyana to obtain samples and data on soils related to Mr. Granger's thesis research; they also consulted on water management practices for sugar cane production on acid sulfate soils and on soil research priorities.

Drs. P. A. Sanchez and C. B. McCants visited Colombia and Guatemala from August 20-September 11, 1971. They accepted an invitation from the Colombian Society of Soil Science to speak at a symposium on nitrogen in the tropics, visited the Carimagua Research Station in the Llanos Orientales and returned via Guatemala to consult with Guatemalan and AID officials on matters pertaining to research projects in the country. Dr. Sanchez conducted a survey on micronutrient deficiencies on the Pacific Coast and Central Altiplano of Guatemala in cooperation with Dr. J. L. Walker of the International Soil Fertility Evaluation Program and Guatemalan soil scientists.

Dr. C. B. McCants attended the Consortium Executive Committee meeting in Hawaii from October 9-16, 1971.

Drs. C. B. McCants and P. A. Sanchez attended the Consortium Annual Review in Washington from December 9-10, 1971. Dr. Sanchez attended the CUSUSWASH Annual Review on December 13 representing the Tropical Soils Consortium.

Dr. S. W. Buol attended the annual meeting of the CUSUSWASH Consortium in Tucson, Arizona from January 10-12, 1972 as a representative of the Tropical Soils Consortium.

Dr. P. A. Sanchez consulted with the staff at the University of Florida from February 7-8, 1972 and gathered unpublished data on shifting cultivation research.

Dr. J. L. Walker traveled from Guatemala to Raleigh to consult with the staff on the development of a soil fertility classification system.

Drs. P. A. Sanchez and S. W. Buol attended the Tropical Soils Research Seminar and the Consortium Executive Committee meeting held at the International Institute for Tropical Agriculture, Ibadan, Nigeria. They also traveled through the western states of Nigeria and Kenya studying soils and visiting research institutions and consulted with soil scientists of FAO in Rome relative to future visiting professorships. Dr. Buol also visited the Rothamsted Experiment Station in England. Dr. Sanchez attended the fourth annual meeting of the Advisory Committee on Rice Fertilization sponsored by the Tennessee Valley Authority in Bangkok, Thailand and traveled through the Bangkok-plain studying rice cultivation on acid sulfate soils (May 12-June 6, 1972).

A summary of travel supported by other funds but relevant to the grant's objectives during the year follows:

Drs. C. B. McCants, S. W. Buol, E. J. Kamprath, F. R. Cox, and G. A. Cummings met in Guatemala with the staff of the International Soil Fertility Evaluation Program and USAID officials to discuss and plan research and technical assistance activities in Latin America (August 1-7, 1971).

Dr. R. E. McCollum advised the National Potato Program staff of the Ministry of Agriculture in Peru on soil fertility research (September 12-October 11, 1971).

Dr. D. L. Waugh initiated the activities of the tropical soil research contract in Guatemala (October 9-December 22, 1971).

Dr. P. A. Sanchez participated in CIAT's Seminar on Rice Policies in Latin America at Cali, Colombia. He also discussed with Peruvian Ministry of Agriculture and USAID officials the proposal for initiating activities sponsored by the research contract in the jungle, and participated in the Annual Agronomy Meeting of the National Rice Program of Peru at Lambayeque (October 10-26, 1971).

Drs. S. W. Buol, E. J. Kamprath and F. R. Cox traveled to Brasilia, Brazil to discuss the priorities for research to be conducted on that site with support from the research contract with the Ministry of Agriculture and USAID officials and to gather soil samples for preliminary evaluation in Raleigh (October 10-17, 1971).

Dr. E. J. Kamprath was invited by the Soil and Crop Science Society of Florida to present a paper on "Detrimental effects of overliming tropical and temperate soils" (December 7-9, 1971).

Dr. R. E. McCollum worked on field research related to the research contract (February 6-April 8, 1972).

Drs. P. A. Sanchez and C. B. McCants traveled to Costa Rica to establish cooperative research arrangements with the Inter-American Institute for Agricultural Sciences in Turrialba to become acquainted with Costa Rican soils, agriculture and institutions, and to gather reference materials from the Turrialba library. A short stop to Guatemala was used to discuss future arrangements with the Ministry of Agriculture officials (February 27-March 8, 1971).

Drs. C. B. McCants and P. A. Sanchez discussed with Cornell University staff plans for cooperative work at Brazil and for the

Tropical Soils Institute. Dr. Sanchez gave two lectures in the tropical soils and advanced soil fertility courses while in Ithaca (March 14-16, 1972).

Dr. J. W. Fitts presented an invitational paper in Rome, Italy at the Vatican-sponsored Pontifical Academy of Sciences on the topic "Soil fertility evaluation and its impact on efficient production of food" (May 1972).

Dr. P. A. Sanchez and Mr. E. J. Tyler traveled to Peru to finalize arrangements for conducting research at Yurimaguas. Dr. Sanchez further consulted on soil fertility research with the National Rice Program staff at Lambayeque and discussed activities of mutual interest with the CIAT staff at Colombia (April 12-16, 1972).

Dr. R. E. McCollum returned to Guatemala to plan additional experiments related to the research contract (May 18-June 24, 1972).

3.6 Information resources: A significant amount of reference materials relevant to tropical soils not previously available at Raleigh has been obtained by the department. All of the soil abstracts of the first five volumes of the Latin American Bibliography of Agriculture were obtained at the Turrialba library and distributed to the other Consortium members.

The review of the literature in soils research in the Latin American tropics was completed by the department and has been published. Although this review was supported by the research contract, it is clearly geared towards the objectives of the grant.

### 3.7 Publications on tropical soils by the Soil Science

#### Department during the report period

- Bartholomew, W. V. 1971. The limitations of natural processes in supplying nitrogen for modern crop production. Proc. of the International Symposium on Soil Fertility Evaluation, New Delhi 1:619-630.
- Bartholomew, W. V. 1972. Soil nitrogen and organic matter, pp. 63-81. Committee on Tropical Soils: Soils of the Humid Tropics. National Academy of Sciences, Washington, D. C.
- Cate, R. B., A. H. Hunter and J. W. Fitts. 1971. Economically sound fertilizer recommendations based on soil analysis. Proc. of the International Symposium on Soil Fertility Evaluation, New Delhi 1:1083-1091.
- Cate, R. B. and L. A. Nelson. 1971. A simple statistical procedure for partitioning soil test correlation data into two classes. Soil Sci. Soc. Amer. Proc. 34:658-660.
- Fitts, J. W. 1971. Using soil fertility evaluation and improvement information. Proc. of the International Symposium on Soil Fertility Evaluation, New Delhi 1: 1065-1071.
- Guerrero, R. 1971. Soils of the Colombian Llanos Orientales. Composition and classification of selected soil profiles. Ph. D. thesis, North Carolina State University.
- Kamprath, E. J. 1972. Soil acidity and liming, pp. 136-149. Committee on Tropical Soils: Soils of the Humid Tropics. National Academy of Sciences, Washington, D. C.
- Moura Filho, W. and S. W. Buol. 1972. Studies on a Latosol Roxo (Eutruxox) in Brazil: Description, setting and characterization. *Experientiae* 13:201-217.
- Moura Filho, W. and S. W. Buol. 1972. Studies on a Latosol Roxo (Eutruxox) in Brazil: Clay mineralogy. *Experientiae* 13:218-234.
- Moura Filho, W., S. W. Buol and E. J. Kamprath. 1972. Studies in a Latosol Roxo (Eutruxox) in Brazil: Phosphate reactions. *Experientiae* 13:235-247.
- North Carolina State University. 1971. Research on soils of the Latin American tropics. Annual Report, Contract AID/CSD 2806. 59 pp.
- Sanchez, P. A. and S. W. Buol. 1971. Características morfológicas, químicas y mineralógicas de algunas suelas principales de la Selva Amazonica Peruana. Programa Nacional de Arroz Informe Técnico No. 56.

- Sanchez, P. A. and M. V. Calderon. 1971. Timing of nitrogen applications for rice grown under intermittent flooding in the Coast of Peru. Proc. of the International Symposium on Soil Fertility Evaluation, New Delhi 1:595-602.
- Waugh, D. L. and A. Manzano. 1971. The correlation of phosphorus response with soil analysis in tall and dwarf wheat varieties in Bolivia. Proc. of the International Symposium on Soil Fertility Evaluation, New Delhi 1:377-382.

3.8 Proportion of expenditures: Grant expenditures during this year were approximately distributed as follows: teaching 19%, visiting scientists and seminars 12%; research 57%; on-site studies 7%; services and consultation 3%; library resources 2%.

4. 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 and 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.

Frequent contacts with the staff from the other Consortium members has been extremely worthwhile due to the many and intensive informal discussions.

5. 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 has appeared in the Directory of USAID

Grant Resources up to last year. The on-going contributions during this year are the following:

5.1 Training of graduate students from tropical areas: In addition to the 13 graduate students directly involved in tropical soils, the department continues to train foreign students supported by USAID, foundations, or foreign government scholarships. Approximately half of the graduate student body comes from tropical areas. Many of these now occupy key leadership positions in soil science in their countries. Notable among these are Mexico, Colombia, Venezuela, Brazil and Peru. The 211(d) grant provides a means for maintaining contacts and cooperative projects between faculty and many of these graduates.

5.2 The North Carolina Agricultural Mission to Peru (Contract AID/1a 510): One faculty member, Mr. Frank Doggett, continued his assignment to the National Forages Program. He is stationed in Lima. Dr. R. E. McCollum continues to advise the National Potato Program in their fertilizer projects through short-term assignments and related work on campus. Dr. P. A. Sanchez continues to advise the National Rice Program through similar efforts. The input of Drs. McCollum and Sanchez represents a continuation of their previous long-term assignments in Peru and provides a means for maintaining professional contacts with their former counterparts.

5.3 The International Soil Fertility Evaluation and Improvement Program (Contract AID/1a 646): Four faculty members--Drs. J. L. Walker, G. S. Miner, S. S. Portch, and R. B. Cate, Jr.--are stationed in Latin America working in the development of soil testing programs in

Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, Panama, Ecuador and Brazil. Drs. J. W. Fitts, W. V. Bartholomew, A. H. Hunter, and D. L. Waugh continue to advise these and other countries in matters pertaining to soil fertility evaluation. The summer seminar on soil testing procedures and practices continues to be taught at Raleigh with an average participation of 15 to 20 professionals from developing countries. New and functioning soil testing laboratories were placed in operation in Costa Rica and Ecuador. This project has had major impact worldwide due to its novel approach and significant success in Latin America.

5.4 The Tropical Soils Research Contract (AID/CSD 2806): The faculty involved in 211(d) grant activities is also involved in this research contract and under the same leadership. During this year the following projects were initiated overseas.

5.4.1 Guatemala: Experiments on nitrogen, phosphorus, potassium, secondary and micronutrient fertilization on major crops of the volcanic ash areas and their relation to soil testing programs. Drs. R. E. McCollum, D. L. Waugh and P. A. Sanchez have been directly involved and worked in close cooperation with Dr. J. L. Walker and the Guatemalan Ministry of Agriculture.

5.4.2 Costa Rica: A cooperative agreement for research and training has been signed with the Inter-American Institute of Agricultural Sciences at Turrialba. Dr. D. D. Oelsligle of this department will be stationed at Turrialba and will conduct and supervise soils research throughout Central America.

5.4.3 Brazil: A cooperative agreement with the Ministry of Agriculture, USAID and Cornell University has made possible the

initiation of research activities on the fertility and management of the soils of the Campo Cerrado. Long-term staff will arrive by October 1972.

5.4.4 Peru: A cooperative agreement with the Ministry of Agriculture and USAID has been approved to initiate research on the management of Ultisols and Alfisols presently under shifting cultivation. On-site research near Yurimaguas in the Amazon Basin will start in September 1972 with the arrival of two staff members.

5.4.5 Region-wide: A review of the literature on soils research in the Latin American tropics has been completed under the auspices of the research contract. This publication brings together a significant amount of the previous tropical soils research in this region. It is expected to have a major impact on planning future work.

6. 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 41 professional soil scientists (34 Ph. D., 6 M. S., 1 B. S. degree) and a supporting staff of 41 technicians and secretaries, for a total full-time personnel input of 82. In addition, there are 34 graduate students working on projects within these categories. The approximate annual cost for salaries and fringe benefits for the faculty and staff is \$1.2 million. About 75 percent of this personnel cost is paid from appropriated funds; less than 1 percent is paid from the 211(d) grant. The approximate annual cost for operation, other than salaries and fringe benefits, is \$350,000; less than 2 percent is paid from the 211(d) grant.

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 3.1 show that approximately 50 percent of the faculty in the department (20 of 41) are involved in international programs that are directly related to the purpose of the 211(d) grant, even though less than 1 percent of their salary and operating costs are paid from this source. Of the total cost of operating the department (approximately \$1.55 million dollars), \$625,000 (see Table 9.1), or 40 percent, is directed to activities related to the 211(d) grant; whereas the financial support from the grant is less than 1 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 the major portion of the support needed 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.

7. 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 Tropical Soils Institute will be taught in cooperation with the other Consortium members. It will also be evaluated and, if appropriate, modified to better serve the needs of professionals working in the tropics.

Several visiting scientists are expected during this year. Mr. Carlos Zamora of Peru will be arriving this fall. Plans for longer term assignments are developing for 1973 and 1974 and include Dr. Rudolf Dudal of FAO and Dr. Goro Uehara of the University of Hawaii.

The extensive involvement in graduate programs on tropical soils will be continued and expanded. Three additional graduate student programs funded by the 211(d) grant are anticipated during the year.

Additional faculty not previously involved in tropical studies are expected to participate, particularly in the area of soil microbiology and the chemistry of oxide systems.

Faculty and graduate students sponsored by the grant will present three papers at a symposium on soil fertility evaluation in Latin America during the annual meetings of the American Society of Agronomy in Miami in October 1972.

On-site visits will continue to countries where related research will be conducted. Requests for consultation services from various countries have been received and plans are made for their implementation.

Continued emphasis will be given to coordinating 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.

8. Other: No additional matters to report.

9. Report of Expenditures

9.1 Distribution of 211(d) grant fund expenditures and contributions from other sources of funding (see Table 9.1).

9.2 Expenditure report, actual and projected (see Table 9.2).

Table 9.1. Distribution of 211(d) grant fund expenditures and contributions from other sources of funding (review period September 1, 1971 through June 30, 1972)

Object	211(d) Source				Non 211(d) Source <sup>a</sup>
	Period Under Review	Cumulative Total	Projected Next Year	Projected to End of Grant	
Research	\$21,113	\$26,485	\$ 70,500	\$292,500	\$200,000
Teaching	6,712	7,240	20,000	60,000	255,000
Libraries	462	462	5,950	17,950	1,000
Consultation	450	450	3,000	9,000	2,000
Publication			1,000	3,000	2,000
Travel	4,300	9,603	12,000	43,000	75,000
Other	3,863	4,110	5,500	26,200	90,000
Total	\$36,920	\$48,350	\$117,950	\$451,650	\$625,000

<sup>a</sup>These data are reasonably close estimates of the total financial input from non 211(d) sources to activities which are related to the objectives of the 211(d) grant; they are not the total operational costs of the Soil Science Department from non 211(d) sources (among the sources are: North Carolina State University, Contract AID/CSD 2806, Contract AID/1a 646; graduate students supported by country AID missions, Rockefeller Foundation, Government of Brazil and Government of Thailand)

Table 9.2. Expenditure report, actual and projected

Object	Actual Expenditures		Projected Expenditures			
	Period Under Review	Cumulative Total	Year			Total
			3	4	5	
<b>Salaries and Wages</b>						
Eligible for fringe benefits	\$13,424	\$14,499	\$ 35,000	\$ 40,000	\$ 50,000	\$139,499
Visiting professors	450	450	15,000	20,000	30,000	65,450
Graduate assistants	9,450	14,175	32,000	50,000	50,000	146,175
Subprofessional assistants	3,122	3,122	3,000	4,000	4,000	14,122
Fringe Benefits	1,850	1,930	5,500	6,000	8,000	21,430
<b>Travel</b>						
Domestic	1,839	1,894	2,000	3,000	4,000	10,894
International	2,460	7,709	10,000	12,000	12,000	41,709
Communications	58	214	500	700	1,000	2,414
Contractual	1,760	1,830	2,000	3,000	4,000	10,830
Supplies	1,008	1,028	3,000	4,000	5,000	13,028
Equipment	1,037	1,037	4,000	5,000	6,000	16,037
Library Acquisitions	462	462	5,950	6,000	6,000	18,412
<b>Total All Objects</b>	<b>\$36,920</b>	<b>\$48,350</b>	<b>\$117,950</b>	<b>\$153,700</b>	<b>\$180,000</b>	<b>\$500,000</b>

## 9.3 Budget: Summary

	<u>Total Expenditures</u>
<b>Salaries and Wages</b>	
Eligible for fringe benefits	\$13,423.57
Visiting professors	450.00
Graduate assistants	9,450.00
Sub-professional assistants	3,122.00
Total	26,445.57
Fringe Benefits	1,849.62
<b>Travel</b>	
Domestic	1,839.44
International	2,460.05
Total	4,299.49
Communications	58.06
Contractual	1,760.27
Supplies	1,007.60
Equipment	1,037.05
Library Acquisitions	462.34

## 9.4 Budget: Detail

## 9.4.1 Salaries and wages

<u>Name and Position</u>	<u>% of Time on Project</u>
M. A. Granger, Graduate Assistant	100
F. T. Turner, Graduate Assistant	100
S. T. Benavides, Graduate Assistant	100
M. H. Moore, Secretary Assistant	50
P. A. Sanchez, Assistant Professor	50
C. B. McCants, Head	15

## 9.4.2 Travel

## (1) Domestic

Name: P. A. Sanchez Cost: \$55.20  
 To: Raleigh, N. C.  
 Date: April 24-27, 1971 (payment made after last report submitted)  
 Purpose: To discuss details and make arrangements for transfer from NCSU Peru Mission Program with location in Peru to NCSU 211(d) program with location in Raleigh.

Name: C. B. McCants Cost: \$649.73  
To: Hawaii

Date: October 9-16, 1971

Purpose: To participate in the regular meeting of the Executive Committee of University Consortium on Soils of the Tropics.

Name: P. A. Sanchez Cost: \$146.85

To: Washington, D. C.

Date: December 9-11, 1971

Purpose: To represent NCSU in the annual review of the University Consortium on Soils of the Tropics.

Name: C. B. McCants Cost: \$121.45

To: Washington, D. C.

Date: December 8-10, 1971

Purpose: To represent NCSU in the annual review of the University Consortium on Soils of the Tropics.

Name: E. W. Glazener Cost: \$85.90

To: Washington, D. C.

Date: December 9-10, 1971

Purpose: To attend annual review of the University Consortium on Soils of the Tropics.

Name: J. E. Legates Cost: \$62.10

To: Washington, D. C.

Date: December 9, 1971

Purpose: To attend review of the University Consortium on Soils of the Tropics.

Name: S. W. Buol Cost: \$308.50

To: Tucson, Arizona

Date: January 8-12, 1972

Purpose: Represent the University Consortium on Soils of the Tropics and present a report on their activities to the Council of U. S. Universities for Soil and Water Development in Arid and Sub-Humid Areas Annual Meeting.

Name: P. A. Sanchez Cost: \$35.50

To: Gainesville, Florida

Date: February 7-8, 1972

Purpose: To obtain and review unpublished data on shifting cultivation in the Latin American tropics for development of graduate course.

Name: J. L. Walker Cost: \$374.21

To: Raleigh, N. C.

Date: April 24-29, 1972

Purpose: To consult with faculty on various matters pertaining to its program on research and training on tropical soils.

## (2) International

Name: S. W. Buol Cost: \$906.40  
 To: Lagos, Ibadan, Nairobi, Rome, Ireland  
 Date: May 18-June 8, 1972  
 Purpose: To participate in the Tropical Soils Research Seminar sponsored jointly by the University Consortium on Soils of the Tropics and IITA, Ibadan.

Name: P. A. Sanchez Cost: \$1533.65  
 To: Lagos, Ibadan, Nairobi, Rome, Thailand  
 Date: May 12-June 6, 1972  
 Purpose: To attend Tropical Soils Research Conference sponsored jointly by the University Consortium on Soils of the Tropics and IITA and related travel in Africa and consult with FAO soil scientists on matters pertaining to tropical soils teaching and research.

Name: M. A. Granger Cost: \$20.00<sup>1</sup>  
 To: Guyana

## 9.4.3 Equipment (items costing over \$100 each)

<u>Item</u>	<u>Cost</u>	<u>Vendor</u>
IBM Selectric typewriter	\$417.50	University Stores
Edison Fi-Cord dictaphone	225.00	University Stores
Edison Envoy dictaphone	394.55	University Stores
and attachments	74.55	University Stores

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<sup>1</sup>Correction for incorrect reporting of expenses in first report