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UNIVERSITY CONSORTIUM ON SOILS OF THE
TROPICS

University Consortium on Soils of the Tropics

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Annual Report

SEPTEMBER 1, 1971—JUNE 30, 1972

UNIVERSITY CONSORTIUM ON SOILS OF THE TROPICS

Report of the
NATIONAL TECHNICAL
INFORMATION SERVICE

The Consortium consists of Cornell University, The University of Hawaii, North Carolina State University, Prairie View A and M College, and the University of Puerto Rico.

Activities of the Consortium are supported by a grant to the individual units through the Institutional Grants Program, Section 211(d) of the Foreign Assistance Act of 1961 as amended in 1966.

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SECOND ANNUAL REPORT
OF THE
UNIVERSITY CONSORTIUM ON SOILS OF THE TROPICS

SEPTEMBER 1, 1971 TO JUNE 30, 1972

The Consortium consists of Cornell University, the University of Hawaii
North Carolina State University, Prairie View A&M College and the
University of Puerto Rico

FOREWORD

This is the second annual report of the University Consortium on Soils of the Tropics to the United States Agency for International Development. The report summarizes accomplishments under grants provided to the five member institutions through the Institutional Grants Program established by Section 211(d) of the Foreign Assistance Act of 1961 as amended in 1966.

The grants, which were made to enhance the competencies of the recipient universities for teaching, research, and service in the subject matter of tropical soils, became effective at different times. The grant numbers and implementation dates are (a) Cornell University (Grant AID/csd 2834) on June 30, 1970; (b) the University of Hawaii (Grant AID/csd 2833) on November 2, 1970; (c) Prairie View A&M College (Grant AID/csd 2836) on June 30, 1970; (d) North Carolina State University (Grant AID/csd 2835) on November 2, 1970; and (e) the University of Puerto Rico (Grant AID/csd 2857) on March 4, 1971. Consequently, the periods covered by the first report differed correspondingly among the five institutions, but the end of the reporting period for each was August 31, 1971. The second report is for the period September 1, 1971 through June 30, 1972. Thereafter, all reports will be on a fiscal year period.

The report consists of six parts, identified by page numbers prefixed by letters A through F. Part A presents the accomplishments for the reporting period and plans for the coming year for the Consortium as a unit. Parts B through F are the detailed reports of the five participating institutions. Each part includes a report of activities for the reporting period and a plan of work for the 1972-73 operational year.

Each of the individual institutional reports also includes a statement of expenditures under the grant for the fiscal year within which that institution has operated and a projection of expenditures for the next fiscal year.

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THE CONSORTIUM PROGRAM
for the period
SEPTEMBER 1, 1971 TO JUNE 30, 1972

A. SUMMARY

This section of the second annual report of the University Consortium on Soils of the Tropics describes the background, objectives, accomplishments, and plans of the Consortium program as a whole.

By the end of FY 1971-72, the five institutions had increased the amount of effort on soils of the tropics substantially. Fifty-five members of the academic faculties were actively participating in the program. The graduate students in residence included 67 specializing in soil science for the tropics.

Teaching about tropical soils had been increased markedly by the end of FY 1971-72. Since the grants were made, 12 new courses had been added to curricula, and outlines and teaching materials had been prepared for four others. Eighteen existing courses had been revised to incorporate subject matter on soils of the tropics. Teachers had modified basic soils courses to incorporate subject matter and techniques studied during 1970-71 at a workshop on teaching soils of the tropics. Over the life of the grants, four professors and scientists with long experience in the tropics had taught or conducted research and advised for periods of a full academic term or longer; 18 had served on the various campuses for shorter periods. The capabilities of the faculties for work with tropical soils had been increased in both depth and perspective by association with them.

All of the institutions concentrated research financed by the 211(d) grants mainly on activities that would help explain or interpret results

of on-going tropical soil research financed from other sources. The 211(d) research activities complemented studies under AID research contracts at Cornell and North Carolina State Universities under normal appropriations and grants at the Universities of Hawaii and Puerto Rico, and under Cooperative State Research Service funding at Prairie View A&M College. Thirty-nine publications, theses, and manuscripts on tropical soils were produced during FY 1971-72 at the five institutions from all sources of funding.

Individuals of the five institutions made 62 visits concerned with soils of the tropics in 23 countries during 1971-72. Ten of these were on assignments for six months or more. The others ranged from short visits concerning cooperative research or action programs to travel concerned primarily with extending faculty competence and experience. Some involved participation in seminars. All of the visits established or consolidated linkages between members of the Consortium and foreign scientists and institutions. Information about 13 institutions visited in Africa has been exchanged among Consortium members.

Each institution has expanded library resources on soils of the tropics and has improved reference capabilities. Four reference compilations on soils of the tropics have been exchanged among members of the Consortium. Initial contacts have been made with the Soil Conservation Service, the Tennessee Valley Authority, and the CUSUSWASH Consortium about collaboration on bibliographical service for soils of the tropics.

The impact of the program is clearly evident in larger numbers of involved faculty, larger numbers of graduate students, increased teaching and research, improved library and reference resources, and

vastly increased perspective of the faculties for applications of soil science in the tropics. Many of the accomplishments have derived from institutional resources whose use for studies of tropical soils has been stimulated by activities under the grants. The institutional contributions to the total effort in tropical soils far exceeds expenditures under the grants.

The plan of work for 1972-73 projects cooperative teaching projects, continued increase of subject matter on tropical soils in resident teaching, continued support of on-going research, continued improvement of library resources, and continued establishment of foreign linkages. Four new resident courses will be initiated. Six short-term and four long-term visiting professors are scheduled. A Tropical Soils Institute will be held in Puerto Rico for professional soil scientists. A seminar on soils of tropical savannas has been planned. At least 10 consulting assignments have been scheduled or are under way.

B. GENERAL BACKGROUND AND PURPOSE OF THE GRANTS

Soils of the tropics pose unique problems for development of agriculture. American interests in education and in development of nations require knowledge of the applications of soil science in the tropics. The aggregate of American expertise in this area of knowledge is substantial; but it is incomplete, and knowledge of the varied facets of the subject is distributed unequally among American institutions. The grants covered by this report were made to develop a coordinated American resource of knowledge about soils of the tropics and their use.

Institutional grants were made to Cornell University, the University of Hawaii, North Carolina State University, Prairie View A&M College, and the University of Puerto Rico to enhance their capabilities in

tropical soils for teaching, research, service, and consultation. The grants were made through the Institutional Grants Program established by Section 211(d) of the Foreign Assistance Act of 1961 as amended in 1966. The grants were made separately to the several institutions on the basis of their plans for development as centers of knowledge about tropical soils within a Consortium organized to develop complementary coordinated programs.

To implement the joint program, the Consortium plan provides for: (a) a council of institutional representatives having administrative authority for policy and for program guidance; (b) an executive committee of institutional project leaders to develop and implement detailed plans of operation and cooperation; (c) additional resident and visiting professional staff to reinforce and complement existing competencies; (d) support of graduate students and faculty for development of competencies and resources; and (e) increase of institutional material resources and supporting staff, including library resources, technicians and stenographic service. The plan provides for exchanges of personnel to capitalize on the respective strengths of the cooperating institutions, assignments of personnel to tropical areas for experience, and joint cooperative activities for special services.

The cooperating institutions provide administrative services, existing physical resources, inputs from existing faculty competent in the field, and various benefits and services normally provided for other operations. Each is committed to development of viable teaching and research programs on soils of the tropics and to accommodate requests for training, technical assistance, and consulting services as feasible and consistent with institutional resources and continuing domestic commitments.

C. OBJECTIVES OF THE GRANTS

The five grants were awarded to develop a coordinated American resource of knowledge and professional competence for soils of the tropics and their use. The objectives of the individual grants vary in detail according to existing institutional competencies and resources and the subject matter areas that need strengthening. Each member institution has defined a field of concentration to be emphasized in the use of grant funds, as follows:

- | | |
|---------------------------------|---|
| Cornell University | - Cultural systems for soils of the tropics |
| University of Hawaii | - Biology and mineralogy of soils of the tropics |
| North Carolina State University | - Soil fertility relating plant nutrition to the physical and chemical properties of soils of the tropics |
| Prairie View A&M College | - Soil fertility problems under savanna-prairie ecology |
| University of Puerto Rico | - Conservation and protection of soils of the tropics |

D. ACCOMPLISHMENTS

The accomplishments that are a direct result of AID support are summarized here under the headings: (a) faculty and student involvement; (b) teaching; (c) research; (d) consultation; and (e) library and reference. These areas of activity are treated in the perspective of the Consortium as a whole, including contributing activities of both the individual institutions and joint projects. Accomplishments of individual institutions are described in detail in subsequent sections of the report.

The report covers the 10-month period from September 1, 1971 to June 30, 1972; e.g., the end of the period covered by the first annual

report to the end of the 1971-72 fiscal year. Hereafter annual narrative reporting periods will correspond to the July 1-June 30 fiscal year.

1. Faculty and Student Involvement: All of the institutions have implemented their respective objectives by direct faculty and student involvement in studies of tropical soils. At the Universities of Hawaii and Puerto Rico, the grants have increased the existing substantial scope of competencies by creating opportunities for broader or more intensive experiences. At the other institutions the grants not only have increased the experience of faculty already involved in studies of tropical soils but also have enlisted staff who had little prior commitment. In the aggregate, 55 members of the academic faculties were involved in tropical soil studies to a significant degree at the five institutions during 1972-72. During the same period, 67 graduate students having majors in soil science and a commitment to the tropics were enrolled. (Only part can be attributed to AID support.)

2. Teaching: Teaching of basic soils courses has been affected significantly by the tropical soils teaching workshop reported for 1970-71. During 1971-72, all of the institutions have modified basic soils courses to incorporate subject matter and teaching techniques studied in the workshop. The result has been substantial enhancement of teaching about tropical soils in courses that enroll hundreds of students. The educational impact is great; the courses affected reach not only students specializing in soils but also many students of the other agricultural disciplines and some students of social, physical, and biological sciences.

All of the institutions have put substantial effort into preparation for a Tropical Soils Institute to be held in Puerto Rico for professional

soil scientists during July and August of FY 1972-73. Instructional staff members from each of the institutions have prepared teaching material, and the University of Puerto Rico has completed institutional arrangements to accommodate participants, instructors, and conduct of the course.

During FY 1971-72, four new courses on tropical soils were added to curricula: 1 at North Carolina State University, 2 at the University of Hawaii, and 1 at Prairie View A&M College. Twelve new courses on tropical soils have been added during the life of the project. Syllabi and teaching materials were prepared for four new courses to be offered for the first time during the 1972-73 academic year: three at the University of Puerto Rico and one at Cornell University. During the life of the project, 18 existing courses have been modified to incorporate subject matter relevant to the tropics: 5 at North Carolina State University; 3 each at the University of Hawaii, the University of Puerto Rico, and Prairie View A&M College; and 4 at Cornell University.

Innovations in teaching include installation and use of autotutorial and audiovisual systems at the Universities of Hawaii and Puerto Rico and at Prairie View A&M College. Both the University of Hawaii and Prairie View A&M College have prepared teaching materials suitable for use by institutions of tropical countries.

During 1971-72, Consortium members have used nine visiting scientists with long experience in the tropics to establish linkages and expose both faculty and students to their knowledge and experience. North Carolina State University, the University of Hawaii, and Prairie View A&M College each had a short-term consultant and lecturer. Cornell University had three visiting scientists on short-term assignments and

two visiting professors for periods of six to nine months. One of the latter was Professor James Silva of the University of Hawaii, whose exchange activities contributed to programs of both Cornell and the University of Hawaii. The University of Hawaii employed one individual on a long-term basis. In addition to the impact of these visitors on teaching and research programs, they have established firm linkages with individuals and, through them, among institutions.

3. Research: The cooperating institutions have used funds from the 211(d) grants for research mainly to augment activities supported by other funds. The Universities of Hawaii and Puerto Rico, however, initiated a joint project, supported largely from the grants, for classification, mineralogical characterization, and correlation of soils of Puerto Rico and Hawaii, including a geomorphic-pedogenic study in Hawaii.

Prairie View A&M College used 211(d) funds to provide personnel and materials for applied research focused on problems of the rural poor and financed largely by other funds. Although serving rural poor in America, the research supported by the grant also applies to problems common in the tropics. Prairie View A&M College has also started to compile a data bank on properties of soils of tropical savannas.

The University of Hawaii's normal research program in soils is predominantly oriented to the tropics. Approximately 60 percent of the expenditure of 211(d) funds was used to augment this large program through soil characterization and mineralogical studies. These studies were mainly of soils of Hawaii but they included certain soils of Puerto Rico as part of the cooperative study mentioned above.

Cornell University and the University of Puerto Rico are collaborating on soil fertility research for food crops on important soils of the humid tropics. This joint program is financed by contract AID/csd 2490, but 211(d) funds have been used by both institutions to investigate subsidiary questions for which answers are needed to explain and interpret results. The University of Puerto Rico, in addition, has used 211(d) resources for studies of correlations between the classification systems of FAO and the United States. Cornell University is extending its program under the contract to Brazil in cooperation with North Carolina State University, and a limited amount of 211(d) funds has been used for development of plans for this activity.

North Carolina State University is conducting two large projects under AID contracts--"The International Soil Fertility Evaluation and Improvement Program" (AID/1a 646) and "Agronomic-Economic Research on Tropical Soils" (AID/csd 2806). The faculty that participate in 211(d) grant activities also contribute to the Research Contract. Funds from the 211(d) grant have been used to support graduate students and travel for studies of related problems. During the year, plans were developed for collaboration with Cornell in Brazil.

Thirty-nine publications, theses, and manuscripts on tropical soils were produced by the five institutions during 1971-72.

4. Consultation: Twelve individuals from the five institutions participated in an international conference on tropical soil research sponsored by the International Institute of Tropical Agriculture, the Ford Foundation, and L'Institut de Recherches Agronomiques Tropicales at Ibadan, Nigeria. Each individual also visited educational and research

institutions in Africa after the seminar. They established linkages with 17 institutions in Nigeria, Ghana, the Ivory Coast, Senegal, Kenya, Uganda, and Ethiopia. Documentation on 13 of these institutions has been exchanged among Consortium members.

Individuals of the Consortium institutions made 36 other short-term visits to 13 foreign countries during 1971-72 on matters pertaining to tropical soils as follows:

Indonesia	- 1 visit	Brazil	- 4 visits
Thailand	- 2 visits	Guatemala	- 11 visits
Ivory Coast	- 2 visits	Panama	- 1 visit
Germany	- 1 visit	Guyana	- 1 visit
Rome (FAO)	- 2 visits	Costa Rica	- 2 visits
Colombia	- 5 visits	Dominican Republic	- 1 visit
Peru	- 3 visits		

These short visits ranged from consultations about cooperative research or action programs to consulting on special problems. Most were not supported by 211(d) funds, but all contributed to objectives of the program. Ten other individuals were stationed overseas on long-term assignments:

Philippines	- 1	Guatemala	- 1
Iran	- 1	Panama	- 1
Peru	- 1	Costa Rica	- 2
Venezuela	- 1	Brazil	- 2

Within the United States, individuals consulted with soil scientists in Florida and at TVA as well as at other cooperating institutions. All of the Consortium institutions were represented at the fall meeting of the Executive Committee meeting in Hawaii in 1971 and at the spring meeting in Nigeria in 1972. The Consortium was represented at three meetings of the CUSUSWASH group, out of which have come recommendations for collaboration between the two consortia.

5. Library and Reference: All of the institutions have continued to increase library resources and improve reference facilities. Contacts were made with the Tennessee Valley Authority, the CUSUSWASH Consortium and the Soil Conservation Service about opportunities for collaboration on bibliographical services. Opportunities for collaboration with one or more are to be discussed at the next Executive Committee meeting.

North Carolina State University has distributed copies of the soils sections of the first five volumes of the Latin American Bibliography of Agriculture, copies of the holdings on tropical soils at the Library of the Interamerican Institute of Agricultural Sciences at Turrialba, and a "Review of Soil Research in Tropical Latin America." Cornell University has distributed copies of research project descriptions catalogued by the Smithsonian Science Information Exchange.

E. IMPACT OF GRANT-SUPPORTED ACTIVITIES IN DEVELOPING INSTITUTIONAL CAPABILITIES

The impact of the 211(d) grants varies in detail among the five institutions. The kinds of impact are described in the reports of the individual institutions, which follow this section. A common denominator for all, however, is the effect the grants have had on the capabilities of professional staff.

For the Consortium as a whole, more scientists are engaged in studies of tropical soils, and the collective institutional capabilities have been enhanced accordingly. Even at the Universities of Hawaii and Puerto Rico, where the focus of attention is normally on the tropics, professional staff have been added to increase capabilities in the

least developed subject-matter areas. For the three institutions in the temperate zone, the activities generated by the grants have involved a high proportion of the existing professional staff, many of whom had previously had little commitment to studies of tropical soils. The Consortium collectively, now has 55 members of the respective faculties who are actively studying the applications of soil science in the tropics. This is about 20 more than at the time the grants were initiated.

Quite apart from numbers of people, however, the grants have provided opportunities for experience not only in the tropics but also in varied environments of the tropics. The soils and environments of the tropics are at least as varied as those of temperate regions. In two years time, the perspective of the faculties of all institutions has been increased immensely by personal experiences with soils and soil problems that had been perceived vaguely if at all. The African experience of 12 people in 1972, for example, revealed many kinds of soil and soil problems that had not been comprehended before.

The aggregate impact is more than the sum of individual experiences. The interaction among individuals from different institutions within the Consortium has been both stimulating and educational. The interaction with scientists of other institutions has added new dimensions of thought. The net effect of all of these factors on total capabilities and enthusiasm cannot be measured in quantitative terms, but it is very large.

F. USE OF INSTITUTIONAL RESOURCES FOR DEVELOPMENT

Only those activities which contribute to advancement of less developed countries through work with foreign nationals or institutions

are summarized here. For clarity, they are identified under training, long-term research, long-term action programs, and short-term consulting.

1. Training

- 1.1 Graduate students from less developed countries in training at the five institutions - 51
- 1.2 Participants in a soil testing seminar for foreign nationals - 15
- 1.3 Staff teaching in a less developed country - 1
- 1.4 Staff conducting training coincident with long-term research and action programs in less developed countries:

Iran	- 1	Brazil	- 2
Venezuela	- 1	Costa Rica	- 2
Philippines	- 1	Panama	- 1
Peru	- 1	Guatemala	- 1

Ten staff members in eight countries

2. Staff Engaged in Long-Term Research in Less Developed Countries:

One each in Costa Rica and Brazil.

3. Staff Engaged in Long-Term Action Programs in Less Developed

Countries: (*served by staff stationed in another country)

Iran	- 1	*Honduras	
Venezuela	- 1	*Nicaragua	
Philippines	- 1	Costa Rica	- 1
Guatemala	- 1	Panama	- 1
*El Salvador		Brazil	- 1
Peru	- 1		

Eight staff members serving 11 countries

4. Staff Visits for Short-Term Consulting to Assist Less Developed

Countries: The list that follows excludes visits made primarily to increase the scope of experience of Consortium members. Visits for general seminars and meetings and visits to 17 African institutions

following the spring meeting of the Executive Committee are not included.

Colombia	- 5	Guyana	- 1
Guatemala	- 11	Brazil	- 4
Peru	- 3	Dominican Republic	- 1
Costa Rica	- 2	Ivory Coast	- 2
Panama	- 1	Indonesia	- 1
		Thailand	- 1

Thirty-two staff member visits to 11 countries

G. OTHER RESOURCES USED FOR GRANT-RELATED ACTIVITIES

The five institutions have contributed salaries and related costs from sources other than the 211(d) grants for 48 of 55 members of their faculties who spend a significant amount of time on teaching, research, and consultation on soils of the tropics. They have also supported 51 of 67 graduate students working in the area of tropical soils. At the Universities of Hawaii and Puerto Rico where most work in soil science is focused on the tropics, and to some degree in the other institutions as well, much of the institutional contribution for personnel service was not necessarily generated by the 211(d) grants. Nevertheless, it contributes to grant objectives. At some of the institutions a major part was generated by grant activities. The aggregate expenditures on personnel for tropical soil studies from sources other than 211(d) funds, though not appraised quantitatively, greatly exceeds expenditures for salaries and related costs under the grants, especially if salaries of supporting staff and fringe benefits not supported by 211(d) funds are included.

At least six major items of travel related to 211(d) activities and costing between \$250 and \$1,000 each, were financed by sources other than AID. Sixteen travel items of similar magnitude financed by AID contracts independently of the 211(d) grants have been identified.

The grants have generated more than \$200,000 in grants for equipment, mainly at the University of Hawaii, from various sources other than AID. A significant sum has also been generated for supplies and services from traditional sources.

The contributions other than those from the various AID contracts are from a variety of sources. They are heavily weighted by institutional funds from normal appropriations, especially for salaries of contributing staff and associated personnel costs. This is especially large for the Universities of Hawaii and Puerto Rico where appropriations for activities in soil science are almost wholly oriented to soils of the tropics. Grants from various sources ranging from industries to foundations are a significant part.

H. PLAN OF WORK FOR 1972-73

The Consortium will initiate cooperation on joint instructional projects during 1972-73. All of the cooperating institutions will collaborate in a four-week Institute of Tropical Soils at the graduate level for professional workers in soil science. Most of the preliminary work was completed during FY 1971-72. If this is successful, plans will be developed for continuation in future years. Prairie View A&M College and the University of Puerto Rico are planning a seminar on soils of savanna areas in the Dominican Republic. A four-day workshop on tropical soils for staff and administrators of the 1890 Land Grant Colleges and other agricultural institutions and agencies has been planned by Prairie View A&M College. This is not scheduled as an activity of the Consortium, but individuals of the cooperating universities will participate. The University of Hawaii plans to propose a

workshop on mineralogy teaching and research for staff of the Consortium institutions. Plans would be developed during 1972-73.

There will be continuing emphasis on teaching about tropical soils at the five institutions. Four new courses on the subject will be initiated. New teaching techniques established during the first two years of operation will be expanded. Existing courses will continue to be modified. Six visiting professors are scheduled for short periods; four are scheduled for an academic term or longer. The number of graduate students studying tropical soils will be increased substantially at two institutions. One new academic position will be established.

Emphasis for research will continue to be placed on problems that support on-going research programs financed by other funds. At North Carolina State and Cornell Universities, the major 211(d) research input will be used to complement research under AID contracts. For the Universities of Hawaii and Puerto Rico, the input will be used to provide studies not adequately covered by normal research budgets, which focus on the tropics. At Prairie View A&M College, 211(d) funds will continue to support work under Cooperative State Research Service funding.

All of the five institutions will continue to consult in developing countries to the extent feasible as opportunities and need become evident. Consultation will be used as a device to increase Consortium expertise as well as for assistance to developing countries. Projects planned or under way include consultation in Iran, Venezuela, several Latin American countries involved with Consortium members in AID research and action programs, the Solomon Islands, the Dominican Republic, and possibly Senegal.

All of the institutions will continue development of library and reference resources. The Consortium will investigate possible collaboration with the Tennessee Valley Authority, the Soil Conservation Service, and the CUSUSWASH Consortium on bibliographical services for tropical soils.

REPORT OF CORNELL UNIVERSITY
FOR THE PERIOD
JULY 1, 1971 TO JUNE 30, 1972

- A. TITLE: A Grant to Strengthen the Capabilities of Cornell University for Special Problems of Tropical Soils (Grant AID/CSD 2834)
- B. GRANTEE: Cornell University
- C. DIRECTOR: Drs. Matthew Drosdoff and Marlin G. Cline
- D. STATISTICAL SUMMARY
1. Period of Grant: June 30, 1970 to June 30, 1975
 2. Amount of Grant: \$500,000
 3. Expenditures
 - 3.1 For report period: \$86,763.73
 - 3.2 Accumulated: \$111,994.32
 - 3.3 Anticipated for next year: \$129,500.00
- E. NARRATIVE SUMMARY

The effort expended on teaching the applications of soil science to the tropics had increased at Cornell to approximately 2.6 times its 1969-70 level by the end of FY 1971-72. The effort by permanent staff had doubled and represented about 13 percent of the total staff effort in soil science. Approximately 60 percent of this was supported by University resources.

The increased effort included: (1) incorporation of subject matter for the tropics in regularly scheduled courses in elementary soils, soil fertility, soil chemistry, and soil classification and genesis by permanent staff; (2) introduction of a course in soil mineralogy and a seminar on soils of the tropics by permanent staff; and (3) special lectures and seminars on soils of the tropics by

visiting authorities. A syllabus for a new course on cultural systems for soils of the tropics to start in FY 1972-73 had been developed. Plans and teaching material had been developed for the Cornell contribution to a Tropical Soils Institute sponsored by the Consortium in Puerto Rico for July-August of FY 1972-73. Counseling of graduate students from the tropics had increased in both quality and amount. Most of these accomplishments were made in 1971-72 but were initiated or planned during the first year of the grant, 1970-71.

Research effort under the grant has focused on answering questions raised by research conducted under an AID research contract for tropical soil investigations. It has included studies of micro-nutrients, organic matter, magnesium, the fate of applied nitrogen, interactions of weather, and mineralogy of tropical soils to explain and interpret data generated by the research contract.

Consultation in 1971-72 included visits to 10 institutions in five African countries and has resulted in documentation of those institutions distributed to AID and Consortium members. It also included one visit to Colombia, one to Brazil, and a number of meetings with AID officials and representatives of Consortium institutions.

Library holdings on soils of the tropics have been increased and consolidated, and reference card files have been developed for holdings in the departmental and college libraries.

Perhaps the most important accomplishment has been developed by depth and perspective of the subject matter of soil science for the tropics by permanent faculty and coordination of subject matter areas, stressing the interactions of specialized knowledge of soils of the tropics.

F. DETAILED REPORT

1. General Background and Purpose of the Grant: The general background and purpose of the five grants to Consortium members are described in the first section of this report. Within that context, Cornell University based its proposal on its need to develop broader and more unified perspective of the applications of soil science in the tropics for quality education, research, and service.

Cornell is far from the tropics. It has long recognized, however, that quality university programs cannot be achieved if the perspective of its faculty is provincial. The University has also recognized obligations as a public institution to serve as a resource for national and international programs and policies. This also requires broad perspective. Consequently, many University faculty, including those in soil science, have been encouraged to work in varied physical and cultural environments as a matter of policy.

Under these policies, faculty representing most of the major specialties of soil science had had substantial experience with soils of the tropics before the grant was initiated. That experience, however, had focused mainly on problems of individual specialties within soil science. Gaps in the range of subject matter also existed, as in the areas of mineralogy and soil-water relationships of soils of the tropics. The grant proposal of Cornell, therefore, focused on development of a comprehensive but unified perspective of soils of the tropics in relation to their uses and culture by concentrating on "Cultural Systems for Tropical Soils."

2. Objectives of the Grant: The objective of the grant to Cornell is to develop a comprehensive and unified perspective of soils of the

tropics in relation to their uses and culture. The objective implies a focus on the combination of practices necessary for viable cultural systems for tropical soils. Achievement of the objective requires coordinating knowledge of at least four areas of soil science-- (1) soil characteristics and classification, (2) plant nutrient requirements, (3) soil-water-plant relations, and (4) conservation and protection of different kinds of tropical soils. In addition, it requires supporting inputs for (1) the impact of climatic conditions on soil and crop behavior, (2) water management, (3) crop management, and (4) the economic and social environments within which knowledge and technology must be applied. To fulfill the objective, the grant provides for:

- (1) Participation of Cornell faculty, one of whom would serve as Cornell project leader and would coordinate Cornell's efforts with those of the other four cooperating institutions.
- (2) Visiting professorships through which Cornell would bring additional expertise and experience to the project.
- (3) Graduate assistantships and related support for students contributing to this project, including exchange students from the four cooperating institutions.
- (4) Travel of contributing staff and students.
- (5) Modification of existing soils courses and development of new courses to enhance teaching about soils.
- (6) Strengthening library and other informational services and preparation of training materials.

The activities under the grant have remained consistent with the original objective and provisions of the grant for implementation. No modification of the objective is contemplated.

3. Accomplishments

3.1 Teaching: Approximately \$35,800 of 211(d) funds were used for teaching a variety of aspects of soils of the tropics. The high

enthusiasm generated among students was a qualitative measure of substantial accomplishment. Specific activities include the following.

(1) Initiation of "Tropical Soil Discussions." This non-credit informal seminar met bi-weekly throughout the academic year. At each meeting a faculty member, student, or visiting professor led open discussion on a specific topic. Although attendance was voluntary, the number of participants was consistently between 25 and 45 people.

(2) Teaching activities of visiting professors and scientists. Five prominent scientists were brought to the campus on 211(d) funds for varying periods during the year:

Dr. S. K. DeDatta, Soil Scientist, International Rice Research Institute, for one week

Mr. Fernando Abruna, Soil Scientist, Agricultural Research Service, USDA, Puerto Rico, for two weeks

Dr. John Coulter, Tropical Soils Advisor, British Overseas Development Administration, for six months

Dr. James Silva, Professor of Soils, University of Hawaii, for nine months

Dr. Madan Dewan, Soil Scientist, FAO, for six weeks

These men gave 35 lectures and seminars during the academic year for students and faculty of soil science, crops, animal science, the college-wide International Agriculture program, and special student groups. In spite of competition with many other events, attendance was large and student enthusiasm remained high.

In addition to formal presentations, the visitors taught informally throughout their residence. They were available to graduate students and faculty for personal counseling. They participated actively in classes that focused on tropical soils and in a variety

of seminars. They injected a wealth of practical and scientific knowledge into the learning experience of at least 20 graduate students who engaged in personal communication with them.

(3) Modification of courses. Regularly scheduled courses in elementary soils, soil fertility, soil chemistry, and soil genesis and classification were modified substantially to accommodate knowledge acquired through the program in tropical soils. These four courses served about 340 students during the past year. Their enrollment is increasing steadily. Funds from the 211(d) grant contributed. Contributing funds from State sources are represented in the contributions other than 211(d) funds listed for teaching in Table 9.1.

(4) Tropical field laboratory. During the January intersession, 30 students from several fields of study were taken to Puerto Rico for two weeks' study of tropical agriculture, including its relationships to soils. This course was not initiated as a consequence of 211(d) funding, but 211(d) resources contributed to the teaching about tropical soils, both in Puerto Rico and during the seminar sessions that followed during the spring term.

(5) Tropical Soils Institute. During the 1971-72 fiscal year, 211(d) funds were used for planning and preparation of teaching material for the Tropical Soils Institute sponsored by the Consortium for July-August 1972 in Puerto Rico. The results of that project will be reported for FY 1972-73.

(6) Course in Cultural Systems for Tropical Soils. This course will be offered for the first time in the spring of 1973, but 211(d) funds were used in FY 1971-72 to develop the initial syllabus.

Dr. John Coulter developed a detailed outline while he was on the campus, and he tested it in part in lectures following the Puerto Rico field laboratory. Dr. Richard Fox, who will teach the course, spent two weeks at Cornell on leave from his duties in Puerto Rico to work with Dr. Coulter on the course outline.

Approximately 41 percent of the 1971-72 expenditure of 211(d) funds was used to develop the teaching in tropical soils. Since the initiation of the grant, a course in soil mineralogy has been established; knowledge about soils of the tropics has been introduced into courses in elementary soils, soil genesis and classification, soil fertility, and soil chemistry; and a syllabus for a course in cultural systems for tropical soils has been developed. The perspective of the teaching staff generally has been broadened through direct experience in the tropics and the impact of visiting professors.

3.2 Research: Approximately \$26,800 of 211(d) funds was used for research on soils of the tropics. All of this was used to augment research conducted under research contract AID/CSD 2490 for investigating the fertility requirements of important soils of the humid tropics. Work under that contract has raised many questions for which answers are needed to explain and interpret results. Funds of the 211(d) grant have been used to investigate these questions. The areas of investigation included the following during 1971-72.

- (1) The fate of nitrogen applied as various kinds of fertilizer to the kinds of soils used in field experiments
- (2) Micronutrient status of various kinds of soils used in field experiments
- (3) Microbiological aspects of organic matter decomposition under tropical conditions

- (4) The magnesium status of major kinds of soils of the humid tropics
- (5) Climatic data in relation to the incidence of drouth and its interaction with fertility in field experiments
- (6) Transformations of nitrogen in flooded soils
- (7) Mineralogical composition of major kinds of soils used for field experiments

Graduate research assistants were employed for varying periods on 211(d) funds for investigations 1-6; a research specialist was employed part time for investigation 7. Funds of the 211(d) grant were also used for part salary of the research project leader, for travel and subsistence of staff and graduate assistants to the Puerto Rico base of research operations, and for supporting supplies, communications, and clerical service.

Most of the investigations supported by 211(d) funds are still in progress, and the results obtained to date are significant mainly in the context of the research project to which they contribute. Results of that project are given in the annual report of the AID research contract. Investigations of the fate of nitrogen applied as fertilizer on soils used in the field experiments are complete, however. The results are of some interest by themselves and are summarized here.

Nitrogen transformations from applied ammonium sulfate and urea were followed with time in fallow field plots on each of three kinds of soil--a quartzipsammentic Haplorthox, an oxidic Tropeptic Haplorthox, and a kaolinitic Aquic Tropohumult. Movement of nitrate and ammonia was followed with depth over time and related to movement of chloride applied in parallel treatments. In all soils, urea produced ammonia

maxima within two weeks; nitrates formed rapidly and at about equal rates from ammonium sulfate and urea; and nitrates formed from either source moved downward in the soil as a function of water movement at the same rate as chloride. In the more sandy Psammentic Haplorthox, ammonium ions were also leached downward. Nitrogen applied before or at planting in the form of either ammonium salts or urea is subject to loss before crop roots can intercept it if water movement occurs during germination and seedling establishment.

Publications and manuscripts reporting work by Cornell on tropical soils during FY 1971-72 are listed below. Funds from the 211(d) grant contributed to research by Ferreira and by Weaver. The other work cited was supported mainly by other funds, though 211(d) resources supported travel by Dr. Fox to present his paper.

3.3 Published or in press

- Drosdoff, M. 1972. Soil micronutrients, pp. 151-162. In Soils of the Humid Tropics. National Academy of Sciences, Washington, D. C.
- Ferreira, F. F. 1972. The fate of nitrogen fertilizers applied to tropical soils. M. S. thesis, Cornell University.
- Lathwell, D. J., Dubey, H. H. and Fox, R. H. 1972. Nitrogen supplying power of some tropical soils of Puerto Rico and methods for its evaluation. Accepted for publication, Agron. Jour., November-December issue.
- Santiago, P. 1972. The role of organic matter in the inhibition of aluminum toxicity in an Ultisol. M. S. thesis, Cornell University.
- Van Raij, B. and Peech, M. 1972. Electrochemical properties of some Oxisols and Alfisols of the tropics. Soil Sci. Soc. Amer. Proc. 36:587-593.
- Zandstra, H. G. 1971. Aluminum toxicity in some highly weathered soils of the tropics. Ph. D. thesis, Cornell University.

3.4 Manuscripts

- Fox, R. H. Nitrogen fertilization in the humid tropics. A paper presented at a Tropical Soils Research Seminar sponsored by the International Institute of Tropical Agriculture, the Ford Foundation, and L'Institut de Recherches Agronomiques Tropicales et des Cultures Vivrieres at Ibadan, Nigeria, May 22-29, 1972.
- Weaver, R. M. Mineralogy of highly weathered and leached soils of the humid tropics. Submitted for publication in McGraw Hill Yearbook of Science and Technology.
- Weaver, R. M. Clay mineralogy of Ultisols and Oxisols of Puerto Rico. To be submitted to Soil Science.
- Weaver, R. M. pH dependent cation exchange selectivity of Oxisols and Ultisols. To be submitted to Soil Sci. Soc. Amer. Proc.
- Weaver, R. M. Influences of amorphous iron oxides and organic matter on the charge characteristics of highly weathered soils of the tropics. To be submitted to Clays and Clay minerals.
- Zandstra, H. G. and Bouldin, D. R. Measurement of aluminum toxicity: I. Effects of aluminum in soil solution on root growth. Submitted for publication in the Soil Sci. Soc. Amer. Proc.

3.5 Consultation: This item is divided into domestic and foreign consultation in the financial report. Domestic consultation includes Consortium Executive Committee meetings, consultation with and reporting to AID officials, consultation with individuals of Consortium institutions on plans for joint activities, and consultation with staff of Consortium and other U. S. institutions and individuals on subject matter of the Consortium. Foreign consultation includes participation in foreign seminars and conferences and consultation with scientists at foreign institutions. Salaries, travel and subsistence, and stenographic services for these activities are charged to consultation in Table 9.1.

Approximately \$9,300 of 211(d) funds were used for domestic consultation. Activities include two Executive Committee meetings,

one in Hawaii; the annual report and review by AID; two trips to consult AID officials, and consultation with scientists of TVA and North Carolina State University.

Approximately \$10,100 of 211(d) funds were used for foreign consultation. Professor Martin Alexander participated in a meeting of the Colombian Society of Soil Science and consulted with Colombian scientists while in the country. Professors Cline, Drosdoff, and Fox and Visiting Professor Coulter participated in a week-long seminar on tropical soils at Ibadan, Nigeria. Each had an assignment in the program. (Costs for air transportation were billed in FY 1972-73 and are not included in expenditures for 1971-72.) Following the seminar, the individuals visited various African institutions to establish relationships and assemble information about the institutions for the Consortium:

- M. G. Cline - (1) Soil Research Institute, Council for Scientific and Industrial Research, Kumasi, Ghana
- (2) University of Science and Technology, Kumasi, Ghana
- (3) IRAT Agricultural Research Center, Bambey, Senegal
- M. Drosdoff - (1) ORSTOM Center, Adiopodoume, Ivory Coast
- (2) IRAT Research Center, Bouaké, Ivory Coast
- (3) IRAT Agricultural Research Center, Bambey, Senegal
- (4) ORSTOM Center, Dakar, Senegal
- R. Fox - (1) Institute for Agricultural Research, Samaru, Nigeria
- (2) Ahmadu Bello University, Samaru, Nigeria
- J. K. Coulter - (1) Agricultural Officials, the Gambia

Reports on all of these visits have been distributed to Consortium members and AID. Individuals also consulted with officials of each AID country mission.

These visits provided an opportunity to appraise the facilities, staff, and work of eight African institutions that work with tropical soils and related problems. They provided bases for appraisal of published research results and of records of students who apply for graduate studies. Of equal importance, they provided personal contacts with scientists of the African institutions and with officials of AID country missions, which greatly assist communication. The visits also established contacts for potential work of American graduate students abroad. One such arrangement is currently being investigated. In most instances, the hosts also gave the visitors valuable information about soils and agriculture of the country, and opportunities were provided for field observations of soils and farming.

Professor Richard Arnold went to Venezuela in February 1972 for a year to consult with Venezuelan authorities on soil classification, soil survey, and resource planning. Two thousand dollars of 211(d) funds for his support is reported under foreign consultation in Table 9.1.

3.6 Library and reference: Approximately \$4,700 of 211(d) funds was spent on library acquisitions and compilation of reference material during 1972-72.

Acquisitions for the departmental library collection on tropical soils numbered 97. Duplicates were already available or were acquired for the stacks of the library of the college.

The card file of the departmental library was searched for holdings on soils of the tropics, and a separate card file was established for easy reference. The extensive card file of the college library was also searched and, when necessary, items of questionable

relevance were inspected in the stacks. A separate card file of college holdings on tropical soils, indexed by country or region and character of subject, was then established in the card catalog of the departmental library. This occupies one standard card file drawer.

A bibliography on manganese in soils of the tropics was completed and awaits editing before reproduction and distribution.

Cornell purchased a compilation of 480 abstracts of active research projects on soils and climates of the tropics from Smithsonian Science Information Exchange, Inc. and distributed sets to all Consortium members.

Initial contacts were made with TVA, the USDA-SCS Soil Geography Unit, and the CUSUSWASH Consortium about potential collaboration on bibliographical service for soils of the tropics. Cornell is proceeding with investigation of means for making the extensive bibliography of the SCS Soil Geography Unit available to the Consortium, or to a greater audience. Collaboration with TVA, CUSUSWASH, or both should be discussed at the next meeting of the Executive Committee.

4. Impact of Grant-Supported Activities in Developing Institutional Capabilities: Most of the impact has been on involvement and perspective of people. The grant has been used deliberately to sponsor activities that will involve as many as possible of the Cornell faculty in a variety of aspects of soil science applied to the tropics. Twelve of the faculty in soil science are actively contributing to studies of soils of the tropics. Graduate students supported by the grant involve the faculty members who represent their special interests. Visiting professors and scientists are used to involve both faculty

and students in scientific discourse and relevant problems. Faculty are provided travel and other support if it involves them in study of the subject or teaching about it. Devices such as seminars, special lectures, and small group or individual conferences are used to develop integrated perspective of the varied aspects of soils of the tropics and their use. It is believed that these impacts will be the ones of greatest long-term value for developing a resource for tropical soils at Cornell that will persist after the grant has terminated.

The impact is difficult to measure in quantitative terms, and that part which is attributable to the 211(d) grant is difficult to appraise as distinct from that resulting from the AID research contract. No attempt is made here to make that distinction, though those elements that relate to teaching, consultation, and library and reference are predominantly consequences of the 211(d) grant. The involvement of financial resources other than 211(d) funding given in Table 9.1 is the best quantitative estimate available. These aggregate about \$110,000 for 1971-72 and exceed expenditures under the grant. About \$48,000 of this is in Cornell salaries paid from sources other than AID funds, representing approximately 1 1/5 full-time equivalents of Cornell faculty and 1 3/4 full-time (40-hour week) equivalents of graduate students.

Functionally, the grant has strongly influenced teaching in three regularly scheduled courses that enrolled about 340 students. It has stimulated addition of two new courses, one in soil mineralogy and one in cultural systems for soils of the tropics. It has stimulated applications for graduate work on various aspects of tropical soils,

especially from African nations. It has established contacts between Cornell faculty and foreign scientists, which should provide continuing liaison and dialogue. The grant has provided library and reference resources that will have continuing value. Finally, the grant has made it possible to maintain a faculty position devoted mainly to enhancement of Cornell's capabilities in the subject, with prospects for continuation beyond the termination of the grant.

5. Utilization of Institutional Resources in Development: During FY 1971-72 three members of the faculty in soils were engaged in developmental work in lesser developed nations:

- R. Reuer; Philippines - Rice and corn programs
- R. Arnold; Venezuela - Soil survey and resource planning
- G. Olson; Iran - Soil survey interpretation

M. Drosdoff, D. Bouldin, and R. Fox consulted with Brazilian officials on establishment of cooperative soil research at Brasilia. M. Alexander consulted with Colombian scientists on problems of soil microbiology.

Three graduate students in soil science conducted thesis research in lesser developed countries on problems related to their development:

- W. Phillipson; Philippines - Aerial photo interpretation
- H. Zandstra; Colombia - Soil fertility
- G. Naderman; Colombia -- Nutritional diseases of rice

Two of these have completed graduate studies and have accepted positions in developing nations. A fourth individual worked as a member of the Peace Corps in Brazil on rice research between his M. S. and Ph. D. candidacies.

Eighteen students from lesser developed nations were candidates for advanced degrees with majors in soil science at Cornell during FY 1971-72. Five others worked in soil science as a minor subject.

Three soil scientists from developing nations conducted post-doctoral studies at Cornell. These students in residence represented 11 developing nations of Africa, Latin America, Southeast Asia, and South Asia. Five graduate majors and six graduate minors in soils from North America have career commitments to work in developing nations.

6. Other Resources for Grant-Related Activities: The value of resources contributed from funding other than AID for 1971-72 are estimated in Table 9.1 as approximately \$110,300. This is exclusive of funds used for research on fertility of soils of the humid tropics under contract AID/CSD 2490. Table 9.1 gives the estimated distribution of these funds among teaching, research, consultation, and library and reference.

Approximately \$63,000 of the total was for salaries and wages, of which \$31,000 was from State appropriations, \$5,000 from institutional grants, and \$27,000 from direct support to individuals from sources outside Cornell. A Cornell contribution of \$31,000 for indirect costs of facilities and services used on the project is included in the total, calculated at the official rate for indirect costs based on 211(d) salaries and wages (Table 9.2). The total also includes costs of \$12,700 to New York State for fringe benefits provided employees on 211(d) salaries and wages. The State assumes these costs for all employees, whatever the source of funds. Minor expenditures for supplies, services, and communications from funds administered by Cornell are included. These contributions are summarized as follows.

Salaries and wages

State appropriations	\$31,000
Other institutional funds	5,000
Individual support	<u>27,000</u>
	\$ 63,000
Indirect costs (based on salaries and wages--Table 9.1)	31,000
Fringe benefits (based on full-time salaries)	12,700
Supplies and services	3,000
Communications	600
	<u> </u>
Total	\$110,300

7. Next Year's Plan of Work: Table 9.2 includes estimated grant expenditures by line items for 1972-73. Table 9.1 includes their estimated distribution by areas of activity.

7.1 Teaching: The 1972-73 estimate for teaching in Table 9.2 is approximately \$20,200 more than was spent for that function in 1971-72. The activities of 1971-72 will continue. These include (1) a course in Geography and Appraisal of Soils of the Tropics for graduate and advanced undergraduate students, (2) a resident course following field studies in the Caribbean area for graduate students, (3) a course in soil mineralogy oriented to the tropics, (4) the informal seminar "Tropical Soil Discussions," and (5) seminars and special lectures similar in number to those offered in 1971-72. The input of applications of soil science in the tropics into regularly scheduled soil courses will continue or increase but will be supported by funds other than those of the 211(d) grant. The increased expenditure will be mainly for the Cornell contribution to a Tropical Soil Institute sponsored by the Consortium in Puerto Rico during July and August 1972 and a new course "Cultural Systems for Tropical Soils" to be offered during the spring semester. Assistant Professor Richard Fox, who is headquartered in Puerto Rico, will be brought to the Cornell campus to

teach that course. Salaries are expected to account for \$16,000 of the \$20,200 increase; teaching supplies and services, for about \$1,600; student fees, for about \$1,700; and minor items of equipment, for most of the remainder. Mr. Carlos Zamora of Peru and Dr. E. W. Russell of England will contribute to the teaching as visiting professors.

7.2 Research: The expenditures for research in 1972-73 are expected to be about \$23,700 more than in 1971-72. Most of the work underway in 1971-72 will continue. Studies in support of the AID-financed research project will be increased through two additional graduate assistants on special problems and a research specialist for supporting laboratory studies. Salaries account for about \$18,000 of the estimated increase. The remaining increase has been budgeted for increased travel to overseas research locations and for research supplies and services.

7.3 Consultation: The estimated 1972-73 budget for consultation is approximately \$7,400 less than expenditures for 1971-72. The reduction is in foreign consultation, for which no major commitments of faculty have been scheduled as of this time. The amount budgeted for foreign consultation is mainly for the air fare for staff travel for the 1971-72 African consultations, for which transportation charges were billed after the end of the 1971-72 fiscal year. The expenditures for foreign consulting could exceed the budgeted amount, depending largely on whether or not AID takes initiative in requesting assistance.

7.4 Library and reference: Approximately \$5,300 more has been budgeted for library and reference service than was spent for that function in 1971-72. The increase is for services and supplies to make

the bibliographical material on tropical soils held by the Soil Geography Unit of the Soil Conservation Service available to Consortium members. There is some possibility that this material should be published, but that remains to be explored. Only a minor sum has been budgeted for publication in 1972-73.

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).

9.3 Budget: Summary (see Table 9.3).

9.4 Budget: Detail (see Table 9.3).

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

Object	211(d) Source ^a				Non 211(d) Source
	Period Under Review	Cumulative Total	Projected Next Year	Projected to End of Grant	
Teaching	\$35,800	\$ 46,900	\$ 56,000	\$200,000	\$ 30,100
Research	25,800	36,100	50,500	190,000	57,000
Consultation					
Domestic	9,300	12,300	9,300	37,000	10,700
Foreign	10,100	10,100	2,700	26,000	8,800
Library & Reference	4,700	6,600	10,000	44,000	3,700
Publication			500	2,000	
Other			500	1,000	
Total	\$86,700	\$112,000	\$129,500	\$500,000	\$110,300

^aTo nearest \$100

Table 9.2. Expenditure report, actual and projected (review period July 1, 1971 to June 30, 1972)

Line Items	Actual Expenditures		Projected Expenditures			Total
	Period Under Review	Cumulative Total	Year			
			3	4	5	
<u>Personnel Salaries & Wages^a</u>						
Resident Professors	\$28,753.46	\$ 43,116.63	\$ 48,500.00	\$ 46,500.00	\$ 26,000.00	\$164,116.63
Visiting Professors	16,494.34	18,794.34	15,000.00	24,000.00	20,000.00	77,794.34
Graduate Assistants	12,964.82	16,064.66	22,000.00	22,000.00	22,000.00	82,064.66
Clerical	5,654.65	7,126.83	6,000.00	6,000.00	6,000.00	25,126.83
Lab & Technical	<u>2,764.71</u>	<u>2,764.71</u>	<u>10,000.00</u>	<u>15,000.00</u>	<u>15,000.00</u>	<u>42,764.71</u>
Total	66,631.98	87,867.17	101,500.00	113,500.00	89,000.00	391,867.17
<u>Operational Support</u>						
Travel & Subsistence						
Domestic	8,896.69	10,915.46	7,000.00	7,000.00	7,000.00	31,915.46
Foreign	<u>2,822.07</u>	<u>3,223.07</u>	<u>5,000.00</u>	<u>5,000.00</u>	<u>5,000.00</u>	<u>18,223.07</u>
Total	11,718.76	14,138.53	12,000.00	12,000.00	12,000.00	50,138.53
Supplies & Services						
Equipment	97.50	567.50	2,000.00	2,000.00	2,000.00	6,567.50
Communications	664.50	664.50	1,500.00	1,500.00	1,500.00	5,164.50
Student Fees	<u>2,795.00</u>	<u>3,732.50</u>	<u>4,500.00</u>	<u>4,500.00</u>	<u>4,500.00</u>	<u>17,232.50</u>
Total	20,131.75	24,127.15	28,000.00	28,000.00	28,005.68	108,132.83
Grand Total	\$86,763.73	\$111,994.32	\$129,500.00	\$141,500.00	\$117,005.68	\$500,000.00

^aIncludes hourly wages shown under "Operational Support" in original budget

^bIncludes library acquisitions, \$421.37; expendable supplies, \$2,224.62; services, \$210.00; advance for supplies overseas, \$2,000.00

Table 9.3. Budget detail (review period July 1, 1971 to June 30, 1972)

Name	Position	% of full time on project
SALARIES AND WAGES		
<u>Resident Professors</u>		
Drosdoff, M.	Professor (Project Leader)	63
Cline, M. G.	Professor	6
Weaver, M.	Assistant Professor	50
Total full-time equivalents:		1.19
<u>Visiting Professors & Scientists</u>		
Abruña, F.	Visiting Scientist	4
DeDatta, S. K.	Visiting Scientist	2
Coulter, J.	Visiting Professor	50
Dewan, M.	Visiting Professor	8
Total full-time equivalents:		0.64
<u>Graduate Assistants</u>		
Ferreira, F. F.	Graduate Research Assistant	11
Ritchey, D.	Graduate Research Assistant	50
Odeyemi, O.	Graduate Research Assistant	44
Kao, C.	Graduate Research Assistant	46
Rodriguez, M.	Graduate Research Assistant	25
Bockus, J.	Graduate Research Assistant	8
Forbes, T.	Graduate Assistant	23
Total full-time equivalents (based on 40-hour week):		2.07
<u>Clerical</u>		
Hays, M. A.	Stenographer II	30
Schoneman, A.	Stenographer II	55
Total full-time equivalents:		0.85
<u>Laboratory & Technical</u>		
Sardi	Research Specialist	13
Other, Temporary	Technicians	5
Total full-time equivalents:		0.18

Table 9.3 (Cont.)

Name	To	Purpose	Cost
TRAVEL (T) AND SUBSISTENCE (S)			
<u>Domestic</u>			
Drosdoff, M.	Washington, D. C. (3 trips)	Consult & report, AID	\$ 324.42(TS)
	Hawaii	Executive Committee meeting	554.88(TS)
	Puerto Rico	Tropical soil research	221.55(TS)
Cline, M.	Washington, D. C. (2 trips)	Consult & report, AID	228.00(TS)
	Hawaii	Executive Committee meeting	541.48(TS)
	Puerto Rico	Cornell winter field course	263.75(S)
Weaver, M.	Puerto Rico (2 trips)	Tropical soil research	439.90(TS)
Lathwell, D.	Puerto Rico	Tropical soil research	102.85(S)
Ritchey, D.	Puerto Rico	Tropical soil research	2,138.99(S)
Scott, T.	Hawaii	Soils teaching workshop	356.20(S)
McCaskill, G.	Hawaii	Soils teaching workshop	353.65(S)
Coulter, J.	Puerto Rico	Cornell winter field course	261.50(S)
	N. C. State; Muscle Shoals	Consultation	244.00(TS)
Silva, J.	Cornell (from Hawaii)	Visiting Professor	807.48(T)
Dewan, M.	Cornell	Visiting Professor	987.11(S)
Abruna, F.	Cornell (from Puerto Rico)	Visiting Scientist	354.16(TS)
DeDatta, S. K.	Cornell	Visiting Scientist	98.82(S)
Fox, R.	Cornell (from Puerto Rico)	Consultation re. teaching	486.70(TS)
		Total Domestic	<u>\$8,896.69</u>
<u>Foreign</u>			
Drosdoff, M.	Nigeria	Tropical Soil Seminar IITA	
	Ivory Coast, Senegal	Consulting	565.46(S) ^a
Cline, M.	Nigeria	Tropical Soil Seminar IITA	
	Ghana, Senegal	Consulting	475.35(S) ^a
Fox, R.	Nigeria	Tropical Soil Seminar IITA	
	Kenya, Nigeria	Consulting	724.00(S) ^a
Coulter, J.	Nigeria	Tropical Soil Seminar IITA	273.50(S) ^a
	Cornell (from London)	Visiting Professor	251.00(T)
Alexander, M.	Colomb. a	Colombian Soc. Soil Sci., Consulting	532.76(TS)
		Total Foreign	<u>\$2,322.07</u>

^aTransportation billed FY 1972-73

Table 9-3 (Cont.)

EQUIPMENT COSTING MORE THAN \$100--None

REPORT OF UNIVERSITY OF HAWAII
FOR THE PERIOD
JULY 1, 1971 TO JUNE 30, 1972

- A. TITLE: A Grant to Strengthen the Capabilities of the University of Hawaii in Special Problems of Tropical Soils (Grant AID/CSD 2833)
- B. GRANTEE: University of Hawaii
- C. DIRECTOR: Dr. Wallace G. Sanford
- 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: \$83,187
 - 3.2 Accumulated: \$107,390
 - 3.3 Anticipated for next year: \$166,744
- E. NARRATIVE SUMMARY

A cooperative project with the University of Puerto Rico in classifying the soils of Hawaii and Puerto Rico according to the FAO system and in correlating the chemical and physical characteristics of these soils at the family level were the major accomplishments during the past year. Drs. H. Ikawa and G. Uehara, in collaboration with Dr. F. Beinroth of Puerto Rico, have completed the classification of Hawaiian soils. Of the 190 soil series in Hawaii, the greatest number are Andosols, Phaeozems, Acrisols, Cambisols, Ferralsols, Histosols, Vertisols; Gleysols are also common. Dr. Ikawa has also developed a computer program for retrieval of these 190 soil series at different categories. This information will enable researchers in the tropics, working with similarly classified soils, to take advantage of the

research done in Hawaii and other tropical areas concerning land use, cropping, fertilization, and irrigation. Drs. Beinroth, Uehara and Ikawa completed a preliminary geomorphic-pedogenetic study of relationships of Oxisols and Ultisols in Hawaii. Generally, Ultisols occur on steeper slopes than Oxisols and the formation of oxic horizons is accelerated by readily weatherable ultrabasic rocks. It is hoped that similar studies in Hawaii and Puerto Rico will increase understanding of the formation of these soils.

Dr. Leslie D. Swindale, Associate Director and Professor of Soil Science, Hawaii Agricultural Experiment Station, and Dr. Goro Uehara, Professor of Soil Science, College of Tropical Agriculture, attended a seminar on Tropical Soil Research which was held in Ibadan, Nigeria, May 22-26, 1972. The sponsors of this seminar were the Ford Foundation, L'Institut de Recherches Agronomiques Tropicales, and the International Institute of Tropical Agriculture (IITA).

The seminar participants included a group of U. S. Soil scientists of the 211(d) University Consortium and from AID. The Institutions involved were Cornell, Hawaii, North Carolina State, Puerto Rico, and Prairie View A&M. Participants of the seminar visited several African nations. The experiences gained from this activity will improve instruction, research, and consultation capability in tropical soil management of member institutions.

One of the goals of this AID grant was the initiation of a faculty and student exchange program with other institutions in the Consortium. Hence under the provisions of the 211(d) grant, Dr. Martin Alexander of Cornell University was able to come to Hawaii to present lectures on

soil microbiology as well as to consult with interested members of this department. In addition, this grant enabled Mr. Cesar Lopez of Prairie View A&M College to work under Drs. Green and Koch in studying the degradation of herbicides in tropical soils.

Implementation of audio-visual tutorial techniques in the instruction of the department's basic soils course, Introduction to Tropical Soils, was successfully accomplished by Dr. H. Ikawa.

Drs. Uehara and Fox will be participants in the AID-sponsored Tropical Soils Institute to be held at the University of Puerto Rico, July 10 to August 5, 1972. Other faculty participants are members of the Consortium. An intensive four-credit course, divided into the following sections: (1) soil classification, geomorphology, and climatology; (2) soil physics and mineralogy; (3) soil chemistry, fertility and water relations; and (4) soil management systems, is being offered. Student participants will be primarily composed of those from Latin American countries.

During the last reporting period, Dr. Uehara was invited by the Thailand AID Mission to discuss possible research contracts on silting and soil-water-plant research in the Mekong Delta. Since that time, Dr. Uehara has been awarded a one-year contract to study the composition of Mekong River silt and its possible role as a source of plant nutrient in the Delta. Negotiations regarding participation in another Mekong Delta contract will be in progress. Actual work on this project should commence in the latter part of the year. From August 11 to 20, 1972, Dr. Uehara will participate in an organizational meeting in Saigon, Vietnam to discuss possible AID-University of Hawaii contracts on agricultural potential of heavy clay delta soils.

Another grant possibility is a proposal submitted by Dr. L. D. Swindale to the AID on the relation of soil families to crop productivity in the tropics. This proposal is designed to classify the soil families of lesser developed countries and to acquaint agriculturalists in those countries with soil management and crop production practices developed for similarly classified soil families in Hawaii and the tropics.

Negotiations will be undertaken with the Bougainville Copper Company in regard to a contract involving revegetation of road cuts, overburden dumps, and tailings involved in the mining operation on the Island of Bougainville which is part of the Soloman chain of islands. The knowledge gained from this project should be extremely useful in other developing nations where similar mining operations are contemplated. Drs. Sanford and Fox are the proposed project leaders.

The Department will propose to the Executive Committee and Council of Deans that we sponsor a workshop on mineralogy similar to the one held in Hawaii in the summer of 1971. It is proposed that participants be those individuals within the Consortium who are involved in soil mineralogy, teaching and research and other related subjects.

F. DETAILED REPORT

1. General Background and Purpose of the Grant: In making this grant, the principal criterion used was the degree of commitment a university is making or willing to make in increasing its competence in tropical agriculture. Development of this competence would lead to a better understanding of significant agricultural problems relevant to emerging nations in the tropics. To this end, AID awarded five-year grants to establish centers of competence in tropical agriculture at

existing institutions with permanent sources of funding and commitments on problems of international development.

2. Objectives of the Grant

2.1 Objectives restated: This grant will strengthen the existing competency of the University of Hawaii by means of a collaborative effort with Cornell University, North Carolina State University, Prairie View A&M College and the University of Puerto Rico to provide training, related research, technical assistance and consultation, and conduct related research in soil science for increasing food production in soils of the tropics. The grant will be used to:

- (1) Further strengthen the soil mineralogy group at the University by the addition of a soil mineralogist, a technician and appropriate support and equipment
- (2) Provide for visiting professorships to be used to bring to the University of Hawaii additional expertise and experience from either the cooperating institutions or from other services
- (3) Provide graduate assistantships in order that students of the other four cooperating institutions may have access to the special strength of Hawaii
- (4) Provide graduate assistantships to conduct research in tropical soils toward advanced degrees at the University of Hawaii
- (5) Provide funds for travel by assistantships that are exchanged among the institutions, for visiting professorships and for staff to consult with other cooperating institutions
- (6) Strengthen the existing curriculum in tropical soils so that it will be more useful to AID and other personnel involved with tropical soils, crop management and other related activities in the less-developed countries
- (7) Strengthen library and other information services with special emphasis on the preparation of manuals or other training materials on tropical soils and other related fields

2.2 Review of objectives: The objectives listed above will remain essentially the same except more emphasis will be placed on

extension work particularly when such work is compatible with the work being done in teaching and research. For example, individuals traveling to other areas whether on 211(d) or other funds should make available their services as experts when requested by appropriate individuals.

3. Accomplishments

3.1 Teaching: One of the goals of this AID grant was the initiation of a faculty and student exchange program with other institutions in the Consortium. Hence under the provisions of the 211(d) grant, Dr. Martin Alexander of Cornell University was able to come to Hawaii to present lectures on soil microbiology as well as to consult with interested members of this department. In addition, this grant enabled Mr. Cesar Lopez of Prairie View A&M College to work under Drs. Green and Koch in studying the degradation of herbicides in tropical soils.

Implementation of audio visual tutorial techniques in the instruction of the department's basic soils course, Introduction to Tropical Soils, was successfully accomplished by Dr. H. Ikawa. With the assistance of Dr. Hank Foth, a visiting professor from Michigan State University, this basic soils course was restructured from the conventional lecture-laboratory to the lecture-audio visual tutorial teaching method. The revamped course was taught in the fall of 1971. Dr. R. E. Green also used the audio visual tutorial system in introductory course entitled "Soils and Man." This course was offered in the spring of 1972 to non-soils majors within and outside the College of Tropical Agriculture. "Soil Microbiology" and "Plant Tissue Culture," two relatively new courses in the department, were offered during the fall and

spring semesters, respectively. State funds and a limited amount of 211(d) funds were used to get these courses underway.

Courses in soil physics, chemistry, mineralogy, and fertility continued to emphasize the unique physical, chemical, and mineralogical properties of tropical soils in comparison to those of temperate regions. Climatic differences were discussed by Dr. P. C. Ekern in "Meteorology in Agriculture." Through the initiative of Dr. R. L. Fox, an innovative field experiment was conducted by classes in soil fertility, soil physics, agricultural engineering, and statistics to allow students in each discipline to apply their classroom knowledge to field conditions. Four plots of sweet corn, with differences in planting density, were grown under varying rates of nitrogen fertilization and irrigation. Indications are that this method of teaching is very effective in integrating knowledge of agricultural systems.

Single page handouts of "Illustrative Concepts of Tropical Agriculture" continued to be printed. Each sheet discussed a single concept which should be emphasized in the teaching of tropical soils and plant nutrition. Four have been printed and are available to the members of the Consortium or to other organizations upon request.

3.2 Research: The University of Hawaii has started a cooperative project with the University of Puerto Rico in classifying the soils of Hawaii and Puerto Rico according to the FAO system and correlating the chemical and physical characteristics of these soils at the family level. Drs. Ikawa and G. Uehara in collaboration with Dr. F. Beinroth of Puerto Rico have completed the classification of Hawaiian soils. Of the 190 soil series in Hawaii, the greatest number are Andosols. Phaeozems, Acrisols, Cambisols, Ferralsols, Histosols,

Vertisols, and Gleysols are also common. Dr. Ikawa has also developed a program for computer retrieval of these 190 soil series at different categories. This information will enable researchers in the tropics working with similarly classified soils to take advantage of the research done in Hawaii and other tropical areas concerning land use, cropping, fertilization, and irrigation. Drs. Beinroth, Uehara and Ikawa have also completed a preliminary geomorphic-pedogenetic study of relationships of Oxisols and Ultisols in Hawaii. Generally Ultisols occur on steeper slopes than Oxisols and the formation of oxic horizons is accelerated by readily weatherable ultrabasic rocks. It is hoped that similar studies in Hawaii and Puerto Rico will increase understanding of the formation of these soils.

Mineralogical characterization of 11 of Puerto Rico's most important agricultural soils was completed at the University of Hawaii. Using electron microscopy and X-ray diffraction, Dr. R. C. Jones, Dr. W. Sakai, and Mr. W. Hudnall studied samples brought to Hawaii by Dr. Beinroth of 65 horizons of 5 Ultisols and 6 Oxisols. In addition to mineralogy, particle size distribution was determined by Dr. G. Tsuji. Detailed descriptions of seven of these soils were included in the handbook compiled by Dr. Beinroth for the Tropical Soils Institute to be held in Puerto Rico, July 10-August 4, 1972. These studies are part of an effort to properly classify the Puerto Rican soils at the family level and to determine if similarly classified soils in Hawaii behave alike. If predictions concerning management can be made through proper classification, then recommendations can be made to agriculturalists using similarly classified tropical soils. Dr. R. Fox made measurements of soluble silica, phosphate, and sulphate sorption by these Puerto Rican

soils. Comparison of these measurements with those of Hawaiian soils will aid in prediction of soil behavior based on family designation.

Dr. A. H. Sayegh, Associate Professor of Soil Science at the American University of Beirut, spent his sabbatical leave here during the period September 1, 1971 to June 2, 1972 and was supported in part by 211(d) funds. During this period he attended advanced courses on the mineralogy and physical chemistry of tropical soils and engaged in preliminary studies with Dr. S. A. El-Swaify on the charge characteristics of oxidic and amorphous separates of a Typic Hydrandept and a Typic Gibbsiumox. The adsorption of H^+ and OH^- was directly related to the adsorption of Cl^- and NH_4^+ , respectively. The first pair acted as charging ions and the second as counter ions. Net charges associated with the Hydrandept were considerably more subject to variation due to changes in pH and concentration of electrolyte than those associated with the Gibbsiumox.

The X-ray fluorescence spectrometer has been installed and is presently being calibrated using data obtained from other instruments. E. Okazaki and Dr. Jones expect to shortly begin processing samples of soil, tissue, and forage.

Dr. J. Silva recently returned from a sabbatical leave spent at Cornell University. While there, he presented guest lectures in Agronomy, Geography of Tropical Soils, Soil Fertility, and Tropical Crop Production, and collaborated in a research project in which extractable Si and P levels and responses to calcium silicate, lime, and phosphate of comparable soils from Puerto Rico, Colombia, and Hawaii were evaluated. Greatest response to calcium silicate was in the Gibbsiumox (Hali) soil from Hawaii, the Oxisol (Catalina) from Puerto

Rico, and Carimagua soil of the two tested from Colombia. All soils responded markedly to phosphorus and most responded to increased calcium and pH.

Drs. L. D. Swindale and G. Uehara attended the AID 211(d) Soils Consortium meeting held in Nigeria. There Dr. Uehara presented a paper relating his work with the behavior of soils with variable charge colloids. Colloids with variable surface charge are more commonly found in tropical soils than in soils of the temperate regions. Minerals which commonly behave as variable charge colloids were found to be crystalline and non-crystalline oxides and hydrous oxides of silicon, aluminum, iron, manganese and titanium, and the non-crystalline alumino-silicates. In soils with variable charge minerals, specific adsorption of anions caused the cation exchange capacity to increase, and specific adsorption of cations caused the cation exchange capacity to decrease. For these soils, research indicated that prediction of soil behavior could be improved if a model based on variable charge colloid was used.

An M. S. program which characterized an almost entirely non-crystalline Hawaiian soil (Hilo, Typic Hydrandepts) was recently completed. Electron microscopy of this important sugar cane-producing soil showed three phases: (1) a gel affected by chemical treatments of H_2O_2 and/or $CaCl_2$, (2) short spindle-shaped rods, and (3) long strings of imogolite not affected by dissolution treatments. Studies of the non-crystalline fraction of several Florida soils were also completed by Dr. T. Yuan of the University of Florida who was on sabbatical leave and Drs. Jones and Sakai. They found that the amorphous organic

and inorganic portion of these sandy soils played an important role in their chemical properties.

Soil chemistry research indicated that sugar cane roots played a predominant role in degrading ametryne herbicide in tropical soils. Work has also shown that water held in small intra-aggregate pores of highly structured Oxisols does participate in liquid flow. However, such micropores hold back adsorbed solutes more than equilibrium measurements predict. Research on nitrogen has shown that nitrate adsorption in dominantly amorphous Akaka soil and kaolinitic Molokai soil increased consistently with increasing electrolyte concentration. The magnitude of adsorption was greater in the Akaka soil and this soil also showed an increase in adsorption with increasing soil depth. Work with the kaolinitic Wahiawa and montmorillonitic Lualualei soils showed that ammonification and nitrification of slowly available nitrogen fertilizers took place at 7, 27, and 40°C but rates of these processes varied with temperature. "Osmocote" (plastic coated) released the highest amount of available nitrogen in the soils at all temperatures followed by sulfur-coated urea, IBDU, urea formaldehyde and sewage sludge. Sulfur-coated urea produced the highest amount of $\text{NH}_4\text{-N}$ and "Osmocote" the highest $\text{NO}_3\text{-N}$ in both soils at all temperatures.

Studies on water quality standards for irrigated tropical soils showed that in addition to total salt concentration and the proportion of sodium to other cation, the presence of certain anions in irrigation water has an effect on soil structure. Among four anions studied, the relative effect on soil structure could be arranged in the decreasing order: $\text{SiO}_3^- > \text{HCO}_3^- > \text{SO}_4^- > \text{Cl}^-$. This effect also increased as the

proportion of amorphous components in the soil decreased. Research using drip irrigation with sugar cane has shown that normal yields can be achieved with a 15 to 25 percent water savings.

Approximately 60 percent of the 211(d) funds were used to support soil mineralization and characterization research. The balance was used in travel and the general support of tropical soil research and teaching within the department.

3.3 Reports, working papers, and publications

- Beinroth, F. H., H. Ikawa, and G. Uehara. 1971. Preliminary report on the placement of the soils of Hawaii in the FAO/UNESCO legend for the soil map of the world. 6 p.
- Beinroth, F. H., H. Ikawa, and G. Uehara. 1971. Report on a preliminary study of landscape relationships of Oxisols and Ultisols in Hawaii. 5 p.
- Chan, J. K., R. C. Jones, and W. S. Sakai. 1972. Mineralogical characterization of the Hilo soil (Typic Hydrandepts). Agron. Abst.
- Fox, R. L. 1971. Growth response curves--The "Law of Diminishing Returns." Illus. Concepts in Trop. Agr.
- Fox, R. L. 1971. Symptoms of plant nutritional deficiency--Visual symptoms and incipient malnutrition. Illus. Concepts in Trop. Agr.
- Fox, R. L. 1972. Solubility, uptake and leaching of plant nutrients: Phosphate, sulfate, and calcium. Proceedings Fifth Hawaii Fert. Conf., Misc. Pub. 86, Hawaii Agr. Exp. Sta. p. 25-32.
- Fox, R. L. and Y. Tamimi. 1971. Symptoms of plant malnutrition--Multiple deficiencies and "The Law of the Minimum." Illus. Concepts in Trop. Agr.
- Fox, R. L. and R. M. Warner. 1971. Symptoms of malnutrition--Influence of nutrient mobility on iron deficiency. Illus. Concepts in Trop. Agr.
- Fox, R. L. and R. M. Warner. 1971. Excess phosphate and micro-nutrient deficiency in macadamia. Hawaii Farm Sci. 20(4): 2-4.
- Jones, R. C. 1972. New methods of elemental analysis for soils and plant tissues at the College of Tropical Agriculture. Proc. Fifth Hawaii Fert. Conf., Misc. Pub. 86, Hawaii Agr. Exp. Sta. p. 39-41.

- Kanehiro, Y. and D. T. Mikami. 1972. Some exchange adsorption and fixation properties of amorphous volcanic ash soils of Hawaii. Trans. of Panel on "Volcanic Ash Soils of America." Pasto, Colombia.
- Sakai, W. S., M. Hansen, and R. C. Jones. 1972. Raphides with barbs and grooves in Xanthosoma sagittifolium (Araceae). (in press) Sci.
- Uehara, G., L. D. Swindale, and R. C. Jones. 1972. Mineralogy and behavior of tropical soils. Seminar on Trop. Soil Res., Ibadan, Nigeria.
- Yuan, T. L., R. C. Jones, and W. S. Sakai. 1972. Colloidal fraction of selected Florida soils. Agron. Abst.

4. Impact of Grant-Supported Activities in Developing Institutional Capabilities: The grant has had a large impact on teaching and research. Hawaii does research in all phases of tropical soils. However, previous to the AID grant much of the work was restricted to Hawaiian soils. Travel by University personnel and visits by researchers working in other tropical areas has greatly increased the scope of interest and teaching at the University. The competence of the University especially in the areas of soil biology and mineralogy has increased greatly under this grant. A soil mineralogist, Dr. R. Jones, with state funds and with AID support two post-doctoral associates, Drs. G. Tsuji and W. Sakai, Dr. C. A. Bower and Mr. E. Okazaki, were hired to work in the area of soil physics, biology, chemistry and mineralogy. The instrumental capabilities in the department has been greatly enhanced by the AID 211(d) grant. Although 211(d) monies were not involved in the acquisition of the X-ray fluorescence quantometer (\$100,000) and the scanning electron microscope (\$80,000) with a micro probe attachment (\$26,000), it provided the initial impetus to acquire both instruments, which were purchased through state and federal sources. Monies from 211(d) were used to buy needed photographic

darkroom equipment and supplies for the film processing and printing of electron micrographs. Accessories to the quantometer and scanning electron microscope (electron probe) were also purchased by this fund. Both instruments have added immeasurably to the analytical capability of this department in terms of biological, chemical and mineralogical research.

5. Utilization of Institutional Resources in Development:

Dr. Leslie D. Swindale, Associate Director, Hawaii Agricultural Experiment Station and Dr. Goro Uehara, Professor of Soil Science, College of Tropical Agriculture, attended a seminar on Tropical Soil Research which was held in Ibadan, Nigeria, May 22-26, 1972. The sponsors of this seminar were the Ford Foundation, L'Institut de Recherches Agronomiques Tropicales, and the International Institute of Tropical Agriculture (IITA). This was the 13th in a series of agricultural research and development seminars held by the three co-sponsors. The seminars in 1970 and 1971 were crop or research discipline oriented. The 1972 seminar series sought to examine those factors of African agriculture's infrastructure that may act as constraints on the development of new agricultural technology. The seminars also identified and brought together workers and agencies engaged in a study of those problems and to exchange information and ideas on the methods of solving infrastructure problems. The seminar participants included a group of U. S. soil scientists of the 211(d) University Consortium and from AID. The universities involved were Cornell, Hawaii, North Carolina State, Puerto Rico, and Prairie View A&M. Participants of the seminar visited several African nations. The experiences gained from this activity

will improve instruction, research, and consultation capability in tropical soil management of member institutions.

Dr. Donald L. Plucknett has been invited by the Regional Center for Tropical Biology (BIOTROP), an organization sponsored by the South-east Asia Ministers of Education Organization (SEAMEO), to teach in a weed science course at Bogor, Indonesia. The course is designed to provide young professionals with knowledge of research methods in weed science for use in their work with government agencies, universities, commercial farms, and plantations. Dr. Plucknett will be one of two Americans teaching the course.

Dr. Yoshinori Kanehiro, Professor of Soil Science, presented a paper at the "II Panel on Volcanic Soils of America" meeting which was held at the University of Narinno, Pasto, Colombia, June 18-24, 1972. After the meeting Dr. Kanehiro spent a week visiting and conferring with officials at CIAT in Cali, Colombia, at the International Soil Fertility Evaluation and Improvement Program in Guatemala.

Drs. Uehara and Fox will be participants in the AID-sponsored Tropical Soils Institute to be held at the University of Puerto Rico, July 10 to August 5, 1972. Other faculty participants are members of the Consortium. An intensive four-credit course, divided into the following sections--(1) soil classification, geomorphology, and climatology; (2) soil physics and mineralogy; (3) soil chemistry, fertility and water relations; and (4) soil management systems--is being offered. Student participants will be primarily composed of those from Latin American countries.

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and soil-water-plant research in the Mekong Delta. Since that time, Dr. Uehara has been awarded a one-year grant to study the composition of Mekong River silt and its possible role as a source of plant nutrient in the Delta. Actual work on this project should commence in the latter part of the year. From August 11-20, 1972 Dr. Uehara will participate in an organizational meeting in Saigon, Vietnam to discuss possible AID contracts involving the University of Hawaii and other state universities on agricultural potential of heavy clay delta soils.

Another grant possibility is a proposal submitted by Dr. L. D. Swindale to the AID on the relation of soil families to crop productivity in the tropics. This proposal is designed to classify the soil families of lesser developed countries and to acquaint agriculturalists in those countries with soil management and crop production practices developed for similarly classified soil families in Hawaii and the tropics.

Dr. W. G. Sanford spent two weeks as a pineapple consultant in the Ivory Coast, one week in October 1971 and one week in January 1972. He also spent two weeks in FAO, Rome and IFAC in Paris in June in preparation for a FAO-UNIDO pineapple mission in Madagascar. The mission was cancelled because of the political situation in Madagascar.

Following are students and faculty in the Department.

Graduate students [supported by State, East-West Center (U. S. State Department), Rockefeller and Ford Foundations, Country of Origin, FAO, etc.]

<u>Name</u>	<u>Arrival Date</u>	<u>Advisor</u>	<u>Home Country</u>
<u>Agronomy--M. S.</u>			
Ayers, Dennis	Fall 71	H. Y. Young	U. S.
Chaudhury, A. J. H.	Spring 70	D. Bartholomew	Pakistan
Dollah, Abdul A. B.	Spring 70	P. Rotar	Malaysia
Golingai, Sylverius	Fall 70	D. Plucknett	Malaysia
Pellek, Richard	Fall 71	Y. Tamimi	U. S.
Saito, Ronald Y.	Spring 71	D. Bartholomew	U. S.
Watanabe, Winifred	Fall 70	D. Bartholomew	U. S.
<u>Agronomy--Ph. D.</u>			
El-Tahir, Awad	Spring 70	J. Silva	Sudan
Escalada, Rodolfo	Fall 70	D. Plucknett	Philippines
Ezumah, Mumfrey	Spring 70	D. Plucknett	Nigeria
Floresca, Emmanuel	Fall 71	P. Rotar	Philippines
Guevarra, Anacleto	Fall 71	P. Rotar	Philippines
Nangju, Dimyati	Spring 70	D. Plucknett	Indonesia
Nicholls, Douglas	Fall 70	D. Plucknett	Australia
Ravoof, Abdul	Fall 69	W. Sanford	India
Seng, Tee	Spring 68	W. Sanford	Malaysia
Shin, Han Poong	Summer 70	P. Rotar	Korea
<u>Soil Science--M. S.</u>			
Asghar, Mohammad	Fall 70	Y. Kanehiro	Pakistan
Bajar, Antonio M.	Fall 71	R. Fox	Philippines
Boonduang, Ampan	Summer 70	Y. Kanehiro	Thailand
Braide, Jonathan O.	Fall 68	G. Uehara	Nigeria
Chan, Jenn K.	Spring 70	R. Jones	Malaysia
Keng, Johnny C. W.	Summer 71	G. Uehara	Taiwan
Nishina, Melvin S.	Fall 71	P. Rotar	U. S.
Periaswamy, Sirapalli	Summer 70	H. Ikawa	India
Santo, Lance T.	Summer 71	G. Uehara	U. S.
Syed Fadzil, Syed	Spring 70	J. Silva	Malaysia
Tianco, Antonio	Fall 70	D. Bartholomew	Philippines
Uchida, Raymond S.	Fall 71	Y. Tamimi	U. S.
Wambiji, Henry	Fall 69	S. El-Swaify	Kenya
<u>Soil Science--Ph. D.</u>			
Balasubramanian, V.	Fall 69	Y. Kanehiro	India
Dangler, Edgar	Summer 67	S. El-Swaify	U. S.
Goswami, Kishore	Fall 67	R. Green	India
Hirunburana, Niwat	Fall 69	R. Fox	Thailand
Jellinger, Alice	Spring 69	P. Ekern	U. S.
Juang, Tzo-chuan	Fall 69	G. Uehara	Taiwan
Khalid, Rashid	Summer 67	J. Silva	Pakistan

Graduate students (Cont.)

<u>Name</u>	<u>Arrival Date</u>	<u>Advisor</u>	<u>Home Country</u>
<u>Soil Science--Ph. D. (Cont.)</u>			
Osman, Abeld-Fatah	Summer 68	S. El-Swaify	UAR
Rao, Palakurthi	Spring 70	R. Green	India
Sinanuwong, Somsri	Fall 69	S. El-Swaify	Thailand
Syed, Muhammad M.	Fall 69	S. El-Swaify	India
Watanabe, Roger	Fall 69	G. Uehara	U. S.

Research and teaching staff (supported by State funds)

<u>Name</u>	<u>Speciality</u>
<u>Soils</u>	
Paul C. Ekern, Jr.	Soil Management, Physics
Samir A. El-Swaify	Soil Physics, Irrigation
Robert L. Fox	Soil Fertility, Crop Management
Richard E. Green	Herbicides, Soil Physics
Haruyoshi Ikawa	Soil Mineralogy
Rollin C. Jones	Soil Mineralogy Characterization
Yoshinori Kanehiro	Soil Chemistry, Fertility
Burton Koch	Soil Microbiology
Wade W. McCall	Soil Fertility
James A. Silva	Soil Fertility, Soil Chemistry
Leslie D. Swindale	Soil Genesis & Classification
Goro Uehara	Soil Physics, Mineralogy, Water Science
Roger T. Watanabe	Soil Testing
<u>Agronomy</u>	
Duane P. Bartholomew	Crop Physiology, Plant Nutrition
Richard Bullock	Tree Physiology
Ramon de la Pena	Root Crop Production, Crop Physiology
Peter P. Rotar	Plant Breeding, Cytogenetics
Wallace G. Sanford	Plant Nutrition, Physiology
Donald Plucknett	Crop Management, Weed Control
Yusuf N. Tamimi	Forest Soils, Nutrition
John R. Thompson	Crop Production
Ukio Urata	Plant Breeding
A. Sheldon Whitney	Plant Nutrition, Crop Physiology
Hong Yip Young	Plant Nutrition, Chemistry
Dennis Matsuyama	Research Associate
Ronald Yoder	Research Associate

Contractual

<u>Name</u>	<u>Title</u>
Charles Bower	Soil Scientist
Annie Chang	Jr. Researcher
Kishore Goswami	Jr. Soil Scientist
Marion Mapes	Asst. Agronomist
Helen Mishima	Research Associate
Douglas Nicholls	Jr. Agronomist
Santiago Obien	Jr. Agronomist
Ernest Okazaki	Jr. Soil Scientist
William Sakai	Asst. Soil Scientist
Gordon Shibao	Research Associate
Gordon Tsuji	Asst. Soil Scientist

Staff and students [supported by 211(d) funds]

<u>Position</u>	<u>Name</u>	<u>Speciality</u>
Soil Scientist	Charles Bower	Soil Chemistry
Jr. Researcher	Annie Chang	Analytical Chemistry
Graduate Res. Asst.	Niwat Hirunburana	Soil Fertility
Graduate Res. Asst.	Wayne Hudnall	Soil Mineralogy
Jr. Soil Scientist	Ernest Okazaki	Soil Chemistry & Mineralogy, X-ray Fluorescence Quantometer
Graduate Res. Asst.	Mayo Ryder	Soil Classification
Post Doctoral Fellow	William Sakai	Electron Microscope
Graduate Res. Asst.	Lance Santo	Soil Physics
Post Doctoral Fellow	Gordon Tsuji	Soil Physics
Graduate Res. Asst.	Raymond Uchida	Soil Chemistry

6. Other Resources for Grant-Related Activities: Largely through the impetus of Dr. R. Jones, the University of Hawaii, was awarded a \$77,000 NSF equipment grant from the purchase of a scanning electron microscope. Drs. Sakai, Jones and Uehara also received a Pacific Biomedical Research grant for \$26,000. This grant is for the purchase of an energy dispersive X-ray probe attachment for the scanning electron microscope. The grant will release AID funds for purchase of computer and software to take quantitative measurements with the X-ray probe. These instruments will be used in studies in soil mineralogy and on mechanisms involved in the uptake of nutrients by roots and leaves.

In teaching, Drs. Uehara, Green and Ikawa were awarded university academic innovation grant for \$9,466. This money was used to purchase

much of the audio visual equipment used in the two basic soils courses developed with AID support.

Support from private companies provided \$4,000 for the purchase of equipment to be used in AID-related studies.

These grants along with State and Federal funds for purchase of the X-ray fluorescence quantometer amount to over \$200,000 in equipment purchased with non-AID monies which are available to AID researchers.

Non-AID funds also provided for travel by Dr. W. G. Sanford to Italy, France, and the Ivory Coast, and by Dr. L. D. Swindale to Guam. Although not directly related to AID projects, these trips broadened the outlook of these researchers and established the basis for future consulting.

Resources of the University in terms of staff time were also used to handle many visitors that came to Hawaii for research and consulting or on short stops in travel between Asia and mainland U. S., including J. B. Aubert, IFAC, Cameroon; A. P. Barnett, ARS, Georgia; K. Kawai, Nat. Inst. Agri. Sci., Tokyo; L. D. Meyers, ARS, USDA, Western Region; E. Takahashi, Kyoto Univ.; T. L. Yuan, Univ. of Florida; and W. Wischmeier, ARS, Purdue.

7. Next Year's Plan of Work

7.1 Teaching and extension services: During the period of July 10-21, Dr. John Coulter of the Rothamsted Experiment Station is scheduled to present a series of seminars on international agriculture. In addition to individual consultation with the staff, Dr. Coulter with Drs. Uehara and Plucknett moderating, will hold an open discussion session with faculty and students on improving the agronomic and educational conditions in the tropics.

From July 10 to August 9, 1972, Drs. Fox and Uehara are planning to participate in the Tropical Soils Institute at the University of Puerto Rico. They will present a series of lectures in soil fertility, soil chemistry, soil physics and mineralogy. These lectures are intended to provide additional insight in the teachings and research on tropical soils at the University of Hawaii to students from Latin America. Plans have also been made for Drs. Uehara and Ekern of this department to participate in a soils workshop at Prairie View A&M College from October 2-6, 1972.

The success of the audio visual tutorial techniques in teaching the basic soils course in this department is reflected in the likely addition of five more audio visual tutorial units to the existing 11 and the installation of 10 more tape recorders in the Sinclair Library Listening Center. Continued use of these systems will be made by Drs. Ikawa and Green. Because of an increase in interest in electron microscopy, a new course entitled "Electron Microscopy in the Plant and Soil Sciences" will be offered by Dr. Sakai during the fall semester. This course will enable students in this department to gain competence in the use of the electron microscope to analyze mineralogical and biological specimens.

Additional topics will be presented in "Illustrative Concepts of Tropical Agriculture." To reiterate, these single page prints will be distributed in courses offered in this department and are available to members of the Consortium.

Based on the interest of other members of the Consortium, this department will propose to hold a two-week workshop for staff of the Consortium who are involved in soil mineralogy teaching and research

and related subject matter. With the availability of the X-ray fluorescence quantometer and the scanning electron with an energy dispersive X-ray probe attachment should make such a workshop very exciting.

7.2 Research: Work in soil mineralogy will concentrate in four areas: (1) investigation of the mineralogy of volcanic ash soils, (2) investigation of Hawaiian and Puerto Rican soils, (3) investigation of soils of the Pacific region, (4) transmission and scanning electron microscopy and electron probe analysis of selected tropical soil minerals.

General procedures to be employed follow. Soils derived from volcanic ash will be collected from Hawaii, Oregon, Japan, and Costa Rica. Electron microscopy and X-ray diffraction analysis of these soils will concentrate on the occurrence of imogolite and halloysite in attempting to determine factors involved in the formation of these two minerals. Electron microscopy and X-ray data of Puerto Rican soils will be compared with similarly classified Hawaiian soils. Of interest will be comparisons of the Tropeptic Eutrorthox of Puerto Rico (Bayamon and Matanzas) with that of Hawaii (Puhi), the Acrorthox of Puerto Rico (Nipe) with that of Hawaii (Kunuweia), and the Orthoxic Tropohumults of Puerto Rico (Cidra and Vicente) with that of Hawaii (Alaeloa, Halawa, Hamakuapoko, Ialeau, and Manana). Soils of the Pacific region which will be studied are primarily the Tongan soils and the delta soils of the Mekong River. The new scanning electron microscope with X-ray probe attachment will allow for the detection of elements in soil particles smaller than a micron in size. The same mineral particles studied with transmission electron microscopy and

scanning electron microscopy can thus be studied with the X-ray probe to determine the elemental composition. Initial studies will be on the mineral goethite which in Hawaiian and Puerto Rican soils apparently has much aluminum substitution. This aluminum substitution causes decreases in d-spacings and intensities with X-ray diffraction.

A preliminary report on the study of Tropical Histosols in Hawaii will be completed by Dr. H. Ikawa, who will be on sabbatical leave from January 1 through August 15, 1973 at the Soil Conservation Service, USDA in Fort Worth, Texas and in Oklahoma. In the interim, an investigation of Tongan soils is being initiated with the assistance of Mr. Andrew Rosenau.

Nitrogen adsorption, movement and transformation under varying redox conditions will continue to be of major interest to Dr. Kanehiro. Identification of the nitrogen-fixing bacteria so far isolated and determination of their contribution to total available soil nitrogen will be of concern to Dr. B. L. Koch. He will also undertake experiments to isolate and identify breakdown products from a mixed or pure culture of microorganisms which are able to utilize diuron, a herbicide, as a carbon source.

Soil physics research will be primarily involved in examining the phenomenon of soil-water hysteresis in Hawaiian Oxisols. Drs. Tsuji and Uehara are also planning studies to determine water infiltration rates into these soils. Additional investigations on the zero point of charge on the surfaces of Oxisols will continue. Along this line, Dr. S. El-Swaify is planning to continue his work on the charge characteristics of tropical soils and their implications to colloidal

stability and Dr. Green and Mr. P. S. C. Rao will pursue a research program on solute transport in Oxisols and Andepts. With the help of grants from USDA, Dr. El-Swify will initiate a conservation program designed to (1) study the erosive properties of agricultural tropical soils and (2) investigate the water-yielding and hydrologic characteristics of soils in forest watersheds.

With the addition of Dr. C. A. Bower, formerly director of the U. S. Salinity Laboratory in Riverside, California to the staff, a study on the chemistry and availability of major cations in relation to the macadamia is being planned. He will also have a major input into irrigation systems. Moreover, Dr. Bower will be available to lend technical assistance in the area of his expertise and experience to others in the department.

As part of the faculty exchange program, the AID grant will support, in part, the sabbatical leave of Dr. W. S. Reid from Cornell University. Dr. Reid will be working in association with Drs. Fox and Silva on a tentative program to determine lime requirements for tropical soils.

Dr. Fox will continue his studies on development of soil P for various tropical crops using the P-sorption method.

Drs. Fox and Sanford plan to spend one week in August visiting the Bougainville Copper Mine in Bougainville to determine if this department can give them help in the revegetation of road cuts, overburden waste piles and tailings which result from the mine operations. A long-range contract involving staff and graduate students is anticipated. Contacts were made with agricultural officials in New Guinea with the anticipation of cooperative work in the future.

8. Other: No additional comments.

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.i. Distribution of 211(d) grant fund expenditures and contributions from other sources of funding^a (review period July 1, 1971 to June 30, 1972)

Object	211(d) Source			Non 211(d) Source ^b	
	Period Under Review	Cumulative Total	Projected Next Year		Projected to End of Grant
Research	\$72,377	\$ 92,890	\$ 97,500	\$325,000	\$590,650
Teaching	8,095	10,276	22,500	75,000	97,600
Libraries	146	185	7,500	25,000	10,000
Consultation	1,469	2,239	19,250	30,000	
Publication	600	1,300	19,250	30,000	10,000
Other	500	500		15,000	49,674 (Extension)
Total	\$83,187	\$107,390	\$166,000	\$500,000	\$757,924

^aThese figures are our best estimates

^b1971-72 estimated State, Hatch, Regional, NSF, NDEA, and other special grant funds (does not include fringe benefits on salaries)

Table 9.2. Expenditure report, actual and projected (review period July 1, 1971 to June 30, 1972)

Object	Actual Expenditures		Projected Expenditures			
	Period Under Review	Cumulative Total	Year			Total
			3	4	5	
Salaries & Wages (Total)	\$66,353	\$ 70,379	\$120,686	\$ 90,515	\$ 90,515	\$372,095
Salaries ^a	51,292	54,281				
Fringe Benefits	5,915	6,148				
Student Help	9,146	9,950				
Supplies (Total)	4,876	10,238	17,554	17,554	17,554	62,900
Supplies & Publications	4,730	10,053				
Library Acquisitions	146	185				
Equipment ^b (Total)	4,051	15,367	23,638			39,005
Travel (Total)	7,907	11,406	4,866	4,866	4,862	26,000
Inter-Island	1,781	3,500				
Out-of-State	2,275	4,055				
Foreign	3,851	3,851				
Total	\$83,187	\$107,390	\$166,744	\$112,935	\$112,931	\$500,000

^aFor salary breakdown for 1971-72, see Exhibit A

^bFor equipment expenditures for 1971-72 over \$100, see Exhibit B

Exhibit A: Individuals Under Salaries

<u>Name</u>	<u>Title</u>	<u>Date Employed</u>	<u>% of Time</u>	<u>Amount 7/1/71-6/30/72</u>
Bower, Charles	Soil Scientist	4/17/72	40	\$ 1,894.00
Sayegh, Antoine	Assoc. Soil Sci.	9/1/72	44	6,197.89
Sakai, William	Asst. Soil Sci.	9/1/71	100	9,243.50
Tsuji, Gordon	Asst. Soil Sci.	7/15/70	100	9,508.91
Chang, Annie	Jr. Soil Sci.	10/1/71	75	2,656.50
Okazaki, Ernest	Jr. Soil Sci.	1/17/72	100	4,971.43
Hirunburana, Niwat	Graduate Assistant	9/1/71	50	4,080.00
Hudnall, Wayne	Graduate Assistant	1/1/72	50	2,448.00
Osman, Abdel	Graduate Assistant	12/1/71	50	1,692.00
Ryder, Mayo	Graduate Assistant	1/1/72	50	2,448.00
Santo, Lance	Graduate Assistant	1/1/72	25	1,980.00
Shin, Han Poong	Graduate Assistant	11/1/71	50	1,903.50
Uchida, Raymond	Graduate Assistant	1/1/72	50	2,268.00
				<hr/>
				\$51,291.73

Exhibit B: Equipment Purchased Over \$100

<u>Vendor</u>	<u>Description</u>	<u>Cost</u>	<u>Justification</u>
Anderson's Camera House Honolulu, Hawaii	Nega file, 3 1/4 x 4" metal filing	\$ 161.70	Darkroom equipment for black and white and color photograph for 211(d)
Anderson's Camera House Honolulu, Hawaii	Omega voltage stabilizer	102.60	Same as above
Anderson's Camera House Honolulu, Hawaii	Arkay load master print washer	102.96	Same as above
Hastings B. Pratt Honolulu, Hawaii	Electrolux vacuum cleaner	197.08	Accessory equipment for X-ray quantometer
Ventures Associates Eleele, Kauai, Hawaii	4-draw file cabinet letter size	111.00	Office equipment
Central Camera, Inc. Honolulu, Hawaii	Camera tripod	217.07	Photographic equipment for soil comparative studies
Applied Research Lab. Sunland, California	Regulator transformer	990.00	Regulation of electrical power to quantometer
New Brunswick Scientific New Brunswick, N. J.	Portable gyrotory shaker	301.00	For growth of various micro- organisms in liquid culture
Van Waters & Rogers Honolulu, Hawaii	Incubator	686.40	For controlled temperature growth of microorganism; for growth and maintaining microorganisms under controlled temperature
Van Waters & Rogers Honolulu, Hawaii	Helium gas regulator oxygen regulatory	257.98	For use with newly purchased gas cylinders
Perkin-Elmer Corporation Norwalk, Connecticut	AA Micro sampling system	400.00	For micronutrient analysis of plants and soils
	Subtotal	\$3,527.79	
	Miscellaneous (less than \$100.00 per item)	522.79	
	Total	\$4,050.58	

REPORT OF PRAIRIE VIEW A&M COLLEGE
FOR THE PERIOD
SEPTEMBER 1, 1971 TO JUNE 30, 1972

A. TITLE: A Grant to Strengthen the Capabilities of Prairie View A&M College in Relation to Soil Fertility Problems Under Savanna-Ecology (Grant AID/CSD 2836)

B. GRANTEE: Prairie View A&M College

C. DIRECTOR: Dr. James I. Kirkwood

D. STATISTICAL SUMMARY

1. Period of Grant: June 30, 1970 to June 30, 1975

2. Amount of Grant: \$500,000

3. Expenditures

3.1 For report period: \$94,332

3.2 Accumulated: \$131,608

3.3 Anticipated for next year: \$122,798

E. NARRATIVE SUMMARY

This year's major efforts have been directed towards achieving two objectives of the Prairie View 211 (d) Grant Program: (1) to establish strong undergraduate and graduate programs in Soils and (2) to increase the knowledge and competency of our staff with regard to the properties and management of tropical soils within the social and economic constraints of the rural poor and their cultural mores. In pursuit of these objectives, we have achieved the following.

1. A program has been established for a Master of Science degree in Soils with options in tropical soils and land-use planning (this program is expected to be approved by appropriate state agencies by September 1, 1972).

2. Linkages have been established with institutions in Sierra Leone, Ghana, and Nigeria, W. Africa to send one student from each country with

the appropriate Bachelor's degree to enter the program for the Master of Science degree in Soils at Prairie View A&M College through the Fellowship offered under the 211(d) grant.

3. Two Graduate Fellows sponsored by the fellowships made available in the 211(d) grant have received their Master of Science degree in Agricultural Education with minor studies in Soils. Another student completed requirements for the Master of Science in Soils. The degree will be awarded when the Master of Science in Soils is approved (retroactive). This student, a Dominican, with an undergraduate degree in Agronomy from Texas A&M University has returned to his country and is involved in lime-phosphorus studies in the Savanna areas as research director of a fertilizer company.

4. Prairie View A&M College has received over \$752,000 in CSRS grants for fiscal year 1972 to research the problems of rural poverty. This program began officially June 1, 1972. This funding has attracted new staff, added facilities, and increased student enrollment and is expected to continue indefinitely. These resources have strengthened our entire program in Soils. Several graduate students are studying in the area of land-use planning and soil aluminum-phosphorus interactions under intensive cultivation of cash crops on small acreages--an important segment of development in the tropics.

5. The entire staff is committed to performance-based teaching. In preparation, are modules for an introductory course in Soils of the Humid Tropics designed for use in African and Caribbean institutions using materials and problems relevant to those areas while placing emphasis on correct English usage and pronunciation. These materials, plus taped documentaries on the Gulf Coast Prairie soils of Texas,

land-use planning and work sheets on soil concepts are deposited in the Resource Center. Two Graduate Fellows sponsored by the 211(d) grant attended the Tropical Soils Institute in Puerto Rico, and another is continuing his studies in Soil Microbiology at the University of Hawaii as part of the student exchange program among consortium institutions.

6. The primary thrust of research in the Soils program is directed to the solution of basic agronomic problems which contribute to rural poverty. As one solution, a program of intensive cultivation of fruits and vegetables by rural people living close to large urban centers is being started as a means to better the quality of their lives and perhaps induce some migration from distressed urban centers to the countryside where a productive life is possible. The 211(d) Soils staff is also conducting experiments in simple cultural devices and procedures to stimulate a rise in production for subsistence farmers of the tropics. Devices such as stick cages instead of wire for tomato production have already shown great promise. Preliminary fertilizer trials have shown that use of finely-ground rock phosphate and legumes as fertilizer sources in rotations without lime can sustain good row crop yields in these South Texas soils which are similar to the soils of the humid tropical Savanna.

7. Staff under 211(d) have already collected samples from the Caribbean areas and they are now under intensive laboratory study. Results of this work have stimulated new soil correlations for South Texas soils, correlations which had not been recognized until these studies were initiated.

8. A main concern is the development of innovations in agronomic practices that will be accepted by subsistence farmers and directly increase

the income of the rural poor, not only in South Texas, but also in the tropics. In this endeavor teaching aids and extension procedures are being developed to enhance the overall program of agricultural development.

F. DETAILED REPORT

1. General Background and Purpose of the Grant: The grant was established to strengthen the United States' capacity to conduct technical assistance and education programs, pertaining to soil science, in areas of rural poverty not only in the continental United States but in other countries and in tropical regions committed to agricultural development.

Increases in national revenues of most tropical countries depend on greater agricultural production achieved through the family unit which is undergoing change from subsistence farming to modified commercial production. This change is very slow and a major emphasis must be placed on increasing the productivity, however small, of the subsistence farmer now.

Tropical soils strongly differ from temperate soils in morphology, properties, and response to treatments. In fact, they differ markedly from each other, reflecting the diverse environments and geomorphology of these regions. The diversity can be grouped into large biomes or similar environmental units such as high forest, upland swamp, arid and humid Savannah, etc. Each biome is a study in itself. The Soils staff of Prairie View A&M College has extensive experience with range soils and because Prairie View is situated on the prairie soils of South Texas, it was given the responsibility of accumulating information and developing competency in managing Savannah soils of the tropics.

2.1 Objectives restated

2.1.1 To develop a core staff, library and laboratory facilities and student support to assist development programs of food and fiber production in the tropics while resolving problems of soil fertility by means of research, technical assistance, and manpower training. Areas of concentration encompass growth of instructional media and curricula on tropical soils, recruitment of staff, and utilization of consultant and advisory services to structure a program that will increase the competency of Prairie View soil scientists in order to make substantial contributions to the agricultural development of tropical countries and to improve the life chances for people living in pockets of rural poverty in the United States.

2.1.2 Specific attention will be given to soil fertility and land-management problems associated with Savannah-Prairie ecology.

2.2 Review of objectives: None of the objectives stipulated in the grant have been modified or found more amenable than others. This year, efforts have been directed to provide the staff with the experiences that will familiarize them with the soil problems facing agricultural development in tropical regions and also including the rural poor in Texas. These experiences have been gained through participation in workshops, conferences, seminars, consultant meetings, professional society meetings, and visitations to foreign institutions of the tropics.

3. Accomplishments

3.1 Criteria for accomplishment: Accomplishments can be measured by the scientific performance of students and the degree of

their involvement in the agricultural and social development of their homelands. Accountability is also measured by the competency of the staff in recognizing the major soil problems of developing nations as well as designing reasonable and realistic programs to solve these problems. Based on this criteria, the accomplishments of the projects planned and written into last year's annual report (page D-22, 23) and the plans formulated for this year are summarized as follows:

3.2 Teaching

3.2.1 Projected plan (1971): Formal approval of a graduate program for the Master of Science degree in Soils.

Accomplished (1972): The program has been approved by the President of the College and is expected to be approved by the Board of Directors of the Texas A&M University System and the Coordination Board of Higher Education by the fall of 1972. Two options will be available: (1) Tropical Soils and (2) Land-Use Planning.

3.2.2 Projected plan (1971): The data in Table 3.2.2 show the number of graduate students that have applied for admission into the graduate program, the number accepted this year under the 211(d) sponsorship, and the number who have graduated or completed requirements for graduation.

3.2.3 Projected plan (1971): Interchange of staff between consortium universities and tropical institutions and participation in soil conferences and workshops.

Accomplished (1972): Three faculty members participated in the Soils Institute in Puerto Rico. One staff member attended the TVA Symposium on Forage Crops and another the Southern Regional Workshop

Table 3.2.2. Study area, national origin, and statistics of students in graduate program

Student No.	Study Area	National Origin
1 ^a	Soil Chemistry-Fertility	Nigeria
1 ^a	Soil Chemistry-Fertility	Sierra Leone
1 ^c	Soil Chemistry	Dominican Rep.
1	Soil Chemistry-Fertility	Dominican Rep.
1	Soil Classification (land-use planning)	United States
1 ^a	Soil Classification	Ghana
1	Soil Chemistry	United States
1 ^a	Soil Microbiology	Haiti
1	Soil Microbiology	Dominican Rep.
1 ^b	Agricultural Education	United States
1 ^b	Agricultural Education	United States
1 ^a	Agricultural Education	Guyana

^aApplied for admission

^bGraduated with M. S. degree in Ag. Ed. with minor in Soils

^cMet the requirements for M. S. in Soils

at Tuskegee, Alabama. One member of the Soils staff attended the Conference on Tropical Soils sponsored by AID and the Ford Foundation at Ibadan, Nigeria.

3.2.4 Projected plan (1971): Exchange of graduate students between consortium universities.

Accomplished (1972): One graduate student in Soil Microbiology was accepted by the University of Hawaii to continue his work on the isolation of soil microorganisms that are able to degrade certain herbicides. Two students participated in the Tropical Soils Institute, University of Puerto Rico.

3.2.5 Projected plan (1971): Development of the Tropical Soils Resource and Enrichment Center.

Accomplished (1972): The College is committed to performance-based teaching methods and our staff has attended several workshops in the preparation of modules. With this commitment, the agricultural staff, using the facilities initiated by the 211(d) grant is preparing modules for the instruction of plant, soil, and animal science. The Tropical Soils Resource and Enrichment Center as a focal point has become the Agricultural Resources and Enrichment Center. Specifically in soils, a performance-based course entitled "Introductory Soils for the Humid Tropics," has been initiated. Today several modules have been prepared based on experience, data, and results of agricultural and soils studies of those regions. Slides and commentaries depicting the physical and social characteristics of the humid tropics are also being used.

Several auto-tutorial documentaries dealing with the role of soil science in land-use planning have been prepared. Tapes for supplemental

study were prepared dealing with soil concepts such as cation exchange, ph, etc.

Soil monoliths, artifacts, and rhizosphere zones were prepared from soil sites of South Texas, Caribbean areas, and W. Africa.

Collections of published materials and taped proceedings of conferences, workshops, seminars, and students were added to the Resource Center as well as a substantial number of technical journals in the field of Soils, Environmental Quality, and the Physical Sciences. As part of the enrichment program, 35 students and 4 staff members visited research centers, farms, and schools in the Rio Grande Valley to become better acquainted with the problems of agriculture in this subtropical area and methods to solve them. The trip was sponsored under 211(d) funds.

3.3 Research

3.3.1 Projected plan (1971): Study the mineralogy of Savannah-Prairie soils.

Accomplished (1972): Samples of Savannah soils from Caribbean areas were collected and are being analyzed, chemically and mineralogically. This information will be compiled as part of the Data Bank on Tropical Savannah soils. Soil samples from diverse sites in the South Texas Gulf Coast Prairie were also collected and are being analyzed. Results from this work have shown a need for further soil correlations by the Soil Conservation Service in the South Texas area.

3.3.2 Projected plan (1971): Study the management of grassland prairie under cattle culture and status of P, Al, and Ca in these soils.

Accomplished (1972): A lime requirement curve was established for the major soil series of this area. Effects of lime on exchangeable Al and P availability were ascertained (M. S. thesis). The effects of various lime levels on production of ryegrass was also studied.

3.3.3 Projected plan (1971): Initiate a research program which will serve as a basis for the development of projects to be funded under Cooperative State Research Service Special Grants Program for the Colleges of 1890 and Tuskegee. This program which would enhance the effectiveness of the 211741 grant program is entitled "The Economic Potential of Intensive Farming on Small Acreages Near Large Urban Centers" (and can serve as) an incentive for rural stabilization and immigration.

Under this project, three lines of investigation were to be pursued:

1. Evaluation of peach culture
2. Evaluation of small fruits (berries)
3. Evaluation of vegetables (tomatoes and sweet corn)

Accomplished (1972): A peach orchard was established comprising 10 acres of approximately 400 trees of June Gold variety and 5 acres of selected trees in a varietal trial consisting of 6 other varieties and trees to be used as root stock.

Six varieties of blueberries were established in an experimental block to test their adaptability to the Gulf Coast climate and soils.

A fertilizer test is being conducted on blackberries as part of management studies of small fruit.

An established tomato variety (Better Boy) for this region is being tested under three cultural systems; viz., open planting, staked, and caged. Plastic mulch was used in all trials to ascertain the relative effectiveness of the method on yield and quality.

Nine varieties of sweet corn were tested for maturity dates, yields, and quality; however, no results were obtained due to accidental damage to the planting. This test is being repeated.

3.3.4 Projected plan (1971): Begin pesticide studies on Prairie soils.

Accomplished (1972): Analysis of several hundred soil samples from South Texas. These samples were analyzed by gas chromatograph for content of residual herbicides. A graduate student is presently working on the isolation of microorganisms that are able to degrade certain resistant herbicides.

4. Impact of Grant-Supported Activities in Developing Institutional Capabilities: The grant has substantially increased participation in workshops, conferences, institutes, and seminars. The grant has enabled staff members to travel to tropical regions and associated institutions gaining valuable experiences in on-site situations, and working with personnel directly involved in agricultural development.

The main research thrust is an applied approach to directly and immediately aid the rural poor, not only in tropical regions, but in the United States as well. Innovations that enhance the quality of rural life here can be, in part, extrapolated to tropical environments elsewhere because many agronomic aspects of the poverty problems within the environs of Prairie View are strikingly similar to other regions irrespective of the cultural differences that may mask the situations.

Thus, the input of 211(d) has enabled Prairie View to contribute directly to the welfare of people, nationally and internationally. The philosophy of direct aid to the small farmer has given a new image

to agriculture and has imbued talented undergraduates to seriously consider careers in agriculture.

5. Utilization of Institutional Resources in Development: As stated in Section 3, student linkages have been established with several African and Caribbean countries. Facilities such as the Learning Resource Center in the library, the Teaching Center, and the Language Center are available in support to their training and enrichment.

Library holdings including facilities and collections are quite adequate at present. Future collections will include microfiche materials or foreign periodicals and collections from large libraries.

Research on maize as a cash crop for the uplands of Sierra Leone conducted by a staff member is directly in line with the idea of innovations annexed to the subsistence based farming that can materially increase the small farmers' income without any drastic change in his mores or traditional methods.

During a trip to the Dominican Republic to collect soil samples of Savannah areas for intensive study, three staff members consulted agricultural administrators and business leaders as to the levels of priority assigned problems in their country.

6. Other Resources for Grant-Related Activities: The CSRS grants awarded to Prairie View entail three major research thrusts:

Improving critical life chances, social conditions, and economic resources of disadvantaged minority populations and communities in selected southeastern Texas counties

Determination of economic opportunities for rural families in southeast Texas to improve their incomes

Improvement of the environment in rural areas close to urban centers (Houston, Galveston, Beaumont Triangle of South Texas)

Each thrust or objective has provided research and instructional personnel whose involvement easily meshes with the 211(d) objectives. These inputs have and will enhance our capabilities to increase student participation in soil studies, enrich our library collections and improve the laboratory equipment and supplies.

A 211(d) grant staff member is the project leader for a project submitted under the Agricultural Research Program "Determination of Economic Opportunities for Rural Families of Southeast Texas to Improve Their Incomes " The project is entitled "Analysis of Technical and Economic Problems in Alternative Systems of Producing and Marketing Selected Vegetables in the Texas Gulf Coast Area." The amount granted for this project was \$131,355. Initial funding to begin the project was received from CSRS June 1, 1972.

The vegetable project ties in with 211(d) objectives and helps develop our expertise in working with small farmers with limited resources.

7. Next Year's Plan of Work

7.1 Fifteen (15) graduate students in Plant and Soils next year are anticipated, of which 10 will be funded through the 211(d) grant. This will be achieved through a concentrated recruitment program which is campus-wide.

7.2 A four-day workshop in Tropical Soils for agriculturists of several institutions and governmental agencies, particularly the 1890 colleges, is planned for October. Visiting professors from consortium universities have been invited to participate.

7.3 Prairie View A&M College and the University of Puerto Rico plan to co-sponsor a seminar on Savannah soils to be held in the Dominican Republic in January.

7.4 An expanded seminar series in the School of Agriculture is planned to include foreign nationals and members of FAO.

7.5 The graduate program for the foreign nationals indicated in Table 3.2.2 will have started and visitations by respective staff to institutions of developing countries is planned in regard to research projects of both students and staff.

7.6 Further development of performance-based teaching modules for all introductory courses in Soil and Plant Science. Particular emphasis will be placed on teaching modules for students in African universities whose experience and objectives are different than ours.

7.7 The staff plans to present a panel during the Agronomy Society of American Meeting dealing with new concepts of development in tropical countries--a grassroot approach. One staff member plans to present a paper on Soil Classification at this same meeting.

7.8 The research accomplishments listed in Section 3 merely represent a part of the long series of units of work involved in each project. Plans will include expanding the research thrusts indicated in this year's report.

7.9 Four more research proposals which coordinate closely with the 211(d) program will be submitted for CSRS funding for FY '73.

They are as follows:

- (1) Economic feasibility of producing and marketing selected fruits in the Texas Gulf Coast area

- (2) Analysis of the technical and economic factors in the production and marketing of feeder and stocker calves on small farms in the Texas Gulf Coast area
- (3) Heavy metal pollution of soils: Effects on agricultural produce of areas adjacent to urban centers
- (4) Assessment of pollutants in rural water supplies

8. Other: No additional 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)

9.3 Budget: Summary

Salaries and Wages

Eligible for fringe benefits	\$41,637.23
Visiting professors	297.00
Graduate assistants	15,278.09
Sub-professional assistants	7,359.13

Total 64,571.45

Fringe Benefits 2,263.97

Travel

Domestic	2,593.00
International	2,434.75

Total 5,027.75

Communications 584.07

Contractual 0

Supplies 11,047.40

Equipment 5,077.30

Library Acquisitions 5,760.10

Total, all objects \$94,332.04

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

Object	211(d) Source				Non 211(d) Source
	Period Under Review	Cumulative Total	Projected Next Year	Projected to End of Grant	
Research	22,503.42	30,460.95	36,399	92,000	
Teaching	59,765.77	79,721.81	70,000	122,000	32,000
Libraries	5,760.10	11,753.11	4,000	7,000	1,800
Consultation			2,399	2,500	
Publication	1,275.00	1,275.00	2,000	2,500	
Travel	5,027.75	8,396.97	8,000	19,594	
Total	94,332.00	131,608.00	122,798	245,594	33,800

Table 9.2. Expenditure report, actual and projected (review period September 1, 1971 to June 30, 1972)

Object	Actual Expenditures		Projected Expenditures		
	Period Under Review	Cumulative Total	Year		
			3	4	5
Salaries	55,815.44	71,257.66	70,000	60,000	60,000
Student Assistants	15,278.09	20,721.80	36,000	45,000	45,000
Supplies and Macerials	14,450.66	19,478.30	4,798	4,500	4,500
Library	5,760.10	11,753.11	4,000	3,500	3,500
Travel	5,027.75	8,396.97	8,000	9,797	9,797
Total	94,332.00	131,608.84	122,798	122,797	122,797

9.4 Budget: Detail

9.4.1 Salaries and wages

<u>Name and Position</u>	<u>Percent of time on project</u>
James I. Kirkwood, Professor and Research Coordinator	50
J. B. Collins, Professor	100
E. A. Brams, Professor--Soils	100
Y. P. Chang, Research Associate	100

9.4.2 Travel

(1) Domestic

<u>Name</u>	<u>To</u>	<u>Cost</u>	<u>Purpose</u>
Cesar E. Lopez	Hawaii	198.34	To University of Hawaii in support of 211(d) tropical science grant
School of Agriculture group	Weslaco, Texas	594.30	Greyhound bus for tropical soils enrichment field trip to Rio Grande Valley
Johnnie B. Collins		70.25	Recapitulation of retroactive travel expense claims due as a result of presidential freeze
James I. Kirkwood		50.20	Recapitulation of retroactive travel expense claims due as a result of presidential freeze
Roger E. Savain	Houston, Texas	9.40	To discuss the printing of the <u>Agronews</u> , the School of Agriculture newsletter, with the Gulf Coast Negative Service
Roger E. Savain	Houston, Texas	9.40	To proof read the materials for <u>Agronews</u> , the School of Agriculture newsletter, at Yates Printing Company
Julio Polanco	Houston, Texas	30.00	To attend gas chromatography training
James I. Kirkwood	Montgomery, Ala.	253.28	To attend and participate in a meeting of the Southern Agricultural Workers in Tuskegee, Alabama and to transport two students on a field trip to Tuskegee Research Institute, Tuskegee, Alabama
James I. Kirkwood	Honolulu, Hawaii	457.77	To attend an Executive Committee Conference to prepare an Annual (Consortium) Report to be submitted to the Agency for International Development, Washington, D. C., December 1971

(1) Domestic (Cont.)

<u>Name</u>	<u>To</u>	<u>Cost</u>	<u>Purpose</u>
James I. Kirkwood	Washington, D. C.	367.95	(1) Annual Review for 211(d) grant (2) Workshop for research coordinators
Eugene A. Brams	Muscle Shoals, Ala.	270.50	To attend a 5-day short course at the National Fertilizer Development Center
James I. Kirkwood	Muscle Shoals, Ala.	279.31	To attend a 5-day short course at the National Fertilizer Development Center

(2) International

<u>Name</u>	<u>To</u>	<u>Cost</u>	<u>Purpose</u>
Eugene A. Brams	Lagos, Nigeria	1,335.05	To participate in the Tropical Soils Research Seminar held at the University of Ibadan, the International Institute of Tropical Agriculture and Kumasi
Johnnie B. Collins	Santo Domingo, D. R.	655.75	To secure and arrange transport of soil samples, to conduct at Prairie View A&M College, mineralogical studies of the mineral colloidal fraction of these soils in an effort to correlate the character- istics of this fraction with similar frac- tions of other soils of tropical and sub- tropical origin
Cesar Polanco	Santo Domingo, D. R.	443.95	To collect, describe and sample varying soil types in the Dominican Republic
	Total	\$5,027.75	

9.4.3 Equipment items costing over \$100 each

<u>Item</u>	<u>Cost</u>	<u>Vendor</u>
Soil core sampler cylinder, 6-cm long	\$ 148.45	Soilmoisture Equipment Co.
Beseler camera (35mm)	490.00	Texas Educational Aids
Fume hood; water still; balance Mettler	2,953.00	Curtin Scientific Co.
Technicolor 810WS, instant movie projector	238.50	Texas Educ. Aids
No. 8636 drawer file with key lock	255.49	University Microfilms
Soil moisture meter; soil moisture blocks; battery	154.70	Soil Moisture Equipment Co.
Troug soil tester reagent N	158.48	Hellige, Inc.
Hoffer soil sampler	268.68	NASCO
Univ. photo inter- preter's group stereoscope	410.00	Stratex Instrument Co., Inc.
	<hr/>	
Total	\$5,077.30	

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

<u>Faculty</u>	
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 Ia/646	
W. V. Bartholomew, Professor; organic matter transformations	
S. W. Buol, 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	
<u>Graduate students in tropical soils supported by 211(d) funds</u>	
S. T. Benavides (Colombia); soil genesis	
M. A. Granger (Guyana); soil genesis	
A. S. Lopes (Brazil); soil micronutrients	
F. T. Turner (USA); soil chemistry	
<u>Graduate students in tropical soils supported by other funds</u>	
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	

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. Oelsgle 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 ^a
	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

^aThese 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			Total
	Period Under Review	Cumulative Total	Year			
			3	4	5	
Salaries and Wages						
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
Travel						
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	5,000	18,412
Total All Objects	\$36,920	\$48,350	\$117,950	\$153,700	\$180,000	\$500,000

9.3 Budget: Summary

	<u>Total Expenditures</u>
Salaries and Wages	
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
Travel	
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: \$20.00¹
 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

¹Correction for incorrect reporting of expenses in first report

REPORT OF UNIVERSITY OF PUERTO RICO
FOR THE PERIOD
JULY 1, 1971 TO JUNE 30, 1972

- A. TITLE: A Grant to Strengthen the Capabilities of the University of Puerto Rico in Special Problems of Tropical Soils (Grant AID/CSD 2857)
- B. GRANTEE: University of Puerto Rico
- C. DIRECTOR: Dr. Rafael Pietri Oms
- D. STATISTICAL SUMMARY
1. Period of Grant: March 4, 1971 to March 3, 1976
 2. Amount of Grant: \$500,000
 3. Expenditures
 - 3.1 For report period: \$77,483.80
 - 3.2 Accumulated: \$77,483.80
 - 3.3 Anticipated for next year: \$124,677.33
- E. NARRATIVE SUMMARY

The main contribution of the grant under Section 211(d) to the total capability of the University of Puerto Rico in the teaching and related research in tropical soil science for increased food production can best be understood if the conditions prior to the grant are fully visualized. The established policy in the institution was to divide the staff members into two groups--those engaged in full-time research and those engaged in full-time teaching. Those assigned to research were under the jurisdiction of the Agricultural Experiment Station and as such did not participate in any matters related to teaching. Those assigned to full-time teaching were required to devote from 12 to 15 credit hours of classroom work per week in direct contact with students, the laboratory periods to be counted as half-time. Under this type of

arrangement the staff members assigned to teaching could not possibly engage in research. As of today and as a direct result of 211(d), all staff members engaged in the teaching of soils are doing some type of research. This has been possible by the appointment of two additional staff members, and a graduate assistant through 211(d) funds as described in the proposal.

An important item, intimately related to the objective of the program, is the Institution's capability to conduct research in tropical soils and to participate in technical assistance programs. Both are indispensable adjuncts of effective training committed to the productive use of tropical soils.

At this stage we can provide expertise in Tropical Soils Management and Tropical Soils Genesis and Classification to any Institution so desiring.

To implement the objectives of the program at the campus level, the following provisions have been taken:

- (1) Provide a senior faculty member to serve as the University of Puerto Rico project leader
- (2) Provide visiting professorships through which Puerto Rico can bring in special competencies either from the cooperating institutions or from other sources
- (3) Provide an additional junior staff member so as to develop specialization within the staff on the different areas of Soil Science
- (4) Provide a junior staff member "half-time" financed by the Agricultural Experiment Station as co-leader in the root crops research projects
- (5) Provide financial support to graduate students contributing to this project
- (6) Provide financial support for travel of contributing staff members

- (7) Revise, modify and develop new courses in tropical soils
- (8) Strengthen library and other informational services and provide for the preparation of training aids pertinent to the project

To implement the joint effort of the cooperative program, the following provisions have been taken:

- (1) Appoint a senior faculty member to coordinate our efforts with those of other participating institutions, and to provide policy and program guidance (this professor serves also as project leader)
- (2) Reinforce existing competency by recruiting and appointing a resident junior staff member
- (3) Make available our physical resources, as well as our existing staff competencies, to the other cooperating institutions through the development of joint education and/or research projects on tropical soils

F. DETAILED REPORT

1. General Background and Purpose of the Grant: A grant by AID would expand and strengthen the existing competencies of the University of Puerto Rico, Cornell University, the University of Hawaii, North Carolina State University, and Prairie View A&M College in tropical soils. These grants are to establish a collaborative program among these universities to develop special competencies, to provide such services as training, research, technical assistance and consultation in soil science for increasing food and fiber production on tropical soils.

The individual grants will strengthen the following areas:

<u>Institutions</u>	<u>Field of Concentration</u>
Cornell University	Tropical Soils Cultural Systems
North Carolina State University	Soil Fertility Relating Plant Nutrition to the Physical and Chemical Properties of Tropical Soils
Prairie View A&M College	Soil Fertility Problems Under Savanna-Prairie Ecology

University of Hawaii

Biology and Mineralogy of Tropical
Soils

The five universities already have institutional commitments to agricultural programs for developing nations and each has an interest in developing greater depth in their tropical soils capability. The five universities collectively represent a broad spectrum of ecological interests ranging from the oxisols of Hawaii to the prairie soils of Texas and the highly weathered soils of North Carolina and Puerto Rico. They represent a range of specialties and interests that complement each other so well that major facets of tropical soils are covered. Therefore, by considering the five universities as a coordinated group, an effective critical mass is achieved in building the United States' competence in tropical soils.

The University of Puerto Rico has long experience with production of food and forage crops on tropical soils and in soil conservation and management. It is Latin American-oriented in culture and language.

2. Objectives of the Grant

2.1 Objectives restated: To implement the joint programs, each institution will:

- (1) Appoint a representative in a position of administrative responsibility to a program council whose function will be to provide policy and program guidance
- (2) Appoint a project leader who will serve on a program executive committee, which will develop detailed plans of cooperation
- (3) Reinforce existing competencies by appointment of resident and visiting staff in areas that will complement existing strengths of the five institutions
- (4) Provide for support of students and faculty including exchanges of students and faculty to capitalize on the respective strengths of the cooperating institutions

- (5) Make available physical resources, including office space, laboratories, equipment and other facilities and services, as well as existing staff competencies as the institution's contributions
- (6) Develop a viable educational and research project on tropical soils and accommodate requests for training, technical assistance and consulting services as feasible and consistent with institutional resources and commitments

2.2 Review of objectives: The major objective of this program is to increase the capability of the Mayaguez Campus of the University of Puerto Rico to provide education and training in the utilization of the soils of the tropics in a joint effort with the University of Hawaii, North Carolina State University, Cornell University and Prairie View A&M College. The primary focus would be on the soils of the humid tropics and how they might be most effectively utilized and conserved for sustained and profitable food production. As an essential component of meaningful education and training, the program includes supporting studies in applications of meteorology, the plant sciences, the animal sciences, and the social sciences to the tropical environment.

An important and intimately related objective is to increase the Institution's capacity to conduct research in tropical soils and participate in technical assistance programs involving utilization of tropical soils. Both are necessary adjuncts of effective training for professional manpower committed to productive use of tropical soils and are, in addition, compelling ends in themselves consistent with the service to AID which is inherent in Section 211(d) of the Foreign Assistance Act of 1966.

This objective requires and will be getting inputs from at least four areas of soil science--(a) the study, characterization, and classification of tropical soils, (b) plant nutrient requirements for the

production of food crops on humid tropical soils, (c) soil-water plant relationships under humid tropical conditions, and (d) management practices for the conservation and protection of tropical soils for sustained crop production.

3. Accomplishments

3.1 Teaching: Since the initiation of the proposals, Professor Rafael Pietri, Professor of Soil Science, has been in charge of all 211(d) activities. He was appointed to serve on the Executive Committee of the Consortium to coordinate our efforts with those of other participating institutions. He has been acting as secretary of the Committee. When the grant became effective, he was appointed project leader and will be responsible in furthering the purposes of the grant.

Since the initiation of the proposal, which called for the addition of a junior staff member (an instrumental analysis specialist), the administration of the College of Agricultural Sciences was approached and asked for funds to appoint this new member. Funds were made available from the Dean of Agriculture's office and matched with funds from the Dean of Studies' office and Miss Milagros Miro was appointed as of August 1970. As the funds were made available for only one year, Miss Miro is now under 211(d) grant funding, as originally planned, and will continue to be for the duration of the grant.

Miss Milagros Miro described a new course in "Instrumental Analysis of Soils and Plants." The course is designed to familiarize the student with the latest instruments and their use in soil and plant analysis and will be offered for the first time in the spring semester of the 1972-73 academic year.

As of July 1, 1971 Dr. Fred H. Beinroth has been incorporated into our staff as Associate Professor in Soils. Dr. Beinroth is revising and will be teaching the course, Soil Genesis, Classification and Morphology; the course, Soils of Puerto Rico, and will also be conducting research on Soil Genesis and Classification as project leader.

Dr. Fred H. Beinroth participated in the 211(d) Soils Teaching Workshop held in Hawaii during the month of July 1971. During the workshop he submitted reports on (a) Soil Formation in the Tropics, (b) Soil Classification with Special Consideration for the Tropics, and (c) Soil Formation, Concepts and Instructional Objectives.

From September 7-13, 1971, Dr. Beinroth attended the Joint Meeting of Commissions V and VI of the ISSS at the University of Hohenheim near Stuttgart, Germany. The meeting focused on hydromorphic soils, their formation and utilization.

Dr. Miguel A. Lugo described two new courses on Soils Management. One is a course on "Topics in Tropical Soils Management" and is designed to teach the student to apply the principles of soil science in the interpretation and use of recent research relating to problems in the management and protection of tropical soils. The other course, "Management of Tropical Soils," deals with the application of the principles of soil science in designing and evaluating management systems for tropical soils. The courses have been already incorporated to the department curriculum and will be offered in the 1973-74 academic year.

A significant new feature in the advanced undergraduate instruction has been the new approach given to the course, "Special Problems in Soils." With the appointment of Miss Miro, this course has been geared

toward exposing advanced undergraduate students to simple research problems. Four students during the fall semester and five during the spring term were involved in this type of academic activity. The topics were the following:

- (1) The micronutrient status in three Ultisols from Puerto Rico (Humatas clay, Alonso clay and Los Guineos clay)
- (2) The aluminum and manganese status of an Oxisol (Nipe clay) and an Ultisol (Humatas clay) under different ammendments
- (3) Chemical analysis of the profile of the Pastillo series
- (4) Chemical analysis of the profile of the Potala series
- (5) Chemical analysis of the profile of the Santa Cruz series
- (6) A comparison of different methods for organic matter analysis
- (7) The aluminum status of Alonso clay
- (8) The chemical composition of the tobacco plant growing under different nutrient levels on an Ultisol

Final plans have been made for a four-week Tropical Soils Institute to be held at the Mayaguez Campus in the summer of 1972. The details of this program are given in the section of this report describing the Plan of Work for 1972-73.

Preliminary arrangements have been made for several distinguished soil scientists to be on the Mayaguez Campus during the coming year. Their identity and their plan of work will be presented on the section of this report intitled Plan of Work for 1972-73.

Equipment has been bought, installed and is already in operation for the preparation of audio-visual and auto-tutorial teaching aids. Audio-visual techniques will be introduced in as many courses as possible. We are equipped to prepare and provide resource materials on different aspects of soil science and of tropical agriculture.

A great amount of interest has been generated among the undergraduate students in soil science because of our involvement in the 211(d) program. As a result of it we expect to have for the 1972-73 academic year local graduate students in soil science for the first time. In addition, we expect to increase the number of graduate students from one to five.

3.2 Research: There are currently two graduate students either totally or partially funded under the 211(d) grant. Their research programs are part of the departmental contribution to the knowledge of tropical soils.

(1) Mr. Ricardo Barahona is a native of El Salvador, Central America. The objective of his research is to measure the physical, chemical and mineralogical properties of an Alonso clay profile. The information thus obtained will be useful in placing this soil within the categories established on the USDA Soil Taxonomy System. Mr. Barahona holds a graduate assistantship fully funded under 211(d).

(2) Mr. J. E. Jordan is a native of Puerto Rico majoring in Horticultural Crops. The objective of his research is to evaluate the effect of different levels of N, P, K, and minor elements, planting distance and planting season on the yield and quality of cabbage. The information obtained will be used in an effort to evaluate the use of tissue analysis and soil tests as diagnostic tools in cabbage fertilization in Oxisols. This research thesis is funded under the 211(d) grant.

Although the University of Puerto Rico does not have a research contract, staff members are actively engaged in research funded by 211(d). In an effort to procure the data required to initiate a

research project on the correlation of FAO/UNESCO soil units with taxa of the USDA Soil Taxonomy, a visit was paid by Fred H. Beinroth to the FAO headquarters in Rome, Italy. With the excellent cooperation of Dr. R. Dudal, Chief, Soil Resources, Development and Conservation and Dr. A. J. Pecrot, Senior Officer and Soil Correlator, much of the information needed was obtained. At the same time the discussions revealed, however, that some difficulties will be encountered in achieving the objectives as outlined in the project proposal.

No thorough evaluation to the data compiled could be done at this time. The brief account that follows merely summarizes the general results of the FAO visit and points out the ensuing position of our project:

(1) With the partial exception of WSRR 33, all previous FAO publications pertaining to soil units of the soil map of the world are obsolete.

(2) The FAO/UNESCO world-wide legend has been finalized and compiled in an unpublished FAO report (AGL:SM/70/2-WS/A7460). There now are 103 soil units which are grouped into 26 higher categories. At this stage definitions have not been written up in full, but there is a key which supplies sufficient information for high-level placement.

(3) The soil units advanced in WSrr 33 have undergone revision and considerable modification. However, most of the definitions remained essentially unchanged, except for nomenclature. The definitions for FAO diagnostic horizons correspond closely to those of Soil Taxonomy.

(4) The FAO/UNESCO legend is not a classification system. Rather, it is a compilation of world-wide correlated and defined soil units

that were grouped into 26 higher categories in recognition of important soil regions of the world rather than taxonomic grounds. The FAO nomenclature is heterogenous. Many names were adopted from current soils literature (e.g., Vertisols, Podzols, Ranker), but in addition some new names were coined (e.g., Acrisols, Luvisols, Nitosols).

(5) FAO units represent different levels of generalization as they do not strictly adhere to taxonomic rules.

(6) The definitions of FAO units are, by necessity, comparatively broad and correspond, in general, with USDA Suborders and in some cases Great Groups. A comparison of the two Schemes demonstrated this point:

<u>FAO/UNESCO</u>	<u>USDA</u>
26 high categories	10 Orders
103 units	43 Suborders
	200 Great Groups

In view of these facts, the prospects for our correlation project appear to be as follows:

(1) Most FAO units will have several USDA correlatives, both at the Suborder and at the Great Group level.

(2) USDA Suborders can likely be correlated with reasonable accuracy, while it will be impossible to meaningfully match some Great Groups with FAO units.

(3) Due to the nature of the two schemes which are based on two divergent rationales, their correlation cannot be achieved in a consistent manner as regards the level of correlation.

(4) It is anticipated that correlation tables will materialize from this project which in spite of their inherent shortcomings will largely meet the objectives forwarded in the project proposal.

Dr. Fred H. Beinroth spent six weeks in Hawaii initiating a geomorphic pedogenetic study, starting in this way a cooperative project whereby soils of Puerto Rico and of Hawaii will be correlated in terms of chemical, physical and mineralogical characteristics. At the same time, these same soils will be also correlated with the FAO system and correlation tables have been prepared. During this work he was financially supported by both Puerto Rican and Hawaiian 211(d) funds. A publication will come out sometime next year.

A number of research projects on the nutritional level requirements of tropical food crops were initiated during this year. Two groups of plants were used--(1) edible legumes which included pigeon peas, field beans and cow peas and (2) root crops which includes yams (Dioscorea sp.), taniars (Xanthosoma sp.) and cassava (Manihot sp.). The objective is twofold--(1) to determine the response of varieties or cultivars of these crops to maximum fertilizer applications and/or (2) to determine the lack of response of any of the varieties or cultivars, thus providing a crop which could be grown under primitive farming systems without the need of complex technological inputs. This work will be done in the two principal tropical soil orders, Oxisols and Ultisols.

Pigeon peas, field beans and cowpeas trials have already been harvested and the data are being analyzed. Full reports are expected to be published during the coming year. The yams, taniars and cassava trials are on the field and are to be harvested during the months of October and November 1972. Complete data and full reports will be available for next year's annual report.

A field trial of the nutritional requirements of field beans and corn was started on a plot simulating severe sheet erosion. The topsoil and part of the subsoil was removed during land level trials and the area was abandoned after several crop failures. After a number of pot experiments, a field trial was set up which included heavy phosphorus treatments and Zn treatments. The response was dramatic and the field was harvested last June. A full report will be available for next year.

4. Impact of Grant-Supported Activities in Developing Institutional Capabilities: The grant-supported activities are considered an integral part of the overall effort of the Department of Agronomy. As a consequence, everybody feels the urge to contribute to the grant program regardless of the source of individual funding.

The main impact has been a result of the opportunity of having a research component among the duties of the staff. This effect was sensed early at the beginning and prompted us to assign a higher priority to research than was anticipated.

The response has been astonishing. The advance undergraduate students got caught on the tide with highly significant results. So far and since the establishment of the graduate school, no local student has been involved in graduate work in soil science. We have never had more than one graduate student at a time in soil science. The second semester of the 1971-72 academic year saw our second student coming in. For the 1972-73 academic year we expect to have our first local graduate student and for 1973-74 we expect to have five in all.

The interest caught up with other sectors and the result has been a number of new grant proposals submitted to different agencies. Among

them--a proposal for the improvement of bean, soybean and cowpea production in the tropics through disease and insect control; a proposal for the improvement of sorghum production techniques in the tropics and a proposal for an international soybean research and development center.

5. Utilization of Institutional Resources in Development: The College of Agricultural Sciences through its Office of International Programs shares and makes available to other institutions its staff competencies and its physical resources. As part of this resource sharing, commitments have been made to provide technical assistance and training to less developed countries.

5.1 AID/ROCAP-83 contract: This contract calls for the graduate training in Puerto Rico of personnel from Central American universities. Eleven participants were in Puerto Rico during the 1971-72 academic year from four different areas--Costa Rica, Nicaragua, Guatemala and El Salvador.

Another phase of the contract calls for our sending visiting professors to these same areas. During the 1971-72 academic year the following staff members were on this assignment:

José R. Mondonedo	Universidad de San Carlos, Guatemala
Alberto Febre	Universidad de San Carlos, Guatemala
Eddie Alvarez	Universidad de El Salvador, San Salvador
Luis Alvarez	Universidad de Nicaragua
Justo Hernandez	Universidad de Nicaragua
Silverio Medina	Universidad de Costa Rica

5.2 Instituto Superior de Agricultura (ISA), Santiago, Dominican Republic: A general contract with ISA calls for staff sharing for teaching and research supervision in any of the fields related to agriculture, at their request. During the 1971-72 academic

year Saulo Rodriguez was assigned for full-time duties at ISA. During this same period Arturo Riollano and Bernardino Rodriguez served as part-time consultants.

During the month of August 1971 nine staff members of ISA visited the Mayaguez Campus for discussions with their colleagues.

5.3 Short courses by agreement with AID/OIT: Short courses were offered during 1971-72 under this agreement. Participants from Brazil, Honduras, Panamá, Colombia, Venezuela and Costa Rica spent from six weeks to six months in Puerto Rico in different short courses that took place during this period. Fifty-five students attended the offerings.

Complete details of all these activities are available through the Office of International Programs of the College of Agricultural Sciences.

In addition to the activities channeled through the Office of International Programs, the Faculty itself serves as a resource-sharing avenue. During the 1971-72 academic year the Mayaguez Campus had a total of 600 undergraduate and 74 graduate foreign students, with the following distribution: Argentina, 5; Aruba, 1; Bolivia, 2; Brazil, 1; Canada, 2; Chile, 4; China, 1; Colombia, 51; Costa Rica, 4; Cuba, 217; Curacao, 1; Ecuador, 8; Spain, 13; Guatemala, 7; Guyana, 1; Haiti, 33; Honduras, 4; British Honduras, 3; India, 2; England, 2; British Virgin Islands, 2; Italy, 2; Jordan, 1; Martinique, 1; Mexico, 2; Nicaragua, 11; Panamá, 19; Pakistan, 1; Peru, 12; Dominican Republic, 231; Salvador, 5; St. Kitts, 1; Surinam, 1; Trinidad, 1; Uruguay, 1; Venezuela, 18.

During the month of January a group of students from the International Agriculture Program of Cornell University visited the island. During January 11-14 they visited the Mayaguez area and were taken care of by staff members. In particular, Prof. Beinroth accompanied the group on their field trips.

6. Other Resources for Grant-Related Activities: The grant contributes to the overall teaching efforts and teaching commitments of the Department of Agronomy of the University of Puerto Rico. As the chief goal of the grant is to strengthen the existing competency, the funds provided by this grant cannot replace existing funds for current projects. On the contrary, activities carried out under this grant have been additives to existing programs at the University. In direct support to the grant, the University has been providing and will continue to make the following inputs.

6.1 Administrative costs including salaries and utilities in all administrative offices and facilities. The basic salary of the project leader, Prof. Rafael Pietri, \$13,620 comes from the university budget. No funds from the grant are used to cover costs of services of senior administrative officers in the College of Agricultural Sciences.

6.2 Access to all persons concerned or related to the grant to relevant laboratories, field research facilities, and libraries. The facilities of the Agricultural Experiment Station and its substations are also available. The field research under the grant is using a three-acre plot at the Isabela substation and an additional three-acre plot will be needed for next year. This land will be provided

free of charges to the grant program. The services of the Central Analytical Laboratory of the Agricultural Experiment Station are also available free of charge.

Money-wise, these contributions are very difficult to assess and they are not shown on Table 9.1.

6.3 Office, classroom and other space for faculty, students and special meetings related to the new program. In addition, the University provides to all persons concerned or related to the grant all services and facilities that are normally provided to the regular staff and to the regular students. These contributions are also very difficult to assess and are not shown on Table 9.1.

6.4 The members of the faculty in the Agronomy Department not directly funded by the grant are considered an integral part of the grant program. Their salaries are shown in Table 9.1 as university support to grant-supported activities.

6.5 The sub-professional personnel of the department who are university-state appropriate funding are considered also an integral part of the grant program and take part in related activities. Their salaries are also shown in Table 9.1.

6.6 The regular budget appropriations for supplies and materials for the Soil Science section of the Agronomy Department provided through state funds have been placed under the direct control of the grant project leader. This follows the same line of thinking already stated in the above paragraphs. All available resources are pooled in order to make a more efficient use of all of them. These appropriations appear in Table 9.1.

6.7 As an additional item, we have to mention the assignment part time of Dr. Jose Badillo from the Agricultural Experiment Station to the research program of the grant. Dr. Badillo will devote 50 percent of his time to supervise the field trials on root crops at the Isabela substation and at the College Farm. He is and will continue to be state-funded.

7. Next Year's Plan of Work

7.1 Teaching: Three new courses will be included in the offerings for next year. These will be Instrumental Analysis of Soils and Plants, Topics in Tropical Soils Management, and Management of Tropical Soils. In addition, the revised courses of Genesis, Morphology and Classification of Soils and Soils of Puerto Rico will be moved to the group of advanced undergraduate and graduate courses.

Final plans for a Tropical Soils Institute have been drawn. The Institute will provide intensive instruction in the application of current knowledge of soil science and related disciplines to problems of crop production in the tropics. It will be an institute for professional soil scientists, both from the U. S. and international, holding B. S. or higher degrees and carrying four credit hours of graduate work. It will take place from July 10 to August 4 at the Mayaguez Campus of the University of Puerto Rico.

A faculty recruited from the five institutions will participate; so far the following have accepted and will be guest lectures:

Dr. Goro Uehara
Dept. of Agronomy & Soil Science
University of Hawaii
2525 Varney Circle
Honolulu, Hawaii 96822

Dr. Modesto Capiel
Department of Agronomy Soils
Agricultural Experiment Station
P. O. Box H
Rio Piedras, Puerto Rico 00928

Dr. M. G. Cline
 Department of Agronomy
 Bradfield Hall
 Cornell University
 Ithaca, New York 14850

Dr. Robert L. Fox
 Dept. of Agronomy & Soil Science
 University of Hawaii
 2525 Varney Circle
 Honolulu, Hawaii 96822

Dr. Douglas J. Lathwell
 Department of Agronomy
 Bradfield Hall
 Cornell University
 Ithaca, New York 14850

Dr. D. R. Bouldin
 Department of Agronomy
 Bradfield & Emerson Halls
 Cornell University
 Ithaca, New York 14850

Sr. Fernando Abruna
 Department of Agronomy
 Agricultural Experiment Station
 P. O. Box 11
 Rio Piedras, Puerto Rico 00928

Dr. F. H. Beinroth
 College of Agricultural Sciences
 Department of Agronomy
 University of Puerto Rico
 Mayaguez, Puerto Rico 00708

Dr. S. W. Buol
 Department of Soil Science
 North Carolina State University
 Raleigh, North Carolina 27607

Dr. Eugene Brams
 Associate Professor of
 Soil Science
 School of Agriculture
 Prairie View, Texas 77445

Dr. Pedro A. Sanchez
 Department of Soil Science
 North Carolina State University
 Raleigh, North Carolina 27607

Dr. José Vicente
 Department of Agronomy
 Agricultural Experiment Station
 P. O. Box 11
 Rio Piedras, Puerto Rico 00928

Dr. M. Weaver
 Department of Agronomy
 Emerson & Bradfield Halls
 Cornell University
 Ithaca, New York 14850

Dr. Eugene Kamprath
 Department of Soil Science
 North Carolina State University
 Raleigh, North Carolina 27607

Four areas of study will be covered; namely:

- (1) Soil Genesis, Geomorphology, Classification and Climatology, under the responsibility of Dr. Fred H. Beinroth, University of Puerto Rico
- (2) Soil Physics and Mineralogy, under the responsibility of Dr. Goro Uehara, University of Hawaii
- (3) Soil Chemistry and Fertility, under the responsibility of Dr. D. R. Bouldin, Cornell University
- (4) Soil Management Systems, under the responsibility of Dr. P. A. Sanchez, North Carolina State University

Each section will meet daily during four days of the week for a 60-minute lecture and a 30-minute discussion period, during four

consecutive weeks. Two weekly field trips will give the opportunity to the participants to visit all the ecological areas in the island.

Applications for admission have been received from 36 students from the following areas: Venezuela, Chile, Sierra Leona, Brazil, Haiti, Ethiopia, Colombia, Panamá, India, Uganda, Peru, Dominican Republic, Guatemala, Paraguay, El Salvador, Indonesia, U. S. mainland and Puerto Rico.

Library facilities on the literature on tropical soils will be inventoried and an index of available material will be prepared.

Plans are been made to use 211(d) funds to purchase a DTA-TGA machine to complete the instrumentation of the soils mineralogy laboratory.

It is intended that all staff members will make visits to collaborating institutions in the mainland, to research stations, agricultural regions and institutions overseas and will attend scientific meetings in order to be able to discuss with other scientists matters of mutual interest thus increasing their capability to work with tropical soils.

It is estimated that the anticipated expenditures related to the above-mentioned activities will be as follows:

Salaries	
Professional	\$31,443.33
Graduate Assistants	9,000.00
Clerical	8,360.00
Stipends: Fringe benefits	9,600.00
Travel	
Domestic	6,000.00
International	5,000.00
Departmental Support	
Library and teaching aids	6,000.00
Equipment	10,000.00
Supplies, Materials and Services	4,000.00

7.2 Research: Two new projects centering on the area of Soil Genesis, Morphology and Classification are contemplated:

- (1) Correlation of the soils of Puerto Rico with soils of South America
- (2) Evaluation of mineralogic criteria applied for Oxisols and Ultisols in the USDA soil taxonomy

In the area of nutrient level requirements the same field trials that are being conducted in the Oxisol Coto clay will be planted in the Ultisol Humatas clay. The residual effect of the fertilizer application on the Coto clay trials will be evaluated.

The close collaboration that has been initiated with the University of Hawaii will be continued through the research projects.

It is estimated that the expenditures related to the above-mentioned activities will be as follows:

Stipends	
Wages (field laborers)	\$6,942.00
Fringe Benefits	932.00
Supplies, Materials & Services	3,000.00

7.3 Visiting scientists and staff additions: Commitments have been made with Dr. Hans W. Fassbender and Dr. Van Wambeke to visit the Mayaguez Campus as Visiting Lecturers. Dr. Fassbender is scheduled to arrive on September 4, 1972 and stay until September 30, 1972. During his stay he will deliver twelve lectures in Soil Chemistry in Mayaguez and two at Rio Piedras and will be available to the graduate students and to staff members for consultation. Dr. Van Wambeke will visit us during the spring term under the same terms as Dr. Fassbender.

Dr. Hector Lugo Mercado who has completed the Ph. D. at North Carolina State University will be incorporated to the staff on a full-time capacity.

Plans are being drawn to recruit a junior staff member in the area of soil fertility and plant nutrition.

To further involve local advanced undergraduate students in the program, the establishment of undergraduate assistantships is being contemplated. These students will work closely with the senior staff members in routine work such as collecting samples for both soil and plant analysis and helping in routine laboratory work. They will be allowed to work not more than 15 hours per week and will be paid accordingly.

It is estimated we will have the following expenditures:

Salaries

Visiting Lecturers	\$ 6,000.00
Junior Staff Member	12,000.00
Fringe Benefits	1,800.00

Stipends

Wages, Undergraduate Assistants	4,000.00
Fringe Benefits	600.00

8. Other: No additional 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).

9.3 Budget: Summary

Salaries

Professional and Technical	\$30,243.33
Graduate Assistants	2,625.00
Clerical	1,566.13
Sub-professional Assistants (field labor, irregular)	9,386.00
Fringe Benefits	1,276.94
Travel	
Domestic	3,667.30
International	8,240.06

Supplies, Materials and Services	\$ 6,773.84
Equipment	7,574.99
Library & Teaching Aids Acquisitions	6,130.21
Total, All Objects	<u>\$77,483.80</u>

9.4 Budget: Detail

9.4.1 Salaries and wages

<u>Name and Position</u>	<u>Percent of Time on Project</u>
Friedrich H. Beinroth, Associate Professor	100
Rafael Pietri Oms, Professor & Project Leader	100
Milagros Miro, Associate Researcher & Assistant Professor	100
Ricardo Barahona, Graduate Assistant	100
Secretary	100

9.4.2 Travel

(1) Domestic

Name: Milagros Miro	Cost: \$499.00
To: New York and Boston	
Purpose: To attend the Soil Science Society of America Meeting in New York and the Norelco Instrumentation Course in Boston	
Name: Raul Abrams	Cost: \$815.22
Rafael Pietri	\$815.22
To: Hawaii	
Purpose: To attend the Executive Committee meeting at the University of Hawaii	
Name: Miguel Lugo	Cost: \$315.00
Rafael Pietri	\$315.00
To: Washington	
Purpose: To attend the annual review of the 211(d) grant and to attend a joint meeting of the Council of Deans and the Executive Committee	
Name: Friedrich H. Beinroth	Cost: \$230.70
To: Ithaca, New York	
Purpose: Lecture at Cornell on Tropical Soil Genesis and discuss final plans for Section I of the Tropical Soils Institute	

9.4.2 Travel (Cont.)

(2) International

Name: Friedrich H. Beinroth Cost: \$772.60
 To: Germany and Italy
 Purpose: Attend meeting of Commission V and VI of
 International Soil Science Society and visit FAO
 headquarters in Rome to discuss research projects

Name: Rafael Pietri Cost: \$2,204.65
 Raul Abrams
 To: Nigeria, Kenya
 Purpose: To attend seminar at IITA and to visit agri-
 cultural regions and experiment station in
 western and eastern Africa

Name: Friedrich H. Beinroth Cost: \$1,993.16
 To: Nigeria, Kenya, Uganda
 Purpose: To attend seminar at IITA, visit agricultural
 regions and experiment stations in west and
 east Africa

Name: Milagros Miro Cost: \$1,065.00
 To: Madrid
 Purpose: To attend the International Clay Conference

9.4.3 Supplies, materials and services: In this item are included items distinct from general departmental supplies, materials and services common to regular departmental projects. Here are included supplies, materials and services in support of specific activities of projects generated by the grant. Expenses will be itemized at request.

9.4.4 Equipment: A pre-mix flow burner kit was added to the existing atomic absorption apparatus to extend and increase the operating range of the machine. An air conditioning unit was installed in the spectrometer laboratory to supplement the dehumidifiers and thus give a greater protection to the equipment.

Fisher Scientific Company pre-mix flow burner kit for Jarrell-Ash atomic absorption spectrometer	\$742.50
Air conditioning unit, Westinghouse 18,000 BTU	249.00

The following equipment was needed to cope with the needs of the new program. The items included are above the normal expenditures which the department incurs in their services to all projects. The equipment was needed to provide minimal facilities for the office and paper work in all phases of the project.

Typewriter, IBM Model D-19	\$ 585.00
Credenza Model 712, Cole	169.00
Desk, Cole, Model 1784N	214.00
Desk with pedestal, Cole	159.00
Gestetner duplicating machine	1,150.00
Gestetner paper folder	380.00
Gestetner paper collator, Model 8S	375.00
Gestetner paper cutter	185.00
Gestetner photocopying machine, Model C-10	1,450.00
Air conditioning unit, Fedders, 18,000 BTU	249.00

9.4.5 Library and teaching aids (equipment): The following equipment was essential for preparation of training materials for teaching and resource development. These items help to provide the capabilities for developing teaching, training materials and informational services as called for in the grant proposal.

Kodak Carrousel 35 mm projector, Model 860W	\$ 207.21
3 mm lens	
Polaroid photographic laboratory with M-P3 hand camera	1,631.04
Gestetner scanner, Gestefax, Model 456	2,505.00
Nystrom relief maps	488.30
Stacor map flat file	260.00
3M portable vertical projector	269.00
Kodak Vugraphic Beseler vertical projector	195.74
Copier cart (two)	300.00
Unitech lettering set	125.00

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

Object	211(d) Source				Non 211(d) Source
	Period Under Review	Cumulative Total	Projected Next Year	Projected to End of Grant	
Salaries					
Professional & Technical	\$30,243.33	\$30,243.33	\$ 49,443.33	\$155,734.47	\$64,403.00
Graduate Assistants	2,625.00	2,625.00	9,000.00	42,625.00	
Clerical	1,566.13	1,566.13	8,360.00	27,926.13	4,140.00
Stipends					
Wages	9,386.00	9,386.00	10,942.00	64,328.00	9,660.00
Fringe Benefits	1,276.94	1,276.94	12,932.00	54,000.00	a
Travel					
Domestic	3,667.30	3,667.30	6,000.00	24,667.30	4,202.68
International	8,240.06	8,240.06	5,000.00	20,240.06	
Supplies, Materials & Services	6,773.84	6,773.84	7,000.00	22,773.84	8,000.78
Departmental Support (Equipment)	7,574.99	7,574.99	10,000.00	57,574.99	5,077.76
Library & Teaching Aids (Acquisitions)	6,130.21	6,130.21	6,000.00	30,130.21	196.50 ^b
Total	\$77,483.80	\$77,483.80	\$124,677.33	\$500,000.00	\$95,680.72

^aFringe benefits are paid by the central administration from a central fund based on total payroll

^bLibrary appropriations are made at a campus level

Table 9.2. Expenditure report, actual and projected (review period July 1, 1971 to June 30, 1972)

Object	Actual Expenditures		Projected Expenditures				Total
	Period Under Review	Cumulative Total	Year				
			2	3	4	5	
Salaries	\$34,434.46	\$34,434.46	\$ 66,803.33	\$ 47,047.81	\$ 46,000.00	\$32,000.00	\$226,285.60
Stipends	10,662.94	10,662.94	23,874.00	30,000.00	30,000.00	23,791.06	118,328.00
Travel	11,907.36	11,907.36	11,000.00	8,000.00	7,000.00	7,000.00	44,907.36
Supplies, Materials	6,773.84	6,773.84	7,000.00	3,000.00	3,000.00	3,000.00	22,773.84
Departmental Support	13,705.20	13,705.20	16,000.00	26,000.00	16,000.00	16,000.00	87,705.20
Total	\$77,483.80	\$77,483.80	\$124,677.33	\$114,047.81	\$102,000.00	\$81,791.06	\$500,000.00