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Annual Report

JULY 1, 1972 TO JUNE 30, 1973

UNIVERSITY CONSORTIUM ON SOILS OF THE TROPICS

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.

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

JULY 1, 1972 TO JUNE 30, 1973

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 third 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 report consists of six parts, identified by page numbers prefixed by letter 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 1973-74 operational year. Each of the individual institutional reports also includes a statement of expenditures under the grant for the fiscal year within that institution has operated and a projection of expenditures for the next fiscal year.

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THE CONSORTIUM PROGRAM

A. SUMMARY

This section of the third 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 this reporting period, the five institutions had increased the amount of effort on soils of the tropics substantially. Sixty members of the academic faculties were actively participating in the program. The graduate students in residence included 71 specializing in soil science for the tropics.

Teaching of tropical soils had been increased markedly by the end of FY 1972-73. Since the grants were made, 20 new courses had been added to curricula, and outlines and teaching materials had been prepared for five others. Eighteen existing courses had been revised to incorporate subject matter on soils of the tropics. Teachers have 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, five 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; 27 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 state appropriations and grants at the Universities of Hawaii and Puerto Rico, and under Cooperative State Research Service funding at Prairie View A&M College. Forty publications, theses, and manuscripts on tropical soils were produced during FY 1972-73 at the five institutions from 211(d) funding.

Fifty-one individuals of the five institutions made visits concerned with soils of the tropics to 35 countries during 1972-73. The visits ranged from short assignments 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.

Since the grants were made 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. Contacts were continued 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 and 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 1973-1974 projects cooperative teaching projects, continued additions 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. Short-term and long-term visiting professors are scheduled.

The University of Hawaii will offer for Consortium members a Workshop on Tropical Soils Mineralogy during the month of July, 1973.

North Carolina State University has been given the responsibility for providing the coordination for a seminar on "Soil Management and the Development Process in Tropical America," to be held at CIAT, Cali, Colombia during the month of February, 1974. A Steering Committee with members from several institutions was formed to prepare this event. This Seminar will be followed by a 10-day tour to key research centers in Colombia, Peru, and Brazil.

A Tropical Soils Institute will be held in the Far East for professional soil scientists. It will be similar to the one held in Puerto Rico in the Summer of 1972. The University of Hawaii will be responsible for the organization of this joint endeavour.

A preliminary study of ways to make available an extensive bibliography on tropical soils geography now in the files of Soil Conservation Service has been completed and negotiations are underway for publishing the material as a joint consortium effort. Cornell University has been assigned the responsibility of such a task.

B. GENERAL BACKGROUND AND PURPOSE OF THE GRANTS

Soils of the tropics pose unique problems for development of agriculture. American interests in education and development 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 subsequent sections of the report.

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 to this subject. In the aggregate, 60 members of the academic faculties were involved in tropical soils studies to a significant degree at the five institutions during 1972-73. During the same period, 71 graduate students having majors in soil science and a commitment to the tropics were enrolled. Their sources of support came from a wide variety of institutions.

2. Teaching: Teaching of basic soils courses has been affected significantly by the Tropical Soils Teaching Workshop reported for 1970-71. Since then all of the institutions have modified basic soils courses to incorporate subject matter and teaching techniques studies 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 on the other agricultural disciplines and some students of social, physical, and biological sciences.

All of the institutions have put substantial effort for a Tropical Soils Institute held in Puerto Rico for professional soil scientists, both from the U. S. and elsewhere, holding B.S. or higher degrees and carrying four credit hours of graduate work. It was held from July to August 4 at the Mayaguez Campus of the University of Puerto Rico.

The faculty consisted of the following:

Mr. Fernando Abruna
Agricultural Experiment Station, Puerto Rico

Dr. F. H. Beinroth
University of Puerto Rico

Dr. D. R. Bouldin
Cornell University

Dr. Eugene Brams
Prairie View A & M College

Dr. S. W. Buol
North Carolina State University

Dr. Modesto Capiel
Agricultural Experiment Station, Puerto Rico

Dr. M. G. Cline
Cornell University

Dr. Robert L. Fox
University of Hawaii

Dr. Eugene Kamprath
North Carolina State University

Dr. Douglas J. Lathwell
Cornell University

Dr. Pedro A. Sanchez
North Carolina State University

Dr. Goro Uehara
University of Hawaii

Mr. Jose Vicente-Chandler
Agricultural Experiment Station, Puerto Rico

Dr. M. Weaver
Cornell University

Four areas of study were covered:

1. Soil Genesis, Geomorphology, Classification and Climatology under the leadership of Dr. Fred H. Beinroth, University of Puerto Rico.

2. Soil Physics and Mineralogy, under the leadership of Dr. Goro Uehara, University of Hawaii.
3. Soil Chemistry and Fertility under the leadership of Dr. D. R. Boulin, Cornell University.
4. Soil Management Systems under the leadership of Dr. P. A. Sanchez, North Carolina State University.

Each section met 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 gave the opportunity to the participants to visit all the ecological areas in the island.

Twenty-eight students attended the institute from the following countries: Chile, Dominican Republic, El Salvador, Guatemala, Haiti, Indonesia, Panama, Paraguay, Puerto Rico, Sierra Leone, U. S. mainland, and Venezuela.

During FY 1972-73, eight new courses on tropical soils were added to curricula: one at North Carolina State University, three at the University of Hawaii, two at Prairie View A & M College, and two at Cornell University. Twenty new courses on tropical soils have been added during the life of the project. Five new courses were offered for the first time during the 1972-73 academic year: three at the University of Puerto Rico, one at Cornell University, and one at North Carolina State University. During the life of the project, 18 existing courses have been modified to incorporate subject matter relevant to the tropics: five at North Carolina State University; three each at the University of Hawaii, the University of Puerto Rico, and Prairie View A & M College; and four at Cornell University.

Innovation in teaching include installation and use of auto-tutorial 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 1972-73, Consortium members have used ten 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 had four visiting scientists and the University of Hawaii a short term lecturer. Cornell University had two visiting professors for a period of nine months. The University of Puerto Rico employed two individuals on short-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, continued with their 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, with the effort centered around the graduate program. Prairie View A & M College has compiled a data bank on properties of soils of tropical savannas with information concerning savanna ecosystems.

The University of Hawaii's normal research program in soils is predominantly oriented to the tropics. 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 soil management systems for root crops as it relates to soils protection and conservation. 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. The main countries involved are Brazil, Peru, Costa Rica, Ecuador, Guatemala, El Salvador, Nicaragua, and Panama.

Forty publications, theses, and manuscripts on tropical soils were produced by the five institutions during 1971-1972.

4. Consultation: Individuals of the Consortium institutions made fifty-one visits to 35 foreign countries during 1972-1973 on matters pertaining to tropical soils as follows:

Australia	Germany	Panama
Barbados	Great Britain	Peru
Belgium	Guatemala	Philippines
Brazil	Guyana	Puerto Rico
Cameroon	Indonesia	Rome (FAO)
Colombia	Ivory Coast	St. Lucie
Costa Rica	Jamaica	St. Vincent
Dominican Republic	Mauritius	Tanzania
Ethiopia	Mexico	Thailand
France	North Africa	Trinidad
		Vietnam

These visits ranged from consultations about cooperative research to action programs. These visits were not supported by 211(d) funds, but all contributed to objectives of the program.

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 Washington.

and at the spring meeting in Prairie View. The Consortium was represented at meetings of the CUSUSWASH group.

5. Library and Reference: All of the institutions have continued to increase library resources and improve reference facilities. Contacts have been established with the Tennessee Valley Authority, the CUSUSWASH Consortium and the Soil Conservation Service about opportunities for collaboration on bibliographical services.

Since the beginning of the grant, North Carolina State University has distributed copies of the soils sections of the first five volumes of the Latin American Bibliography of Agriculture and copies of the holdings on tropical soils at the Library of the Interamerican Institute of Agricultural Sciences at Turrialba. During this year, this institution published a literature review entitled, "Review of Soil Research in Tropical Latin America." Cornell University has distributed copies of research project descriptions catalogued by the Smithsonian Science Information Exchange. During FY 1972-73 acquisitions for the departmental collection numbered 104 books, bulletins, and maps. An annotated bibliography on zinc was prepared.

The University of Hawaii contracted under 211(d) funds a new employee to index information on tropical soils. The University of Puerto Rico increased substantially the departmental collection of books, bulletins, and maps.

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 60 members of the respective faculties who are actively studying the applications of soil science in the tropics. This is about 25 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 faculty members 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: 70
- 1.2 U. S. graduate students being trained in tropical soils: 31
- 1.3 Participants in a soil testing seminar for foreign nationals: 15
- 1.4 Participants in a Tropical Soils Institute: 28

2. Research

- 2.1 Staff engaged in long-term research and technical assistance in developing countries: 15
- 2.2 Research publications: 31
- 2.3 M.S. and Ph.D. Theses in Tropical Soils: 14
- 2.4 Manuscripts, abstracts, and other unpublished but finished work: 47

3. Staff Visits for Short-Term Consulting to Assit Developing Countries: 18

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 on a large number 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.

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

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 1973-74

The Consortium will continue cooperation on joint instructional projects during 1973-74. 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 to be held in the Philippines in June, 1974. The University of Hawaii is responsible for its organization. The University of Hawaii plans to hold a workshop on mineralogy teaching and research for staff of the Consortium institutions. The second region-wide Consortium Seminar will be held in Latin America during the next year.

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

Emphasis for research will continue to be placed on problems that support on-going research programs in Latin America financed

by other funds. At North Carolina State and Cornell Universities, the major 211(d) input will be to complement research under AID contracts.

The five institutions will continue to consult in developing countries to the extent feasible as opportunity and need become evident. Consultation will be used as a device to increase Consortium expertise as well as per assistance in developing countries. Projects planned or underway include consultations in several West African, Latin American, and Asian countries.

Rafael Pietri O., Chairman
Executive Committee

REPORT OF
CORNELL UNIVERSITY

REPORT OF CORNELL UNIVERSITY

FOR THE PERIOD

JULY 1, 1972 TO JUNE 30, 1973

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: \$120,792.64

3.2 Accumulated: \$232,786.96

3.3 Anticipated for next year: \$132,600.00

E. NARRATIVE SUMMARY

The total expenditures for teaching the applications of soil science to the tropics at Cornell increased about 20 percent during FY 1972-1973, and by the end of the year had increased to about three times the level at the initiation of the project. Approximately 36 percent of the total teaching effort was supported by resources other than the grant. The increased effort included continuing incorporation of subject matter for the tropics in regularly scheduled courses, continuation of two new courses initiated in 1971-1972, and initiation of one new course. Four members of the faculty contributed

to the Tropical Soils Institute in Puerto Rico sponsored by the Consortium. A new summer session course was planned for 1973-74. One long-term and two short-term visiting professors and scientists taught at Cornell. Thirty-five graduate students having career commitments to tropical agriculture received training. Twenty-seven of these were from LDC's.

Research supported by the grant has focused mainly on problems related to work on fertility of acid soils of the humid tropics under AID research contract csd 2490. It has included studies of factors responsible for adverse effects of soil acidity, methods for estimating lime requirement, magnesium fixation, organic matter decomposition, potential for correcting serious nutrient deficiencies, greenhouse techniques, soil mineralogy, and the extent of soils to which results of the contract research should apply. Funds of the grant were also used for travel and some incidental expenses relating directly to the research contract. The expenditures from grant funds for research were approximately 70 percent more in FY 1972-73 than in FY 1971-72

Foreign consultation supported by 211(d) grant funds during FY 1972-73 was slightly less than in FY 1971-72, but a major contribution (about \$42,000) was made from institutional resources apart from the 211(d) grant. This is almost five times the amount used from these resources in FY 1971-72. About half of the contribution

resulted from salaries of two professors who consulted while on sabbatic leave for extended periods in Venezuela and Iran. Linkages with thirty-five soil scientists and administrators at sixteen foreign institutions were established from June 1972 to July 1973.

Library holdings have been augmented by new accessions, many of which were obtained gratis through visiting professors of 1971-72 and 1972-73. A preliminary study of ways to make available an extensive bibliography of soils of the tropics held by the Soil Conservation Service has been completed, and negotiations are under way for publishing the material.

Perhaps the most important accomplishment for the long-range objectives of the 211(d) grant program was the authorization by the College of Agriculture and Life Sciences of a full-time professorial position on State appropriations to insure continuation of the work on tropical soils when the grant expires.

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 the need to develop a 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 this policy, 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 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 immediate objective of the grant to Cornell is to develop a comprehensive and unified perspective of soils of the tropics in relation to their potentials and requirements for use. This is not an end in itself. The long-range purpose is to serve national goals in international agricultural development.

The long-range purpose of the grant implies development of a quality educational program on soils of the tropics for both foreign and domestic students at Cornell. This will contribute to manpower needs of the future both for developing nations and for domestic activities in the international field. The purpose also implies development of a resource base of knowledge about soils of the tropics at Cornell which can actively contribute to international agricultural development. It also implies development of relationships with soil scientists of the tropics and their institutions to facilitate such contributions.

The immediate 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-soil relationships, (3) soil-water-plant relations, and (4) conservation and protection of different kinds of tropical soils. In addition, it requires supporting inputs to help understand (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 courses and development of new courses to enhance teaching about soils of the tropics.
- (6) Strengthening library and other informational services and preparation of training materials.

The activities under the grant have been consistent with these purposes. No modification of objectives or general nature of the program is contemplated.

3. Accomplishments

3.1 Teaching: During 1972-73, approximately \$52,000 of 211(d) funds were used to enhance teaching about soils of the tropics. The activities that follow were designed deliberately to perform two functions. They were done to have direct impact on student audiences. They were also designed to strengthen the subject-matter competencies of teaching faculty and develop linkages between them and other scientists knowledgeable about soils of the tropics.

1. "Tropical Soils Discussions." This non-credit informal seminar met bi-weekly during the fall semester and weekly during the spring. The

211(d) grant supported part of the faculty salary costs and support. During the fall, a faculty member, student, or visiting professor led an open discussion on a specific topic. During the spring, Visiting Professor E. W. Russell lectured and led discussions emphasizing the physical aspects of soil-water-plant relations in the tropics. Although attendance was voluntary, faculty and student participation ranged consistently between 25 and 35 people.

2. Management Systems for Tropical Soils. This new course, Agronomy 480, was offered for the first time. Assistant Professor Richard Fox, who is normally stationed in Puerto Rico as local leader of Cornell's research contract csd 2490, was brought to the Ithaca campus on 211(d) funds to teach the course. Although the course was given in the spring in competition with two other courses on related subjects and Dr. Russell's lectures, it enrolled 16 students. It will be offered again in the fall of 1973 when the competing courses are not given.

3. Tropical Soils Institute. Four faculty from Cornell taught in this four-week institute at the graduate level. The course was offered at the University of Puerto Rico under auspices of the Consortium. It was designed to present developments in soil science for the tropics to professional soil scientists who work in the tropics. In addition to contributions to students enrolled, the institute provided an opportunity for Cornell faculty to establish relationships with soil scientists from a number of countries and with contributing

faculty from the other four Consortium institutions. Funds from the 211(d) grant supported staff travel.

4. Visiting Professors and Scientists. Three prominent soil scientists with long experience in the tropics were brought to the campus on 211(d) funds during the year:

E. W. Russell, Professor Emeritus, University of Reading, and former Director of the East African Agriculture and Forestry Research Organization--November 1, 1972 to May 15, 1973.

Carlos Zamora, Director de Estudios Integrados de Recursos Naturales, ONERN, Peru--October 1 to October 20, 1972.

A. Van Wambeke, University of Ghent and frequent FAO Consultant on soils of the tropics--three days.

These visitors gave 30 formal lectures and seminars for students and faculty of soil science, crop science, animal science, and the College-wide International Agriculture program. One also met with students and faculty of Anthropology and Sociology for informal discussions. Much time was spent counseling individual students and faculty on special research and instructional problems related to soils of the tropics.

5. Workshop on Soils of the Savanna. Professor Drosdoff lectured on "Cultural Systems on Tropical Soils" at a workshop on Soils of the Savanna sponsored by Prairie View A and M College. Travel and part salary were supported by 211(d) funds.

6. Teaching Assistants. Three graduate students experienced in the tropics served as teaching assistants in the elementary soils course.

They were supported by 211(d) funds for the impact their experience could have on perspective of soils of the tropics in a course that reaches about 300 students. A teaching aid on rice cultivation was developed by one of the teaching assistants.

7. Summer Session. A special course, "Natural Resource Potential for Food Production in the Tropics," Agronomy 411, was organized for the Summer Session of 1973. The course is designed for students in fields other than soils, including especially those in fields such as social sciences, who have concerns about world food problems in lesser developed countries but normally have little insight into the natural resource base. (The course will be taught during FY 1973-74.) Funds from the 211(d) grant support part of the faculty salary costs.

8. Continuing Activities. These include graduate student training, regularly scheduled established courses, and course revision.

a. Graduate student training. Thirty-five graduate students in the Department have career commitments to work in developing countries. Of these, 27 were from LDC's and 8 were U. S. citizens. Twenty-three had majors in Soil Science. The 12 majoring in crop science received soil science instruction. One additional student was in Brazil on research from which the Ph.D. thesis will be developed. At least six of the thirty-five will be working on thesis research in the tropics during FY 1973-74. Seven graduate assistant

stipends were provided by 211(d) funds for part or all of the year.

b. Continuing courses. Two courses specific for soils of the tropics were continued from previous years. One of these, an interdisciplinary course, took 30 students to the Dominican Republic and Puerto Rico for two-weeks' intensive field laboratory in the tropical environment. Part of the staff salaries was provided by the 211(d) grant for both courses.

c. Course revision. Subject matter on soils of the tropics continued to be incorporated in courses in elementary soils, soil fertility, soil mineralogy, and soil genesis and classification. The 211(d) grant provided teaching assistant stipends for 22 man-months in these courses.

Approximately 43 percent of the 1972-73 expenditures of 211(d) funds is charged to teaching in the financial summary. This includes not only expenditures for formal instruction and graduate training but also those costs incurred for training and experience of faculty which are not directly chargeable to specific research or consulting assignments. Thus, an indeterminate part contributes to faculty qualifications for future research and consulting as well.

3.2 Research: Approximately \$47,000 of 211(d) funds were used for research on soils of the tropics during 1972-73. Most of this was used to augment the research conducted under contract AID/csd 2490 for investigations on fertility requirements of important

kinds of acid soils of the humid tropics. The expenditures were for:

- (1) Salaries of 5 graduate assistants who conducted supplementary research to answer questions raised by the research program in Puerto Rico and Brazil.
- (2) Fractions of salaries and travel of 5 faculty members who supervised graduate assistant research or consulted with researchers at experimental sites in the tropics.
- (3) Salaries of laboratory technicians who performed analytical work at Ithaca in support of the project.
- (4) Miscellaneous supplies, communications, freight, and services for activities.

About \$1,500 was used for support of graduate student and faculty research on subjects that contribute to an understanding of soils of the tropics but are not directly related to the research contract.

Specific research supported wholly or in part by 211(d) funds follows:

1. A study of the factors responsible for adverse effects of soil acidity on growth of plant roots--Mr. C. W. Kao, graduate assistant.

The study confirmed findings of Zandstra in 1971-72 that concentration ratios of $\text{Ca}^{1/2}/\text{Al}^{1/3}$, $\text{Ca}^{1/2}/\text{H}$, and Ca/Mg in nutrient solution are closely related to root growth whereas absolute concentrations of Ca^{+2} , Mg^{+2} , Al^{+3} , or H^{+} by themselves are not. Supported mainly by 211(d) funds.

2. A study of lime requirement of some highly weathered soils of the tropics--Mr. G. Amedee, graduate assistant.

The study showed that KCl-extractable acidity grossly underestimated the exchange acidity and the BaCl_2 -triethanolamine

method overestimated lime requirement for neutralization of nine soils representing Oxisols, Ultisols, and Inceptisols sampled in Brazil, Puerto Rico, and Colombia. Supported mainly by 211(d) funds.

3. A study of response of crops to magnesium on some soils of Colombia--Mr. M. Rodriguez, Graduate assistant.

The study is incomplete, but preliminary results indicate that lack of response of crops on certain low-magnesium soils of Colombia to magnesium applications in the field may be related to some mechanism of magnesium fixation in the soil. Preliminary results also suggest that Ca and K are fixed by these soils. Supported mainly by 211(d) funds.

4. A study of the effects of different soil and environmental factors on microbial degradation of organic matter and nitrogenous constituents of soil--Mr. O. Odeyemi, graduate assistant.

Incomplete results indicate that microbial degradation of organic matter is more rapid in the presence of montmorillonite than in the presence of kaolinite. Temperature of about 30°C favored mineralization above higher or lower temperatures under good aeration, but mineralization was not markedly more rapid at 30°C when soils were waterlogged. Soil texture has a marked effect on mineralization. Supported mainly by 211(d) funds.

5. A study of limitations to productivity of some Ultisol and Oxisol surface and subsoils from Puerto Rico--Mr. D. Ritchey, graduate assistant.

Greenhouse experiments demonstrated that disturbed soil materials of a wide range of Ultisol and Oxisol surface soils and subsoils can be brought to the same high levels of productivity if adequate mineral fertilization (including Zn and high rates of phosphorus), liming, and water management are used. Supported mainly by 211(d) funds.

6. A study of watering technique for pot experiments in the tropical environment--Mr. D. Ritchey, graduate assistant.

A simplified modification of the wick-watering technique of Dolar and Keeney gave greatly superior performance of plants compared to conventional methods under high transpiration rates. It saved up to 2/3 of the time required after the initial installation. Support mainly by 211(d) funds.

7. A study of inorganic and organic phosphorus fractions and phosphorus adsorption characteristics of some high weathered Oxisols and Ultisols of Puerto Rico--R. M. Weaver, Assistant Professor, and O. Sardi and K. Roberts, laboratory assistants.

The study characterized phosphorus status and behavior of soils at specific sites as background information for studies of mineralization of organic phosphorus in experiments at those sites. Supported mainly by 211(d) funds.

8. Mineralogical characterization of soils of Puerto Rico and Venezuela--R. M. Weaver, Assistant Professor, and O. Sardi and K. Roberts, laboratory assistants.

Clay mineralogy was characterized for soils at 40 sites in Puerto Rico to aid University of Puerto Rico collaborators

interpret results of potassium fertility studies. Clay mineralogy was characterized for Vertisols at 14 sites in Venezuela to help explain high shrink-swell potential observed in the field. Supported mainly by 211(d) funds.

9. A study of representative clayey soils of Venezuela--D. Dumith-M., graduate student.

This study describes physical and chemical properties, kinds, amounts, and distribution of so-called "heavy soils" of Venezuela. An M.S. thesis to be completed in 1973, primarily on funds other than 211(d) but supported by item 8 above.

10. A review of objectives and organization of the soil survey program of Venezuela with recommendations for the future--R. Abreu, graduate student.

This is a professional study designed to define a model for future soil survey work in Venezuela. The study is supported mainly by funds other than 211(d) but contributions by Professor Arnold were supported in part by 211(d) funds.

11. A field study of the similarities of soils at the experimental site near Brasilia to soils of the region--M. G. Cline, Professor (with S. Buol, N. Carolina State Univ.)

The supporting laboratory work is not complete, but field studies indicate that the results of research near Brasilia under contract AID/csd 2490 should apply to an immense area of central Brazil. Supported in part by 211(d) funds.

3.3 Publications and Manuscripts: Publications and manuscripts

issued during 1972-73 follow.

a. Published Articles

Ritchey, K. Dale. 1973. Limitations to productivity of some Oxisol and Ultisol surface and subsoils. Ph.D. Thesis, Cornell University.

Weaver, R. M. 1973. Mineralogy of highly weathered and leached soils of the humid tropics. In 1973 Yearbook of Science and Technology. McGraw Hill. New York.

Lathwell, D. J., Dubey, H. D., and Fox, R. H. 1972. Nitrogen-supplying power of some tropical soils of Puerto Rico and methods for its evaluation. Agron. Jour. 64:763-766.

Cline, M. G. 1973. In recognition of Richard Bradfield on the occasion of his seventy-seventh birthday. Soil Sci. 115:273-275. (This emphasizes his international work.)

b. Manuscripts prepared for publication

Drosdoff, M. Recent research on soils of the humid tropics. Submitted to McGraw Hill for the section on Soils in the 1974 Yearbook of Science and Technology.

Ritchey, K. Dale. Use of wick-watering for greenhouse pots in the tropics. Submitted to Tropical Agriculture (Trinidad).

Ritchey, K. Dale and Fox, R. H. Limitations to productivity of some Oxisol and Ultisol subsoils. Submitted to Journal of Agriculture of the University of Puerto Rico.

Weaver, R. M. A simplified determination of reductant-soluble phosphate in soil phosphate fractionation schemes. To be submitted to Soil Sci. Soc. Amer. Proc.

Weaver, R. M. Inorganic and organic phosphorus of some highly weathered soils of Puerto Rico. To be submitted to Tropical Agriculture (Trinidad).

Arnold, R. W. Managing soils under tropical conditions: Some underlying concepts. A paper presented at the IV Latin American Soil Congress, Maracay, Venezuela.

c. Processed Articles for Limited Distribution

Ritchey, K. Dale. 1973. A partially annotated bibliography on zinc in the tropics.

Weaver, R. M. 1972. Chemical and clay mineral properties of a highly weathered soil from the Colombian Llanos Orientales. Agron. Mimeo 72-19. Cornell Univ.

Roberts, K. J. and Weaver, R. M. 1973. Organic phosphorus in soils, with special interest in soils of the tropics. Agron. Mimeo 73-1. Cornell Univ.

Dumith, D. and Abreu, R. 1973. Informe sobre la visita al Servicio de Conservación de Suelos del Departamento de Agricultura de los Estados Unidos de Norteamérica. A report to Venezuelan Soil Survey.

Arnold, R. W. 1972. Soil research in the Quibor Basin. 3 pp. A report to the Faculty of Agronomy, Universidad Centro-Occidente, Venezuela.

Arnold, R. W. 1972. A model of mission-oriented research for an agricultural institute. 3 pp. A report to the rector, Universidad Centro-Occidente, Venezuela.

Arnold, R. W. 1972. Course sequence in soils orientation. 12 pp. A report to the Faculty of Agriculture, Universidad Centro-Occidental, Venezuela.

Arnold, R. W. 1972. Advance report on soils and their interpretation in the Chirimena Area, Venezuela. 30 pp. A report to the Soil Survey of Venezuela.

Drosdoff, M. 1972. Cultural systems on tropical soils. Proceedings of the Tropical Soils Workshop, Prairie View A & M College, October 2-5, 1972.

Kass, D. C. L. 1973. A teaching aid on rice cultivation. For internal classroom use.

3.4 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, planning of joint Consortium activities, and seminars, meetings, and consultation with U. S. individuals and institutions on subject matter of the grant. Foreign consultation includes participation in seminars and meetings with scientists in foreign countries as well as person-to-person discussions with foreign scientists. Salaries, travel and subsistence, and related services are charged to consultation in the financial report.

Approximately \$7,500 of 211(d) funds were used for domestic consultation. Activities include the following:

1. Two executive committee meetings, in Washington, D.C., and at Prairie View, Texas.
2. The Annual Report and review of 1971-72 operations with AID in Washington.
3. Travel of Visiting Scientist Zamora to consult with USDA officials in Washington.
4. Travel of Visiting Professor Russell to consult with U. S. scientists.

Approximately \$8,900 of 211(d) funds were used for foreign consultation. This includes delayed billing of approximately \$3,000 for travel of four participants to the seminar on tropical soils at Ibadan, Nigeria, and subsequent visits to African countries during FY 1971-72. These activities were reported in the annual report for

1971-72. Activities supported by 211(d) funds during FY 1972-73

include the following:

1. Participation of Professor Lathwell in a conference on soils of the tropics in Trinidad.
2. Consultation with soil scientists of Venezuela and participation in a meeting of the IV Latin America Soil Congress at Maracay, Venezuela, by Professor Arnold.
3. Freight for reference material shipped to Universidad Nacional Pedro Henriquez Urena, Dominican Republic, as a consequence of consultation with scientists of that University, which was supported by funds other than 211(d).
4. Consultation of Professor Cline with soil scientists of Brazil on the relationships of soils of the Central Plateau to soils of experimental sites (to be billed during FY 1973-74).

A number of foreign soil scientists consulted with Cornell staff at Ithaca. Four were supported by 211(d) funds for teaching and consultation. As the flow of information was primarily from the visitors to Cornell faculty and students, their costs have been charged to teaching in the financial report. Others were supported by funds other than the 211(d) grant.

The following linkages established with foreign institutions and scientists include those made during the African consultation of late FY 1971-72 for which travel costs were billed during FY 1972-73.

- (1) International Institute of Tropical Agriculture, Ibadan, Nigeria
Dr. Frank Moormann, especially.

(2) University of Ibadan, Ibadan, Nigeria

Dr. A. A. A. Fayemi, Head of Department
Dr. C. T. I. Odu, Soil microbiology
Mr. A. A. Agboola, Soil fertility

(3) Institute for Agricultural Research and Ahmadu Bello University,
Samaru, Nigeria

Dr. J. A. Hobbs, Head of Soil Science Department
Dr. M. Dagg, Director IAR
Mr. A. R. Bromfield, Soil chemist
Dr. M. Jones, Research Fellow in Soils
Mr. R. Heathcote, Senior Research Fellow in Soils

(4) Soil Research Institute, Council for Scientific and Industrial
Research, Kumasi, Ghana

Dr. H. B. Obeng, Acting Director
Mr. S. V. Adu, Research Officer in Charge, soil survey
Mr. G. K. Asamoah, Research Officer, soil survey
Dr. C. S. Ofori, Senior Research Officer, soil fertility
Dr. S. K. Takyi, Research Officer, soil fertility
Mr. A. T. Halm, Research Officer, soil chemistry

(5) University of Science and Technology, Kumasi, Ghana

Dr. E. Baffoe-Bonnie, Acting Head, crop production and
physicist

(6) University of Ghana, Legon, Ghana

Dr. David K. Acquaye, Chairman, crop science

(7) IRAT Research Center, Bouake, Ivory Coast

M. Claude Dumont, Director
M. Le Buanec, Soil Fertility Specialist

(8) IRAT Agricultural Research Center, Bambey, Senegal

M. R. Nicou, Head, study and improvement of the environ-
ment

(9) ORSTOM Center, Dakar, Senegal

Dr. Alain Perraud, Director

(10) IRAT, Paris, France

M. C. Charreau, Maitre de Recherches

(11) Universidad Nacional Pedro Henriquez Urena, Santo Domingo,
Dominican Republic

Dr. Hector Luis Rodriguez, Dean Agriculture
Mr. Ramon Tio-Garcia, Head, Soils Department

(12) Oficina Nacional de Evaluacion de Recursos Naturales, Lima, Peru

Sr. Carlos Zamora, Director de Estudios Integrados de Recursos
Naturales

(13) University of Reading, Reading, England

Dr. E. W. Russell, Professor Emeritus

(14) University of Ghent, Ghent, Belgium

Dr. Armand van Wambake, Soil Scientist

(15) Divisao de Pedologia e Fertilidad do Solo, Ministerio da
Agricultura, Brazil

Mr. Marcello N. Camargo, Chief, Soil Survey of Brazil
Mr. Clotario Oliver da Silveira, Soil Scientist
Mr. Jorge Olmos Iturri Larach, Soil Scientist
Mr. Paulo Klinger Tito Jacomine, Soil Scientist
Mr. Nathaniel Bloomfield, Director of Soil Research,
Ministry of Agriculture
Dr. Roberto Meirelles de Miranda, Director do Escritorio
de Pesquisas e Experimentacao

(16) Division of Soils, Directorate of Hydrologic Resources, MOP,
Venezuela

Mr. Pedro Urriolu, Chief
Mr. Deud Dumith-M., Soil Scientist
Mr. Rafael Abreu, Soil Scientist

3.5 Library and Reference: Approximately \$3,500 of 211(d) funds was spent on library acquisitions and compilation of reference material during 1972-73. This includes graduate assistant salaries for library and reference work, acquisitions for the departmental collection, and reproduction services.

Acquisitions for the departmental collection numbered 104 books, bulletins, and maps. Many of the bulletins and maps were obtained gratis through linkages with the scientists identified under consultation. An annotated bibliography on needs for zinc in soils of the tropics was compiled. A paper to interpret the French soil classification system was developed.

3.6 Publication: Approximately \$1,700 of 211(d) funds was spent for publication. A consultant appraised the automated bibliographical services of the National Agricultural Library and other major systems in relation to potential services to the Consortium on soils of the tropics, with special reference to the bibliography of tropical soil geography in the files of the Soil Conservation Service but not accessible for general use. His recommendation to reproduce the file manually was accepted by the Executive Committee of the Consortium. Negotiations are proceeding with the Soil Conservation Service and the consultant on a contract or other means of implementing the recommendation. The \$1,700 includes charges for reprints of two journal articles.

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

The impact of the program in tropical soils is difficult to measure in quantitative terms, and that which is attributable to the 211(d) grant is difficult to appraise as distinct from that of the AID research contract. No attempt is made here to make that distinction, though those elements that relate to teaching, consulting, and library and reference are predominantly attributable to 211(d) funding.

The involvement of financial resources other than 211(d) funds in Table 9.1 is one index of the impact on the institution. These aggregate about \$118,900 for FY 1972-73. About \$66,500 of this is in Cornell salaries paid from sources other than AID funds, representing approximately 2.75 full-time equivalents of Cornell faculty and 0.55 full-time (40-hour week) equivalents of graduate assistants. Ten Cornell faculty are currently actively participating in the program.

Perhaps the most important measure of the impact on Cornell commitment to a continuing program on soils of the tropics is the authorization by the Administration of the College of Agriculture and Life Sciences to recruit a senior faculty member on a State salary item to devote full time to the departmental international program. This is a major accomplishment that reflects the College Administration's favorable appraisal of the current program. It insures continuation of the program beyond the end of the 211(d) grant with a continuing commitment

of at least \$20,000 of State funds annually.

Functionally, the grant has strongly influenced teaching in regularly scheduled courses that enroll about 400 students annually. It has resulted in the addition of two new regular courses on soils of the tropics to complement the two courses specific for this subject, which were offered when the grant was initiated. It has initiated a new course for the Summer Session. It has stimulated applications for graduate work on various aspects of soils of the tropics from African, Asian, and Latin American nations. It has provided library and reference resources that will have continuing value. The grant has permitted linkages with soil scientists and institutions in developing nations, which will remain important elements of institutional capability in the subject matter area.

The most important lasting impact on institutional capability, however, is on the faculty of the department. In three years time the perspective of the faculty in soils has been increased immensely by personal experience with soils of the tropics, personal contacts with scientists in the tropics, and work with students from the tropics on soil problems of the tropics. The net effect on total capability of the faculty and on enthusiasm for the subject cannot be measured in quantitative terms, but it is very large.

5. Utilization of Institutional Resources in Development:

During half of FY 1972-73, two members of the faculty were engaged

in technical assistance in lesser developed countries:

R. Arnold; Venezuela - Soil survey and resource planning
C. Olson; Iran - Soil survey interpretation

Nineteen students from developing nations did graduate work at Cornell with majors in soil science preparatory to careers in their countries. Four students from the U. S. did graduate work in soils preparatory to careers in development work. One individual from a developing country did post-doctoral work.

One Assistant Professor, one Research Associate, and one graduate assistant were stationed overseas on AID research contract csd 2490, which is designed for solution of soil fertility problems of developing countries. Three individuals who completed doctoral programs during the year accepted employment in development work overseas.

6. Other Resources Used for Grant-Related Activities: The value of resources contributed from funding other than that provided by AID is estimated in Table 9.1 as approximately \$119,000. This is exclusive of AID funding for either the 211(d) grant or research contract AID/csd 2490. Table 9.1 gives the estimated distribution of these funds among teaching, research, consultation, library, and publication. The following tabulation gives the distribution of these funds among budget items.

Salaries and Wages		
State appropriations	\$ 40,300	
Other Cornell funds	8,800	
Individual support	17,400	
		<hr/>
		\$ 66,500
Indirect Costs (based on salaries and wages from 211(d) and other grants)		29,200
Fringe Benefits (based on salaries and wages from 211(d) grant, excluding Visiting Professors)		12,400
Supplies and Services		4,900
Communications		500
Travel		<hr/> 5,400
	TOTAL	\$118,900

State appropriations for salaries and wages include half salaries contributed by the State for three professors who used sabbatic leaves for consulting and research on tropical soils as a contribution to the program. Indirect costs include Cornell contributions by waiver of standard indirect costs for activities on the 211(d) grant and overhead received for one other grant. The item for fringe benefits includes New York State contributions to employee retirement, social security, health insurance, workman's compensation, and survivors benefits at standard rates applied to 211(d) salaries of domestic employees.

7. Next Year's Plan of Work: Table 9.2 gives estimates of grant expenditures by line items for FY 1973-74. Table 9.1 gives the estimated distribution of anticipated 1973-74 expenditures by areas of activity.

7.1 Teaching: The estimate of expenditures for teaching in FY 1973-74 (Table 9.1) is about \$5,000 more than the amount used for that purpose in FY 1972-73. This reflects salary increases and slightly greater effort. Activities of FY 1972-73 will continue, including (1) a course in Geography and Appraisal of Soils of the Tropics, (2) a course in soil mineralogy oriented to the tropics, (3) a course in Cultural Systems for Tropical Soils, (4) the informal seminar Tropical Soil Discussions, (5) seminars and special lectures, and (6) an interdepartmental course following field studies in the Caribbean area. A one-month Tropical Soil Institute for professional soil scientists of Southeast Asia will be offered jointly with other members of the Consortium. A new course will be offered in the University Summer Session.

Part salaries of three resident professors will replace the salary of Assistant Professor Fox who was brought to the Ithaca campus to teach for one semester in FY 1972-73. Salaries are expected to account for about \$45,000 of the total, student fees for about \$5,800, travel for about \$3,500, and miscellaneous supplies and services for the remainder. Dr. G. Uehara of the University of Hawaii and M. Claude Charreau of IRAT, Paris, France, will contribute to teaching as Visiting Professors.

7.2 Research: Expenditures for research are expected to be about \$44,200 in FY 1973-74. Activities will continue to be mainly in support of the AID/csd 2490 research contract through graduate

assistants. Salaries are expected to account for about \$39,600 of the total, mainly divided between graduate assistant stipends, allocations of fractional salaries of professors who supervise them, and laboratory and technical personnel who perform routine analytical work. Projections for travel to overseas locations of research, for miscellaneous supplies and services, and for communications aggregate about \$4,600.

7.3 Consultation: Approximately \$20,000 is projected as expenditures for consultation in FY 1973-74, reflecting an increased expenditure of about \$4,200 for foreign consultation. The foreign consultation includes delayed billing for travel costs of two-weeks study of soils of the Central Plateau of Brazil with Brazilian soil scientists in late FY 1972-73. It also includes attendance of one Professor at the FAO/CIDA Conference on Shifting Cultivation in Nigeria, discussion of soil research with personnel of the Institute of Soil Research at Kumasi, Ghana, and participation of three staff members in the joint Consortium seminar on Soils of Latin America at CIAT in Colombia. Costs of a staff member's participation in a meeting on tropical crops and soils in Barbados are also included. Domestic consultation includes salaries and travel for consultation with AID officials and representatives of Consortium institutions, participation in the soil mineralogy workshop to be held at the University of Hawaii, and work with soil scientists of other U. S. Institutions on their programs on

tropical soils.

7.4 Library and Reference: The \$6,300 budgeted represents primarily staff time in developing library resources, graduate assistant time in developing reference material, and library acquisitions. The amount is larger than in previous years, reflecting anticipation of greater input.

7.5 Publication: The \$4,500 budgeted is mainly for Cornell's share for assembling and publishing the bibliography of soil geography of the tropics. Staff time is also projected for documentation of workers in soil science in the tropics, which is expected to contribute to a comprehensive register of soil scientists who have competence in the field.

8. Other: One of the most significant accomplishments during FY 1972-73 was obtaining authority from the College Administration to recruit a senior professor for continuing the program developed with 211(d) funds. The position is to be on a line item of New York State appropriations, fulfilling the commitment made by accepting the 211(d) grant.

9. Report of Expenditures: See the following tables:

- Table 9.1. Distribution of 211(d) grant fund expenditures and contributions from other sources according to functions of the program (review period 7/1/72 to 6/30/73).
- Table 9.2. Expenditure report, actual and projected, according to budget items (review period 7/1/72 to 6/30/73).
- Table 9.3. Budget detail: Percent of full time of personnel on the project and accounting for travel and subsistence (review period 7/1/72 to 6/30/73).

Table 9.1. Distribution of 211(d) grant fund expenditures and contributions from other sources of funding according to functions of the program (review period 7/1/72 to 6/30/72). a/

Object	211(d) Source			Projected to End of Grant	Non-211(d) Sources ^{b/} 1972-73
	FY 1972-73	Cumulative Total	Projected 1973-74		
Teaching	\$ 52,000	\$ 98,900	\$ 57,400	\$ 215,000	\$ 28,800
Research	47,200	83,300	44,200	175,000	31,400
Consultation					
Domestic	7,500	19,800	7,100	33,000	12,000
Foreign	8,900	19,000	13,100	43,000	42,000
Library & Reference	3,500	10,100	6,300	24,000	3,500
Publication	1,700	1,700	4,500	10,000	1,200
TOTAL	\$120,800	\$232,800	\$132,600	\$500,000	\$118,900

a/ Rounded to nearest \$100

b/ Exclusive of AID funds

Table 9.2. Expenditures report, actual and projected, according to budget items (review period 7/1/72 to 6/30/73).

Line Items	Actual Expenditures		Projected Expenditures		
	PY 1972-73	Cumulative Total	Year		Total
			4	5	
<u>Personnel Salaries & Wages</u> ^{a/}					
Resident Professors	\$ 48,695.49	\$ 91,812.12	\$ 53,500.00	\$ 53,500.00	\$198,812.12
Visiting Professors	15,133.50	33,927.84	16,500.00	16,500.00	66,927.84
Graduate Assistants	20,503.30	36,567.96	21,500.00	22,000.00	80,067.96
Clerical	70.20	7,197.03	3,500.00	4,000.00	14,697.03
Lab & Technical	9,051.12	11,815.83	9,500.00	10,500.00	31,815.83
Total	\$ 93,453.61	\$181,320.78	\$104,500.00	\$106,500.00	\$392,320.78
<u>Operational Support</u>					
Travel & Subsistence					
Domestic	\$ 5,083.73	\$ 15,999.19	\$ 3,300.00	\$ 3,300.00	\$ 22,599.19
Foreign	6,349.51	9,572.58	8,000.00	8,000.00	25,572.58
Total	11,433.24	25,571.77	11,300.00	11,300.00	48,171.77
Supplies & Services					
Equipment	9,518.88 ^{b/}	14,562.00	9,000.00	9,013.04	32,556.04
Communications	---	567.50	1,000.00	1,000.00	2,567.50
Student Fees	605.41	1,269.91	1,000.00	1,000.00	3,269.91
	5,781.50	9,514.00	5,800.00	5,800.00	21,114.00
Total Support	\$ 27,339.03	\$ 51,466.18	\$ 28,100.00	\$ 28,113.04	\$107,679.22
GRAND TOTAL	\$120,792.64	\$232,786.96	\$132,600.00	\$134,613.04	\$500,000.00

^{a/} Includes hourly wages shown under operational support in original budget as well as honoraria in lieu of salary for short-term visiting scientists.

^{b/} Includes library acquisitions, expendable supplies, freight, duplicating services, and consultant fees.

Table 9.3. Budget Detail (Review Period 7/1/72 to 6/30/73).

a. Percent of full time of personnel on the project

Name	Position	Percent of Full Time on the Project		
		211(d) Funding	Other Funding	Total
<u>RESIDENT PROFESSORS</u>				
Drosdoff, M.	Professor (Project Leader)	75	--	75
Cline, M. G.	Professor	25	25	50
Weaver, R. M.	Assistant Professor	50	--	50
Fox, R. H.	Assistant Professor	40	--	40
Arnold, R. A.	Associate Professor	5	55*	60
Bouldin, D. R.	Professor	5	15	20
Lathwell, D. J.	Professor	5	15	20
Olson, G. W.	Associate Professor	--	75*	75
Reid, W. S.	Associate Professor	--	80*	80
Scott, T. W.	Associate Professor	--	10	10
Total full-time equivalents		2.05	2.75	4.80
* Sabbatic leave spent in consulting capacity in the tropics.				
<u>VISITING PROFESSORS & SCIENTISTS</u>				
Russell, E. W.	Visiting Professor	55	--	55
Zamora, C.	Visiting Scientist	8	--	8
Van Wambeke, A.	Visiting Scientist	1	--	1
Coulter, J.	Visiting Professor	1	--	1
Total full-time equivalents		0.65	--	0.65
<u>GRADUATE ASSISTANTS</u>				
Kao, C. W.	Research Assistant	50	--	50
Odeyemi, O.	Research Assistant	25	25	50
Ritchey, D.	Research Assistant	50	--	50
Rodriguez, M.	Research Assistant	50	--	50
Forbes, T. R.	Teaching Assistant	50	--	50
Kass, D. L.	Teaching Assistant	30	20	50
Amadee, G.	Teaching Assistant	40	10	50
Total full-equivalents (40-hour week)		2.95	0.55	3.50
<u>CLERICAL</u>				
Buyukcolak, M.	Stenographer	--	50	50
Schoneman, A.	Stenographer	1	9	10
Total full-time equivalents		0.01	0.59	0.60
<u>LABORATORY & TECHNICAL</u>				
Sardi	Research Specialist	25	--	25
Roberts	Laboratory Technician	20	--	20
Sim	Laboratory Technician	60	--	60
Other, Temporary	Technicians	5	--	5
Total full-time equivalents		1.10	--	1.10

Table 9.3 (cont'd)

b. Travel (T) and Subsistence (S)

<u>Name</u>	<u>To</u>	<u>Purpose</u>	<u>Cost</u>
<u>Domestic Travel</u>			
Cline, M. G.	Puerto Rico	Instructor, Tropical Soil Institute	\$ 378.75(TS)
	Washington, D.C.	Report to AID	124.00(TS)
	Columbia, Mo.	Report 211(d) project to Dir. Intern. Agr. Meeting	206.05(TS)
Drosdoff, M.	Prairie View, Tex. Local	Consortium Executive Committee	282.78(TS)
	Prairie View, Tex. Local	Field studies, Mr. Zamora of Peru	23.70(T)
Bouldin, D. R.	Puerto Rico	Research supervision	218.11(T)
	Prairie View, Tex. Local	Workshop, soils of savanna	322.00(TS)
Lathwell, D. J.	Puerto Rico	College fleet charges	89.00(T)
Weaver, R. M.	Puerto Rico	Instructor, Tropical Soil Institute	352.50(TS)
Scott, T. W.	Puerto Rico	Instructor, Tropical Soil Institute	356.95(TS)
	Puerto Rico	Instructor, Tropical Soil Institute	390.85(TS)
Fox, R. H.	Puerto Rico	Preparation for January class, field laboratory	497.41(TS)
	Puerto Rico	Research	201.85(S)
Silva, J.	Ithaca (from P. Rico)	Consultation re pending assignment	120.00(S)
	Ithaca (from P. Rico)	Teaching assignment for five months	284.00(TS)
Zamora, C.	Hawaii	Visiting Professor-return & consulting in route	801.58(TS)
Russell, E. W.	Ithaca	Visiting Scientist, local subsistence	480.00(S)
Forbes	Ithaca	Visiting Professor, local travel	86.30(TS)
Ritchey, D.	Ithaca	Training, local travel	167.90(TS)
	Puerto Rico	Refund, travel advance in 1971-72	(-300.00)
TOTAL			\$5,083.73)

Table 9.3. (cont'd)

b. Travel (T) and subsistence (S) (cont'd)

<u>Name</u>	<u>To</u>	<u>Purpose</u>	<u>Cost</u>
<u>Foreign Travel</u>			
Cline, M. G.	Nigeria, Ghana, Senegal	IITA Seminar, consulting	\$ 617.00(T)*
Drosdoff, M.	Nigeria, Ivory Coast, Senegal Brazil	IITA Seminar, consulting Establish coop. research, Brazil	617.00(T)* 259.69(S)
Fox, R. H.	Nigeria, Kenya Brazil	IITA Seminar, consulting Establish coop. research, Brazil	1,193.37(TS)* 918.78(TS)
Coulter, J.	Nigeria, Ivory Coast, Gambia England	IITA Seminar, consulting Visiting Professor, return	631.48(T)* 289.82(T)
Arnold, R. W.	In Venezuela	Consulting, Soil Survey	682.75(TS)
Russell, E. W.	Ithaca from England	Visiting Professor, one-way fare	228.00(T)
Zamora, C.	Ithaca from Peru	Visiting Scientist, round-trip fare	572.92(T)
Lathwell, D. J.	Trinidad	Tropical Soil Conference	338.70(T)
TOTAL			<u>\$6,349.51</u>

* FY 1972-73 billing for travel in late FY 1971-72

Table 9.4: Sources for funds^{1/} for eleven research activities supported in part by 211(d) grant AID/csd 2834, 1972-73 FY. Cornell University.

Activity	211(d) Sources		State Sources		Ford Grant	AID/csd 2490	Total
	Full-time Equiv. man months	Funds \$	Full-time Equiv. man months	Funds \$			
No. 1	5.0	4,400	0.7	2,200	700	None	7,300
No. 2	2.9	3,000	0.9	2,000	400	None	5,400
No. 3	5.2	5,300	0.8	2,700	900	None	8,900
No. 4	2.4	1,900	-	100	-	None	2,000
No. 5	4.3	5,200	1.0	3,900	900	None	10,000
No. 6	1.8	1,700	0.1	800	100	None	2,600
No. 7	11.2	10,200	0.6	6,700	1,000	None	17,900
No. 8	10.7	9,300	-	4,800	500	None	14,600
No. 9	0.6	1,700	0.2	1,300	-	None	3,000
No. 10	0.3	1,000	0.1	600	-	None	1,600
No. 11	0.7	3,500	0.3	1,800	-	None	5,300
Total	45.1	47,200 ^{2/}	4.7	26,900 ^{3/}	4,500	None	78,600

^{1/} Rounded to nearest \$100 because amounts are based on estimates of proportions of full time spent on activities by staff whose time is divided.

^{2/} Includes \$41,200 in salaries and \$6,000 in maintenance and operation support.

^{3/} Includes \$8,400 in salaries, \$17,000 in indirect costs and fringe benefits provided by the State on staff salaries from 211(d) sources, and \$1,500 in maintenance and operation support.

REPORT OF
UNIVERSITY OF HAWAII

REPORT OF UNIVERSITY OF HAWAII
FOR THE PERIOD
JULY 1, 1972 TO JUNE 30, 1973

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: \$167,599

3.2 Accumulated: \$270,102

3.3 Anticipated for next year: \$139,000

E. NARRATIVE SUMMARY

An objective of the 211(d) Grant is to strengthen the existing tropical soils program of the University of Hawaii so that it will be more useful to AID and other personnel involved with tropical soils, crop management and related activities in the less-developed countries. Staff from Hawaii's improved tropical soil program was used by AID to provide assistance and advice to the Government of Tanzania. Dr. L. D. Swindale and Dr. J. A. Silva of Hawaii made a reconnaissance survey of the land systems of the Arusha province, Tanzania, and consulted with AID and GOT personnel on devising a set

of proposals for soil survey and land capability evaluation. A number of soil samples were also collected for analysis in Hawaii. After detailed classification of the soils in Tanzania is complete, information concerning agricultural practices on similarly classified soils in Hawaii can be made available to the agriculturalist of Tanzania.

Dr. C. A. Bower, a recent addition to our staff with 211(d) funds, was also used in an advisory role by the Consultative Group on International Agricultural Research. Dr. Bower served as U.S. representative on a Near East and North Africa Agricultural Research Review Mission. The purpose of the Mission was to identify gaps and priorities in existing agricultural research in the region with the view of providing additional support for selectivities in research, training, information and related work.

Dr. W. G. Sanford in February, 1973, did consulting on the agronomy of pineapple and visited IFAC personnel. This was followed by a week's visit to the United Republic of the Cameroons at the invitation and expense of IFAC. The purpose of the trip was to get acquainted with agricultural problems in this area and to discuss possible cooperation with IRAT personnel. The trip was followed by a visit to Paris where Dr. Sanford talked to personnel in the Soils Division of ORSTOM.

The University of Hawaii will also provide technical assistance

and personnel for a project to study management of heavy delta clay soils of the Mekong Delta. This project, headed by Dr. G. Uehara, will study river silt and delta soils to aid in the planning of the control of the Mekong River.

In research, the joint project with 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, is progressing rapidly. A four part publication should be completed this year. Additional studies of soil nitrification and zero point of charge on these Puerto Rican and Hawaiian soils are also nearing completion.

A cooperative project with Prairie View A&M was also initiated. This project will compare the external phosphorus requirements of crops on soils of similar texture. Results on Hawaiian soils have shown that there is a large variation in amount of fertilizer required to reach a prescribed level of P in soil solution, but the prescribed level is the same (dependent on the crop) for most of the diverse soils of Hawaii.

Research in mineralogy has centered on halloysite and imogolite. It was discovered that these two minerals are present in the same soil, which was a particularly interesting find. Other work concerned the amorphous portion of the soil. Techniques were also developed to prepare holey support films and films of silicon monoxide. These

films are of aid in the study of soil minerals.

Work in soil biology by Dr. Burton Koch with non-symbiotic nitrogen fixing bacteria, resulted in the isolation of five facultative anaerobes. These bacteria apparently undergo a seasonal variation in number. However, their high fixation rate suggested a significant contribution to total soil nitrogen by these bacteria. Other work has shown that s-triazine herbicides were rapidly degraded in Hawaiian soils, but the substituted urea, Diuron, persists for several years in a non-bioactive form, apparently adsorbed to soil organic matter.

Much work was accomplished in soil chemistry. Studies of nitrogen transformation and movement have shown that NO_3^- moves rapidly down the soil profile and movement is enhanced by reducing plant population density. Also, the low concentration of mineral nitrogen in soils with high organic matter was shown probably to be caused by nitrogen immobilization. A critical evaluation of chemical methods for determining the lime requirements of soils was performed by Dr. S. Reid who visited our department from Cornell. A similar study by Dr. Silva on aluminum, showed that N BaCl_2^- -extracted Al closely correlated with plant yield and plant Al. Since the method was tested on soils with a range of mineralogy and pH, it is expected to have wide application to tropical soils. Also, studies on calcium silicate showed that over a five year period, plant uptake accounted for about 20 percent, soil extraction with phosphate about 20 percent, and resi-

dual in the soil about 60 percent of the applied silicon. Since there was no evidence of Si movement below 18 inches it appears that much of the applied Si is in a form in the soil which is not readily displaced by phosphate.

Research in all phases of tropical agriculture has benefited greatly by the installation and calibration of the x-ray fluorescence quantometer. Plant tissue and soil and mineral samples can now be analyzed for sixteen elements simultaneously. Although techniques of application of this instrument are still being developed, it is believed that many previously unanswered questions concerning interaction of elements in both soils and plants can be answered by simultaneous quantitative analysis.

In soil physics, soil water hysteresis has been measured in aggregated Oxisols in the zero to 0.2 bar suction range, and mathematical models to predict hysteresis based on the hydraulic properties of the soil are being developed. One dimensional infiltration of water in laboratory columns of aggregated Oxisols has also been measured for several initial water content and boundary conditions. Measurement was also made of zero points of charge for most of the soils of Hawaii. Relative to zero points of charge measured in NaCl, the zero points of charge shift to lower pH values with CaCl_2 and higher pH values with Na_2SO_4 .

In teaching, Drs. R. Green and H. Ikawa have made use of the in-

structional techniques evaluated during the Soils Teaching Workshop in Hawaii in 1971. The methods evaluated in the workshop were well accepted by the students of Dr. Green's course. The value of these workshops should be stressed. Two new courses now taught in our department are in Soil Microbiology and Techniques of Electron Microscopy. The former course benefited greatly by the visit of Dr. M. Alexander of Cornell. In soil physics, teaching has been improved by the completion of a laboratory manual that is applicable to tropical soils. Other Consortium members may wish to consult with Drs. G. Tsuji and G. Uehara concerning their approach.

Several members of our department have also participated in teaching of short courses and workshops held at other Consortium institutions. Drs. Uehara and P. Ekern lectured on South East Asian agriculture and applications of soil physics to agricultural practice at the Soil Workshop held at Prairie View A&M, and Dr. Fox and Uehara participated as speakers and group discussion leaders at the Tropical Soils Short Course held in Mayaguez, Puerto Rico.

One of our most important accomplishments during this last year has been the development of a system of information retrieval for the wealth of information on Hawaiian soils and agricultural practices. Ms. Thompson has indexed and ordered information gathered on tropical soils, and has also abstracted technical papers, theses, and dissertations of this department. These will be published

and distributed to Agronomy and Soil Science Departments of all Land Grant Universities as well as other interested institutions. Plans have also been made to acquire new books and journals to upgrade the Departmental library in the next fiscal year.

One of Dr. Sanford's students has reproduced boron, nitrogen, and magnesium visual deficiency symptoms on the leaves of macadamia and papaya, two crops of potential value in the tropics.

Future plans include a Mineralogy Workshop for members of the Consortium in July, 1973, and a Tropical Soils Institute to be held in the Philippines in June, 1974. Dr. A. R. Southard from Utah State University will spend his sabbatical leave in Hawaii during 1973-74. In addition to teaching, he will help to strengthen our soil classification program.

All staff presently housed in Gilmore Hall will move to the St. John and Pope Plant Science Laboratories during July and August 1973. This should strengthen our program by creating a closer working relationship with other staff working on tropical food and fiber production.

F. DETAILED REPORT

1. General Background and Purpose of the Grant: In making this grant, the principle 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 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 tro-

pical 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 the 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. In meeting the fulfillment of this objective, section 5 of this report should be perused. In the future, individuals traveling to other areas whether on 211(d) or other funds, will continue to make available their services as experts when requested by appropriate individuals.

3. Accomplishments

3.1 Teaching: Instructional techniques evaluated during the Soils Teaching Workshop in Hawaii in 1971, were incorporated into two introductory soils courses: "Tropical Soils" by Dr. H. Ikawa, and "Soils and Man" by Dr. R. E. Green. Instructional sheets were prepared for distribution to students for every lecture; these specified

the overall objective of the activity, detailed instructional objectives, and reading assignments. An evaluation at the end of the semester indicated that students thought the specific objectives aided them in learning the subject matter.

A new course, Soil Microbiology, was taught in our department by Dr. Burton Koch. This course has an emphasis on population, mineral metabolism, and plant microbial interrelations. This course benefited by the visit and lectures of Dr. M. Alexander of Cornell University under the provisions of the 211(d) grant. Dr. Alexander's lectures contributed to the subject matter of the course, and they also increased student interest in this area of tropical soils research.

A second new course, Techniques of Electron Microscopy, was offered to agronomists and soil scientists in the fall of 1972 and summer of 1973. This course, taught by Dr. Sakai (paid by 211(d)), will allow graduate students to use this valuable tool in their studies. Methods of fixing, embedding, and sectioning plant material, observation of particulate matter (bacteria, clay), and embedding and sectioning of soil minerals were described.

One of the objectives of the grant is to prepare manuals or other training materials on tropical soils. With this in mind, Dr. Tsuji assisted by Mr. L. Santo, prepared a laboratory manual for the course in soil physics. The manual (financed by 211(d)) will greatly upgrade the course, espe-

cially in the area of soil water, which is Dr. Tsuji's area of specialization. The manual will also be applicable to the soil physics of most tropical soils.

Another objective of the grant is to provide funds for travel by staff to consult with other cooperating institutions and to bring to Hawaii persons with additional expertise and experience. These funds enabled the University to bring to Hawaii Dr. John Coulter of the Rothamsted Experiment Station. During the period July 10-21, 1972, Dr. Coulter presented a series of seminars on international agriculture. In addition, Dr. Coulter consulted with staff and helped moderate a series of discussions with faculty and students on "Improving the Agronomic and Educational Conditions in the Tropics."

Dr. G. Uehara and Dr. R. Fox, also using these funds, participated in the Tropical Soils Institute held in Mayaguez, Puerto Rico, during July of 1972. While there, they consulted with University of Puerto Rico staff on research as well as teaching certain parts of the Short Course. Dr. Fox presented lectures and helped with the discussions on "Soil P and S" and on "Soil Management for Tropical Crop Production", using sugarcane and banana to illustrate the lectures. Dr. Uehara lectured and helped with the discussion on "Mineralogy of Oxide Systems" and "Physics of Tropical Soils". On the return trip to Hawaii, Dr. Fox also presented seminars and

lectures at Prairie View and Texas A&M on "Some Aspects of Soil Fertility in the Tropics," and a seminar at Colorado State University on "Relationships Between Yields and the External and Internal Phosphorus Requirements of Crops."

Dr. Y. Kanehiro, while on a 211(d) funded trip to Pasto, Colombia, for a volcanic soils meeting in June, 1972, collected soils with the specific objective of studying these soils in the laboratory exercise on chemical analysis in his Soil Chemistry course in Fall, 1972. The students thus benefited by comparing these data with data from Hawaiian soils.

Drs. Uehara and Ekern of this department participated in a soil workshop at Prairie View A&M College from October 2-6, 1972. Lectures were given in the area of "Probable transition trends in South East Asian agriculture, based on the experience in Hawaii," and "Application of Soil Physics and Water Relations to Agricultural Practices." The travel was financed by 211(d) funds.

Another Illustrated Concept in Tropical Agriculture has been published with 211(d) funding. It is "Symptoms of Plant Nutritional Deficiency--Visual Symptoms and Incipient Malnutrition." Another has been prepared and should be published soon. It deals with "Low Soil Temperatures Depress Root Activity in the Tropics." To reiterate, these single page prints will be distributed in courses offered in this department and are available to members of the Consortium.

3.2 Research: Good progress has been made on the 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. This is a collaborative effort of Drs. Fox, Jones, Uehara, Ikawa, and Sakai of Hawaii, and Dr. Beinroth and Professor Pietri of Puerto Rico, to determine if similarly classified soils in Hawaii and Puerto Rico behave similarly. If predictions concerning management can be made through proper classification, recommendations can be made to agriculturalists using similarly classified soils. The results of a portion of this work are being prepared for publication in four papers to be published in one journal. The work is funded by 211(d).

Additional studies by Dr. Fox and Mrs. Annie Chang (paid by 211(d) on nitrogen mineralization were made on 11 surface soils of Puerto Rico. In general, nitrification rates were very low in comparison with ammonification rates. Extremes in the ratio NH_4 : NO_3 produced, seemed to be related to high rainfall and cool temperatures. These in turn were associated with high levels of extractable aluminum.

Studies were also made of the point of zero net charge in surface soil and subsoil of the Puerto Rican soils. Only one instance out of 8 investigated showed evidence of significant net positive charge. That was in the Nipe subsoil at pH below about 5.3.

Cooperative work has also been started by Dr. Fox of Hawaii with

Prairie View A&M. This research will compare the external phosphorus requirements of crops on coarse-textured soils with those on fine-textured soils, permitting the transfer of data on a wide scale. One experiment using corn as the experimental crop is in progress at Prairie View. In Hawaii, 6 locations with soils having diverse mineralogical properties are being used to determine the external and internal phosphorus requirements of crops. Results of experiments completed this year indicate that the external requirement for corn and sorghum are similar, and that the amount of phosphorus required in solution is approximately the same for diverse soils of Hawaii. Amounts of phosphate fertilizer required to establish a prescribed level of P in solution varies greatly. It is dependent primarily on soil mineralogy and texture.

Recent work in mineralogy was concerned with volcanic ash soils described as allophanic. Soils collected in Hawaii, Japan, Oregon, Tonga, and Costa Rica, were studied by Mr. Delmar Dingus of Oregon State University, and Drs. Jones and Sakai of Hawaii. Transmission electron micrographs showed an abundance of gelatinous material in the soils investigated along with varying ratios of imogolite-like strands and spherical halloysite. Soils containing high concentrations of the spherical halloysite produced halloysitic x-ray diffractograms. It appears from these studies that allophane is not present as a mineral species or that the portion of the soil referred

to as allophane was part of the gelatinous material. Partial support was provided by 211(d).

Mr. Wayne Hudnall, a graduate student supported by 211(d), after taking Dr. Sakai's course in electron microscopy, has been experimenting with various techniques for producing ultra thin cross sections of halloysite and spherical halloysite. By sectioning the material, the layering of the mineral can be seen. Standard A. P. I. halloysite has been observed using this method. Mr. Hudnall has also developed methods for preparing SiO substrate films which are very fine grained and are superior to the carbon substrate films which are normally used in the observation of clay minerals with the electron microscope. A simple method for preparing both carbon and silicon holey support films was also developed. Clay minerals can be observed over the holes on these films without the interfering substrate.

In soil biology, a project headed by Dr. Koch, related to non-symbiotic nitrogen-fixation in selected Hawaiian pasture soils, has resulted in the isolation of 5 facultative nitrogen-fixing bacteria. At least 3 of these bacteria have not been previously isolated or identified. Estimates of numbers of these bacteria over a two year period indicated a relatively low population with definite seasonal variations. Examination of soil samples from these pastures with the acetylene assay indicated nitrogen-fixation rates of 0 to 0.1 $\mu\text{g N}_2$ fixed per gram soil per day, depending on the soil and moisture content. Although these bacteria were generally low in numbers, some have a fixation rate in pure culture higher than previously encountered

with facultative anaerobes. These results suggest a significant contribution of total soil nitrogen by these facultative bacteria, especially during certain times of the year. Some graduate student support was provided by 211(d).

Mr. Okazaki (paid by 211(d)) and Dr. Jones have progressed in calibrating the x-ray fluorescent quantometer. Matrix corrections were handled by multiple regression techniques. Plant tissues can be quantitatively analyzed for Mg, Si, P, S, K, Ca, Mn, Cu, and Zn. Additional elements which are still in the calibration stage are Na, Al, Cl, Fe, Br, and Mo. The Br is of interest because of its high level in many plant tissues, the source being a contaminant in fertilizers or from the bromide fumigants for nematode control or sea spray. Br is important in analysis because its presence affects matrix absorption and fluorescence. The 15 elements are analyzed simultaneously and the analysis of each sample is completed in two minutes.

Mr. Grant Gribble, a graduate student supported by 211(d), who works with Drs. Jones and Uehara, has developed a method for total soil and rock silicate analysis using the x-ray fluorescence quantometer. Matrix effects were accounted for by a multiple correlation equation which related the amount of a particular element to the x-ray intensities of the interfering elements. This method was successful because the intensities of 16 elements were measured simultaneously. Elements analyzed in soil and rock samples were Na, Mg, Al, Si, P, K, Ca, Ti, Mn, and Fe.

Mr. Johnathan Braide, a graduate student from Nigeria, is currently developing a soil testing method using ion exchange discs. The disc is allowed to equilibrate with moist soil and the adsorbed ions are measured on anion exchange resin. This method shows promise as a technique for accurate assessment of soil fertility in all types of soil.

Dr. W. S. Reid, from Cornell, engaged in a study with Drs. Silva and Fox of Hawaii, on the estimation of the lime requirements of tropical soils. The numbers of soil profiles (taken by horizons to a depth of approximately 3 feet) and the State or Country where they were obtained were as follows: Brazil - 3, Colombia - 1, Hawaii - 13, Mississippi - 5, Puerto Rico - 2, New York - 1, Mekong Delta - 10, Tanzania - 5. Dr. Reid has evaluated several chemical methods for estimating the lime requirement of acid soils and will compare results obtained on soils from tropical vs. non-tropical regions. The chemical methods selected for evaluation were (a) barium chloride-triethanolamine method used by the Cornell Soil Test Laboratory, (b) Adams and Evans' buffer, (c) Woodruff's buffer, (d) Shoemaker, Pratt & McNeal's buffer, (e) neutral salt extractable aluminum method of Kamprath, (f) Ca and Na hydroxide titration curves and (g) subtraction of summation of bases from the cation exchange capacity. Dr. Reid was supported in part by 211(d).

Dr. Silva made a comparison of six methods for extracting Al from

tropical soils and has compared extractable Al with plant Al and plant growth. Soil Al extracted with \underline{N} BaCl_2 was more closely correlated with plant yield and plant Al than soil Al by other extractants. Since the method was tested on soils with a range of mineralogy and pH, the method is expected to have wide application to soils in the tropics. The three plant species, corn, Desmodium intortum, and white clover, used in the experiment were comparable in their tolerance to Al.

Long term effects of applied calcium silicate were investigated during five years of cropping successively with sugarcane, corn, and kikuyugrass. Plant uptake accounted for 12 to 21% of the applied Si while exhaustive extraction of profile samples at the end of five years recovered 14 to 28% of the applied Si. Apparently, about 57 to 72% of the applied Si remained in the soil in some form not readily displaced by phosphate extraction since there was no evidence that applied Si moved below 18 inches.

Energy dispersive x-ray analysis of sugarcane leaves grown on soils of high available silicon showed that although silicon was deposited selectively in silica cells, prickles, basal cells of microhairs, and stomata in very young leaves, silicon in mature leaves occurred in all of the epidermal cells except the upper cells of microhairs. Other studies by Dr. Sakai have been concerned with the location and the form of calcium and magnesium crystals in plants.

The secretion of hydrated magnesium carbonate (nesquehonite) by plant glands was first described. Also, electron micrographs were presented that showed the formation of calcium oxalate crystals in plants could be at the expense of calcium in the calcium pectate middle lamella.

Mr. Lance Santo has soil water hysteresis in aggregated Oxisols in the zero to 0.2 bar suction range and is currently working on a mathematical model to predict hysteresis based on the hydraulic properties of the soil. One dimensional infiltration of water in laboratory columns of aggregated Oxisols has been measured for several initial water content and boundary conditions by Dr. Tsuji. Research on the distribution of water and solutes under drip irrigation is in the planning stages. Measurement was also made of zero points of charge for most of the major soils of Hawaii by Mr. Johnny Keng. With minor exceptions most of the soils show well defined zero points of charge measured in NaCl, the zero points of charge shift to lower pH values with CaCl₂ and higher pH values in NaSO₄.

Research on nitrogen transformation and movement by Dr. Kanehiro using urea in a Vertic Haplustoll, showed that increased trickle irrigation moved transformed NO₃⁻ deep into the profile, whereas there was no such NH₄⁺ movement under the same conditions. The downward movement of NO₃⁻ was enhanced by reducing the plant population density. In another study it was found that NO₃⁻ sorption capacity of Hydrandepts was substantially reduced when the soil was air-dried or oven-

dried. In a study comparing the slow release nitrogen fertilizers with corn and bermuda grass on a Typic Eustrustox, it was found that Osmocote was most effective for corn and Osmocote, sulfur-coated urea and IDDU were equally effective for Bermuda grass. In a study by Mr. Asghar, organic matter from pineapple residue and sugarcane trash were incorporated into a Typic Torrox at different levels and changes in nitrogen status were followed up to 16 weeks. The concentration of available forms of nitrogen ($\text{NH}_4\text{-N}$ and $\text{NO}_3\text{-N}$) remained low during the first three months of incubation with no noticeable loss of nitrogen as indicated by total nitrogen concentration. In a separate experiment with the same soil, the critical redox potential range for nitrate stability was found to be between 300-400 mv. However, the redox potential of the soil, even at 100 tons/acre organic matter, was found to be well above the critical range for nitrate stability. Thus the low concentration of mineral nitrogen was most probably due to nitrogen immobilization.

Research by Dr. Green on herbicide persistence in soils cropped to sugarcane for several years, revealed that while s-triazine herbicides degrade relatively rapidly, the substituted urea, diuron, persists for several years in some soils. The relatively high organic matter content of some of Hawaii's soils may account for the apparent irreversible adsorption of diuron. The adsorbed chemical

is probably not bio-active.

Dr. Bower's research (211(d) supported) has been concerned with salinity problems in highly-aggregated tropical soils. Whereas the soil water content at saturation is usually about twice that at the field capacity, it was found in a Low Humic Latosol that the water content at saturation was only slightly higher than at field capacity. The implication was that with highly-aggregated soils EC_e values ordinarily associated with a given percentage decrease in crop yield should be reduced by nearly one-half. It was also found that leaching by drip irrigation was more effective in reducing the salinity than ponding. The low leaching efficiency under ponding resulted from the rapid movement of water through the large pores of the highly-aggregated soil during saturated flow, leaving the salt in the small pores of the aggregates behind.

While Dr. S. El-Swaify is on sabbatical leave, Drs. Ahuja and Dangier have served as research leaders on two U.S.D.A. funded projects on forest hydrology and soil erosion. Dr. Ahuja has set up field experiments to measure the hydrologic properties of forested areas in the state. Dr. Dangier, with the initial assistance from A. P. Barnett, U.S.D.A.-A.R.S. Georgia, have completed erosion studies on four different soils sites on Oahu. Several sites on the island of Hawaii are currently being considered for future erosion studies.

One of Dr. Sanford's students, Mr. N. Hirunburana, was able to

reproduce both visual deficiency symptoms of boron and magnesium on papaya and macadamia, as well as establish tentative critical values for these two elements within the plants. He also established tentative critical values for N in papaya and macadamia leaves. Both boron soil and tissue levels were also established for boron toxicity of papayas. Mr. Hirunbwiana was supported by 211(d).

3.3 Reports, working papers and publications

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THESES AND DISSERTATION

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- Boonduang, A. 1972. Some studies on slowly available nitrogen sources in Hawaiian soils. M.S. Thesis.
- Chan, J. K. 1972. Chemical and morphological characterization of the non-crystalline fraction in the Hilo soil (Typic Hydrandepts). M.S. Thesis.
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- Ezumah, H. C. 1972. The growth and development of taro, Colocasia Reculenta (L) Schott, in relation to selected cultural management practices. Ph.D. Dissertation.

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- Ravoof, A. A. 1973. Effects of root temperatures and nitrogen carriers on nutrient uptake, growth, and composition of pineapple plants, Ananas comosus (L) Merr. Ph.D. Dissertation.
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- Syed-Fadzil, Syed Farooq. B. 1972. Ion retention and movement in soils with variable charge colloids. M.S. Thesis.
- Wambiji, H. 1972. Salinity tolerance of the pineapple plant, Ananas Comosus (L) Merr. M.S. Thesis.
- Uchida, R. S. 1973. The effect of calcium silicate on cation exchange capacity and on exchangeable potassium, calcium and magnesium in a field trial on a Hydric Dystrandept. M.S. Thesis.

4. Impact of Grant Supported Activities in Developing

Institutional Capabilities: As reported in the last fiscal year, the 211(d) grant has had a tremendous impact in increasing the instrumental capabilities in biological, mineralogical, and chemical research in tropical soils. This was due largely to the purchase of an x-ray fluorescence quantometer and a scanning electron microscope with a micro probe attachment through other funds, augmented by some 211(d) funds.

This grant has permitted the Department of Agronomy and Soil Science to increase its professional staff with the addition of post-doctoral associates, technicians, and visiting professorships. It has also provided assistantships for graduate students in dis-

ciplines associated with the 211(d) grant. The staff and graduate student additions have increased capabilities in the lesser developed areas of research in tropical soil science.

Furthermore, Ms. Dianne Thompson has been employed under the 211(d) grant to index information gathered on tropical soils and to place them in some logical order so that they will be more readily accessible to interested parties. Abstracts of technical papers, theses, and dissertations from the Department of Agronomy and Soil Science will be published and distributed to Agronomy and Soils Departments of all Land Grant Universities as well as other interested institutions. Ms. Thompson will also be responsible for cataloging all existing books, journals, etc. in the Departmental library. Under the auspices of the 211(d) grant, the Department has expended approximately \$800.00 in new book acquisitions and \$2800 in bound series of journals purchased from the now defunct Pineapple Research Institute of Hawaii. Plans have already been made to acquire more new books and journals to upgrade the Departmental library in the next fiscal year.

5. Utilization of Institutional Resources in Development:

At the request of the AID, Dr. L. D. Swindale, Associate Director of the Hawaii Agricultural Experiment Station, and Dr. J. A. Silva, Associate Professor of Agronomy, traveled to Africa to provide the Government of Tanzania with information on development of a land

capability system for the Arusha District. A brief reconnaissance survey of the land systems in the Arusha province, covering some 30,000 square miles, was made over a period of 10 days. A number of soils were sampled and shipped to Hawaii for analysis.

Enroute to and from Tanzania, Dr. Silva stopped at Mauritius and Ethiopia, on 211(d) funds, to learn of the soil and crop management systems in these countries. Contacts with scientists at the Mauritius Sugar Industry Research Institute were established and arrangements were made to have samples of important soils used in sugarcane culture sent to the University of Hawaii. Discussions were held with scientists at the Institute of Agriculture Research at Holetta, and at the Debre Zeit Experiment Station in Ethiopia. Problems in soil chemical analyses and in soil fertility were explored and possible solutions proposed. Management problems of the Black Vertisols, which are the principal agricultural soils of Ethiopia, were discussed and research to develop management practices to improve the physical properties of this soil was suggested. Consultation with the staff from the Department of Agronomy and Soil Science of the University of Hawaii was proposed.

Dr. Swindale also traveled to London and Gent to discuss the possibility of obtaining information in England and Belgium on tropical soil management for the AID/UH 211(d) Tropical Soils program. The development of communication ties with officers of the Common-

wealth Agricultural Bureaux, the Rothamsted Agricultural Experiment Station, and the Geological Institute of the University of Gent, would enable the 211(d) Consortium to obtain access to both published and non-published reports which these institutions possess on tropical soil science. The opportunity was also taken in Gent to discuss the possibility of finding common soil families in Hawaii and the Republic of Zaire that could be used in linked experiments in soil management.

Dr. Goro Uehara and Dr. Robert L. Fox were participants in the Tropical Soil Institute held in Mayaguez, Puerto Rico, in August, 1972. Dr. Uehara lectured on the mineralogy of oxide systems and physics, of Tropical soils. Dr. Fox presented lectures, and helped with the discussion on soil phosphorus and sulfur, and on soil management for tropical crop production. Dr. Fox also visited the Puerto Rico Agricultural Experiment Station to discuss possible collaboration on a comparative study of Puerto Rico and Hawaii soils. While in the Caribbean area, Dr. Fox attended a symposium on Soils of the Tropical Savanna in the Dominican Republic, and visited the Windward Islands Banana Research Scheme, St. Lucia, and Banana Board and Citrus Research Personnel on Jamaica.

In January, Dr. Fox presented a paper "Examples of Anion and Cation Adsorption by Soils of Tropical America" at the Conference on Soils of the Caribbean and Tropical America at the University of

the West Indies, Trinidad. Field trips to Barbados, St. Vincent and Granada were also included as a side light to the conference.

Dr. Uehara, principal investigator for the Mekong River Silt Project and Melvin Nishina, graduate student, visited Viet Nam in March to collect silt and soil samples on the Mekong Delta. Dr. Uehara also attended the first annual meeting of The Heavy Clay Delta Soils Project which was held in Saigon and Can Tho University, between June 11, and June 15, 1973. His attendance at this meeting was a result of a memorandum of understanding signed by Vietnamese government agencies, AID-Washington, the AID mission in Viet Nam, the Regional Economic Development Office in Bangkok, Thailand, and Can Tho University, to study management of heavy clay delta soils. The University of Hawaii and Colorado State University will provide technical assistance and personnel for this project. This project, along with the one year research contract between the Department of Agronomy and Soil Science of the University of Hawaii and the Committee for the Coordination of the Development of the Lower Mekong Basin to study river silt and delta soils in the Mekong Delta, will aid in the overall planning of the control of the Mekong River.

Dr. W. G. Sanford traveled to the Ivory Coast to do consulting on the agronomy of pineapple and met with personnel of the IFAC. At the invitation of IFAC, he also spent one week in the United Republic of Cameroon where he visited the staff of the National Agricultural

Research Centre at Ekona, met the local Director of IRAT (basic food crops) at Yaounde, and the local Director of IRCT (fiber crops) at Maroua, and got a general look at the agricultural problems, particularly under extremely dry conditions. Seeds of a sorghum variety that are either extremely drought tolerant or deep rooted have been received from the Cameroons as a result of this trip. The trip ended in Paris where Dr. Sanford met and discussed with soils officials of the main headquarters of ORSTOM the possibility of cooperative research with the University of Hawaii. Funds for this trip were provided by a private firm and IFAC.

During March and April 1973, Dr. C. A. Bower served as U.S. representative on a Near East and North Africa Agricultural Research Review Mission sponsored by the Consultative Group on International Agricultural Research. The purpose of the Mission was to identify gaps and priorities in existing agricultural research in the region, with the view of providing additional support for selected activities in research, training, information and related work.

In early June, Dr. Y. N. Tamimi traveled to Indonesia, the Philippines, and Australia on 211(d) funds. In Indonesia he assisted Richard Pellek, graduate student, on his thesis problem of soil site-productivity evaluation of tropical tree species. Dr. Tamimi also studied various soil profiles in the investigation area of Udjong Kulon Natural Reserve on the island of Java, and visited the College

of Agriculture and School of Forestry and the National Soil Research Institute. In the Philippines, he presented a seminar on phosphorus problems and liming of tropical soils at the University of the Philippines, College of Agriculture at Los Baños. Dr. Tamimi also visited with scientists at the International Rice Research Institute and observed rice culture and multiple cropping systems. In Australia, he spent time at the C.S.I.R.O. in Brisbane, visited an agricultural experiment station in Beerwa, and discussed practices and problems associated with forest soils and forest tree planting with members of the Forestry Department in Queensland.

A possible contract for the coming year includes a proposal submitted by Dr. Swindale to the AID on the relation of soil families to crop productivity in the tropics. Dr. Swindale reported that the pending University of Hawaii research contract on tropical soil families has achieved some noteworthy progress by being unanimously endorsed by the Research and Institutional Grants Council of AID, and now will be presented to the external Research Advisory Committee in the very near future. Other staff that may participate in this contract are Drs. Sanford, Silva, Ikawa, and Bartholomew. Dr. Swindale also reported that the UH/AID 211(d) contract on animal production is being included in tentative AID plans for fiscal year 1974, and that a proposed University of Hawaii research contract on root crops is considered interesting but needs considerable further revision.

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>			
Aragon, Ernesto L.	Fall '72		Philippines
Arian, Mohammad S.	Fall '72	R. Fox	Pakistan
Ayers, Dennis	Fall '71	H. Y. Young	U.S.
Chaudhury, A. J. H.	Spring '70	D. Bartholomew	Pakistan
Hurdus, Alan R.	Fall '72	P. Rotar	U.S.
Kagbo, Robert	Fall '72	W. Sanford	Sierra Leone
Pellek, Richard	Fall '71	Y. Tamimi	U.S.
Pyon, Jong-Yeong	Fall '72	D. Plucknett	Korea
Saito, Ronald Y.	Spring '71	D. Bartholomew	U.S.
Tama, Kato	Fall '72	D. Bartholomew	Cook Islands
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, Humphrey	Spring '70	D. Plucknett	Nigeria
Floresca, Emmanuel	Fall '71	P. Rotar	Philippines
Guevarra, Anacleto	Fall '71	P. Rotar	Philippines
Nicholls, Douglas	Fall '70	D. Plucknett	Australia
Ravoof, Abdul	Fall '69	W. Sanford	India
Seng, Tee	Spring '68	W. Sanford	Malaysia
<u>Soil Science--M.S.</u>			
Alvarez, Robustiano	1967	J. Silva	Argentina
Asghar, Mohammad	Fall '70	Y. Kanehiro	Nigeria
Braide, Jonathan O.	Fall '68	G. Uehara	Nigeria
Elder, Vincent	Spring '73		U.S.
Furukawa, Michael N.	Spring '73	R. Green	U.S.
Gribble, Grant	Fall '72	G. Uehara	U.S.
Keng, Johnny C. W.	Summer '71	G. Uehara	Taiwan
Mukhtar, Muhammad	Fall '72	R. Green	Pakistan
Nishina, Melvin S.	Fall '71	P. Rotar	U.S.

Graduate students (Cont.)

<u>Name</u>	<u>Arrival Date</u>	<u>Advisor</u>	<u>Home Country</u>
<u>Soil Science--M.S.</u>			
Oya, Jean	Fall '72	B. Koch	U.S.
Periaswamy, Sirapalli	Summer '70	H. Ikawa	India
Prasomsook, Suwit	Fall '72	R. Fox	Thailand
Santo, Lance T.	Summer '71	G. Uehara	U.S.
Teh, Saidin Bin	Fall '72	S. El-Swaify	Malaysia
Tengah, Abdullah B. C.	Fall '72		Malaysia
Uchida, Raymond S.	Fall '71	Y. Tamimi	U.S.

Soil Science--Ph.D.

Asghar, Mohammad	Fall '70	Y. Kanehiro	Pakistan
Balasubramanian, V.	Fall '69	Y. Kanehiro	India
Dangler, Edgar	Summer '67	S. El-Swaify	U.S.
Hirunburana, Niwat	Fall '69	R. Fox	Thailand
Hudnall, Wayne	Spring '72	R. Jones	U.S.
Jellinger, Alice	Spring '69	P. Ekern	U.S.
Khalid, Rashid	Summer '67	J. Silva	Pakistan
Rao, Palakurthi	Spring '70	R. Green	India
Sinanuwong, Somisri	Fall '69	S. El-Swaify	Thailand
Stoop, Willem	Fall '71	R. Fox	Netherlands
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

Research and teaching staff (Cont.)

<u>Name</u>	<u>Speciality</u>
<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 L. 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>
Lajpat Ahuja	Assistant Soil Scientist
Ayers, Dennis	Research Associate
Charles Bower	Soil Scientist
Annie Chang	Junior Researcher
Edgar Dangler	Junior Soil Scientist
Kishore Goswami	Junior Soil Scientist
Marion Mapes	Assistant Agronomist
Helen Mishima	Research Associate
Douglas Nicholls	Junior Agronomist
Ernest Okazaki	Junior Soil Scientist
William Sakai	Assistant Soil Scientist
Gordon Shiba	Research Associate
Gordon Tsuji	Assistant Soil Scientist

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

<u>Position</u>	<u>Name</u>	<u>Speciality</u>
Graduate Res. Asst.	Robustiano Alvarez	Soil Fertility
Soil Scientist	Charles Bower	Soil Chemistry
Jr. Researcher	Annie Chang	Analytical Chemistry
Graduate Res.Asst.	Vincent Elder	

Staff and students (Cont.)

<u>Position</u>	<u>Name</u>	<u>Speciality</u>
Graduate Res. Asst.	Michael Furukawa	Soil Physics
Graduate Res. Asst.	Grant Gribble	Soil Mineralogy
Graduate Res. Asst.	Niwat Hirunburana	Soil Fertility
Graduate Res. Asst.	Wayne Hudnall	Soil Mineralogy
Graduate Res. Asst.	Rashid Khalid	Soil Fertility
Jr. Soil Scientist	Ernest Okazaki	Soil Chemistry & Mineralogy, X-ray Fluorescence Quantometer
Graduate Res. Asst.	Jean Oya	Soil Microbiology
Post Doctoral Fellow	William Sakai	Electron Microscope
Graduate Res. Asst.	Lance Santo	Soil Physics
Post Doctoral Fellow	Gordon Tsuji	Soil Physics

6. Other Resources Used for Grant-Related Activities. Because of Hawaii's location in the tropics, much of the research in soil science is focused on the tropics. Thus, approximately fifteen researchers and an equal or larger number of graduate students that are supported by state or federal funds, are carrying on 211(d) grant-related activities. This amount exceeds \$ 200,000 annually.

The department has signed a year contract with the Committee for the Coordination of the Development of the Lower Mekong Basin to study river silt and soils in the Mekong Delta. Dr. Uehara, principal investigator in this project, has used funds from this project to travel to South East Asia. Funds from this project were also used to provide travel expenses for a graduate student as well as the provision of support during the study. This non 211(d) funded study will increase our competence in tropical Asian soils.

A grant-in-aid of \$1000 was also received by Dr. Green from

private funds for research on the behavior of herbicides in tropical soils.

Resources of the University in terms of staff time were also used to handle many visitors who came to Hawaii for research and consultation, or on short stops in travel between Asia and the mainland U.S., including Dr. John Coulter, Rothamsted Experiment Station; Dr. John Replogel, Mr. Gary Frasier and Mr. John Griggs, U.S. Water Conservation Laboratory; Dr. Joe Kubota, USDA-ARS, Ithaca, N.Y.; Dr. K. R. Stockinger, Washington, D.C.

7. Next Year's Plan of Work

7.1 Teaching and Extension Services: A clay mineralogy workshop involving all Consortium institutions will be held in Hawaii starting July 14, 1973. The two week workshop will allow members of the Consortium staff involved in soil mineralogy teaching and research to become familiar with the capabilities of the x-ray fluorescence quantometer and the scanning electron microscope. Field trips to the islands of Kauai, Maui and Hawaii are also on the agenda.

Audio visual tutorial techniques, successfully established two years ago, will continue to play a vital role in teaching the basic soils course offered by Dr. Ikawa and Green. Another in the series of Illustrated Concept in Tropical Agriculture will be prepared by Dr. Fox. The new series will be entitled "Low Soil Temperatures

Depress Root Activity in the Tropics." Photographic work for still another concept which will deal with nitrogen nutrition of banana has been completed.

New instructors for courses presently offered in the department are Dr. Wade McCall (Tropical Crop Production) and Dr. Al Southard, (Soil Genesis and Classification) from Utah State University. A special course entitled, "Chemistry of Submerged Soils" is currently being planned to be offered during the summer of 1974. Dr. W. Patrick of Louisiana State University will be the guest instructor. Other course offerings in the Department of Agronomy and Soil Science will remain unchanged.

Dr. Uehara will be on sabbatical leave for a year starting September, 1973. He will be at Cornell till December, 1973 to assist Drs. Matthew Drosdoff and Marlin Cline in the instruction of "Management of Tropical Soils." From January to August, 1974, Dr. Uehara will be at North Carolina State University to work with Dr. C. B. McCants and associates on a text on the management of tropical soils.

A second Tropical Soils Institute will be held in the Philippines at the Southeast Asian Regional Center for Graduate Study and Research in Agriculture. It will be held in the month of June, 1974, and will be organized by the University of Hawaii.

Several of the staff will participate in the Seminar to be

held at CIAT, Colombia, in February, 1974.

7.2 Research: Comparison of similar classified Hawaiian and Puerto Rican soils by means of chemical measurements, electron microscopy, and X-ray diffraction analyses will continue to be made by Drs. Ikawa, Jones, Sakai and Fox. Of primary 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, Laleau, and Manana). Emphasis will be given to those properties of soils which can be related to management practices.

The highest priority for the quantometer project in the future is to develop methods for the analysis of soil extracts. This will involve both students and staff in assessing extraction techniques, preparation of extracts for analysis by the quantometer, and correlation of the results with field data.

Depending on the availability of outside funds, Dr. Koch plans to undertake research in the areas of diuron degradation in Hawaiian soils and Rhizobium-legume relationships. The latter project would involve the establishment of a Rhizobium collection for test inoculation of various legumes common to Hawaii and would evaluate environmental conditions which might effect the inoculation process

and corresponding rates of nitrogen fixation. Studies on soil denitrification and redox conditions, especially as related to the removal of nitrate from the soil environment, and on organic matter residue decomposition will be conducted by Dr. Kanehiro.

Dr. Green will continue his work in herbicides. The adsorption on soil of diuron and bromacil will be related to the properties of both inorganic and organic constituents of a number of Hawaiian soils in an attempt to understand the factors determining the persistence of these compounds. Herbicide and nitrate movement under drip irrigation of sugarcane will be examined. Studies of this nature will be aimed at relating solute dispersion to the structural characteristics of an Oxisol and a Hydrandept.

Dr. Kenneth Doxtader, Associate Professor in the Agronomy Department, Colorado State University, will spend a six month sabbatical in Hawaii. As a soil microbiologist, he has been involved in research and teaching in microbial ecology, nutrient recycling, and pesticide metabolism. While in Hawaii he will work with Dr. Green on the application of computer simulation techniques to kinetics of pesticide breakdown. He will also organize and participate in a series of seminars dealing with the biology and biochemistry of natural systems.

Collection of basic soil water parameters that describe the retention and movement of water in Hawaiian soils will continue to be of primary interest to Drs. Uehara and Tsuji. Soil water transport

coefficients of two Oxisols will be determined from experimental vertical infiltration data and compared to those previously obtained from outflow methods and simulation models. Similarly, a mathematical model to describe soil water hysteresis in Oxisols is being studied. Computed data will then be matched to experimental data. A new project proposal to study the distribution of water and solutes in soils under drip irrigation has been submitted for funding.

Dr. Silva will carry out experiments on the pH requirement of sugarcane harvested in the fall. Complete plant and soil sampling will be made. A nutrient culture experiment designed to further clarify the role of pH in sugarcane growth and nutrient uptake will be undertaken. The fate of silicon applied to soil and the reactions of calcium silicate in tropical soils will continue to be studied. Results of lime requirement study should be available for interpretation and recommendation.

The research program for 1973-74, will be disturbed to some extent by the move of all staff housed in Gilmore Hall into the St. John and Pope Plant Science Laboratories. However, this has the brighter side of a better working relationship with staff in Botany, Horticulture, and Plant Pathology who are working on research to improve tropical and crop and fiber production.

The use of phosphate adsorption curves will evaluate phosphate requirements of sandy soils which will be done in cooperation with

Prairie View. In Hawaii, the emphasis will shift to evaluation of residual effects and side effects of phosphate fertilization, while at the same time information will be gathered on external and internal phosphorus requirements of important tropical crops which have received little attention. Availability of adsorbed sulfate in subsoils will be continued, and the internal and external S requirement of crops estimated by Dr. Fox. Nutritional requirement of banana will emphasize N and K requirements, but other elements such as sulfur and zinc will receive increasing attention. Dr. Fox will also initiate more continuous function experimental designs for soil fertility studies as examples of how this technique can be utilized to maximize information in areas with limited research facilities.

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 9.1. Distribution of 211(d) grant fund expenditures and contributions from other sources of funding^{a)} (review period July 1, 1972 to June 30, 1973)

Object	Period Under Review	211(d) Source		Projected to End of Grant	Non-211(d) Source ^{b)}
		Cumulative Total	Projected Next Year		
Research	\$144,340	\$237,230	\$107,200	\$425,900	\$600,000
Teaching	17,784	26,060	17,000	50,000	98,000
Libraries	750	935	4,000	5,000	-----
Consultation	3,000	3,609	5,000	10,000	-----
Publication	750	1,050	4,000	6,050	9,000
Other	<u>1,218</u>	<u>1,218</u>	<u>1,800</u>	<u>3,050</u>	<u>51,000</u>
TOTAL:	\$167,842	\$270,102	\$139,000	\$500,000	\$758,000

^a These figures are our best estimates

^b 1972-73 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, 1972 to June 30, 1973)

	Actual Period Under Review	Expenditure Cumulative Total	Projected Expenditures Year		Total
			4	5	
Salaries & Wages (Total)	\$126,018	\$196,397	\$120,000	\$80,000	\$396,397
Salaries	100,263	154,544			
Fringe Benefits	10,125	16,273			
Student Help	15,630	25,580			
Supplies (Total)	6,081	13,978	6,000	6,000	25,978
Supplies & Publications	6,052	13,042			
Library Acquisitions	750	935			
Equipment (Total)	22,020	36,933	5,000	-----	42,376
Travel (Total)	12,317	22,351	8,000	4,898	35,249
Inter-Island	1,865				
Out-of-State (U.S.)	7,409				
Foreign	3,044				
TOTAL	\$167,156	\$269,659	\$139,000	\$90,898	\$500,000

Exhibit A: Individuals Under Salaries

<u>Name</u>	<u>Title</u>	<u>Date Employed</u>	<u>% of Time</u>	<u>Amount 7/1/72-6/30/73</u>
Bower, Charles	Soil Scientist	4/17/72	40	\$ 7,917.48
Reid, W. Shaw	Assoc. Soil Sci.	10/1/71	75	7,335.26
Sakai, William	Asst. Soil Sci.	9/1/71	79	10,125.06
Tsuji, Gordon	Asst. Soil Sci.	7/15/70	75	8,270.50
Chang, Annie	Jr. Soil Sci.	10/1/71	75	9,108.00
Okazaki, Ernest	Jr. Soil Sci.	1/17/72	100	11,232.00
Rosenau, Andrew	Jr. Soil Sci.	7/24/71- 10/13/72	100	2,763.64
Thompson, Dianne	Specialist	1/2/73	100	3,490.52
Tomlinson, Deane Jr.	Res. Assoc.	5/1/73	100	1,126.00
Nagasako, Gayle	Temp. Steno	2/1/72- 7/31/73	100	1,968.89
Alvarez, Robustiano	Grad. Asst.	5/1/73	50	816.00
Asgar, Mohammad	Grad. Asst.	11/1/72	50	1,632.00
Ayers, Dennis	Grad. Asst.	9/1/72- 2/28/73	50	2,268.00
Braide, Jonathan	Grad. Asst.	9/1/72	50	4,080.00
Elder, Vincent	Grad. Asst.	1/15/73	50	2,103.65
Furukawa, Michael	Grad. Asst.	1/1/73	50	2,268.00
Gribble, Grant	Grad. Asst.	9/1/72	50	3,780.00
Hirunburana, Niwat	Grad. Asst.	9/1/71	50	5,076.00
Hudnall, Wayne	Grad. Asst.	1/1/72	50	5,076.00
Nishina, Melvin	Grad. Asst.	9/1/72	50	1,701.00

Exhibit A: Individuals Under Salaries (con't)

<u>Name</u>	<u>Title</u>	<u>Date Employed</u>	<u>% of Time</u>	<u>Amount 7/1/72-6/30/73</u>
Oya, Jean	Grad. Asst.	9/1/72- 1/31/72	25	945.00
Ryder, Mayo	Grad. Asst.	1/1/72- 7/16/72	50	204.00
Santo, Lance	Grad. Asst.	10/1/71	50	2,448.00
Uchida, Raymond	Grad. Asst.	1/1/72- 1/16/73	50	2,548.00
Coulter, John	Consultant	7/21/72	50	<u>1,980.00</u>
				\$100,263.00

Exhibit B: Equipment Purchased Over \$100

<u>Vendor</u>	<u>Description</u>	<u>Cost</u>	<u>Justification</u>
Electrical Distributors, Ltd. Honolulu, Hawaii	23,000 BTU air conditioner	\$ 375.00	Air conditioning for the room having the x-ray fluorescence quantometer
Perkin-Elmer Corp. Los Angeles, Calif.	Automatic null recorder	504.70	Micronutrient analysis of plant and soil
Haverhill's San Francisco, Calif.	Bowmar 901B electronic calculator	187.00	For research calculations
Spex Industries Metuchen, New Jersey	2 1/4" x 2 1/2" grinding container	205.77	Plant sample preparation for analysis
Hopaco Honolulu, Hawaii	36" x 12" steel storage	124.59	Storage of quantometer supplies
Van Waters & Rogers Honolulu, Hawaii	Deminerlizer, solenoid, cartridge	369.82	To develop soil testing methods
Spex Industries Metuchen, New Jersey	Mixer, tungsten carbide	1,572.02	Sample preparation for x-ray fluorescence analysis
Hunter's Inc. Honolulu, Hawaii	Bookcase, shelving	331.60	Departmental library use
Beckman Instruments Honolulu, Hawaii	Phasar-1 pH meter	556.40	For measurement of soil pH
Van Waters & Rogers Honolulu, Hawaii	Mill, lab, Wiley model ED-S, 5" x 2" oven, lab, utility	2,156.40	For gringing plant samples
Eberline Inst. Corp. Sante Fe, New Mexico	Portable Beta-gamma geiger, hand probe, SK-1 audio	420.30	For monitoring radioactive research
Rondikn Corp. Honolulu, Hawaii	3 1/4 mm diamond knife with boat to fit	884.00	For cutting mineral samples
Kent Cambridge Morton Grove, Ill	Cambridge S-4 stereoscan scanning electron minicroscope with the following accessories: LaB ₆ configuration electron gun, microanalysis specimen stage, cathodoluminescence unit, video presentation unit, T.V. scanning system less monitor	12,500.00	For examination of mineralogy and plant samples

Exhibit B: Equipment Purchased Over \$100 (con't)

<u>Vendor</u>			
Applied Research Labs Sunland, Calif.	Sola 4KVA regulator transformer	\$ 878.54	Regulation of electrical power to quantometer
New Brunswick Scientific New Brunswick, NJ	Portable gyrotory shaker	285.29	For growth of various micro- organisms in liquid culture
Van Waters & Rogers Honolulu, Hawaii	Helium gas regulator 2 stage; oxygen regulator, 2 stage	257.98	For use with newly purchased gas cylinders (Project W-158)
Cole-Palmer Instrument Chicago, Illinois	Test tube support Max. tube dia. 20 mm and lab tool kit	59.60	Laboratory maintenance and upkeep
Central Camera Inc. Honolulu, Hawaii	Exhaust blower for condenser lamphouse and filter holder for zoom condenser lamphouse	88.00	Equipment will be used with Omega enlarger in preparing electron micrographs for 211(d) publications
Hunter's Inc. Honolulu, Hawaii	Storage cabinet with lock, 5 shelf, 36" x 78" x 24"	87.09	For storage and protection of spare parts and accessories for the x-ray quantometer
	Equipment purchased	\$21,844.10	
	less \$100	175.50	
	TOTAL	<u>\$22,019.60</u>	

Exhibit C: Foreign Travel

<u>Name</u>	<u>Place of Travel</u>	<u>Left</u>	<u>Date</u> <u>Return</u>	<u>Justification</u>	<u>Amount</u>
Tamimi	Roundtrip-Hilo-Honolulu Hong Kong-Djakarta-Singapore Manila-Honolulu-Hilo	3-25-73	4-11-73	Assist graduate student in selecting sites, describing, and collection of soil samples from research study area at Udjon Kulon National Reserve in Indonesia. A stopover at Manila will allow for discussions on tropical soil properties pertaining to soil fertility and chemistry with scientists at the International Rice Institute in the Philippines.	\$ 954.00
Silva	Additional airfare: Ethiopia and Mauritius			To collect soil samples and study management practices of tropical soils.	375.07
Swindale	Additional airfare: Brussels-London	4-13-73	5-11-73	To provide to government of Tanzania information on development of a land capability system for the Arusha District and to obtain information on tropical soil management for the AID/UH 211(d) Tropical Soils Program	349.05
Fox	Rountrip--Honolulu- Trinidad-Santo Domingo- Honolulu	1-04-73	1-27-73	Attend and present paper before conference on soils of Caribbean and Tropical America	1,365.88
TOTAL					<u>\$3,044.00</u>

REPORT OF
NORTH CAROLINA STATE UNIVERSITY

REPORT OF NORTH CAROLINA STATE UNIVERSITY
FOR THE PERIOD
JULY 1, 1972 TO JUNE 30, 1973

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

B. GRANTEE: North Carolina State University

C. DIRECTOR: Dr. P. A. Sanchez

D. STATISTICAL SUMMARY

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

2. Amount of Grant: \$500,000

3. Expenditures

3.1 For report period: \$53,190

3.2 Accumulated: \$101,540

3.3 Anticipated for next year: \$189,960

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

- (1) A closely coordinated and expanded teaching, research and technical assistance program on soils of the tropics involving additional faculty and graduate students.
- (2) Closer coordination of efforts with other Consortium members, AID-sponsored organizations, international institutes and various national research and development agencies in Latin America.

- (3) The initiation of a graduate level course, "Characteristics and Management of Soils of the Tropics" at North Carolina State University and active participation in the Tropical Soils Institute held at Puerto Rico in July 1972.
- (4) Strengthening field research programs in Brazil, Peru and Central America and technical assistance activities in the region.
- (5) Additional on-site experience by 16 faculty members and 7 graduate students in 13 tropical countries.
- (6) Active involvement in planning the Consortium-sponsored Seminar on "Soils and the Development Process in Tropical America" to be held in Colombia in February 1974 as a step towards establishing a more identifiable network of workers in this field.

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 approved on November 2, 1970 for a five-year period. Its purpose is to increase the capability of the Soil Science Department in becoming a center of expertise for training, research, and technical assistance in soils of the humid tropics. The subject matter emphasis is on soil fertility and management; the initial geographical emphasis is Latin America. Additional financial support in the subject matter area is provided by two other AID-funded activities: The International Soil Fertility Evaluation and Improvement Program, (ISFEIP), Contract AID/1a 646 and a research program entitled "Agronomic-Economic Research on Tropical Soils", Contract AID/csd 2806.

2. Objectives of the Grant

2.1 Objectives restated

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

2.2 Review of objectives: The activities during this report period remain consistent with these objectives. No modification of the original objectives is contemplated.

3. Accomplishments

3.1 Organization and personnel involved: The organizational scheme developed in the previous annual report has proved successful in

keeping the international activities of the Department in sharp focus. The basic approach continues to be direct faculty and graduate student involvement in tropical soils studies in such a way that the increased competence gained is woven throughout the fabric of the Department. At present nineteen professors and seventeen graduate students are involved in various degrees in teaching, research, and services in tropical regions (Table 3.1). Five faculty members and four graduate students are presently stationed in Central and South America and are involved in research or technical assistance activities supported by the two AID contracts.

The campus-based staff presently involved in tropical soils meets monthly to report on current research, field trips and to interchange ideas. An average of 25 people attend these meetings.

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

Faculty

- C. B. McCants, Professor and Department Head.
 P. A. Sanchez, 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, (ISFEIP) 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, ISFEIP, (Guatemala).
 M. G. Cook, Professor and Coordinator, Academic Affairs.
 F. R. Cox, Associate Professor, soil micronutrient research.
 J. W. Gilliam, Associate Professor, analytical services.
 A. H. Hunter, Visiting Associate Professor, ISFEIP, Laboratory development.
 E. J. Kamprath, Professor, soil fertility teaching and research.
 G. S. Miner, Visiting Assistant Professor, ISFEIP, (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, ISFEIP, (Panama).
 J. L. Walker, Visiting Associate Professor, ISFEIP, (Guatemala).
 D. L. Waugh, Visiting Associate Professor, ISFEIP.
 S. B. Weed, Professor, soil chemistry teaching and research.
 A. G. Wollum, Associate Professor, soil microbiology teaching and research.

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

- S. T. Benavides (Colombia), soil genesis (Dr. Buol).
 M. A. Granger (Guyana), soil genesis (Dr. Buol).
 A. S. Lopes (Brazil), soil micronutrients (Dr. Cox).
 F. T. Turner (USA), soil chemistry (Dr. Gilliam).
 D. G. Rossiter (USA), soil genesis (Dr. Buol).

Graduate students in tropical soils supported by other funds

- A. Alvarado (Costa Rica), soil genesis (Dr. Buol).
 E. Gonzalez (Paraguay), soil fertility (Dr. Kamprath).
 I. Lepsch (Brazil), soil genesis (Dr. Buol).
 C. E. Lopez (Dominican Republic) soil fertility (Dr. Sanchez).
 A. Manzano (Bolivia), soil fertility evaluation (Dr. Fitts).
 J. Mendez (Panama), soil fertility (Dr. Kamprath).
 F. Munevar (Colombia), soil microbiology (Dr. Wollum).

C. E. Seubert (USA), soil fertility (Dr. Sanchez).
P. Solorzano (Venezuela), soil fertility (Dr. McCollum).
E. J. Tyler (USA), soil genesis (Dr. Buol).
S. Villagarcia (Peru), soil fertility (Dr. McCollum).
M. K. Wade (USA), soil fertility (Dr. Sanchez).
R. S. Yost (USA), soil fertility (Dr. Kamprath).

3.2 Teaching: A new course entitled "Characteristics and Management of Soils of the Tropics" (SSC 501) was taught during the 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, subsistence cropping, extensive pasture production and plantation crops.

Most of the students who enroll in the course are involved in tropical soils research but some are majoring in other disciplines such as forestry, crop science and agricultural engineering. The student evaluation indicated that such a course was useful to their needs. About half the students were U. S. citizens and half from Latin America, Africa and Asia.

Three faculty members and three graduate students participated in the Tropical Soils Institute held at the University of Puerto Rico on July 10 to August 4, 1972. Dr. S. W. Buol lectured for two weeks on soil classification, Dr. E. J. Kamprath lectured and served as

discussion leader in the soil chemistry and fertility section for three weeks. Dr. P. A. Sanchez organized the soil management section, lectured and served as discussion leader for four weeks. Messrs. C. E. Seubert, E. Gonzalez and R. S. Yost, students from North Carolina State University, took the course for credit in preparation for research assignments in Peru and Brazil. The faculty and graduate students felt that the course was worthwhile experience and appreciate the efforts of the University of Puerto Rico in making it a success.

The Soil Fertility Evaluation Seminar was held for its eighth consecutive year under the sponsorship of ISFEIP. Lectures were given by faculty employed under the 1a 646 and csd 2806 contracts, the 211(d) grant and state and federal appropriations for operation of the University.

3.3 Visiting scientists and seminars: Ing. Carlos Zamora, head of the soil survey of Peru spent two weeks on campus lecturing and consulting with the faculty on matters of mutual interest. Dr. John Freeney, CSIRO, Australia spent three days lecturing and consulting on sulphur aspects of tropical areas. Dr. Carlos Valverde of the Peruvian Ministry of Agriculture also spent three days discussing cooperative soil fertility programs. Dr. E. W. Russell of the University of Reading, England spent several days visiting the Department and giving inspiring lectures on tropical agriculture. All these visits were sponsored by the 211(d) program.

Many other visitors spent a few days consulting and usually gave seminars to the Department or at the tropical soils meeting. During this year the following scientists visited us in relation to tropical soils activities: Dr. Christopher R. Panabokke, Mahaweli Development Board, Sri Lanka; Dr. Thomas H. Wickham, International Rice Research Institute, Philippines; Dr. A. Colin McClung, Centro Internacional de Agricultura Tropical, Colombia; Dr. Richard L. Sawyer, Centro Internacional de la Papa, Peru; Dr. Earl H. Heady, Iowa State University; Dr. Adrian Yñiguez and Ing. Carlos Miaczynski, Universidad de Buenos Aires, Argentina.

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 their program was described in the previous annual reports. Mr. Benavides obtained his doctorate in January 1972 after completing his studies of characteristics of soils of the Colombian Amazon Jungle.

The 211(d) grant has been used to supplement the support of research by faculty and graduate students in order to make their efforts more meaningful to developing areas. For example, Mr. José Mendez-Lay is a graduate student from Panama whose tuition and subsistence is supported by a USAID scholarship. Funds from the 211(d) grant were used to enable him to travel to Panama and obtain soil samples for greenhouse and laboratory studies on lime-phosphorus interactions.

Similar supplemental support has been provided for research projects conducted by graduate students on soils from Costa Rica and Colombia.

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 personally acquainted with personnel and on-going programs at different institutions, and it often provides consultation services to the host countries. A total of 16 professors and 7 graduate students either are stationed in or spent short-term assignments in 13 countries of Latin America, during this year, for a total of 23 man-months away from the campus. Three professors and three graduate students traveled to Puerto Rico under grant support. Eighteen days of faculty travel within the United States to coordinate activities among the Consortium universities was also supported by grant funds.

A summary of travel activities follows:

Dr. S. W. Buol, E. J. Kamprath, P. A. Sanchez, and three graduate students: Christopher Seubert, Enrique Gonzalez, and Russell Yost participated in the Tropical Soils Institute held in Puerto Rico from July 10 to August 5, 1972 as previously described.

Mr. Jose Mendez-Lay, a graduate assistant from Panama, returned to his country to obtain soil samples for his study on lime-phosphorus interactions from June 12 to July 5, 1972.

Dr. P. A. Sanchez attended the annual meeting of the American

Society of Agronomy at Miami, Florida from October 30 to Nov. 3, 1972.

During the year, there was a significant amount of international travel, and almost exclusively in the tropical regions, by members of the faculty and staff in fulfilling the responsibilities of contracts 1a 646 and csd 2806. The details of these trips are recorded in the annual reports for these contracts. Although no 211(d) grant funds were involved the experience gained and contributions made by the individuals are supportive of the general objectives of the 211(d) program.

3.6 Information resources: A significant amount of reference material relevant to tropical soils that was previously not available in Raleigh has been obtained by the department. This includes valuable unpublished materials as well as an increased number of books and periodicals now organized and shelved in a place accessible to staff and graduate students.

3.7 The following articles on tropical soils were written by the Soil Science Department staff during the report period. Those supported by the 211(d) grant are identified.

- Bartholomew, W. V. 1972. Soil nitrogen in the tropics. In Sanchez (ed): "A Review of Soils Research in Tropical Latin America". pp. 93-120. Soil Science Department, North Carolina State University.
- Bartholomew, W. V. 1972. Soil nitrogen: supply processes and crop requirements. Int. Soil Fertility Evaluation and Improvement Program. Tech. Bull. No. 16.
- Benavides, S. T. 1972. Mineralogical and chemical characteristics of some soils of the Amazonia of Colombia. Ph.D. thesis, North Carolina State University. 216 pp. (Supported by 211(d) funds).
- Buol, S. W. 1972. Soil genesis, morphology and classification. In Sanchez (ed): "A Review of Soils Research in Tropical Latin America". pp. 1-51. Soil Science Department, North Carolina State University.
- Buol, S. W., F. D. Hole and R. J. McCracken. 1973. Soil Genesis and Classification. The Iowa State University Press, Ames. 348 pp. (A basic text with ample references from the tropics).
- Cox, F. R. 1972. Potassium. In Sanchez (ed): "A Review of Soils Research in Tropical Latin America". pp. 183-192. Soil Science Department, North Carolina State University.
- Cox, F. R. 1972. Micronutrients. In Sanchez (ed): "A Review of Soils Research in Tropical Latin America". pp. 244-263. Soil Science Department, North Carolina State University.
- Ezeta, F. N. and R. E. McCollum. 1972. Dry matter production, nutrient uptake and removal by Solanum andigena in the Peruvian Andes. Amer. Potato Journal. 49:151-163.
- International Soil Fertility Evaluation and Improvement Program. 1971. The evaluation and improvement of fertility in Latin America. Annual Report. Soil Science Department, North Carolina State University.

- Kamprath, E. J. 1972. Potential detrimental effects from liming highly weathered soils to neutrality. Proc. Soil Crop. Sci. Soc. Florida. 31:200-203.
- Kamprath, E. J. 1972. Soil acidity and liming. In Sanchez (ed): "A Review of Soils Research in Tropical Latin America". pp. 167-172. Soil Science Department, North Carolina State University.
- Kamprath, E. J. 1972. Phosphorus. In Sanchez (ed): "A Review of Soils Research in Tropical Latin America". pp. 205-237. Soil Science Department, North Carolina State University.
- Kamprath, E. J. 1972. Sulfur. In Sanchez (ed): "A Review of Soils Research in Tropical Latin America". pp. 238-243. Soil Science Department, North Carolina State University.
- Kawano, K., P. A. Sanchez, M. A. Nureña and J. Velez. 1972. "Upland Rice in the Peruvian Jungle". pp. 637-643. "Rice Breeding" International Rice Research Institute, Los Baños, Philippines.
- Lepsch, I. F. 1973. Genesis, morphology and classification of soils in an Oxisol-Ultisol toposequence in Sao Paulo State, Brazil. M.S. thesis. North Carolina State University. 89 pp.
- Lutz, J. F. 1972. Soil physical properties. In Sanchez (ed): "A Review of Soils Research in Tropical Latin America". pp. 52-61. Soil Science Department, North Carolina State University.
- McCants, C. B. 1972. Movimiento de nitrógeno en el suelo. Suelos Ecuatoriales. 4(1):29-34. (Partially supported by 211(d) funds).
- Sanchez, P. A. 1972. Nitrogen fertilization and management in tropical rice. North Carolina Agr. Exp. Sta. Tech. Bull. 213. Spanish version in Suelos Ecuatoriales. 4(1):197-240. (Partially supported by 211(d) funds).
- Sanchez, P. A. 1972. Técnicas agronómicas para optimizar el potencial productivo de las nuevas variedades de arroz en la America Latina. Centro Internacional de Agricultura Tropical, Cali, Colombia. (Supported by 211(d) funds).

- Sanchez, P. A. 1972. Soil management under shifting cultivation. In Sanchez (ed): "A Review of Soils Research in Tropical Latin America". pp. 62-92. Soil Science Department, North Carolina State University.
- Sanchez, P. A. 1972. Nitrogen fertilization. In Sanchez (ed): "A Review of Soils Research in Tropical Latin America". Soil Science Department, North Carolina State University.
- Sanchez, P. A. and M. A. Nureña. 1972. Upland rice improvement under shifting cultivation systems in the Amazon Basin of Peru. North Carolina Agr. Exp. Sta. Bull. 210.
- Sanchez, P. A. and N. Larrea L. 1972. Influence of age of seedlings at transplanting on rice performance. Agronomy Journal 64(6):828-833.
- Sanchez, P. A. 1973. Puddling tropical rice soils I: Growth and nutritional aspects. Soil Science 115:149-158.
- Sanchez, P. A. 1973. Puddling tropical rice soils II: Effects of water losses. Soil Science 115:303-308.
- Sanchez, P. A. and A. M. Briones. 1973. Phosphorus availability of some Philippine rice soils as affected by soil and water management practices. Agronomy Journal 65:226-228.
- Soil Science Department. 1972. Agronomic-economic research on Tropical Soils. Annual Report Contract AID/csd 2806. 43 pp.

3.8 Proportion of expenditures: Grant expenditures during this year were approximately distributed as follows: teaching 32%, visiting scientists and seminars 6%, research 43%, on-site studies 12%, services and consultation 5%, 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

or 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 related to the training of graduate students for tropical areas, the North Carolina State University Agricultural Mission to Peru, (Contract AID/1a 510), the International Soil Fertility Evaluation and Improvement Program (Contract AID/1a 646) and the Tropical Soils Research Contract (Contract AID/csd 2806) have appeared in the previous annual report. With the exception of the Peru Contract which terminated on January 31, 1973, all the other activities have continued and in many cases expanded.

An estimation of the degree of the total involvement of the

Department in tropical soil science is the actual time spent overseas by Soil Science Department faculty and graduate students (Table 3.2). This table shows that the Department devoted approximately 10.3 man-years overseas in assignments related to tropical soil science. Of these, 8.4 man-years were contributed by the faculty and graduate students stationed in several countries, some of which also devoted considerable time to assistance in neighboring countries.

The campus-based staff spent a cumulative total of 1.9 man-years in 55 short-term visits to 14 countries by 16 professors and 7 graduate students. Most of these short visits provide support for on-going technical assistance and research projects in various Latin American countries. A small proportion of them served to establish and continue relations with local soil scientists and AID Missions as well as continuing contacts with former graduate students now occupying key positions in Latin America.

The absence of visits outside of Latin America emphasizes our commitment to this region but does not imply lack of interest towards other regions. During the months immediately preceding this report period, several faculty members travelled to Africa, Europe and Asia. The successive visits to specific countries imply gathering more in-depth knowledge and deeper involvement in the development process of those countries.

Some of this year's highlights in direct involvement overseas

Table 3.2. Actual overseas involvement by North Carolina State University, Soil Science Department Staff from July 1, 1972 to June 30, 1973 (Includes personnel on contracts 1a 646 and csd 2806.)

Country	Campus-based Staff		Overseas staff	Total.
	Trips	Man-days	Man-days	Man-months
Brazil	8	189	810	33.3
Peru	6	62	870	31.0
Costa Rica	9	63	540	20.1
Guatemala	4	83	275	12.0
Panama	4	14	245	8.6
Ecuador	4	42	120	5.4
Puerto Rico	6	160	0	5.3
Nicaragua	2	6	90	3.2
El Salvador	3	9	60	2.3
Honduras	1	2	30	1.1
Guyana	2	29	0	1.0
Colombia	4	23	0	0.8
Paraguay	1	3	0	0.1
Venezuela	1	3	0	0.1
Total trips	55			
Total Man-months		1.9	8.4	10.3

are summarized below:

- 1) Establishment of new soil testing laboratories in Ecuador and on-site training courses in Ecuador and Guyana. (Contract Ia 646).
- 2) Teaching the Tropical Soils Institute at Puerto Rico to 30 participants from 11 developing countries. (211(d) grant).
- 3) Initiation of on-site field research progress in Yurimaguas, Peru; Brasilia, Brazil; Turrialba, Palmar Sur, Liberia in Costa Rica; and in five sites in northern El Salvador. (Contract csd 2806).
- 4) Assisting USAID/Panama in evaluating the technical adequacy of soils and land use classification in relation to a proposed sector loan. (211(d) grant).
- 5) Assisting the Ford Foundation and CIAT in evaluating the needs for increasing upland rice research in Brazil. (Foundation support).
- 6) Organizing a seminar on "Soil Management and the Development Process in Tropical America" to be held at CIAT, Colombia in February 1974 sponsored by the Consortium, AID, CIAT, the Colombian and Latin American Societies of Soil Science. The purpose of this seminar is to gather the leading Latin American and U. S. soil scientists to discuss recent relevant advances in tropical soils research as a means for developing a "research network" among tropical soil scientists in this hemisphere. A Steering Committee was formed by Dr. J. M. Spain, (CIAT); F. Fernandez, (CIAT); R. Pietri, (Puerto Rico); L. A. León, (ICA); T. S. Gill, (AID); and P. A. Sanchez, Chairman. The Steering

Committee timetable is proceeding on time. (211(d) grant).

7) Close cooperation with Cornell University in a joint research project at Brasilia. Cornell and North Carolina State University each are providing two scientists who work together as a team. (Contract csd 2806).

8) Assisting the Tennessee Valley Authority in the operation of their new AID contract for testing new fertilizers in tropical crops. (TVA support).

9) Assisting the Research and University Relations Office of USAID Washington in developing strategies towards improving the transfer of information to developing countries. (211(d) grant).

10) Translation into Spanish of the "Review of Soils Research in Tropical Latin America" with the assistance of the Instituto Interamericano de Ciencias Agricolas in Turrialba, in order for this information to be more accessible to Latin American soil scientists. (Contract csd 2806).

11) Distribution of the Department's publication to a list of over 350 soil scientists throughout the world. (Contract csd 2806).

6. Other Resources for Grant-Related Activities:

The Soil Science Department conducts extensive programs in four broad categories: (1) teaching, (2) research, (3) extension, (4) international. Involved in these programs are 47 professional soil scientists (38 Ph.D., 7 M.S., 2 B.S. degree) and a supporting staff

of 27 technicians and 13 secretaries, for a total full-time personnel input of 87. In addition, there are 37 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. The approximate annual cost for operation, other salaries and fringe benefits, is \$750,000; 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 shows that approximately 40 percent of the faculty in the department (19 of 47) are involved in international programs that are directly related to the purpose of the 211(d) grant. Of the total cost of operating the department (approximately \$1.95 million dollars), approximately \$600,000 (see Table 9.1), or 30 percent, is directed to activities related to the 211(d) grant; whereas the financial support from the grant is less than 3 percent of the total. These facts clearly illustrate that the University, through its Soil Science Department, has a solid base of expertise in soil science, is providing major support to sustain the base, and is involving a high percentage of the faculty in the department in 211(d)-related activities. Funds provided by the 211(d) grant have been and will continue to be used

to deepen, rather than broaden, the base with emphasis on increasing the expertise of faculty interested and engaged in teaching, research or extension programs related to tropical soils.

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.

Three faculty members will participate in the Tropical Soils Mineralogy workshop to be held in Hawaii from July 8-22, 1973 under the auspices of the Consortium.

The main 211(d) effort for next year will involve the planning and execution of the Seminar to be held at CIAT in Colombia. North Carolina State University has been given the responsibility for providing the coordinating leadership.

Dr. Goro Uehara of the University of Hawaii will be a Visiting Professor on campus from January to August 1974 while on sabbatical leave. Several short term visitors are expected to be supported by 211(d) funds.

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

On-site visits will continue to countries where related research and technical assistance is conducted. Requests for consultation

services from various countries have been received and plans are being 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 3.3).

9.2 Expenditures report, actual and projected (see Table 3.4).

9.3 Budget: Summary

9.4 Budget: Detail

Table 3.3. Distribution of 211(d) grant fund expenditures and contributions from other sources of funding (July 1, 1972 through June 30, 1973).

Object	Previous Expenditures	Period Under Review	Cumulative Total	Projected Next Year	Projected to End of Grant	Non 211(d) Sources ^{a/}
Research	\$26,485	\$23,480	\$49,965	\$100,000	\$200,000	\$300,000
Teaching	7,240	17,575	24,815	50,000	100,000	100,000
Libraries	462	544	1,006	6,000	13,000	2,000
Consultation	450	3,000	3,450	5,000	10,000	3,000
Publication	0	500	500	3,000	6,000	5,000
Travel	9,603	5,091	14,694	15,000	33,000	75,000
Other	4,110	3,000	7,110	10,960	36,460	115,000
Total	\$48,350	\$53,190	\$101,540	\$189,960	\$398,460	\$600,000

^{a/} These are reasonable estimates of the total financial inputs from non-211(d) sources which have resulted in accomplishments that are supportive of the objective of the 211(d) grant. These sources are: North Carolina State University, North Carolina Agricultural Experiment Station, Contract AID/csd 2806, Contract AID/1a 646, USAID/Costa Rica, USAID/Panama, USAID/Bolivia, ICA, Rockefeller Foundation, and the Brazilian Government.

Table 3.4. Expenditure report, actual and projected.

Object	Actual Expenditures		Projected Expenditures		
	Period Under Review	Cumulative Total	4	5	Total
Salaries and Wages					
Eligible for fringe benefits	15,980	30,479	50,000	50,000	130,479
Visiting professors	3,000	3,450	30,000	40,000	73,450
Graduate assistants	15,793	29,968	50,000	50,000	129,968
Subprofessional assistants	2,785	5,907	9,000	9,000	23,907
Fringe Benefits	2,132	4,062	8,000	10,000	22,062
Travel					
Domestic	1,400	3,294	5,000	5,000	13,294
International	3,691	11,400	15,000	18,000	44,400
Communications	725	939	1,000	1,500	3,439
Contractual	1,756	3,586	4,000	5,000	12,586
Supplies	2,370	3,398	5,960	6,000	15,358
Equipment	3,014	4,051	6,000	7,000	17,051
Library Acquisitions	544	1,006	6,000	7,000	14,006
Total All Objects	\$53,190	\$101,540	\$189,960	\$208,500	\$500,000

9.3 Budget: Summary

	<u>Total Expenditures</u>
Salaries and Wages	
Eligible for fringe benefits	\$ 15,980
Visiting professors	3,000
Graduate assistants	15,793
Sub-professional assistants	<u>2,785</u>
Total	37,558
Fringe Benefits	2,132
Travel	
Domestic	1,400
International	<u>3,691</u>
Total	5,091
Communications	725
Contractual	1,756
Supplies	2,370
Equipment	3,014
Library Acquisitions	<u>544</u>
Total all objects	53,190

9.4 Budget: Detail

9.4.1 Salaries and wages

<u>Name and Position</u>	<u>% of Time on Project</u>
A. S. Lopes, Graduate Assistant	100
M. A. Granger, Graduate Assistant	100
F. T. Turner, Graduate Assistant	100
S. T. Benavides, Graduate Assistant	100
D. G. Rossiter, Research Assistant	100
M. H. Moore, Secretary	50
P. A. Sanchez, Assistant Professor	50
C. B. McCants, Head	10

9.4.2 Travel

Jose Mendez-Lay, June 12, 1972 - July 3, 1972, to Panama to obtain soil samples for characterization of acidity properties of soils of that area.

P. A. Sanchez, July 8 - August 6, 1972, Mayaguez, Puerto Rico to teach in Tropical Soils Institute.

E. J. Kamprath, July 15 - August 15, 1972, Mayaguez, Puerto Rico to teach in Tropical Soils Institute.

S. W. Buol, July 23 - August 4, 1972, Mayaguez, Puerto Rico to teach in Tropical Soils Institute.

P. A. Sanchez, October 4-5, 1972, Prairie View, Texas to teach in Tropical Soils Workshop.

P. A. Sanchez, October 29 - November 2, 1972, Miami, Florida to participate in Annual meetings of the American Society of Agronomy.

P. A. Sanchez, November 26-28, 1972, Washington, D.C. to attend annual review of University Consortium on Soils of the Tropics.

C. B. McCants, November 26-28, 1972, Washington, D.C. to attend annual review of University Consortium on Soils of the Tropics.

C. B. McCants, January 3-6, 1973, San Francisco, California to attend meeting of CUSUSWASH.

P. A. Sanchez, April 11-13, 1973, Prairie View, Texas to attend executive committee meeting of University Consortium on Soils of the Tropics.

9.4.3 Equipment costing more \$100

Desk (2)	\$519.56
Ectographic Visual maker	272.31
Collator	317.36
Projector	255.85
Gas Chromatograph (total cost \$ 9590)	1590.85
	<hr/>
Total	\$2955.93
Total equipment expenditures	\$3014.79

REPORT OF
PRAIRIE VIEW A & M COLLEGE

REPORT OF PRAIRIE VIEW A&M COLLEGE

FOR THE PERIOD

JULY 1, 1972 TO JUNE 30, 1973

A. TITLE: A Grant to Strengthen the Capabilities of Prairie View A&M College in Relation to Soil Fertility Problems Under Savanna-Prairie 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: \$ 130,315.72

3.2 Accumulated: \$ 224,647.76

3.3 Anticipated for next year: \$ 136,000

E. NARRATIVE SUMMARY

1. Since the inception of the grant to Prairie View A&M College, the first phase, described in the Annual Reports of 1971 and 1971-72 has been perpetuated and enlarged towards achieving the ultimate objective of the grant of increasing the competency of faculty and students in the acquisition and utilization of substantive knowledge of tropical soils, especially within the savanna-prairie ecosystem, for the purposes of human development.

The Master of Science program has been enlarged to include 5 new courses and 10 students, of which 5 came from foreign institutions. This year, 3 students have completed the requirements for the M.S. degree in Soils and have graduated.

The expansion of the Resource Center is continuing with special emphasis on the collection of materials relevant to savanna ecosystems.

Since the last report, the number of faculty who have incorporated an open system of instruction (competency-based-systems) have increased. Supplemental to this system, additional classroom space, audio-visual equipment, and programmed teaching aids have been acquired.

Having structured a foundation staff, facilities, graduate program, resource materials, and updated teaching systems, this year phase 2 (the phase delineation is an arbitrary one) begins to evolve and stresses the services of consortium personnel, consultant-lectures, and visiting professors from diverse geographical regions and disciplines to supplement and increase our knowledge of tropical soils. In addition, the graduate research program and teaching thrust has been expanded to include agricultural problems relevant to the countries from which the students originate as well as those regions predominately in the savanna zones. On-site visits to savanna sites and institutions concerned with agricultural development have been conducted and more are being planned.

A computer-based program for information storage and retrieval has been developed at Prairie View which will permit greater flexibility in the analysis of stored information than conventional library files systems. This is particularly relevant for the compilation of data from savanna ecosystems.

The work in phase 3 (not yet initiated) will be aimed to build on the structures encompassed in phases 1 and 2, but the future efforts will utilize the accumulated knowledge and expertise to (1) delineate the most

relevant research commitments and (2) evaluate the most promising systems that would alleviate the pressing constraints to agricultural production, preserve the tropical ecosystems, and improve the livelihood for the farmer of limited resources in developing countries, a segment of the rural population that is of particular concern to Prairie View A&M College.

2. Information Retrieval and Storage

This year, information concerning savanna ecosystems came from consultants who have had extensive experience in both Anglophone and Frankophone countries. Also acquired were special publications, documents, and abstracts from diverse sources dealing with this ecosystem. Our staff attended conferences, workshops, symposiums and seminars concerning different phases of agricultural development. These presentations were taped for the Soils Resource Center and the Data Bank and handout materials cataloged and filed for future storage in the APL computer file system. This system, a programmed language plus file sub-system was installed which adds two fundamental capabilities to information acquisition. They are (1) the entry, retention, and access, under programmed control, of more data than could be stored by conventional library files and (2) the sharing and selective modification of the data base by any group of users.

3. Institutional Linkage

Linkage with indigenous institutions in several developing countries has strongly enhanced our own efforts to gain competency in our discipline. The linkage was especially strong where established through our graduate students and where our research and teaching commitments were oriented to their needs and aspiration, particularly for those students from foreign countries.

4. Soil Science Meetings

A workshop and soil symposium were developed by our staff. The former Soils of the Tropics was based at Prairie View, and the latter Simposium Sobre Suelos od Sabana en el Tropico, in cooperation with the University of Puerto Rico, was based in Santo Domingo, Dominican Republic and presented in Spanish. Both efforts substantially increased our knowledge of tropical soils through the participation of scientists from diverse locales. Probably the greatest advantage came from the linkage established between our staff and the visiting scientists. Relationships such as these have already borne fruit through the establishment of linkage between several institutions.

5. Commission on Savanna

Through the symposiums referred to above, the creation of a Commission on Soils of the Savannas had been proposed and initial contacts made to convene a charter core of scientists interested in fostering this commission.

6. Student Programs

We are committed to graduate studies in soils at Prairie View, because our competency in soils of the tropics can be strengthened through a strong teaching and research program, at the same time leaving a legacy for the perpetuation of this knowledge through students. About one-half of our graduate enrollment are American while the remainder are nationals from tropical countries.

7. Teaching and Research

Progress has been made in the competency-based instructional systems through improvements in the module format and accompanying materials in agronomic subjects. Additional lecture and laboratory space was acquired for teaching as well as new audio-visual materials. Several soil courses originally proposed in 1972 were approved and presented during this report year. As before, our research commitment is to solve problems that directly affect the quality of rural life of the small farmer. This research involves testing simple innovations under systems of intensive cropping. Most farming enterprises in the tropics are carried out within small acreages under intensive cultural systems and with limited resources.

8. Future Plans

Plans for the following year include a Soils Workshop, expanded to include more disciplines and their relationships to soils and agricultural growth. A lecture series for the proposed Tropical Soils Institute to be held at IRRI in the Philippines is being planned. Several proposals for a University Consortium network between member institutions, LDC institutions, and supporting agencies have been formulated.

Of paramount importance we hope to isolate seminal constraints to the development of savanna lands from on-site assessments made during several tours of African and South American savannas. This information would enable us to design relevant research which would attenuate these conditions or constraints that hamper human development in these areas.

F. DETAILED REPORT

1. General Background and Purpose of the Grant: A major concern of the Foreign Assistance Act of 1961 (Amended 1966) is to help overcome the confinements to human development brought about by agricultural systems that cannot cope with increasing populations and rising aspirations for a better life. To help accomplish this end, an Institutional Grant Program was established under Section 211(d) of the act which, in part, provided funds to enhance the competency of agricultural scientists in tropical soils encompassing research, teaching, and services. Experience has shown however, that competency in soil science is not enough to master the complexities of agricultural development. That to intelligently assess the seminal problems which hinder development or to design research projects relevant to the solution of these problems, a sensitivity to the social, political, and economic mores of the people is required as well. The primary objective given to Prairie View A&M College under the Grant Program implicitly infers this overall aspect of development stating "...assist in the development of food and fiber production in the humid tropics where specific attention will also be given to typical soil fertility problems under ecological conditions associated with the development of Savanna-Prairie vegetation." It becomes therefore, our major effort within the purposes of the grant to ultimately offer technical assistance directly to the rural poor in a manner that is acceptable to him and within the limits of his ecological system and resources.

2. Objectives of the Grant

Objectives restated: To achieve the purposes of the grant stipulated above, certain conditions of objectives must be fulfilled. The grant specifically delineates these as follows:

- 2.1 Provide senior faculty as complementary staff to present soil science staffing and to provide additional staff strength as required.
- 2.2 Provide visiting professorship and consultants through which Prairie View can bring to its campus additional expertise and experience in tropical soils science program and curriculum, in coordination with other participating Grant Institutions.
- 2.3 Provide student assistantships for research on tropical soils.
- 2.4 Modify and upgrade existing soils courses and develop new courses in tropical Soil Science which will strengthen the capability of personnel preparing to be engaged in tropical soil and crop management activities.
- 2.5 Strengthen library and other informational services and provide support for the preparation of training and teaching materials for a basic comprehensive soils program which can be related to tropical soil science.

3. Review of Objectives: This year, as before each objective is considered important, however, to meet the purposes encompassed in the grant; objectives 2.3 and 2.4 have received the greatest effort by the staff. Coupled with this effort has been an intensive program to visit tropical ecosystems. Only in this way can the agricultural scientists become familiar with the interrelated and complex problems of human development associated with a particular area.

4. Accomplishments

4.1 Information acquisition

Substantial amounts of information concerning tropical soils were gained from the seminars and discussions with the consultants listed in Table 1.

Table 1. Contribution by consultants and area of expertise in Tropical Agriculture to Prairie View A&M College during period of this report.

<u>Name</u>	<u>Institutions</u>	<u>Subject</u>
Dr. Khālid Ashraf	Cornell	Agricultural Economics
Dr. Humphrey C. Ezumah	Hawaii	Root Crops
Mr. D. Levandowsky	AID/Texas A&M (Ret.)	Savanna Ecology
Dr. Jose F. Alfaro	Utah	Water Management
Dr. Idlefonso Pla	Venezuela	Soil Management
Dr. H. O. Kunkel	Texas A&M	Agriculture in World Affairs
Dr. W. P. Kuvlesky	Texas A&M	Research Needs for Rural Poor
Dr. J. A. Morris	Alcorn A&M	Research Needs for Rural Poor
Dr. L. Mugwira	Alabama A&M	Research Needs for Rural Poor
Dr. J. Gray	Teexas A&M	Youth in Agric Development
Dr. Elemer Bornemisza	Costa Rica	Soil Fertility

Dr. H. C. Ezumah and an assistant searched agricultural and ecological journals back to the year 1926, for information concerning savanna ecosystems.

Papers were copied and filed into the Soil Resource Center at Prairie View A&M College.

Textbooks and journals have been continuously acquired during the year to increase the collections in the Soils Resource Center. Rich sources of information were made available from the following:

- (a) Catalog of F.A.O. Publications 1945-68 Rome
- (b) "UNESCO" 1937 - UNI Pub., New York
- (c) United Nations Office of Public Information, Specialized Agencies, New York, N. Y.

Guidelines were prepared to assist staff in the acquisition of important information during on-site scientific visits. (See Appendix).

4.2 APL Plus File System

The APL (A Programmed Language) Computer terminal was acquired through the Texas Agricultural Experiment Station and placed in the Resource Center at the disposal of staff also working under the 211(d) grant. This year the initial project for data processing concerned the entry, retention, and access of the biodata of scientists working in savanna areas world-wide. The variables for each component (scientist) consist of: name, year, positions, institution, address, education, discipline, speciality crop, geographical areas of work, languages, service, duration of service, and date available.

A computer program for information storage has been designed and given the name (ADDNAMES). The raw data is obtained from the questionnaires sent from Prairie View by a research assistant to scientists at

agricultural institutes and agencies world-wide. The questionnaire generally follows the format suggested by North Carolina State University during the last executive meeting of the Consortium.

The unique feature of this computer file system permits retrieval of any combinations of data. For this purpose a program is presently being designed to retrieve the information by any classification desired. The name of this program is (SEARCH).

4.3 Institutional Linkage

Although the term "linkage" is not clearly defined, we shall consider this term to imply a relevant interchange with institutions concerned with agricultural resource development and encompassing student and staff exchanges and cooperative research efforts. This year we have established the following linkages primarily through our graduate student program. This includes private companies as well.

- (a) International Institute of Tropical Agriculture (IITA) Ibadan, Nigeria
- (b) Complejo Industrial Pedernales, SA. Dominican Republic (Agricultural Chemicals).
- (c) Central Agricultural Station, Mon Repos, E. Coast Guyana, South America
- (d) Njala University College, University of Sierra Leone, West Africa

Hopefully, as the staff increases its number of visits to savanna areas of the world, additional linkage will be established with indigenous institutions. At the time of this report several tours had been planned including Frankophone and Anglophone countries of sub-Saharan Africa and N. E. South America.

Tentative plans for a linkage network were formulated and presented to the Consortium Executive Committee during their last meeting held at Prairie View A&M College.

Through the Consortium linkage, we were able to place Mr. Cesar Lopez, M.S. student in Soils at Prairie View in the doctoral program at North Carolina State University. From the University of Hawaii, we obtained the professional service of Dr. Humphrey C. Ezumah, agricultural scientist specializing in tropical root crops for the period encompassed in this report.

As a result of the Symposium on Soils given in the Dominican Republic, Dr. Alfaro (See Section E-4) hosted our visit to Utah State University where methods of information storage and retrieval through Fortran programming systems were discussed.

A comprehensive library file containing lists of publications relevant to special topics in water and soil management were obtained from Utah State University and incorporated into the collection of Prairie View's Resource Center.

A very important effort to create institutional and personal linkages as well as increase the awareness of the staff to problems of agricultural production under diverse ecosystems was on-site visits to research institutions, and conferences. The following indicate the visits made by our staff:

<u>Name</u>	<u>To</u>	<u>Purpose</u>
James I. Kirkwood	Ft. Collins, Colorado	To participate in a meeting representing the AID Consortium at the Council of U.S. University for Soil and Water Development in Arid and sub-Humid areas.
Johnnie B. Collins	Muscle Shoals, Alabama	To participate in a Forage Fertilization Symposium-TVA. In order to enhance expertise and give depth to the Plant and Soil Science Program at Prairie View.
Johnnie B. Collins	Miami, Florida	To participate in the Annual Meeting of the American Agronomy Society and give leadership to Prairie View A&M College Agricultural students.
Eugene A. Brams	Austin, Texas	To attend shortcourses sponsored by the National Science Foundation.
Johnnie B. Collins	Batesville, Ark.	To serve as coach for the Prairie View Soil Judging Team in the Region IV soil judging contest at the University of Arkansas.
Eugene A. Brams	Miami, Florida	To participate in the Annual Meeting of the American Agronomy Society.
Johnnie B. Collins	College Sta., Texas	To participate and moderate sessions of Texas Soil Survey Technical Work-Planning Conference.
James I. Kirkwood	Logan, Utah	To consult with the Director of the On-Farm Water Project, a retrieval system, on matters relative to utilization of this system at Prairie View A&M College using APL for data on Savanna soils.

<u>Name</u>	<u>To</u>	<u>Purpose</u>
Robert H. Dixon	College Sta., Texas	To consult with Dr. Warren Anderson on zinc-soil analysis.
Eugene A. Brams James I. Kirkwood Johnnie B. Collins Yung Ping Chang Humphrey C. Ezumah	Dallas, Texas	To participate in seminars at five Dallas high schools, discussing the Tropical Soils Program at Prairie View A&M College
Johnnie B. Collins	Temple, Texas	To confer with principals and counselors concerning development of interest of students in International Programs in Soils at Prairie View A&M College.
Eugene A. Brams	Houston, Texas	To attend and participate in the 76th Annual Academy of Science Meeting.
Eugene A. Brams	Mayaguez, P. R.	To present a series of lectures for the Institute of Tropical Soils at the University of Puerto Rico.
Robert H. Dixon	Mayaguez, P. R.	To participate in Tropical Soils Shortcourse.
Ronald Harvey	Mayaguez, P. R.	To participate in Tropical Soils Shortcourse.
Yung Ping Chang	Mayaguez, P. R.	To participate in Tropical Soils shortcourse.
James I. Kirkwood	Santo Domingo, D. R.	To coordinate and participate in the Tropical Soils Symposium with the University of Puerto Rico.
Yung Ping Chang	Santo Domingo, D. R.	To participate in the Symposium of Soils of the Savanna in the Tropics sponsored by Prairie View A&M College.

<u>Name</u>	<u>To</u>	<u>Purpose</u>
James I. Kirkwood	Mayaguez, P. R.	To participate in the Tropical Soils Workshop sponsored by the University Consortium for Tropical Soils.
Eugene A. Brams	Mexico City, Mexico Turrialba, Costa Rica CIMMYT, Mexico	To participate in the American Association for the Advancement of Science National meeting on Tropical Ecosystems and visit research institutions in Central America.

4.4 Soil Workshop and Symposium

The Soils Workshop was held at Prairie View A&M, October 2-6, 1972, with the University Consortium on Soils of the Tropics cooperating. In addition to the staff at Prairie View A&M, participants included:

Dr. M. Drosdoff Cornell University	Cultural Systems on Tropical Soils
Dr. G. Uehara & Dr. P. Ekern University of Hawaii	Utilization of Soils in Hawaii and Southeast Asia
Dr. P. Sanchez N. Carolina State University	Physical & Chemical Properties of Tropical Soils as Related to Plant Nutrition
Dr. R. Pietri University of Puerto Rico	Utilization of Soil in the Caribbean Area
Dr. Murray Milford Texas A&M University	Education and Training of Agronomists to meet the needs in tropical regions
Dr. John Malcolm USAID/Washington, D. C.	Education and Training of Agronomists to meet the needs in tropical regions

Several members of governmental agencies also presented discussions, specifically in the area of soil mapping and land-use classification. The Proceedings of this workshop were published at Prairie View A&M, School of Agriculture as Bulletin No. 2, Soils of the Tropics.

5. A symposium on soils of the savanna was developed in cooperation with the University of Puerto Rico and coordinated through the efforts of Dr. James I. Kirkwood (Prairie View) and Dr. R. Pietri (University of Puerto Rico.) The Symposium was held in Santo Domingo, Dominican Republic and given in Spanish. Participants included:

Dr. F. Beinroth	Pedology	University of Puerto Rico
Dr. Ildefonso Pla	Soil Mgt.	Institute de Edafologia Venezuela
Dr. R. Pietri	Moderator	Univ. of Puerto Rico
Dr. Jose Alfaro	Water Mgt.	Utah State University
Dr. A. Van Wambeke	Pedology	Ghent State University Ghent, Belgium
Dr. Robert Fox	Soil Fert.	University of Hawaii
Ing. Agron C. Scherer	Soil Fert.	Estacion Experimental de Arroz, Brazil
Mr. Robert Cheaney	Soil Fert.	CIAT, Cali, Colombia
Dr. G. Samuels	Moderator	Univ. of Puerto Rico
Dr. F. H. Redman	Soil Fert.	Consejo Estatal del Azucar, Dominican Republic
Dr. E. Bornemisza	Soil Fert.	IICA, Lima, Peru

Publication of the Proceedings is scheduled for Fall, 1973.

At the termination of the Symposium on Soils of the Savanna (see above) a committee was established to coordinate the creation of a Commission for Soil Studies of Savanna Areas of the World. The committee was chosen from members of the symposium and given the responsibility to contact scientists working in the savannas. The geographical areas were allocated as follows:

Africa	Dr. F. Beinroth and Dr. E. A. Brams
Central America and Caribbean	Dr. R. Pietri and Dr. J. B. Collins
South America	Dr. I. Pla and Mr. Y. P. Chang
Asia and Oceania	Dr. J. I. Kirkwood
Australia	Dr. J. Alfaro and Dr. H. C. Humphrey

6. Graduate and Undergraduate Programs

The strong commitment of our staff to education follows from our mandate as an institution of higher learning and our dedication to education as teachers. However, through teaching others we ourselves become more competent in our disciplines. At Prairie View, we orient our teaching and research to the needs of the student, his background and his commitment to human development in his own country or to countries requesting technical assistance. The table below shows the student enrolled (1972-73) in Plant and Soils, their respective projects, man-month and funding. Students funded directly from the 211(d) grant are identified with an asterisk.

Name	Country	Activity Monthly	Funds AID	Research Activity
*Robert Dixon	U.S.A.	60 hrs.	\$300	Zinc Movement in Prairie Soils
*Hilary Maduakor	Nigeria	60 hrs.	\$300	Cadmium and Mercury Pollution of soils & produce: extent, effect and control.

Name	Country	Activity Monthly	Funds AID	Research Activity
*Charles Kargo	Sierra Leone	60 hrs.	\$300	Production of Onion under Tropical and sub-Tropical Environments.
*Henry Normil	Haiti	60 hrs.	\$300	Grass-Tropical Legume Pastures
*Lu Etuk	Nigeria	60 hrs.	\$300	Reforestration of Land Under Shifting Culture
*Louis Andre	Haiti	60 hrs.	\$300	Soil Sodium and Maize Growth
*Albert Agard	Guyana	60 hrs.	\$300	Competency-Based Teaching Methods in Agronomy
*Ronald Harvey	U.S.A.	60 hrs.	\$300	Characterisitcs of Several Soils of Prairie View Experiment Station
*Luis Tejada	Dominican Rep.	60 hrs.	\$300	Response of Tomato to Rock Phosphate and Superphosphate in South Texas Soils
Kelvin Kindle	U.S.A.	60 hrs.		Marketing Systems for Small Farmers
Robert Banks	U.S.A.	60 hrs.		Protein Content of Tropical and Subtropical Forages as Influenced by Fertilize Practices

7. Education and Research:

Our educational philosophy, in part, recognized that the aspirations and needs of the student are paramount. The courses were designed and taught to make the information relevant to their needs. This is particularly important when teaching the foreign national students.

Our instructional methods are oriented to problem-solving and "brainstorming" techniques. We place great importance on field or on-site study in an attempt to improve cognitive learning by experiences in field and laboratory. Most of our courses are designed within performance-based (competency) systems.

New and improved graduate courses were presented during the academic year of this report. They are listed:

*603. Soil Mineralogy in Relation to Soil Formation. (Agro 603 Soil Mineralogy) (3-0) Credit 3. I. A study of weathering processes and products in relation to soil formation and effect of mineralogical composition on soil properties and profile characteristics.
PREREQUISITE: 9 hours of soil and 3 hours of physics or consent of instructor.

*703. Soil Fertility Problems of Savanna-Prairie Ecology. (Agro 703 Savanna-Prairie Ecology). (3-0) Credit 3. II. A consideration of management practices of Savanna-Prairie soils in relation to yields of pasture and row crops and on soil properties. Particular attention will be given to the effect of lime and rotational systems on efficiency of fertilizers under varying rainfall and temperature situations.

753. Soil Genesis, Morphology and Classification. (Agro 753 Soil Gen. and Class.) Credit 3. I. The principles dealing with the reasons why soils differ, how soils differ and how soils are related to one another and to the landscape in which they occur.

802. Special Problems. (Agro 802 Problems) (2-0) Credit 2. I. II. Students will select topics from agricultural sciences to develop investigative papers based on library, field, and/or laboratory sources.

733. Grain and Fiber Crop Production. (Plt. Sci. 733 Crop Production) (3-0) Credit 3. I. Study of grain and fiber ecology, utilization, physiology, morphology, cultural practices, and production.

A conference at Florida International University Miami, Florida was attended to develop methods of module preparation and evaluation.

As a result of the Consortium one of our graduate students was accepted into the doctoral program at North Carolina State University where he will continue his studies in soils and conduct research in crop and soil management in the international soils program.

Staff members attended two NSF Chautaugua-type short courses for college teachers (1) Water Pollution and, (2) Population, and several seminars on methods of preparing competency-based instructional modules.

Five graduate and undergraduate students and 4 staff members attended the American Society of Agronomy Convention at Miami Beach Florida where the staff presented two papers. For the first time, the Prairie View Agronomy Club participated in the Soil Judging Contest sponsored by ASA.

The Prairie View graduate students presented a seminar-panel to the staff and students at Texas A&M University, College of Agriculture in which the problems of agricultural development of their respective countries were discussed.

The research effort at Prairie View is centered around our graduate program. Projects undertaken by the staff always involve the graduate students. The projects are mission-oriented and in the area of applied science (See Section 5).

Publications and presentations of our research efforts during the period of this report are as follows:

1. J. I. Kirkwood, E. Brams, and Y. P. Chang. The People Left Behind: A World-Wide Concern. - ASA Meeting.
2. J. B. Collins and E. P. Whiteside. Characteristics of Spodosols Developed on a Sandy Topo-Biosequence in Michigan - ASA Meeting.

3. J. B. Collins, J. C. Polanco, and J. I. Kirkwood. Soil of the Savanna Guabatico-Dominican Republic. Departmental Technical Report No. 72-3.
4. E. Brams. Effect of Lime on pH, Acid Extractable P, and Al in Hockley Soils of the Texas Gulf Coast Prairie. Departmental Technical Report No. 72-2.
5. E. Brams. Agricultural Research - A Reply. Science, June 15, 1973 Vol. 180, No. 4090.
6. E. Brams. Residual Soil P Under Sustained Cropping in the Humid Tropics. Soil Sci. Soc. Proc., July-August, 1973.
7. E. Brams, B. Chopra. Effect of Growth Regulators on Uptake of Nutritive Ions and Yield of Soybean in Texas Gulf Coast Prairie. Texas Academy of Science. (In Press).
8. J. I. Kirkwood and E. C. Lopez. TAES Report. Growth Patterns of Fusarium SP under Different Concentrations of Two Urea Derivative Herbicides.
9. E. Brams. Plant and Soil 1973 (In Press). Soil Organic Matter and Phosphorus Relationships Under Tropical Forests.

Those publications directly resulting from grant activities are Nos. 1, 3, 5, 6, 8, and 9. The manner in which the publications relate to the objectives of the grant are implicit in the titles. Briefly, No. 1 was written to show that the soil scientist should transcend his narrow discipline and concern himself with all aspects of an ecosystems, particularly aiming his technology to aid the grassroot people in context of their limited resources. Number 3 attempts to present important soil parameters of savanna soils which limit crop production in the Dominican Republic. Knowing this, the soil scientist can plan relevant research to alleviate the constraints not only in this country but those of similar environment.

The publication No. 5 attempts to clear the air to the scientific community concerning the nature of agricultural science and its responsibility to the needs of people. The paper implicated elucidate the objectives of the 211(d) grant. The remaining articles, Nos. 6, 8, and 9 are technical papers which present soil information which can be used to develop and increase agricultural production in the tropics.

The acquisition of senior staff made possible through the grant has enhanced the teaching quality and commitments to the students of Prairie View A&M College. New courses have been added to the calendar and made available to other departments. This has resulted in a diffusion of new ideas, campus-wide, particularly in the realm of social and technological change as such changes affect the life of people everywhere.

The 211(d) grant has provided the research thrust that has increased the awareness of the staff and students to the complexity of the problems affecting the life of people living in rural poverty. For this reason, the staff has been increasingly involved as supporting personnel in projects concerned with rural development (See Section 6).

Travel to foreign institutions and countries as well as consultations with visiting scientists from diverse places have greatly expanded the sensitivity of the students and staff to the problems that beset people of different cultures. This has enriched the learning milieu and has in some measure invoked a change from the more pedantic education usually offered students to a creative, problem solving atmosphere.

The viability of the 211(d) program has strengthened our recruitment efforts and has increased the number of young people enrolled in the School of Agriculture and related fields.

7.1 Utilization of Institutional Resources in Development

The work dealing with maize as a second crop for Sierra Leone, W. Africa which is part of our 211(d) efforts has been expanded in that country. Several foreign graduate students involved in this work have visited Prairie View to discuss implementation of the project to fit different sites and conditions.

As previously stated, foreign students have been attracted to Prairie View as a direct result of personal linkages developed during staff conferences in Africa and workshops in the Caribbean areas. These students are now engaged in research relevant to problems in their country and their correspondence with colleagues has already disseminated information acquired here to help development in their country.

Our library acquisitions, particularly those dealing with agricultural development of savanna have been loaned to countries requesting specific information regarding these ecosystems. Countries such as Suriname, South America and Costa Rica, Central America have made requests for materials which have been sent.

Senior staff have been asked to participate in a Cropping Systems Symposium sponsored by the Instituto Interamericano de Ciencias Agrícolas de la O.E.A. Turrialba, Costa Rica and in Ibadan, Nigeria.

7.2 Other Resources for Grant-Related Activities

In lieu of the fact that there is presently an acute shortage of classroom space, campus-wide, the administration at Prairie View has made available for the use of the students and staff of the School of Agriculture, an additional classroom in the Animal Industries Building. This

area has subsequently been modified into a laboratory-teaching unit for both undergraduate and graduate students in Plant and Soil Science.

The grant funded to Prairie View under the CSRS-USDA have aspects which can contribute to the objectives and purposes of the 211(d) grant. Information gathered from the results of these projects will substantially increase our knowledge of tropical ecosystems.

This year, research and development have been aided by the completion of three greenhouses. Several projects have already been started which include, (a) collection of tropical root crops and legumes, (b) salinity effects on maize.

8. Next Year's Plan of Work

The major efforts next year will be directed to the following: (a) Expansion of the data bank to permit storage of technical information concerning savanna ecosystems. A retrieval computer program is presently being designed to correlate the various parameters associated with the savanna. Analysis of these parameters might elucidate the major constraints to agricultural production in these areas, (b) Identification of seminal constraints to human development (by human development is meant, in part, increased agricultural production within the contexts of the mores of the people) and the relevant research to alleviate those constraints. (c) In addition, the following efforts will be continued in response to the responsibilities already undertaken during previous periods of the grant:

Develop graduate and undergraduate curricula in Soil Science, adding courses and/or strengthening present courses to emphasize soil fertility problems of tropical soils and savanna ecosystems.

Recruit additional staff and draw upon consultant and other advisory services. Recruit and select graduate and undergraduate students.

Acquire training and teaching materials such as visual and audio aids to complement course offerings in the soils program.

Acquire library holdings such as journals of disciplines related to soil science, films, microfilms, and slides. Films, filmstrips, and slides will be made where suitable ones cannot be acquired.

Develop a viable research project on soils of savanna to complement our present Institutional Grant.

Expand our present laboratory facilities and equipment.

Collaborate with other participating institutions for sharing of competencies and resources.

(d) Liaison with sub-Saharan African and South American countries through institutional scientists have been proposed and visits are being planned. (e) Plans have been formulated for another Tropical Soils Workshop to be held at Prairie View A&M. The format would be expanded to include Animal Science, Sociology, and Home Economics in an effort to relate soils and these disciplines in development schemes for tropical countries as well as South Texas. (f) A series of special lectures are being prepared for the Tropical Soils Institute to be held at IRRI in the Philippines. These lectures are designed to expand the themes of the Institute and include the broad topics of:

(a) Technology and Human Welfare

(b) Population Growth and Agricultural Development

(c) Responsibility of the Change Agent to the Rural Poor

(d) Competency-based Teaching of Agronomy

(g) Prairie View is cooperating with AID in developing a paradigm for a research network that would encompass the Consortium Universities, LDC's institutions, and governmental agencies world-wide. Sample models for the network were presented at the executive meeting of 211(d) held this year at Prairie View A&M College. (h) An expanded Seminar Program will include broad topics which concern relevant issues of agriculture in world affairs.

Several papers are scheduled for presentation during the American Society of Agronomy Meetings in November, 1973. These include:

1. The Development of a Generative Competency-based Instructional System in Agronomic Education. E. Brams, J. Shores, and P. Brams.
2. The Soils of the Savanna Quabatico-Dominican Republic. J. B. Collins.
3. The Adsorption and Strength of Bonding of Zinc in Texas Soils. A. S. Mangaroo, R. Dixon.
4. Tropical Savanna - A Potential Frontier for Increasing Food, Fiber. J. I. Kirkwood and Y. P. Chang.
5. The Movement of Pichloram and 2, 4, 5-T in Soils of the Texas Coastal Plains Under Simulated Rainfall Conditions. A. S. Mangaroo.
6. The Characteristics of Several Soils Developed on the Sandy Interior of the Texas Coast Prairie. R. D. Harvey and J. B. Collins.

9. Report of Expenditures

9.1 Distribution of 211(d) grant fund expenditures and contributions from other sources of funding (See Table 8.1).

9.2 Expenditure report, actual and projected (See Table 8.2).

9.3 Budget: Summary

Salaries and Wages

	Eligible for fringe benefits	\$ 60,352.00
	Visiting Professors	2,576.00
	Graduate Assistants	25,812.85
	Sub-professional assistants	10,275.57
	Total	99,016.42
Fringe Benefits		3,275.49
	Domestic	6,212.49
	International	5,236.60
	Total	11,448.94
Communications		3,353.06
Contractual		00
Supplies		9,939.87
Equipment		2,315.50
Library Acquisitions		966.44
	Total, all objects	130,315.72

Table 9.1. Distribution of 211(d) grant fund expenditures and contributions from other sources of funding (review period July 1, 1972 to June 30, 1973).

Object	211(d) Source				Non 211(d) Source
	Period Under Review	Cumulative Total	Projected Next Year	Projected to End of Grant	
Research	51,127.85	73,631.27	43,000	25,000	
Teaching	63,627.49	123,393.26	70,000	75,000	32,000
Libraries	966.44	6,726.54	3,000	1,500	1,800
Consultation	2,576.00	2,576.00	3,000	1,000	
Publication	569.00	1,844.00	1,000	2,000	
Travel	11,448.94	16,476.69	16,000	18,000	
Total	130,315.72	224,647.76	136,000	136,000	33,800

Table 9.2. Expenditure report, actual and projected (review period July 1, 1972 to June 30, 1973).

Object	Actual Expenditures		Projected Expenditures	
	Period Under	Cummulative	Year	
	Review	Total	4	5
Salaries	69,639.01	123,454.45	75,000	82,000
Student Asst.	32,652.90	47,930.99	40,000	32,500
Supplies and Materials	15,608.43	30,059.09	2,000	2,000
Library	966.44	6,726.54	3,000	1,500
Travel	11,448.94	16,476.69	16,000	18,000
Total	130,315.72	224,647.76	136,000	136,000

Table 9.3. Travel

(1) Domestic

<u>Name</u>	<u>To</u>	<u>Cost</u>	<u>Purpose</u>
James I. Kirkwood	Ft. Collins, Colorado	\$ 261.61	To participate in a meeting representing the AID Consortium at the Council of U.S. Universities for Soil and Water Development in Arid and Sub-humid Areas.
Johnnie B. Collins	Muscle Shoals, Alabama	323.95	To participate in Forage Fertilization Symposium-TVA. To enhance expertise and give depth to the Plant and Soil Science Program at Prairie View.
Yung Ping Chang	San Antonio, Texas	53.30	To attend a meeting on Vegetable Research as it related to savanna prairie ecology.
Yung Ping Chang	Houston, Texas	11.75	To participate in a greenhouse short course in support of special collections of tropical food crops.
Yung Ping Chang	College Station, Texas	5.50	To attend a research meeting at Texas A&M University.
Eugene A. Brams	Houston, Texas	59.27	To transport Drs. Matt Drosdoff, Goro Uehara, Pedro Sanchez from Houston International Airport to participate in Tropical Soils Workshop at Priarie View A&M College.
Johnnie B. Collins	Miami, Florida	431.21	To participate in the Annual Meeting of the American Agronomy Society and give leadership to Prairie View A&M College Agriculture students attending the meeting.

(1) Domestic (cont'd.)

<u>Name</u>	<u>To</u>	<u>Cost</u>	<u>Purpose</u>
Yung Ping Chang	Miami, Florida	\$ 645.83	To attend the Annual meeting of the American Agronomy Society and give paper.
Eugene A. Brams	Austin, Texas	59.98	To attend short course sponsored by the National Science Foundation in support of Soils Program
Humphrey C. Ezumah	College Station, Texas	26.30	To discuss aspects of a Cooperative Soils Research project with Texas A&M University Soils group and to consult with Dr. McWilliams on plant materials for tropical collection.
James I. Kirkwood	Logan, Utah	338.38	To consult with the Director of the On-Farm Water Project, a retrieval system, relative to utilization of this system at Prairie View A&M College using the APL for data on savanna soils.
Robert H. Dixon	College Station, Texas	13.09	To consult and work with Dr. Warren Anderson on thesis research.
James I. Kirkwood	Dallas, Texas	140.07	To participate in seminars at five Dallas high schools, discussing the Tropical Soils Program at Prairie View A&M College.
Garfield Hicks	Dallas, Texas	100.94	To participate in seminars at five Dallas high schools discussing Tropical Soils Program at Prairie View A&M College.
Ronald D. Harvey	Gainesville, Florida	290.20	To participate in the Microbiology of Crop Roots shortcourse in support of Soils Program.

(1) Domestic (cont'd.)

<u>Name</u>	<u>To</u>	<u>Cost</u>	<u>Purpose</u>
Johnnie B. Collins	Temple, Texas	\$ 52.32	To confer with principals and counselors concerning development interest of students in International Programs in Soils at Prairie View A&M College.
Johnnie B. Collins Humphrey C. Ezumah Eugene Brams Y. P. Chang	Dallas, Texas	172.93	To participate in seminars at five Dallas high schools, discussing the Tropical Soils Program at Prairie View A&M College.
James I. Kirkwood	Washington, D. C.	304.20	To participate in the Executive Committee Meeting of the Tropical Soil Consortium.
James I. Kirkwood	Miami, Florida Santo Domingo Port-au-Prince	700.31	To participate in Annual ASA Meeting and give paper. Meet with seminar officials in Santo Domingo and Port-au-Prince.
Johnnie B. Collins	Batesville, Arkansas	232.80	To serve as coach for the Prairie View Soil Judging Team in the Region IV soil judging contest at the University of Arkansas.
Eugene A. Brams	Miami, Florida	589.16	To participate in the Annual meeting of the American Society of Agronomy and give leadership to several students attending the meeting.
Robert H. Dixon	Miami, Florida	296.00	To participate in the Annual meeting of the American Society of Agronomy.
Eugene A. Brams	Austin, Texas	47.80	To participate in shortcourse at the University of Texas and apply expertise gained to soils program at Prairie View A&M College.

(1) Domestic (cont'd.)

<u>Name</u>	<u>To</u>	<u>Cost</u>	<u>Purpose</u>
Oliver E. Smith	Athens, Texas	\$ 20.00	To confer with principals, Vocational Agriculture teachers and counselors on the performance of former agricultural students and give seminar on soils program.
Oliver E. Smith	Houston, Texas	12.15	To secure information on equipment and supplies for soils program.
Johnnie B. Collins	College Station, Texas	26.18	To participate and moderate sessions of Texas Soil Survey Technical Work-Planning Conference.
Yung Ping Chang	College Station, Texas	13.09	To confer with Dr. McWilliams regarding greenhouse operations at Prairie View.
Luis Tejeda	Houston, Texas	12.15	To attend and participate in the 76th Annual meeting of the Academy of Science and present a paper on research developed under the Soils Program.
Oliver E. Smith	San Antonio, Texas	119.30	To attend the Tropical Soil Emphasis Program.
Eugene A. Brams	Houston, Texas	301.29	To attend and participate in the 76th Annual Academy of Science meeting and present a paper.
Robert H. Dixon	College Station, Texas	26.18	To work with Texas A&M Soil staff on thesis research.
Cesar E. Lopez	Honolulu, Hawaii	197.31	To participate in a soil training program at the University of Hawaii.
Humphrey Ezumah	College Station, Texas	59.67	To collect research information on savanna ecosystem.

(1) Domestic (cont'd.)

<u>Name</u>	<u>To</u>	<u>Cost</u>	<u>Purpose</u>
J. I. Kirkwood	Washington, D. C.	\$ 257.49	To attend conference with AID officials.
Ronald Harvey	Houston, Texas	10.64	Travel to Houston International Airport to transport Dr. Pietrie to Prairie View A&M College for participation in Symposium.

(2) International

<u>Name</u>	<u>To</u>	<u>Cost</u>	<u>Purpose</u>
Eugene A. Brams	Mayaguez, Puerto Rico	\$ 465.78	To present a series of lectures for the Institute of Tropical Soil at the University of Puerto Rico.
Robert H. Dixon	Mayaguez, Puerto Rico	234.00	To participate in Tropical Soils shortcourse at the University of Puerto Rico.
Ronald D. Harvey	Mayaguez, Puerto Rico	234.00	To participate in Tropical Soils shortcourse at the University of Puerto Rico.
Yung Ping Chang	Mayaguez, Puerto Rico	468.00	To participate in Tropical Soils Workshop at the University of Puerto Rico.
James I. Kirkwood	Santo Domingo, D. R.	972.98	To coordinate and participate in the Tropical Soils Symposium with the University of Puerto Rico.
Yung Ping Chang	Santo Domingo, D. R.	732.82	To participate in the Symposium of Savanna Soils in the Tropics sponsored by Prairie View A&M College.
Normil Henry	Houston, Texas	151.00	From Port-au-Prince to Houston, Texas to enter Tropical Soils Program at Prairie View A&M College.
Charles Kargbo	Houston, Texas	714.60	From Sierra Leone, West Africa to Houston, Texas to enter Tropical Soils Program at Prairie View A&M College.
James I. Kirkwood	Mayaguez, Puerto Rico	452.20	To participate in the Tropical Soils Workshop sponsored by the University Consortium for Tropical Soils.

(2) International (cont'd.)

<u>Name</u>	<u>To</u>	<u>Cost</u>	<u>Purpose</u>
Louis Alix Andre	Houston, Texas	\$ 211.90	From Port-au-Prince to Houston, Texas to enter Tropical Soils Program at Prairie View A&M College.
Hillary Maduakor	Prairie View, Texas	608.32	From Lagos, Nigeria to Prairie View A&M College to enter Tropical Soils Program at the College.
	Domestic Travel	\$ 6212.34	
	International Travel	<u>5236.60</u>	
	Total	\$11448.94	

Table 9.4. Equipment items costing over \$ 50 each

<u>Item</u>	<u>Cost</u>	<u>Vendor</u>
Typewriter IBM Selectric II	\$ 530.01	International Business Machines
Desk; steno chair; side chair; letter trays, lamps, costumer, storage cabinets, drawer file	1,208.26	Mayer Officer Furniture Company
Electric Multi Outlet Strip Electrical Outlet Spectrum Flexaframe End to End Connector	89.40	Curtain Scientific Co.
Bookcase	50.00	Newcomb Furniture Inc.
Transformer for A/C Unit	58.91	21-250 Whse. Operation
Storage Cabinet; Axson file with lock	378.92	Texas Office Supply Co.
	<hr/>	
Total	\$2,315.50	

REPORT OF
UNIVERSITY OF PUERTO RICO

REPORT OF UNIVERSITY OF PUERTO RICO

For the Period

July 1, 1972 to June 30, 1973

A. TITLE: A Grant to Strengthen the Capabilities of the University of Puerto Rico in Special Problems of Tropical Soils.

B. GRANTEE: University of Puerto Rico

C. DIRECTOR: Professor 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 year: \$ 126,392.96

3.2 Accumulated: \$ 203,876.76

3.3 Anticipated for next year: \$ 108,677.33

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 three graduate assistants 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 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

I. 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>
1. Cornell University	Tropical Soils Cultural Systems
2. North Carolina State University	Soil Fertility Relating Plant Nutrition to the Physical and Chemical Properties of Tropical Soils.
3. Prairie View A&M College	Soil Fertility Problems under Savanna-Prairie Ecology
4. 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 specialities 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 mean 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 America oriented in culture and language.

II. Objectives of the Grant

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. 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 protection and conservation 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 protected 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 and conservation of tropical soils and are, in addition, compelling ends in themselves consistent with the service to AID which is 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.

III. Accomplishments

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, and has been elected chairman for F/Y 1972-1973. 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

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 designated to familiarize the student with the latest instruments and their use in soil and plant analysis and was offered for the first time in the spring semester of the 1972-1973 academic year.

A significant new feature in the advanced undergraduate instruction has been the new approach given to the course "Special Problems in Soils" since the academic year 1971-1972. With the appointment of Miss Miro, this course has been geared toward exposing advanced undergraduate students to simple research problems. Five students during the fall semester and three during the spring term were involved in this type of academic activity. The topics were the following.

- 1) A comparative study of the extraction methods used in geochemistry.
- 2) A comparison of instrumental methods for fertilizer analysis.
- 3) Cation exchange capacity as affected by different parameters.
- 4) The distribution of macronutrients around the rhizosphere of *Dioscorea* sp.
- 5) Phosphorus adsorption curves of some Oxisols under different agronomic field practices.

Since July 1, 1971, Dr. Fred H. Beinroth has been in 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.

During F/Y 1972-1973, Dr. Beinroth offered the courses on "Genesis Morphology and Classification of Soils" and "Soils of Puerto Rico." He coordinated the section on Soil Genesis and Geomorphology together with Dr. M. G. Cline, Cornell University for the Tropical Soils Institute and was in charge of the preparation and guidance of the field trips.

Dr. Hector Lugo Mercado who was working toward his Ph.D. at North Carolina State University was re-incorporated to our staff on a full-time basis. He revised and offered a new course on "Mineral Nutrition of Plants."

A Tropical Soils Institute was organized for the summer of F/Y 1972-1973, July 1972. The Institute offered intensive instruction in the application of current knowledge of soil science and related disciplines to problems of crop production in the tropics. It was 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.

A faculty recruited from the five institutions were guest lecturers:

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

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

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

Dr. S. W. Buol
Department of Soil Science
North Carolina State University
Box 5907
Raleigh, North Carolina 27607

Dr. R. 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 Abruña
 Department of Agronomy
 Agricultural Experiment Station
 P. O. Box H
 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. 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

Sr. Jose Vicente
 Department of Agronomy
 Agricultural Experiment Station
 P. O. Box H
 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 were 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 met 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 offered the opportunity to the participants to visit all the ecological areas on the island.

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

Twenty-six attended.

During F/Y 1972-1973, two distinguished soil scientists visited the Mayaguez campus: Dr. A. Van Wambeke, University of Ghent, Belgium and Dr. H. W. Fassbender, University of Gottingen, Germany.

While visiting Professor at the College of Agriculture, Dr. Van Wambeke concentrated his activities mainly on the following topics:

- Four seminars on various aspects of tropical Soils of South America (at the College of Agriculture)
- One seminar on management of Oxisols of South America (at the Agricultural Experiment Station, Rio Piedras)
- Correspondence of selected soils of Puerto Rico with those of South America
- Review of the proposal on soil classification submitted to AID
- Review of papers presented during the pedology session of the seminar on Savanna Soils

- Correlation of the French Soil Classification System with the USDA and FAO schemes
- Compilation of lists of soil scientists that
 - a) are useful contacts in South America
 - b) work on savanna soils in Africa
 - c) could serve as consultants to AID

While at Mayaguez, Dr. Fassbender offered seven lectures as part of the Agronomy Seminar. The following topics were covered:

- 1) Physio-chemical evaluation of the soil phosphorus
- 2) Chemical nature of phosphorus fixation
- 3) Cationic equilibria in tropical soils
- 4) Liming effects on the exchange complex in tropical soils
- 5) Liming factors in nitrogen fixation in the tropics
- 6) Manganese equilibria in soils of Central America
- 7) Translocation of nutritive elements in tropical soils

In addition, Dr. Fassbender was available for consultation by students, staff members, and researchers from the Agricultural Experiment Station.

Preliminary arrangements have been made for several distinguished soil scientists to be on the Mayaguez Campus during the coming year.

Additional 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 have for the 1972-1973 academic year, local graduate students in soil science for the first time. In addition the number of graduate students increased from one to three and we expect to have six for F/Y 1973-1974.

The University of Puerto Rico participated on a Soils Workshop held at Prairie View, Texas on October 2-6, 1972 with all consortium members cooperating. Professor R. Pietri presented a paper "Changing Patterns in Land Use." The Proceedings were published at Prairie View as Bulletin No. 2 soils of the Tropics.

A Symposium of Soils of the Savanna was developed by Prairie View A&M and the University of Puerto Rico and coordinated through the efforts of Dr. James I. Kirkwood (Prairie View) and Professor R. Pietri (University of Puerto Rico). The Symposium was held in Santo Domingo, Dominican Republic and given in Spanish. Participants included:

Dr. F. H. Beinroth	Pedology	Univ. of Puerto Rico
Dr. Ildefonso Pla	Soil Management	Instituto de Edafologia Venezuela, Venezuela
Professor R. Pietri	Moderator	Univ. of Puerto Rico
Dr. José Alfaro	Water Management	Utah State Univeristy
Dr. A. Van Wambeke	Pedology	Visiting Scientist Univ. of Puerto Rico
Dr. Robert Fox	Soil Fertility	Univ. of Hawaii

Ing. Agron C. Scherer	Soil Fertility	Estación Experimental de Arroz, Brazil
Mr. Robert Cheaney	Soil Fertility	CIAT, Cali, Colombia
Dr. G. Samuels	Moderator	Univ. of Puerto Rico
Dr. F. H. Redman	Soil Fertility	Consejo Estatal del Asucar, Dominican Republic
Dr. E. Bornemisza	Soil Fertility	IICA, Lima, Peru

Publication of the proceedings is scheduled for Fall, 1973.

At the termination of the Symposium on Soils of the Savanna (see above) a committee was established to coordinate the creation of a Commission for Soil Studies of Savanna Areas of the World. The committee was chosen from members of the symposium and given the responsibility to contact scientists working in savannas from diverse geographical areas. The geographical areas were allocated as follows:

Africa	Dr. F. Beinroth and Dr. E. A. Brams
Central America and Caribbean	Dr. R. Pietri and Dr. J. B. Collins
South America	Dr. I. Pla and Mr. Y. P. Chang
Asia and Oceania	Dr. J. I. Kirkwood
Australia	Dr. J. Alfaro and Dr. H. C. Humphrey

New books and publications as well as teaching aids have been continuously acquired during the year to increase the collections in the Agronomy Department.

Research. During F/Y 1972-1973 research of three graduate students was totally or partially funded under the 211(d) grant.

1. Mr. Ricardo Barahona is a native of El Salvador, Central America. The objective of his research is to evaluate the utilization of the nutrient elements by the yam (*Dioscorea* sp.). This problem is part of the research on root crops in an effort to evaluate the full potential of this neglected food crop. Mr. Barahona holds a Graduate Assistantship funded by 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.
3. Mr. Jose E. Ramirez is a native of the Dominican Republic. The objective of his research is to study the effect of the most common agronomic practices on the properties on an Oxisol (Coto clay).

Although the University of Puerto Rico does not have a research contract, staff members are actively engaged in research funded by 211(d).

Research projects on the nutritional level requirements of tropical food crops were continued during F/Y 1972-1973. Two groups of plants were used: (1) edible legumes which included field beans and cow peas; and (2) root crops which includes yams (*Dioscorea* sp.) taniens (*Xanthosoma* sp.) and cassava (*Manihot* sp.). The objective is twofold: (a) to determine the response of varieties or cultivars of these crops to maximum fertilizer

applications and/or (b) to determine the lack of response of any varieties or cultivars, thus providing a crop which could be grown under primitive farming systems without the need of complex technological inputs. This work is being done in the two principal tropical soil orders Oxisols and Ultisols.

Pigeon peas, field beans, and cow peas trials for F/Y 1971-1972 have already been harvested and the data is being analyzed. Full reports are expected to be published during the coming year after residual effects have been studied. The yams, taro, and cassava trials were harvested during the months of October and November, 1972. Complete data and full reports will be available for next year after residual effects and plant chemical composition have been studied.

A field trial of the nutritional requirements of field beans and corn was completed during F/Y 1971-1972 on a plot simulating severe sheet erosion. The top-soil 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 June, 1972. A new planting was made for F/Y 1972-1973 to evaluate residual effects of the applied nutrient elements.

A research project on the characterization of the clay fraction from tropical soils by differential dissolution, X-ray, and DTA was started during F/Y 1972-1973. The objective is to evaluate the suitability of differential dissolution techniques in the determination of non-crystalline

clay components from tropical soils and to search for modifications that might improve the efficiency of separating the amorphous from the crystalline clay particles. A research project to evaluate the effect of soil compaction on the development of underground storage plant organs was initiated during F/Y 1972-1973. The objective is to determine the resistance of tropical root crops (*Dioscorea* sp., *Xanthosoma* sp.) to soil compaction.

As a result of the activities since the beginning of the grant, the following publications have been prepared:

1. The Natural Environment of Puerto Rico. University of Puerto Rico, CAAM, 30 pp. (mimeo), July, 1972.
2. Field Guide to the Soils of Puerto Rico. University of Puerto Rico, CAAM, 120 pp. (mimeo), July, 1972.
3. Classification of the Soils of Hawaii in Different Classification Systems. Manuscript prepared, 20 pp.
4. Soil-Geomorphic Relations on Kauai, Hawaii. Co-authored by G. Uehara and H. Ikawa. Submitted for publications to Soil Sci. Amer. Proc., 15 pp.
5. General Pedology of Tropical Savanna. Submitted for publication in Transactions of Seminar on Soils Tropical Savannas, 15 pp.
6. Pedologic, Mineralogic, and Chemical Properties of Highly Weathered Soils of Puerto Rico. Part I: Morphology, Formation, and Classification. Manuscript completed, 127 pp., 1 figure, 8 tables.
7. Changing Patterns in Land Use. Submitted for publication in Proceedings of Soil Workshop, Prairie View A&M, 42 pp.

IV. 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 promoted 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 1971-1972 academic year saw our second student coming in. For the 1972-1973 academic year we have our first local graduate student and for 1973-1974, we expect to have a total of six.

V. 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.

1. AID/ROCAP-83 Contract

This contract calls for the graduate training in Puerto Rico of personnel from Central American Universities. Twelve participants were in Puerto Rico during the 1971-1972 academic year from four different areas: Costa Rica, Nicaragua, Guatemala, and Honduras.

Another phase of the contract calls for our sending visiting professors to these same areas. During the 1972-1973 academic year, the following staff members were on this assignment:

José R. Mondoñedo - Universidad de San Carlos, Guatemala

Alberto Febre - Universidad de San Carlos, Guatemala

Francisco Jordán - Universidad de Nicaragua

Jesús Vélez - Universidad de Honduras

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 1971-1972 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.

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 1972-1973 academic year the Mayaguez Campus had a total of 590 undergraduate and 71 graduate foreign students, with the following distribution: Argentina - 5; Aruba - 1; Bolivia - 2; Colombia - 52; Costa Rica - 3; Cuba - 175; Curacao - 1; Ecuador - 6; Spain - 18; Guatemala - 5; Guyana - 2; Haiti - 32; Honduras - 3; British Honduras - 1; India - 3; England - 1; British Virgin Islands - 1; Italy - 1, Jordan - 2; Mexico - 3; Nicaragua - 9; Panama - 14; Paraguay - 1; Peru - 11; Dominican Republic - 186; Salvador - 3, Turkey - 1; Uruguay - 1; Venezuela - 16.

During the month of January, a group of students from the International Agriculture Program of Cornell University visited the island. During January 11 through January 17, they visited the Mayaguez area and were taken care of by staff members. In particular Professor Beinroth accompanied the group on their field trips.

VI. 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 provide:

1. Administrative costs including salaries and utilities in all administrative offices and facilities. The basic salary of the project leader, Professor Rafael Pietri, \$ 14,400.00 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.
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 6-acre plot at the Isabela substation. 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 in Table 1.
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 1.

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 1 as university support to grant supported activities.
5. The sub-professional personnel of the Department who are under university state funding are considered also an integral part of the grant program and take part in related activities. Their salaries are also shown in Table 1.

VII. Next Year's Plan of Work

Teaching: The University of Puerto Rico will continue cooperation on joint projects during 1973-1974. Two faculty members will be participating in the Tropical Soils Mineralogy workshop to be held in Hawaii from July 8-22, 1973. One of our staff members will be presenting a paper at the Seminar to be held at CIAT in Colombia as a joint consortium effort. Our staff members will be available for participation at the Tropical Soils Institute to be held during the summer of 1974 at the Philippines as a joint consortium effort.

In addition the following effort will be continued:

- (1) New courses on the subject of tropical soils will be added, and existing courses will be modified.
- (2) Training and teaching materials will be acquired to complement course offerings.
- (3) Physical layouts and facilities will be added or modified.
- (4) More graduate students will be recruited.
- (5) New laboratory facilities and equipment will be developed to support teaching and research activities of the program.

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 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-----	\$ 8,000.00
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Travel:

Domestic-----	\$ 4,000.00
International-----	5,000.00

Departmental Support:

Equipment-----	\$10,000.00
Library and teaching aids-----	6,000.00
Supplies, Materials & Services-----	4,000.00

Research

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 Ultisols Humatas clay. The residual effect of the fertilizer application on the Coto clay trials will be evaluated, as well as on the Humatas clay.

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)-----\$10,942.00

Supplies, Materials & Services-----\$ 3,000.00

To further involve local advanced undergraduate students in the program, the establishment of undergraduate assistantships is being continued. 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:

Stipends:

Wages Undergraduate Assistants-----\$ 8,932.00

VIII, Report of Expenditures

Review Period, July 1, 1972 to June 30, 1973

A. Summary

1. Salaries

1.1 Professional and Technical-----\$38,279.96

1.2 Graduate Assistants----- 11,175.00

1.3 Clerical----- 7,260.00

2. Stipends

2.1 Wages (field labor, irregular)-----\$11,643.54

2.2 Undergraduate Assistants----- 7,424.46

2.3 Employer contribution to fringe benefits--- 6,805.78

3. Travel	
3.1 Domestic	
3.11 In Puerto Rico-----	\$ 639.80
3.12 Outside Puerto Rico-----	2,843.61
3.2 International-----	4,610.30
4. Supplies, Materials and Services-----	13,459.27
5. Department Support	
5.1 Equipment-----	16,704.85
5.2 Library and teaching aids acquisitions-----	4,592.99
	Grand Total-----
	-\$126,392.96

B. Details

1. Item 1 of summary: Salaries

Friedrich H. Beinroth	Associate Professor	100%	\$14,500.00
Rafael Pietri Oms	Professor and Project Leader		
		100%	2,400.00
Milagros Miro	Associate Researcher & Assistant		
	Professor	100%	11,079.00
Ricardo Barahona	Research Assistant	100%	8,500.00
Victor Snyder	Graduate Assistant	100%	2,750.00
Jose E. Ramirez	Graduate Assistant	100%	2,625.00
Luz M. Velez	Typist	100%	3,960.00
Olga Carrero	Typist	100%	3,300.00

2. Item 2 of summary: Stipends

Secretarial irregular	100%	3,000.00
Field labor Laborers	irregular	8,643.54
Undergraduate students		7,424.46
Fringe Benefits (all employees)		6,805.78

3. Item 3.12 of summary: Travel Outside of Puerto Rico

3.1 Domesitc

3.121. R. Pietri, R. Abrams, F. H. Beinroth

To: Miami

Cost: \$ 1,015.35

Purpose: To attend the Soil Science Society of America Meeting.

3.122 Rafael Pietri Cost: \$ 358.36

To: Texas

Purpose: To attend the Executive Committee Meeting at Prairie View A&M College.

3.123 Rafael Pietri Cost: \$ 273.00

To: Washington

Purpose: To attend the annual review of the 211(d) grant, and to attend the meeting of the Council of Deans and the Executive Committee.

3.124 Friedrich H. Beinroth Cost: \$ 785.40

To: Hawaii

Purpose: To work on the preparation of manuscript of publications resulting from joint research.

3.125 Rafael Pietri Cost: \$ 411.50

To: Texas

Purpose: To attend the Soil Workshop at Prairie View A&M.

4. Item 3.2 of summary: Travel, International

3.21 Friedrich H. Beinroth Cost: \$ 274.00

To: Dominican Republic

Purpose: Objective: To correlate some soils of the Dominican Republic with soils of Puerto Rico, and to prepare field trip of Cornell students.

3.22 Rafael Pietri
Raul Abrams Cost: \$ 1,453.30

To: Trinidad

Purpose: To attend seminar at University of the West Indies.

3.23 Rafael Pietri
Friedrich H. Beinroth Cost: \$ 1,090.65

To: Venezuela

Purpose: To attend meeting of the Latin American Congress of Soil Science and visit the Llanos Orientales of Venezuela.

3.24 Rafael Pietri
Raul Abrams Cost: \$ 1,010.35

To: Colombia

Purpose: To visit CIAT to organize an international symposium sponsored by consortium.

3.25 Rafael Pietri
Fred H. Beinroth Cost: \$ 782.00
Victor Snyder

To: Dominican Republic

Purpose: To attend and present papers at the Seminar on Tropical Savanna Soils.

5. Item 4 of summary: Supplies, Materials and Services

Here 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 your request.

6. Item 5.1 of summary: Equipment

5.11 Digital Read-out Accessory \$ 2,000.00

The accessory was added to the existing atomic absorption apparatus to increase the efficiency of the machine.

5.12 Air Conditioning Units \$ 1,538.52

Units were installed in different rooms to protect valuable electronic and optical equipment and to supplement the dehumidifiers.

5.13 Olivetti Microcomputer \$ 5,725.00

This piece of equipment is used for calculations of parameters involved in curve fitting for fertilizer response and statistical analysis. Used in all advance courses.

5.14 Water Still \$ 495.00

5.15 pH Meter \$ 415.00

5.16	Equipoise Shaker	\$ 605.00
5.17	Dry Bath Block	\$ 197.75
5.18	GBC Electric Perforator	\$ 1,295.00
5.19	GBC Electric Ring Binder	\$ 695.00
5.20	D. T. A. equipment, portable	\$ 802.50
5.21	Flat file	\$ 209.00

This equipment was needed to cope with the needs of the new program. These items are above the normal expenditures of the department and were needed to provide facilities for the work developed as a result of the new phases of the project.

7. Item 6 of summary: Library & Teaching Aids Equipment

6.1	Duplicating Machine	\$ 340.00
6.2	35 mm. Camera with accessories	\$ 982.50

The above equipment is essential for preparation of training materials and aids for teaching and resource development. These items help to increase the capabilities as called for in the grant proposal.

Table 1. Distribution of 211(d) Grant Funds and Contributions from other sources of Funding
Review Period July 1, 1972 to June 30, 1973.

	211(d) Funding				Non 211(d) Funding Amount July 1, 1972 to June 30, 1973
	Period Under Review	Cumulative Total	Projected Next Year	Project End of Grant	
Salaries:					
Professional & Technical	\$38,279.96	\$68,523.29	\$31,443.33	\$155,734.47	\$70,843.30
Graduate Assis- tants	11,175.00	13,700.00	9,000.00	42,625.00	-----
Clerical	7,260.00	8,826.13	8,360.00	27,926.13	4,554.00
Stipends:					
Wages	11,643.54	21,029.54	10,942.00	64,328.00	10,626.00
Undergraduate Assistants	7,424.46	7,424.46	18,932.00	54,000.00	(1)
Fringe Benefits	7,759.18	9,036.12	8,000.00	8,000.00	-----
Travel:					
Domestic	3,483.41	7,150.71	4,000.00	24,667.30	4,622.94
International	4,610.30	12,850.36	5,000.00	20,240.06	-----
Supplies, Materials and Services	13,459.27	20,233.11	7,000.00	22,773.84	8,800.78
Departmental Support:					
Equipment	16,704.85	24,279.84	10,000.00	57,574.99	5,585.53
Library and teach- ing aids acqui- sitions	4,592.99	10,723.20	6,000.00	30,130.21	(2)
Total	\$126,392.96	203,876.76	108,677.33	500,000.00	

(1) Fringe benefits are paid by the central administration from a central fund based on total payroll.

(2) Library appropriations are made at a campus level.

Table 2. Expenditure Report (actual and projected) under institutional Grant AID/csd 2857
 Review period July 1, 1972 to June 30, 1973.

Line Items	Expenditures to Date Period Under		Projected Expenditures Year			Total
	Review	Cumulative	3	4	5	
Salaries	\$ 56,714.96	\$ 91,149.42	\$ 47,136.18	\$ 46,000.00	\$ 42,000.00	\$226,285.60
Stipends	26,827.18	37,500.12	28,000.00	28,000.00	24,828.88	118,328.00
Travel	8,093.71	20,001.07	8,500.00	8,500.00	7,906.29	44,907.36
Supplies, Materials	13,459.27	20,233.11	3,000.00	3,000.00	3,540.73	29,773.84
Departmental Support	21,297.84	35,003.04	16,000.00	16,000.00	13,702.16	80,705.20
Total	\$126,392.96	\$203,876.76	\$102,636.18	\$101,500.00	\$ 91,978.06	\$500,000.00