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REPORT OF CORNELL UNIVERSITY

FOR THE PERIOD

JULY 1, 1973 TO JUNE 30, 1974

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: Dr. Matthew Drosdoff

D. STATISTICAL SUMMARY

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

2. Amount of Grant: $500,000

3. Expenditures: To be submitted as a separate document

E. NARRATIVE SUMMARY

During the four years of the grant, faculty involved in the program for the tropics has increased from six to sixteen. Two new courses on the subject have been added, and eleven others, including two inter-departmental offerings, have been substantially revised to incorporate subject matter relevant to the tropics. These courses reach about 700 students annually. Seventy-one graduate students having career commitments to LDC's have been candidates for advanced degrees, including 51 from 24 developing nations. Thirty-nine total and 26 LDC students were engaged in the program during 1973-74. Faculty expertise has been strengthened by six Visiting Professors who are authorities on the tropics, two in 1973-74, and by direct experience in LDC's. Five Visiting Scientists for short periods have contributed.

Research has concentrated mainly on problems raised by work of contract AID/csd 2490 but peripheral to the objectives of that contract. A smaller

number of other relevant subjects have been investigated. Nineteen of such short-term projects have been supported largely by 211(d) funds. Ten others have been similar in character but supported mainly from other sources. Ten were supported by 211(d) funds and three from other sources during 1973-74.

These activities have produced twelve published articles, nine manuscripts accepted for publication, seventeen processed articles and master's theses catalogued in libraries, and sixteen typescript reports for internal use. Thirteen of the processed articles have been reproduced in quantity for distribution to AID and selected institutions and individuals.

During the four years, Cornell personnel have spent 589 man-days in consultation in LDC's, 87 man-days in conferences in LDC's, and 86 man-days in domestic consultation on the topic of tropical agriculture. During 1973-74, 208 man-days were spent in consultation, of which 143 were in LDC's. These are exclusive of consultation with members of the Consortium on Consortium activities and exclusive of activities directly concerned with contract AID/csd 2490. About 40 man-days of those listed as domestic were for AID on problems of LDC's.

Linkages involving cooperation on activities related to the subject of the grant have been established with 13 institutions of LDC's in nine countries and with six institutions of developed nations devoted to agricultural development in LDC's. Seven of the former and two of the latter involved active cooperation during 1973-74. In addition, the University has established firm contacts but without collaboration on activities with 19 other institutions of 12 LDC's, exclusive of contacts with 14 others through graduate students.

Holdings of items pertaining to the tropics have been increased by about 400 volumes in the Agronomy reference library as an adjunct to the extensive holdings of the University library. A consultant is assembling the 12,000 references held by the Soil Conservation Service for publication as a bibliography of soils of the tropics.

F. DETAILED REPORT

1. General Background and Purpose of the Grant: The general background and purpose of the five grants to Consortium members are described in the section on the "Consortium Program" as a whole. Within that context, Cornell University has focused its project on the development of competence of a cadre of faculty to understand the applications of the varied elements of soil science in the tropics and to apply that understanding to practical cultural systems for food-crop production on soils of the tropics.

Cornell's interest in the grant as an instrument for domestic institution building was based on two long-term commitments. First, the University is committed to a quality domestic program of teaching, research, and public service. It has long recognized that this cannot be achieved unless its faculty has world-wide perspective of their subject matter. This is especially critical in soil science, which cannot be a complete science without understanding of the kinds of soil and their behavior in the tropics. Second, the University has long recognized obligations as a public institution to serve as a resource of knowledge for national and international programs and for policy development at the State and National levels. This too requires world-wide perspective of subject matter. Consequently, many of the University faculty, including those in soil science, have been encouraged to work in varied physical and cultural

environments as a matter of policy.

Under University policies, faculty members representing most of the major specialties of soil science had acquired substantial experience with soils of the tropics before the grant was made. The grant offered an opportunity to augment existing competencies and to consolidate subject matter specialties into a unified perspective of soils of the tropics in relation to their use and culture.

In accepting the grant, the University anticipated serving the objectives of AID as a development agency while reinforcing its own commitments to both quality education and public service. Within limits imposed by educational commitments, it anticipated increased and more effective direct participation of faculty in development programs and policy decisions of immediate concern to AID. It also anticipated major, and probably greater, long-term impact on international development through its many foreign students and through American students having international commitments.

2. Objectives of the Grant: The immediate objective of the grant 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 of the granter 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

linkages 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. As the project enters its fifth year, changes are contemplated to bring the expertise developed to bear more directly on programs in developing nations.

3. Accomplishments: Accomplishments of the project are discussed under six major topics: 3.1. Teaching, 3.2. Research, 3.3. Publications, 3.4. Consultation, 3.5. Linkages and Contacts, and 3.6. Library and Reference. Under each of these topics, accomplishments for the first four years of the grant ending June 30, 1974 are summarized and are followed by an account of activities for the 1973-74 reporting year.

3.1. Teaching: During the four years of operation institution building has focused on enhancement of the expertise and perspective of the faculty in applications of soil science for the tropics. Six authorities on soils and cultural systems of the tropics have been brought to the campus for periods of three to six months for this purpose and to teach. Five others were brought to Cornell for shorter periods on special subjects. The faculty has also been given opportunities to work in the tropical environment and with soil samples from the tropics. Sixteen faculty members have been involved in a variety of such activities and now constitute a major resource of knowledge and expertise for soils of the tropics and their use and management.

The expertise and perspective of this cadre of faculty is reflected in their teaching. Two new courses that focus on the tropics have been added. Eleven other courses have been modified substantially to incorporate and enlarge on subject matter relevant to the tropics. A seminar on soils of the tropics has been established as a regular activity. These courses enroll about 700 students annually from a broad spectrum of subject matter areas of the University. The impact this teaching has had and will continue to have on thousands of students over the years cannot be measured quantitatively, nor can their influence on LDC's directly, and on U.S. policy as regards foreign assistance be estimated. It can be

said that thousands of students from such diverse fields as sociology, economics, government, and engineering as well as agriculture and biological sciences will work in society with far better understanding of the soil resources and their use in the tropics than would otherwise have been possible. The courses affected are the following:

Agronomy 200 - The elementary course in soil science
Agronomy 301 - The first course in soil classification and survey
Agronomy 324 - The first course in soil fertility
*Agronomy 401 - Geography and appraisal of soils of the tropics
Agronomy 405 - Soil clay mineralogy
Agronomy 406 - Soil survey interpretation
*Agronomy 422 - Tropical agriculture
*Agronomy 480 - Management systems for tropical soils
Agronomy 503 - A graduate course in soil genesis and classification
Agronomy 701 - A graduate course in soil chemistry
Agronomy 724 - A graduate course in soil fertility
*Animal Science 403 - Forage production in the tropics
*International Agriculture 602 - Special studies of agricultural problems in the tropics

Those marked by an asterisk are specific to the tropics. The last two listed are taught jointly with faculty of other departments.

Over the four years of the grant, 71 graduate students having career commitments to agriculture in developing nations have majored in the Department. Thirty-nine of the 71 were in residence in 1973-74. Fifty-one came from 24 different developing nations, distributed as follows:

The Caribbean Area	- 7 from	4 countries
South America	- 10 from	5 countries
East and Southeast Asia	- 15 from	5 countries
South Asia	- 8 from	3 countries
East Africa	- 3 from	3 countries
West Africa	- 8 from	4 countries
	51 from	24 countries

The other 20 students are citizens of the United States (17), the Netherlands (2), and Canada (1) with career commitments to agricultural development in LDC's. Forty of the 71 are Ph.D. candidates. Twenty students will have completed thesis research in LDC's when they graduate. The impact

of these trained people on LDC's remains to be determined, but on the basis of past experience, they will become leaders in teaching, research, and advisory services in developing nations. Many will advance to administrative posts where they will help to determine policy.

In addition to the graduate majors in the Department, the faculty has served an approximately equal number of students majoring in other disciplines and minoring in the Department. The faculty has also served as guest lecturers in courses of other disciplines of the University and at other Universities of the United States and Canada. They have participated in an institute and two major seminars overseas for soil scientists of the tropics. They have participated in four workshops for members of the Consortium.

During 1973-74, teaching activities specific to soils of the tropics included the following, which were supported in part or entirely by 211(d) funds.

1. Visiting Professor Goro Uehara of the University of Hawaii delivered a series of ten special lectures on recent developments in soil chemistry, mineralogy, and physics and their significance to use and management of soils of the tropics.

2. Visiting Professor Claude Charreau delivered a series of thirteen special lectures on soils and environment of the Sahelian zone of West Africa in relation to soil use and cultural systems in dry tropical areas. The lectures will be published and distributed.

3. A special three-credit course was given during the summer session of 1973 on Natural Resource Potential for Food Production in the Tropics designed especially for students having limited agricultural background.

4. Faculty and staff gave 16 special lectures and seminars on subjects relating to soils of the tropics at Cornell (6) and in Canada (2), the Netherlands (1), Colombia (2), Brazil (2), Hawaii (2), and the State University of New York at Buffalo (1).

5. Faculty participated in development of an interdisciplinary course on problems of agriculture in the tropics and in two weeks of field study in the Dominican Republic and Puerto Rico as part of the course.

6. Thirty-nine graduate students having career commitments to agricultural development in LDC's were enrolled. Twenty seven of these were from LDC's. Ten students were engaged in thesis research in LDC's part or all of the year, as follows:

Character and formation of laterite	- Venezuela
Soil production potential and cropping systems	- Nigeria
Cultural systems including rice and cassava	- Brazil
Water resources for potential irrigation	- Brazil
Soil water-crop relations	- Brazil
Crop physiology-soil relations	- Brazil
Quinoa culture and production	- Bolivia
Soil changes in the draw-down area of the Volta reservoir	- Ghana
Rhizobium for the tropics	- Colombia
Nutrition of cassava	- Colombia

7. A collection of 67 crops of the tropics has been assembled and is grown continuously under greenhouse conditions as a teaching facility open to all relevant courses and to interested individuals.

8. A collection of approximately 800 colored 2 x 2 slides of tropical crops, cultural systems and management practices has been assembled as a teaching resource.

3.2. Research: During the four years ending June 30, 1974, nineteen problems have been investigated under funds largely from the 211(d) grant. Sixteen of these dealt with questions raised by research under contract AID/csd 2490 but which were not strictly within the scope of its objectives. These were undertaken to elaborate or explain results of that research. An additional twelve problems were investigated under funding independent of both contract AID/csd 2490 and grant AID/csd 2934 (211d) except for portions of salaries from 211(d) funds for some faculty who directed graduate student research. All thirty-one of these research activities are listed here with the names of investigators and the fiscal years of the investigations. Results of those in progress

during the 1973-74 reporting period are reported later in this section.

A. Major support from 211(d) funds

1. *K. D. Ritchey, student, and R. Fox, advisor. Micronutrients limiting yields of Oxisols and Ultisols of Puerto Rico. 1971-1972-1973.

2. *K. D. Ritchey, student, and R. Fox, advisor. Wick-watering techniques for pot culture in tropical environments. 1972-1973.

3. *F. F. Ferreira, student, and T. Scott, advisor. Fate of nitrogen from fertilizers applied to tropical soils. 1971-1972.

4. O. Odeyemi, student, and M. Alexander, advisor. Factors affecting the rate and character of organic matter decomposition with reference to tropical conditions. 1972-1973.

5. M. Rodriguez, student, and D. Bouldin, advisor. Calcium and magnesium release from highly weathered soils. 1972-1973-1974.

6. J. Bockus, student, and M. Drosdoff, advisor. Climatic data and incidence of drouth as it affects response to fertilizers in the tropics. 1972.

7. C. Kao, student, and D. Bouldin, advisor. Transformations of nitrogen in flooded soils. 1972.

8. C. Kao, student, and D. Bouldin, advisor. Effects of soil acidity on root development. 1973.

9. G. Amedee, student, and M. Peech, advisor. Liming and loss of calcium in highly weathered soils of the humid tropics. 1973-1974.

10. S. Mughogho, student, and M. Weaver, advisor. The role of organic forms of soil phosphorus in phosphorus nutrition in soils of the tropics. 1973-1974.

11. *M. Weaver, professor. Mineralogy of selected soils of the humid tropics. 1972-1973-1974.

12. *M. Cline, professor. Application of research results to soils of the Central Plateau of Brazil. 1973.

13. *T. Forbes, student, and R. Arnold, advisor. The potential for food crop production on a soil climosequence of West Africa. 1974.

14. *L. Daugherty, student, and R. Arnold, advisor. Characteristics of soils with plinthite in Venezuela. 1974.

15. *T. Scott, professor. Evaluating soil testing methods for available phosphorus for soils of the humid tropics. 1974.

16. *D. Lathwell, professor. A soil test for nitrogen-supplying power for soils of the humid tropics. 1973-74.

17. *J. Pruntel, student, and P. Zwerman, advisor. Potential for water empoundment for supplemental irrigation on the Central Plateau of Brazil. 1974.

18. *M. Whittaker, student, and H. MacDonald, advisor. Production of Quinoa in Bolivia. 1974.

19. *J. Silva, Visiting Professor. Potential for response of crops to silicates on soils of Puerto Rico. 1973.

B. Limited supported from 211(d) funds

20. *H. Zandstra, student, and D. Bouldin, advisor. Aluminum toxicity in some highly weathered soils. 1972-73.

21. *G. Naderman, student, and M. Drosdoff, advisor. Yellowing of rice as related to root development and mineral nutrition in soils of the Eastern Plains of Colombia. 1972-73.

22. M. Carrasco, student, and M. Peech, advisor. Distribution of electrical charges in Chilean soils derived from volcanic ash. 1972-73.

23. B. Van Raij, student, and M. Peech, advisor. Electrochemical properties of some Brazilian soils. 1971-1972.

24. *W. S. Reid and J. Silva (Hawaii), professors. Lime requirement of some soils of the tropics. 1973.

25. *S. Danso, student, and M. Alexander, advisor. Rhizobium and legume innoculation for soils of the tropics. 1973-1974.

26. *A. Ngongi, student, and H. MacDonald, advisor. Nutrition of cassava. 1974.

27. D. Dumith, student, and R. Arnold, advisor. Properties of soils high in clay in Venezuela. 1973.

28. R. Abreu, student, and G. Olson, advisor. Considerations for a cooperative soil survey in Venezuela. 1973.

29. *D. Kass, student, and M. Drosdoff, advisor. Cultural systems of mixed cropping of cassava, upland rice, and maize in Brazil. 1973-74.

30. *J. Amatekpor, student, and M. Drosdoff, advisor. The effect of seasonal flooding on the modification of soil properties in the Volta Lake Drawdown Area in Ghana. 1973-74.

31. *W. Philipson, student, and M. Drosdoff, advisor. Analysis and characterization of Philippine crop occurrence in relation to soil and climatic factors. 1971-1972-1973.

*Those marked with an asterisk have involved work overseas by the investigator.

The progress of research supported by 211(d) funds during 1973-74 follows:

1. Calcium and magnesium release from highly weathered soils. M. Rodriguez, graduate student.

Total Ca, Mg, and K in soils of the Llanos of Colombia are approximately <100, 800, and 2000 ppm, respectively. Of these small amounts, only about 4 to 20 ppm of Ca, 8 ppm of Mg, and 20 ppm of K are exchangeable, and essentially none of the reserve is converted to exchangeable form on incubation with wetting and drying. The reserves are apparently in non-weatherable minerals. All three of these elements must be limiting as plant nutrients.

2. Liming and loss of calcium in highly weathered soils of the humid tropics. G. Amedee, graduate student.

KCl-extractable acidity greatly underestimated and exchange acidity by $BaCl_2$-triethanol amine overestimated the lime requirement of 9 Oxisols and Ultisols of Brazil, Colombia, and Puerto Rico. The capacity of these soils to adsorb cations was markedly increased by liming, The pH-dependent charge of these soils was as effective as the permanent charge of soils of temperate regions in adsorbing and preventing loss of Ca^{++} and other cations.

3. The role of organic phosphorus in phosphorus nutrition in soils of the tropics. S. Mughogho, graduate student, and M. Weaver.

Oxisols and Ultisols of Puerto Rico can supply up to 50 ppm of phosphorus by mineralization. Amounts were less for selected soils of Malawi. The amount of phosphorus released by mineralization of organic matter is important in phosphrous nutrition and appears to depend in part on cropping history of the soil.

4. Mineralogy of selected soils of the humid tropics. M. Weaver.

Mineralogical characterization started in previous years was extended to Oxisols of Brazil and to Ultisols of Ghana during 1973-1974. Mineralogically, the clay fractions of soils of the Central Plateau of Brazil are 75 to 95 percent kaolinite, gibbsite, iron oxides and amorphous material but with major unexplained differences in the proportions of kaolinite and gibbsite, one or the other of which is most abundant. In the coarser textured soils, silication of active oxidic surfaces is high, contributing to increased cation retention and decreased phosphorus retention per unit of clay and to some degree offsetting the effects of low clay content. This may account for the qualitative observation of Brazilians that the coarse loamy soils behave as well as the clayey soils of the area. For the Ultisols of Kumasi, Ghana, kaolinite was 2/3 to 3/4 of the clay fraction with minor amounts of goethite and about 1/5 amorphous material. No gibbsite was detected. This may signify important management differences from the soils of Brazil.

5. The potential for food-crop production on a soil climosequence of West Africa. T. Forbes, graduate student.

Studies in cooperation with IITA are under way on morphology and chemical and physical properties of soils in a sandy formation extending from rainfall of 900 mm in Togo to 2000 mm in Eastern Nigeria in conjunction with maximum yield trials and a survey of small farmer cultural systems and yields. Results are not available at this time.

6. Characteristics of soils with plinthite in Venezuela. L. Daugherty, graduate student.

Field studies in cooperation with soil scientists of Ministerio de Obras Publicas of Venezuela have been completed for characterization of the

morphology and geomorphic relationships of soils having oxide-rich layers that harden on exposure. Laboratory phases on samples from Venezuela are in progress at Cornell.

7. Evaluating soil testing methods for available phosphorus for soils of the humid tropics. T. Scott.

Chemical soil tests for available phosphrous are being evaluated against phosphorus response in field experiments with Oxisols and Ultisols in Puerto Rico and in greenhouse work with eight soils and three crops. Results are not available at this date.

8. A soil test for nitrogen supplying power for soils of the humid tropics. D. Lathwell.

Nitrogen uptake by crops is highly correlated with organic nitrogen extracted by neutral salt solutions for Oxisols and Ultisols of Puerto Rico and central Brazil. The predictive value of the test was poor for soils of IITA in Nigeria, where crop residues were returned. The effects of residues are being investigated in cooperation with IITA.

9. The potential for water empoundment for supplemental irrigation on the Central Plateau of Brazil. J. Pruntel, graduate student.

This investigation is an outgrowth of soil studies by Cline and Buol reported in 1973. They suggested that short dry periods during the rainy season are critical and that the potential for small empoundments for supplemental water should be investigated. Field studies began in June, 1974.

10. Production of Quinoa in Bolivia. M. Whittaker, graduate student.

This staple food crop of highlands of Bolivia and adjacent areas has high protein. Little is known about its culture and potential. Local cultural practices were studied during the summer of 1973, and other information about the crop and its culture is being assembled.

Four other studies having no AID support were in progress during 1973-1974.

1. Rhizobium and legume innoculation for soils of the humid tropics. S. Danso, graduate student.

Work at CIAT in Colombia has demonstrated that Rhizobium can persist in competition with soil microflora under tropical conditions, but is subordinated or eliminated by some pathogenic organisms.

2. Nutrition of cassava. A. Ngongi, graduate student.

Work in Colombia in cooperation with CIAT was started in February, 1974 and is proceeding. Results are not yet available.

3. Cultural systems of mixed cropping of cassava, upland rice, and maize in Brazil. D. Kass, graduate student.

The first crops are approaching harvest in systems that simulate mixed cropping by farmers on an experimental station and in the plantings of small farms near Belem. Results will be reported for 1974-1975.

4. The effect of seasonal flooding on the modification of soil properties in the Volta Lake Drawdown area in Ghana. J. Amatekpor, graduate student.

Changes in the physical and chemical properties of these soils after five years of intermittent flooding are being studied with the objective of determining what effects these changes might have on crop production in future years.

3.3. Publications and Manuscripts: During the four years of the grant, Cornell scientists have issued the following on soils and related subjects for the tropics:

a. 12 published articles, including Ph.D. theses
b. 9 manuscripts accepted for publication
c. 17 processed articles and Master's theses catalogued in libraries
d. 16 typescript reports for internal use, mainly

Thirteen of the processed articles have been reproduced in quantity for distribution to AID and selected institutions and individuals.

Publications and manuscripts issued during 1973-74 follow. Those directly supported in whole or in part by 211(d) funds are marked by an asterisk.

a. Published Articles

*Drosdoff, M. 1974. Recent research on soils of the humid tropics. McGraw Hill Yearbook of Science and Technology, 1974, pp. 377-378.

*Gonzales, R. A., Schargel, R., and Arnold, R. 1973. Normas y esocificaciones para los estudios de suelos de Division de Edofolgia, M.O.P., de Venezuela. Div. Edofol. M.O.P. Caracas. 35 pp.

Olson, G. W. 1973. Improving uses of soils in Latin America. Geoderma 9:257-267.

Olson, G. W. 1973. Geographic aspects of soil use considerations in Latin America. In Latin American Development Issues. Proc. Conf. Latin Amer. Geogr. Vol. 3, pp. 91-100, A. D. Hill, ed., CIAG Publ., Inc., East Lansing, Mich.

Schmidt, D. R., MacDonald, H. A., and Kelly, W. C. 1973. Yield and content of iron, manganese, and copper in tropical leaf vegetables when variously fertilized. Comm. Soil Sci. and Plant Anal. 4:95-103.

*Weaver, R. M. 1974. A simplified determination of reductant-soluble phosphorus in soil fractionation schemes. Soil Sci. Soc. Amer. Proc. 38:153-154.

b. Articles Accepted for Publication

*Ritchey, K. D. Use of wick-watering for greenhouse pots in the tropics. Accepted for Tropical Agriculture (Trinidad).

*Ritchey, K. D. and Fox, R. H. Limitations to productivity of some Oxisol and Ultisol subsoils. Accepted for Jour. Agr. Univ. Puerto Rico.

*Weaver, R. M. Inorganic and organic phosphrous occurrance in some highly weathered soils of Puerto Rico. Accepted for Tropical Agriculture (Trinidad).

c. Manuscripts Prepared for Publication

Alexander, M. Environmental consequences of rapidly rising food output.

*Charreau, C. Soils of the tropical dry and dry-wet climatic areas and their use and management. A comprehensive treatment based on a series of lectures about the Sahelian zone of West Africa. Approximately 400 typed pages.

*Drosdoff, M. and Cady, F. B. Design of soil fertility research for the tropics: I. Some Cornell University experiences. II. Rationale for design of subsequent studies. Papers presented at the Workshop on Experimental Design, Honolulu, Hawaii. May, 1974.

Fox, R. H., Badillo, J., Del Valle, R., and Scott, T. W. Response to phosphrous fertilization by corn in greenhouse, sunken drum and field experiments.

Gonzalez, E., Wolf, J., Naderman, G., Soares, W., and Galrao, E. Relationship of aluminum toxicity with root growth, water uptake, and yield of corn in an Oxisol (Latosol Vermelho Escuro) of the Federal District. A paper to be presented at the Brazilian Genetics Society meetings in Recife.

Soares, W., Lobato, E., Gonzalez, E., and Naderman, G. Liming of soils associated with the Brazilian Cerrado. A paper presented at the Seminar on Soil Management and the Development Process in Tropical America at Cali, Colombia.

Soares, W., Galrão, E., Gonzalez, E., Yost, R., and Naderman, G. Preliminary results in experiments with lime and phosphorus on a Dark Red Latosol near Brasilia. A paper presented at the XIV Annual Meeting of the Brazilian Soil Science Society at Santa Maria Rio Grande du Sul.

*Uehara, G., and Keng, J. Management implications of soil mineralogy in Latin America. A paper presented at the Seminar on Soil Management and the Development Process in Tropical America at Cali, Colombia. (Dr. Uehara was supported as a Visiting Professor at Cornell by 211(d) funds).

Wolf, J. Relaciones suelos-agua los latesolicos de Puerto Rico y Brasil. A paper presented at the Seminar on Soil Management and the Development Process in Tropical America at Cali, Colombia.

d. Processed Articles

*Abreu, R. E. 1973. Considerations for a cooperative soil survey in Venezuela. Cornell Univ. Professional Paper for the M.P.S. degree.

*Charreau, C. 1974. An outline of French research and development organizations for technical assistance in tropical countries. Cornell Agronomy Mimeo 74-15. 18 pp.

*Charreau, C. 1974. Origin and development of two Chadian tropical soil toposequences, biogeodynamic interpretation. Cornell Agronomy Mimeo 74-21. 16 pp.

*Cline, M. G., and Buol, S. W. 1973. Soils of the Central Plateau of Brazil and extension of results of field research conducted near Planaltina, Federal District to them. Cornell Agronomy Mimeo 73-13. 43 pp.

*Dumith, D. A. 1973. Taxonomic considerations of some clayey soils of Venezuela. Cornell University Thesis for the M.S. degree.

*Forbes, T. R. 1973. Ferrallitic and ferruginous tropical soils of West Africa. Cornell Agronomy Mimeo 73-20. 34 pp.

*Lathwell, D. J. 1974. Report of the Caribbean and Tropical America Soils Conference at the University of West Indies, Trinidad, January 8-18, 1973. Cornell Agronomy Mimeo 74-7. 55 pp.

*Lathwell, D. J., and Cline, M. G. 1974. A report on the potential for collaboration of Cornell University with an institution in Ghana for extension of research under Contract AID/csd 2490 to Africa. Xeroxed.

Ngongi, A. G. N. 1973. Tropical root and tuber crops: Factors affecting production and utilization. Cornell University Thesis for M.S. degree. 105 pp.

Olson, G. W. 1973. A soils consultants photographs from Iran. Cornell Agronomy Mimeo 73-7. 27 pp.

Olson, G. W. 1973. Outline of a course in soil survey interpretations in Venezuela. Cornell Agronomy Mimeo 73-14. 4 pp.

*Peech, M. 1973. Loss by leaching of adsorbed Ca^{++} from some highly weathered soils. Cornell Agronomy Res. Rpts., 1973. 2 pp.

*Ritchey, K. D. 1974. A partially annotated bibliography on manganese with special attention to the tropics. Cornell Agronomy Mimeo 74-16. 40 pp.

*Ritchey, K. D. 1974. A partially annotated bibliography on zinc in the tropics. Cornell Agronomy Mimeo 74-14. 22 pp.

*Weaver, R. M. 1974. Soils of the Central Plateau of Brazil: Chemical and mineralogical properties. Cornell Agronomy Mimeo 74-8. 45 pp.

*Wolf, J., and Drosdoff, M. 1974. Soil water properties of representative soils of Puerto Rico. Cornell Agronomy Mimeo 74-22. Approximately 61 pages.

3.4. Consultation: The activities reported here involved direct contributions to another institution or group by Cornell personnel and visiting scientists employed by Cornell. It includes contributions to conferences and meetings in which Cornell personnel actively participated as well as service to other institutions. In previous annual reports, linkages involving cooperative work with another institution and contacts made for the primary benefit of Cornell were included under this heading. The costs of these latter kinds of activities will be included under "consultation" in the financial report to be consistent with past practice, but the activities themselves are described separately in section 3.4a., which follows.

During the four years of the grant ending June 30, 1974, Cornell personnel have participated regularly in planning by the Consortium and in consultation with AID officials on activities concerned with the grant. Costs for these are reported under domestic consultation. In addition, Cornell personnel have provided service for the following domestic institutions and groups:

1. North Carolina State University - on research on soils of the tropics, 1971-72, 72-73. 7 man-days.
2. Soil Conservation Service - on taxonomy of soils of the tropics. 5 man-days.
3. Puerto Rico Agricultural Experiment Station - on soil research in Puerto Rico, 1970-71, 71-72, 72-73, 73-74. 20 man-days.
4. University of Puerto Rico and University of Hawaii - on experimental design for soil research in the tropics, 1973-74. 14 man-days.
5. AID - on project evaluation in Viet Nam, 1973-74. 14 man-days.
6. AID - on North Carolina State University soil testing project evaluation, 1973-74. 24 man-days.
7. AID - on drouth problems in the Sahelian zone of Africa, 1973-74. 1 man-day.

8. American Technical Assistance Corporation - on personnel for overseas assignment, 1973-74. 1 man-day.

Items 1 and 3 involved no 211(d) funds. All others involved part salaries of Cornell personnel on 211(d) funds, and items 2 and 7 were supported by 211(d) for travel.

During the four years of the grant, Cornell personnel have provided service to the following foreign institutions and conferences:

1. ICA, Colombia - on soil microbiology, 1971-72. 1 man, 5 man-days.

*2. Federal Experiment Station, Ministry of Agriculture, Km. 47, Brazil - on nitrogen fixation, 1970 to date. 3 men, 10 man-days.

3. Conference on Soil Research for the Tropics, IITA, Nigeria, 1971-72. 4 men, 20 man-days.

4. Division of Edofology, M.O.P., Venezuela - on organization and operations of soil survey of Venezuela, 1971-72, 72-73. 1 man, 10 man-months.

*5. Faculty of Agronomy, Universidad Centro-Occidente, Venezuela - on curriculum development for soil science, 1972-73. 1 man, 2 man-months.

6. Caribbean and Tropical America Soils Conference, University of West Indies, Trinidad, 1972-73. 1 man, 10 man-days.

7. Divisao de Pedologia e Fertilidad do Solo, Brazil, 1972-73. 1 man, 20 man-days.

*8. FAO, Rome - on soil survey interpretation, 1971-72. 1 man, 3 man-months.

*9. Soil Institute of Iran, Teheran - on soil survey interpretation, 1971-72, 72-73. 1 man, 6 man-months.

10. Nacional University Pedro Henriquez Urena, Dominican Republic - on soils and soil fertility, especially of the University farm, 1973-74. 2 men, 14 days.

11. Barbados - on soil fertility problems, 1973-74. 1 man, 5 man-days.

*12. International Biological Program, Kenya, 1973-74. 1 man, 7 man-days.

13. FAO/CIDA Regional Seminar on Shifting Cultivation. Ibadan. Nigeria, 1973-74. 1 man, 20 man-days.

*14. Instituto Agronomo Campinas, Brazil - applied soil microbiology, 1973-74. 1 man, 10 man-days.

*15. Polytechnic Institute, Mexico - on soil microbiology, 1973-74. 1 man, 3 man-days.

*16. Faculty of Agriculture, Israel - on environmental microbiology, 1973-74. 1 man, 7 man-days.

17. Limon Provence Development Project, Costa Rica, 1973-74. 1 man, 4 man-days.

18. Seminar on Soil Management and the Development Process in Tropical America, Cali, Colombia, 1973-74. 5 participants, 30 man-days

19. CIMMYT, Mexico - on soil fertility considerations for plant breeding, 1973-74. 1 man, 7 days.

20. Federal Agricultural Research Institute, IPEAN, Belem, Brazil - on research on rice and cassava cultural systems, 1973-74. 1 man, 3 man-days.

21. EMBRAPA, Brasilia, Brazil - on cooperative research on soil fertility, 1973-74. 2 men, 9 man-days.

22. Soil Research Institute, Kumasi, Ghana - on cooperative soil fertility research project, 1973-74. 2 participants, 28 man-days.

23. CIDIAT, Venezuela - on plans for soils teaching, 1973-74. 1 man, 2 man-days.

Activities marked with an asterisk involved no 211(d) funds. All others except activity number 4 involved part salary of participants from 211(d) sources. Activities 1, 3, 4, 6, 7, 10, 11, 13, and 18 also had support for part or all of travel costs from 211(d) funds.

Consulting activities for 1973-74 are identified in the two lists. They aggregate about 208 man-days for the period, of which about 150 were foreign consultation, all except seven in LDC's.

3.4a. Linkages and Contacts: The term "linkage" is used for relationships that have involved direct participation of Cornell personnel in activities with scientists of other institutions. The linkages

identified include current relationships established through both presently active and past collaboration. The term "contact" is used for relationships of Cornell personnel with scientists of other institutions without direct participation in joint activities. The term implies more than normal correspondence or casual meetings between scientists. The linkages and contacts identified include those established both through 211(d) activities and under other auspices. Those that have involved 211(d) funding for part or all of the costs are identified by an asterisk.

A. Linkages

1. In the United States

*North Carolina State University
*Prairie View A&M University
*University of Hawaii
*University of Puerto Rico

2. In Other Developed Nations

Food and Agriculture Organization of the United Nations
*British Ministry of Overseas Development
*University of Reading, England
*University of Oxford, England
*Institute for Tropical Agronomic Research and Crop Culture (IRAT), France
*Office of Scientific Research and Technology Overseas (ORSTOM), France

3. Southeast Asia

College of Agriculture, University of the Philippines, Los Banos
International Rice Research Institute (IRRI), Philippines

4. Africa

*International Institute of Tropical Agriculture (IITA), Nigeria
*Soil Research Institute, Ghana

5. Latin America

*Division of Pedology and Soil Fertility, Brazil
EMBRAPA, Brasilia, Brazil
Federal Experiment Station, Km. 47, Brazil
Federal Agricultural Research Institute, IPEAN, Belem, Brazil

*National University Pedro Henriquez Urena, Dominican Republic
*Division of Soils, M.O.P., Venezuela
*International Center for Tropical Agriculture (CIAT), Colombia
International Center for Improvement of Rice and Corn (CIMMYT), Mexico

6. Middle East

Soil Institute of Iran, Teheran

During 1973-74, Cornell personnel participated directly in activities with personnel of the following institutions identified above.

1. The four Universities of the soils consortium, in

*(a) A Seminar on Soil Management and the Development Process in Latin America, Cali, Colombia
*(b) A Workshop on Soil Mineralogy, Hawaii
*(c) Development of a Directory of Soil Scientists for Tropics
(d) A Conference on Experiment Design for Soil Research in the Tropics, Hawaii
(e) Soil fertility research in Brazil, with North Carolina State University
(f) A winter field laboratory on problems of agriculture in the tropics for Cornell students, with the University of Puerto Rico
*(g) Activities of Professor Uehara of the University of Hawaii as Visiting Professor at Cornell for four months.

*2. IRAT and ORSTOM, France, in activities of Dr. Claude Charreau as Visiting Professor at Cornell for six months.

*3. IITA, Nigeria, in (a) a study of cropping systems and the potential for food crop production on a soil climosequence in West Africa by a graduate student, (b) work on a test for nitrogen supplying power of soils, and (c) plants for soil fertility research in Ghana.

4. The Soil Research Institute, Kumasi, Ghana, in a study of the potential for cooperative research at the Institute and plans to initiate that project.

5. EMBRAPA, Brasilia, Brazil, in soil fertility research for the Central Plateau of Brazil.

6. The Federal Agricultural Research Institute, IPEAN, Belem, Brazil, in research on rice and cassava mixed cropping systems.

*7. The National University Pedro Henriquez Urena, Santo Domingo, Dominican Republic, on (a) soil fertility research plans and (b) a winter field laboratory for Cornell students.

8. CIAT, Colombia, on research of two graduate students on (a) rhizobium and innoculation of legumes in the tropics and (b) nutrition of cassava.

9. CIMMYT, Mexico, on preliminary plans for an interdisciplinary research project on corn production on small farms by eight graduate students.

B. Contacts

1. In the United States

Relationships are maintained with scientists of many institutions including casual contacts about matters pertaining to international development and personnel for overseas work. These are considered part of normal operations and are not listed separately.

2. In Other Developed Nations

*Belgian Cooperative and Development Office, Brussels
*University of Ghent, Ghent, Belgium

3. Southeast Asia

Soil Research Institute, Bogor, Indonesia

4. Africa

*University of Ibadan, Ibadan, Nigeria
*Institute for Agricultural Research and Ahmadu Bello University, Samaru, Nigeria
*University of Science and Technology, Kumasi, Ghana
*University of Ghana, Legon, Ghana
*Crops Research Institute, Kumasi, Ghana
Council for Scientific and Industrial Research, Accra, Ghana
*IRAT Research Center, Bouake, Ivory Coast
*IRAT Agricultural Research Center, Bambey, Senegal
*ORSTOM Center, Dakar, Senegal
Makerere University, Kampala, Uganda

5. Latin America

Institute of Agronomy, Campinas, Brazil
*University of West Indies, St. Augustine, Trinidad
Interamerican Center for Integral Development of Water and Land Resources (CIDIAT), Merida, Venezuela
University of the East-Central Region, Venezuela
*Division of Integrated Studies of Natural Resources, Lima, Peru
National Center for Agricultura Research, Bogota, Colombia
Polytechnic Institute, Mexico

In addition to the 12 LDC's for which linkages and contacts are listed above, graduate students of the past four years provide contacts

in the following countries:

Cameroon	Korea
Ceylon	Malawi
Chile	Malaysia
Ethiopia	Pakistan
Honduras	Taiwan
India	Thailand
Jamaica	Uruguay

Contacts in the preceding list which were established during 1973-74 include:

The Soil Research Institute, Bogor, Indonesia through consultation with Dr. D. M. Muljadi, Director, on Cornell's international program and soil fertility research in the tropics.

The Council for Scientific and Industrial Research, Accra, Ghana, through consultation with Dr. Tackie, Executive Chairman, concerning cooperative research by Cornell and the Soil Research Institute of Ghana.

Contacts were renewed during 1973-74 with ten of the nineteen other institutions listed, either by visits to the institution by Cornell scientists or by visits of scientists from the institution to Cornell.

3.5. Library and Reference: The Cornell University library system ranks between eighth and twelfth by various measures among University libraries of the United States and contains an exceptional collection on agriculture, including the tropics. Few items needed during the life of the grant have been unavailable in it. Consequently, the effort under the grant has been to increase critical holdings in the working library of the Agronomy Department. Emphasis for acquisitions has been placed on series that emphasize soils, such as the Soil Resource Bulletins of FAO and bulletin series of institutions with which Cornell maintains linkages and contacts. New books are ordered as they appear. Acquisitions

of this kind aggregate about 400 volumes to date.

A set of cards listing the main holdings of the Cornell University Libraries on soils and agriculture of the tropics has been prepared and inserted in the Agronomy card catalogue and is indexed by countries. A separate file lists holdings in the Agronomy library.

Considerable effort was expended on investigation of bibliographical services and retrieval systems for soils of the tropics for the Consortium. It was concluded that service of this kind is beyond the resources and expertise of the Consortium and that existing and projected services and systems on a national scale can satisfy most needs if institutions take advantage of them. A project was undertaken by Cornell acting for the Consortium to assemble and publish a bibliography of soils of the tropics consisting of some 12,000 references held by the Soil Conservation Service.

Cornell has also been active in developing a directory of expertise in soil science for the tropics as part of a Consortium effort.

During 1973-74, approximately 100 items were acquired for the Agronomy library collection, mainly by contributions from the publishing institutions. These include a collection of the publications of ORSTOM, IRAT, and other French institutions contributed by Visiting Professor Charreau.

A consultant has assembled that part of the bibliography of soils of the tropics dealing with general subjects and most of West Africa. His work will continue for the rest of the tropics during 1974-75.

Cornell has mailed questionnaires for biographical data of soil scientists for the tropics to about 400 individuals and institutions in Latin America and Africa. Questionnaires were sent in English, Spanish, and Portuguese, as appropriate, to encourage response. The first responses have been received. As they are received they will be forwarded to Prairie

View A&M University, which is responsible for the final publication of the directory. Visiting Professor Charreau has agreed to obtain biographical data for soil scientists of Francophone Africa on his return to Paris.

Nine reference documents have been issued and distributed in quantity to AID, other institutions, and selected individuals during 1973-74. These are listed in the section on Publications and Manuscripts under "Processed Articles" as "Agronomy Mimeos."

4. Impact of Grant-Supported Activities in Developing Institutional Capabilities: No attempt is made here to separate the impact of the contract for soil fertility research in the humid tropics (AID/csd 2490) from that of the 211(d) grant (AID/csd 2834). The two have run concurrently. Both have contributed to faculty experience and competence. The research contract, however, has involved mainly six faculty members, four of whom had had substantial experience with tropical soils when the project started. Impact on the competence and commitment of other faculty, and some of the expertise of these six must be attributed to the 211(d) grant.

The numbers of faculty members who have expertise and commitment for soils and agriculture of the tropics have increased from six in 1970 to sixteen in 1973-74. In terms of full-time man equivalents (FTE), this represents an increase from about 2.5 FTE prior to initiation of the grant to 5.6 FTE in 1973-74. The faculty involved and the subjects they represent follow:

D. R. Bouldin - Soil fertility	0.2 FTE
D. J. Lathwell - Elementary teaching and fertility research	0.3 FTE
T. W. Scott - Elementary teaching and fertility research	0.5 FTE
M. Peech - Soil chemistry	0.1 FTE
M. Alexander - Soil microbiology	0.1 FTE
R. W. Arnold - Soil genesis and classification	0.2 FTE
W. S. Reid - Soils extension	0.1 FTE

G. W. Olson - Soil survey interpretation	0.1 FTE
P. J. Zwerman - Soil and water management	0.1 FTE
G. Levine - Soil and water engineering (Agr. Engineering)	0.1 FTE
R. B. Musgrave - Crop ecology - soils relations	0.1 FTE
R. M. Weaver - Soil mineralogy	1.0 FTE
M. Drosdoff - Soils of the tropics	1.0 FTE
M. G. Cline - Soil genesis and classification	0.5 FTE
R. H. Fox - Soil fertility research (Puerto Rico)	1.0 FTE
H. A. MacDonald - Tropical agriculture	0.2 FTE
	5.6 FTE

All have had experience in the tropical environment, and thirteen of the sixteen have spent at least a year of full-time assignment in the tropics. This cadre of faculty is a resource of expertise representing all of the major areas of soil science.

Cornell has established contacts and linkages with 29 institutions in LDC's, exclusive of connections in 14 other countries through graduate students. These relationships are important elements of institutional capability for both development and maintenance of expertise and the potential for bringing that expertise to bear on problems of LDC's. The contacts and linkages with international programs of four institutions of the United States and six international institutions of other developed nations augment this capability.

The research activities summarized under "Accomplishments" have not only had a major and lasting impact on the expertise of faculty but also have enhanced the knowledge base of the institution. The publications arising from them are resources that increase institutional capability for teaching, research and consultation. Library resources also represent a substantial asset that was less easily accessible prior to the grant.

Authorization to fill a full-time position on a State salary item for continuing work with soils in the international program of the College

is a major contribution to institutional capability for the foreseeable future. This fulfills an obligation for continuity beyond the life of the 211(d) grant. It insures continuing involvement of the Department for the purposes of the grant and reflects the institutional commitment to those purposes.

5. Utilization of Institutional Resources in Development: Over the four years that the grant has been in effect, Cornell faculty have spent approximately 575 working man-days in a consulting capacity with institutions of LDC's, exclusive of conferences, seminars, and training institutes. Seventy man-days were spent in this capacity during 1973-74. An additional 40 man-days were spent in consultation with or for AID on problems of LDC's at no expense to AID except for travel.

Seventy-one graduate students from 24 developing nations and the United States, Canada, and the Netherlands have been in training for development work in LDC's over the life of the grant. Thirty-nine of these were still in training during 1973-74. This is by far the most significant use of institutional resources from the standpoint of total impact that can be expected in LDC's.

One Assistant Professor, one Research Associate, and two Graduate Assistants were stationed overseas during 1973-74 on funds of AID research contract csd 2490. This project, though funded independently of the 211(d) grant, uses institutional expertise for solution of soil fertility problems of developing nations. Seven graduate students, in addition to those supported by this contract, conducted research in five LDC's on problems of soils and agriculture in the respective developing countries.

6. Other Resources Used for Grant-Related Activities: The value of resources contributed to the 211(d) program, exclusive of all AID funds, averaged $114,600 per year for the first three years of the grant. This is about $7000 per year more than support from 211(d) funds. This amount includes estimated salaries and wages, supplies and services, communications, and travel from New York State appropriations and other funds administered by Cornell. It includes direct support of faculty and students from outside sources for activities directly related to the 211(d) program but does not include outside support for foreign or domestic graduate students who were not directly involved in 211(d) activities. It also includes indirect costs and fringe benefits contributed by Cornell for employees whose salaries came from 211(d) funds.

Cornell contributions exclusive of AID funds for 1973-74 amount to about $128,000. Details are given in the financial report for 1973-74, which is to be submitted separately. They are larger in proportion to 211(d) expenditures than in previous years, however, as unusual budgetary circumstances permitted almost the entire cost of the project for two months to be borne by other funds. Net expenditures from 211(d) funds for the February and March expenditure summaries, therefore, were only $1467 compared to normal monthly expenditures of $8000 to $9000.

7. Next Year's Plan of Work:

7.1. Teaching: Teaching activities described for 1973-74 will continue during 1974-75 with the exception of the special summer session course for students with nonagricultural backgrounds. Participation in 1973-74 was not great enough to justify continuation. The course on Cultural Systems for Tropical Soils will be taught during the fall semester

1974. Professor Fox, who is stationed in Puerto Rico, will be brought to the Ithaca campus on 211(d) funds to teach it. The informal seminar, Tropical Soils Discussions, has been highly successful and will be continued with Visiting Professors responsible for most of the sessions.

Dr. P. H. Nye of Oxford University, an authority on cropping systems in the tropics and ion equilibria in soils, will serve as Visiting Professor from August 15 to December 15, 1974. Sr. Marcello Camargo, Chief of the National Soil Survey of Brazil, will be Visiting Scientist during September. His services will be shared with North Carolina State University and the University of Puerto Rico. It is planned that during the spring term Dr. Eshel Bresler, head of the Soil Physics Department at the Volcani Center in Israel, will give a series of lectures on water management in the dry tropics and subtropics. He will be supported in part by 211(d) funds. Plans are still not firm for Dr. Collins of Prairie View A&M University to spend the spring semester at Cornell.

If the Tropical Soil Institute for soil scientists of Southeast Asia, which was cancelled in 1973-74, is held, Cornell faculty will participate, as they will in any seminar or conference planned by the Consortium as a continuation of the series held in Nigeria in 1972 and Colombia in 1974. At a meeting of the executive committee of the Consortium held in April, 1974, endorsement was given to a proposal for Institutes or Workshops to be held under the Consortium sponsorship on the subject: "Recent Advances in Tropical Soil Science: Soil Classification for Resource Evaluation" at suitable locations in the following regions:

Latin America - April or June 1974

Asia - September or November 1974

Africa - February or April 1976.

Also the Consortium accepted the offer of the University of Hawaii as the site and responsible institution for conducting a course in Tropical Agronomy requested by the International Agronomy Division of the American Society of Agronomy. The other overseas teaching activity planned is the January, 1975, field studies in the Caribbean in conjunction with Cornell's interdepartmental course on Special Studies of Problems of Agriculture in the Tropics.

7.2. Research: Work will continue on the problems of items 3, 4, 5, 6, 7, 8, and 9 for which 1973-74 progress is reported in the last part of section 3.2. These will continue to receive significant 211(d) support. The work on nutrition of cassava in Colombia and on mixed cropping systems in Brazil, which received no AID support in 1973-74, will also continue with independent sources of funds. In addition, work on limiting soil factors as criteria for maize breeding will be initiated at CIMMYT as part of an interdisciplinary project supported independently of AID sources. A project to evaluate the predictive value of ERTS satellite imagery for soil survey objectives in the tropics will be initiated, with testing against the ground truth available in Puerto Rico. This will be supported by 211(d) funds. Activities of soil fertility research under contract AID/ta-c-1104 is expected to be extended to Ghana, with no 211(d) input for contract objectives.

7.3. Publications: Primary emphasis will be placed on three items: (a) Publication of the technical manuscripts accepted and prepared for publication as listed under 3.3 of the section on accomplishments, (b) publication of the lectures by C. Charreau on soils and cultural systems of the African Sahelian zone, and (c) publication of the bibliography of soils of the tropics from files of SCS, currently being assembled by a consultant. Other technical articles on research now under way are anticipated.

7.4. Consultation and Linkages: Activities are expected to concentrate on development of plans and linkages for formalizing the Consortium and extending its expertise to LDC institutions. The Consortium is exploring with AID officials the possibilities for revision of the institutional grants upon termination of the present grants. Revised programs for the Consortium as a whole and for the individual Universities are under consideration. A tentative outline of a plan for institutional linkages and collaborative arrangements with LDC's was formulated at the Spring 1974 Meeting of the Consortium executive committee and was discussed at a later meeting of the Council of Deans with representatives of AID. If the plan is developed fully as a formal proposal for AID funding, a considerable amount of time and effort will be required during 1974-1975 to complete the details.

The tentative plan would establish a Consortium headquarters with specified functions. All of the Consortium institutions would be involved in the planning and recruitment of staff. The plan also calls for the establishment by each of the individual Consortium members of a linkage with institutions in two or three LDC's with a specific objective of working

jointly with each to solve important soils problems in the country's agricultural development programs. This would involve intensive consultation with the LDC institution to develop plans and establish the necessary agreement for implementing the problem solving operations. Advance consultation with AID officials both in Washington and in country missions would be required to select appropriate countries, institutions, and key problem areas.

7.5. Library and Reference: In addition to normal acquisitions of relevant material for the Agronomy Library, major emphasis will be placed on completing the bibliography of soils of the tropics now held by SCS in a form for publication, and on the canvass for biographical data for the directory of soil scientists for the tropics that is being assembled for the Consortium by Prairie View A&M University.

8. Other: Recruitment of a qualified soil scientist to fill the soils position as leader of the international soils program in the University will be pursued vigorously. It is essential that this position be filled before the retirement of Professor Drosdoff in 1975.

9. Report of Expenditures: By consent of AID authorities, the financial reports of Consortium members will be submitted as separate documents. This is being done because official financial statements of University transactions are not available in time to permit development and distribution of this narrative report by the time it is needed for review in AID.