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REPORT OF NORTH CAROLINA STATE UNIVERSITY

Summary of Contributions

The competency of North Carolina State University as a center of expertise on soil fertility-plant nutrient relationships in soils of the tropics is being significantly and measurably strengthened through the financial support provided by a grant under the 211(d) program. Some specific manifestations of these improvements are: (1) addition of a professor of tropical soils to the faculty, (2) on-site studies of soil properties in tropical zones by six Soil Science Department senior faculty, (3) modification in the content of four courses in soil science to add additional emphasis to the characteristics of soils of the tropics, (4) initiation of two research projects to acquire additional information on comparative genesis and fertility-related characteristics on soils of tropical and temperate regions, and (5) consultation with soil scientists and other agricultural leaders in governmental and foundation organizations serving in the tropical regions.

Extensive and detailed plans are being developed to strengthen further this competency by increasing the exposure of the faculty to situations existing in tropical regions and concepts related to soils of these regions. This effect will be accomplished through a departmental tropical soils research program in three major ecological regions of tropical Latin America, visiting lecturers, and active involvement in teaching programs.

Goals

The grant awarded to North Carolina State University under section 211(d) of the Foreign Assistance Act of 1966 is entitled: "A Grant to

Strengthen the Capabilities of North Carolina State University in Special Problems of Tropical Soils." The field of concentration is soil fertility relating plant nutrition to the physical and chemical properties of humid tropical soils. The grant is for a five-year period; the initiation date was November 2, 1970. It is administered through the Soil Science Department and will be used to:

(1) Establish a senior faculty professorial position in tropical soils, who will serve as the project leader and will coordinate efforts with those of the other four cooperating universities and other departmental research activities in the tropical regions.

(2) 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) Provide exchange graduate assistantships so that students of the four cooperating institutions may have access to special strengths of North Carolina State, for example, courses, consultation or use of research facilities, not available at the institutions in which they are enrolled.

(4) Provide graduate research assistantships for students in tropical soils in North Carolina State degree programs.

(5) 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 and agencies.

(6) Modify existing soil courses and develop new courses in tropical soils for use by AID and other personnel involved in tropical soil and crop management and related activities in the less developed countries.

(7) Strengthen library and other informational services and provide support for the preparation of training materials on soil and crop management in the tropics.

Major Accomplishments

Teaching: Dr. M. G. Cook participated in a workshop in the summer, 1971, on course content and teaching concepts on temperate and tropical soils with emphasis on the latter. The workshop was sponsored by the Consortium and hosted by the University of Hawaii. Dr. Cook is in-charge of undergraduate programs in Soil Science at North Carolina State University and is coordinator of graduate course offerings.

Three members of the faculty who are engaged in teaching undergraduate and graduate level courses have made on-site visits to tropical regions under sponsorship of the grant. The information obtained from study and observations of local conditions and consultation and discussions with local soil scientists on the unique properties and management of soils in the tropical regions has been used in modification of courses which they teach. The courses involved, the instructors and the nature of the modification follows:

1. Introductory Soils, SSC 200, Dr. M. G. Cook.

The interaction of soil forming factors, especially time, is discussed with a different emphasis as a result of observing soils whose genetic variables are different from those in the continental United States. More attention will be given to the hydrous oxide clays, their physical and chemical behavior and implications in soil usage.

2. Soil Classification, SSC 452, Dr. M. G. Cook.

More attention is given to the characteristics and classification

of the Oxisols. Important suborders, for example, Andepts, have been added to those discussed previously. Criteria for soil classification is discussed more fully with the additional knowledge of soil properties in tropical and subtropical regions.

2. Soil Mineralogy, SSC 553, Dr. M. G. Cook.

Considerably more time is being allocated to the structure, composition, behavior and practical implications of hydrous oxide clays. Methods for mineralogical analysis of soils high in hydrous oxides and amorphous materials are receiving more attention since such analyses may be conducted and interpreted somewhat differently than those for soils containing primarily silicate clays.

3. Soil Fertility, SSC 541, Dr. E. J. Kamprath.

In the discussion of soil acidity and liming, similarity in the cation saturation of the highly weathered acid soils of the tropics and the acid soils of the southeastern United States is discussed. The response to liming of tropical soils is related to neutralization of exchangeable aluminum which is obtained at relatively low rates, 1 to 2 tons/ha. The similarity of the reactions of fertilizer phosphorus in the soils of tropical regions to those in the southeastern United States is discussed. The extremely high phosphorus fixation of volcanic ash soils containing allophane and its implication in applying fertilizer phosphorus is discussed. Examples from tropical regions will be included in the discussion on the various topics covered in the course.

4. Soil Genesis and Classification, SSC 551, Dr. S. W. Buol.

Photographs were taken of soil profiles and their geomorphic position on the landscape and they will be used to document and serve as reference for

discussions on the genesis and classification of soils of the region. They include Tropudalfs, Tropaqualfs, Tropudults, Tropofluevents, Tropaquepts and Paleudults from the Amazon Basin in Peru and Tropaquepts, Quartipsamments and Tropudults from the coastal plain, deep-sand areas and inland savanna of Guyana. Also, micromonoliths were prepared from these soils for use in displays and study in our tropical soils work. The trips have provided valuable experience, which greatly increase the fluency and confidence of the professor in speaking, culture, and management practices in tropical areas.

Research: There currently are two students on doctoral degree programs funded under the 211(d) grant. Their research programs are making direct contributions to the department's knowledge and expertise on tropical soils.

1. Mr. Michael A. Granger is a native of Guyana. The objective of his research is to compare the potassium release characteristic of certain soils from eastern North Carolina with those of related soils in Guyana. The information obtained from this study will be useful in evaluating the extent to which data on certain fundamental properties of soils from temperate regions can be extrapolated, for practical application, to the management of soils in tropical regions. This research is under the direction of Dr. S. W. Buol.

2. Mr. Fred T. Turner was formerly a research fellow with the Ford Foundation and located in India. The objective of his research is to study the phosphorus availability characteristics of soils used for paddy rice production in tropical regions. The information acquired will be useful in considerations on the use of soil testing as a guide in phosphorus fertilization of paddy rice. This research is under the direction of Dr. J. W. Gilliam.

The department is engaged in several research programs under a Tropical Soils Research Project funded by AID, (Contract AID/csd 2806). This work is highly complementary to the objectives of the 211(d) grant. Information obtained from investigations on soil test-fertilizer response correlations and on methods of analyses conducted by personnel working jointly on the 211(d) program and the International Soil Fertility Evaluation and Improvement project (AID/la 646) are making valuable contributions to the overall understanding of tropical soils by the entire faculty.

Services and Consultation: Drs. W. V. Bartholomew, R. B. Cate, Jr., J. W. Fitts, P. A. Sanchez and D. L. Waugh were invited by USAID/India to participate in the presentations and discussions at the International Symposium on Soil Fertility Evaluation in New Delhi in February, 1971. Dr. J. W. Fitts provided consultation on the use of soil testing as a guide to fertilizer use at the Southeast Asia Soils Research Institute in Kyoto, Japan. Dr. W. V. Bartholomew discussed nitrogen fertilization at various institutes in Thailand and the Phillippines. Dr. P. A. Sanchez serves on the advisory committee on rice fertilization to the Tennessee Valley Authority and is involved in testing slow release nitrogen fertilizers in Peru. Drs. S. W. Buol and P. A. Sanchez consulted with the Peruvian Ministry of Agriculture on matters pertaining to the establishment of a research center in the Selva region to study soil management under shifting cultivation, including a soil characterization study of the proposed property. Drs. P. A. Sanchez and C. B. McCants presented papers at a symposium on nitrogen use in the tropics sponsored by the Colombian Society of Soil Science and consulted with soil scientists at Palmira and the Llanos Orientales. Drs. C. B. McCants and P. A. Sanchez discussed with the

Guatemalan Ministry of Agriculture and USAID soils problems needing attention and experimental procedures in that country. CIAT invited Dr. P. A. Sanchez to present a paper on agronomic practices for new rice varieties at the recently held Seminar on Rice Policies in Latin America. Dr. Sanchez returned to Peru to make further arrangements for establishing the shifting cultivation station in the jungle and attended the annual agronomy review meeting of the National Rice Program.

The faculty of the department cooperated with the International Soil Fertility and Improvement Project in conducting its annual seminar for approximately 25 participants from tropical regions. Participation was in the form of lectures, guided tours and personal consultation.

An average of three visitors per month from tropical regions are programmed through the department. These visitors generally are seeking information to aid in the understanding and management of their soils. The ability of the faculty to speak from a base of personal experience gives further weight to the impact of their consultation with these influential people.

Involvement of Other University Resources: The specific activities made possible through the 211(d) grant are interrelated with the other teaching, research, and extension programs of the department. This favorable condition results from the interaction of personnel involved in the various programs and the prevailing high level of interest among the faculty on soils of the tropics. Major interaction occurs with the following other University programs.

1. Tropical Soils Research Project (Contract No. AID/csd 2806). Personnel involved in the 211(d) grant are also serving as project leaders

on this contract. It's major objectives are to acquire technical information related to fertilization and management of soils of the tropics with special emphasis on three major ecological regions of tropical Latin America and factors pertaining to the use of soil testing as a guide to fertilizer recommendations.

2. International Soil Fertility Evaluation and Improvement Project (Contract No. AID/la 646). The objective of this program is to provide technical assistance in the development and operation of soil fertility evaluation and improvement programs in selected countries in Latin America including the establishment and operation of soil testing laboratories. Personnel involved in the 211(d) program are also serving as short-term consultants in the la 646 project.

3. Peruvian Rice Program. Dr. P. A. Sanchez, who is employed as Assistant Professor of Tropical Soils through funds provided by the 211(d) grant, is actively involved as a soils management advisor to the rice program in Peru. Prior to appointment to this position, Dr. Sanchez worked for three years as Coleader of the National Rice Program in Peru, being actively involved in rice fertilization research in the Coast and Selva regions.

4. Peruvian Potato Program. Dr. R. E. McCollum, Associate Professor in the Soil Science Department, is now and has been for six years an active consultant on soil fertility matters pertaining to the National Potato Program of Peru. He was stationed in Peru for two years with responsibility for soil fertility research on potatoes. He will become increasingly involved in other projects related to the objectives of the 211(d) grant.

5. Graduate Training. The faculty of the department is involved in programs leading to advanced degrees in Soil Science for the following students from tropical regions.

Name	Degree	Country	Sponsor
Benavides, Servio	Ph.D.	Colombia	ICETEX
Chuntanaparb, Nilprapai	M.S.	Thailand	Rockefeller
Ezeta, Fernando	Ph.D.	Peru	AID
Granger, Michael	Ph.D.	Guyana	AID
Khomvilai, Somchai	M.S.	Thailand	Thailand Govt.
Lepsch, Igo	M.S.	Brazil	Brazilian Govt.
Lugo, Hector	Ph.D.	Puerto Rico	NCSU
Manzano, Amado	M.S.	Bolivia	AID
Mendez, Jose	M.S.	Panama	AID
Soepardi, Goeswono	Ph.D.	Indonesia	AID
Tan, Keat	Ph.D.	Malaysia	NCSU
Tonapa, Sampe	Ph.D.	Indonesia	NCSU
Villagarcia, Sven	Ph.D.	Peru	Rockefeller

Personnel: The following personnel in the Soil Science Department have been actively involved in 211(d) grant related activities:

Dr. C. B. McCants, Professor and Department Head

Dr. P. A. Sanchez, Assistant Professor, Tropical Soils

Dr. W. V. Bartholomew, Professor

Dr. S. W. Buol, Professor

Dr. M. G. Cook, Professor

Dr. F. R. Cox, Associate Professor

Dr. G. A. Cummings, Associate Professor

Dr. J. W. Fitts, Professor

Mr. M. A. Granger, Graduate Student

Dr. E. J. Kamprath, Professor

Dr. J. F. Lutz, Professor

Dr. R. E. McCollum, Associate Professor

Mrs. Mary Moore, Secretary

Mrs. Patricia Patrick, Research Technician

Mr. F. T. Turner, Graduate Student

Dr. J. L. Walker, Visiting Associate Professor

Plan of Work for Next Year

Teaching: Dr. P. A. Sanchez is developing the syllabus for a graduate level course on "Properties and Management of Tropical Soils." This course will be offered annually to graduate and advanced undergraduate students. The "Colloquium on Tropical Soils", which has been conducted for several years, will be conducted again in 1972.

The content of all courses offered by the department will be analyzed further and, where appropriate, subject matter on the unique properties of tropical soils will be incorporated into the course.

Additional graduate student programs will be initiated for domestic and foreign students interested in tropical soils.

Plans are in the advance stage for Dr. John K. Coulter, who has had extensive experience in the tropics, to visit the campus as a visiting lecturer under the sponsorship of the 211(d) grant. It is our hope that arrangements can be made for Mr. Carlos Zamora of Peru and Mr. Marcelo Camargo of Brazil to also spend some time on the campus as visiting lecturers.

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

Research: Specific plans are being developed to initiate research on soils-related problems in the countries listed below to provide the faculty with additional knowledge and experience on properties and management of tropical soils. A portion of the work will be performed in the tropical region of the country and a portion on the Raleigh campus.

1. Guatemala: Studies on nitrogen and micronutrient fertilization in the Pacific Coast lowlands and volcanic ash highlands.

2. Colombia: A study of the composition and classification of selected soil profiles from tropical humid (rain forest) area of southeastern Colombia.

3. Panama: Correlation of soil test results with crop response to fertilizer.

4. Bolivia: Correlation of soil test results with crop response to fertilizer.

5. Peru: Studies on the properties and management of soils under shifting cultivation.

6. Brazil: Studies on the physical, chemical and nutritional problems of soils of the Camp Cerrado.

Services and Consultation: On-site visits will be made to the countries where related research will be conducted to obtain soils for intensive study, to secure background information and, where appropriate, to initiate on-site research. These activities will be closely coordinated with local soil scientists working with universities, ministries of agriculture and foundations (for example, IRRI, CIAT and CIMMYT).

Continued emphasis will be given to coordinating the activities sponsored by the 211(d) grant with those under the Tropical Soils Research Project and the la 646 project to insure that the expertise of the department in tropical soils is strengthened and its overall contributions to international soil science is advanced.

Plans are being developed to participate in a special seminar in Idadan, Nigeria in the spring of 1972 to discuss the identification of priority problems on soils of the tropical area of Africa. Field trips will be made to several countries in the tropical regions of Africa to gain additional on-site experience on tropical soils.

Expenditures

International Travel

Name: J. W. Fitts

Travel Points: Portugal, Spain, Japan and Hawaii

Date: January 19 - March 21, 1971

Purpose of Trip: To participate in seminars, symposiums and conferences relative to soil fertility evaluation.

Accomplishments: Advantage was taken of an assignment to India with the Ford Foundation to visit Portugal, Spain, Japan and Hawaii to become acquainted with their soil fertility evaluation programs. In Portugal, visits were made to the National Agricultural Research Station at Qeiras, the Ministry of Agriculture, and the soils laboratories at the University. In Spain, time was spent at the National Research Institute where several conferences were held with the staff relative to their research and educational programs and two seminars were presented to the

staff. The visits in Japan included the National Research Institute in Tokyo, Kyoto University in Kyoto, and the Southeast Asia Soils Research Institute in Kyoto. A seminar on soil fertility evaluation was presented at Kyoto University. A trip was made to a reclaimed area near Kyoto and also to two of their field research stations where both their field and laboratory studies were reviewed. Most of the time in Hawaii was spent at the Rice Training Center and Research Station on the island of Kauai studying the programs in progress.

Cost: $441.20

Name: M. G. Cook

Travel Point: Puerto Rico

Date: April 11-16, 1971

Purpose of Trip: Participate in the 211(d) Executive Committee meeting, plan teaching workshop to be held in Hawaii, and study local soil characteristics.

Accomplishments: Individual professional proficiency was enhanced significantly as a result of on-site observations and discussions of soils in tropical and subtropical regions. The characteristics and usage of soils in such regions generally are in contrast to soils of temperate regions. Consequently, the knowledge gained has increased the competence to advise the large number of international undergraduate and graduate students in our department concerning their native soils problems.

Cost: $291.20

Name: C. B. McCants

Travel Point: Puerto Rico

Date: April 11-16, 1971

Purpose of Trip: To attend Executive Committee meeting of 211(d) Consortium and visit soils research sites in Puerto Rico.

Accomplishments: Plans were initiated for the Tropical Soils Teaching Workshop held in Hawaii in July and other business matters pertaining to the Consortium were discussed with other members of the Executive Committee. Plans for the next meeting of the Executive Committee were made. Visits to research stations and examination of soil profiles and management systems contributed to an improvement in knowledge and understanding of the soils of Puerto Rico which is useful in consideration on other soils of the tropics.

Cost: $325.95

Name: W. V. Bartholomew

Travel Points: Thailand and the Phillippines

Date: February 19-25, 1971

Purpose of Trip: To observe and review soil fertility problems and research in Thailand and the Phillippines and to study organization of short-time training at the International Rice Research Institute.

Accomplishments: A study was made of the management of the flat, poorly drained aluvial soils along the rivers. They are referred to as cat clays with subsoils containing sulfides. The methods in use involve construction of shallow surface drains to remove surface water and permit the topsoil to stay aerobic but keep the subsoils anaerobic and

in a reduced state of oxidation. Information was obtained on management experiments in progress at the International Rice Research Institute at Las Banos, the Phillippines. Included in this study are systems which permit the year-round production of crops on a given site. Studies were also made on the training procedures used by the Institute for professional and subprofessional personnel.

Cost: $163.19

Name: S. W. Buol

Travel Point: Peru

Date: May 26 - June 4, 1971

Purpose of Trip: Locate representative sites for soil experiments in the selva region and develop personal contacts with Peruvian soil survey personnel to attain a better working knowledge of humid tropical soils.

Accomplishments: The trip provided a valuable opportunity to merge soil fertility and soil survey experience and data. During the trip, Peruvian agronomos provided a demonstration of how these disciplines can cooperate. A very suitable site was established for a research station to be used by the Peruvian government and it was decided that the site selected also had great potential as a "field station" to train graduate students in shifting cultivation problems of forested tropical soils.

Cost: $731.56

Name: M. G. Cook

Travel Point: Hawaii

Date: July 7-25, 1971

Purpose of Trip: To represent North Carolina State University in the Tropical Soils Teaching Workshop sponsored by the Consortium.

Accomplishments: Additional professional proficiency was obtained as a result of on-site observations and discussions of soils in this tropical region. During the workshop, profitable discussions were held with representatives of the member institutions of the Consortium concerning the dissemination of soils information peculiar to tropical regions. The information and procedures are being incorporated into our present courses.

Cost: $716.25

Name: S. W. Buol

Travel Point: Guyana

Date: August 8-22, 1971

Purpose of Trip: To work with graduate student (Michael A. Granger) to obtain soil samples for use in his Ph.D. research program. The sampling sites were studied to provide a field evaluation for interpretation of the laboratory results.

Accomplishments: The trip yielded samples from two major soil types extensively used in agriculture in the coastal plains of Guyana for experimentation in the course of Mr. Granger's thesis. The experience also provided an opportunity to observe water control measures in sugar cane production on acid sulfate "cat clay" soils. A seminar was presented for the research workers at Mon Repos.

Cost: $527.01

Name: Michael A. Granger

Travel Point: Guyana

Date: August 10-23, 1971

Purpose of Trip: To collect samples for use in Ph.D. research and to study sampling area to provide a field evaluation for interpretation of analyses of samples.

Accomplishments: The samples required for the thesis research were taken and characterization data obtained on the sample sites. A study was made of the agricultural situation in the country with respect to those aspects that relate to the professional training program. This information is useful in guiding modifications in the graduate program to make it more relevant to tropical soil conditions.

Cost: $624.76

Name: P. A. Sanchez

Travel Points: Colombia and Guatemala

Date: August 29 - September 11, 1971

Purpose of Trip: To present a paper and participate in the meetings of the Colombian Society of Soil Scientists; to visit experimental sites in Colombia and to discuss with Colombian soil scientists matter of mutual interest on the characteristics, fertilization and management of tropical soils; to visit agricultural regions in Guatemala and consult with Guatemalan soil scientists and AID mission personnel.

Accomplishments: The paper "Nitrogen Fertilization of Rice" was presented at the Colombian Society of Soil Scientists and numerous informal discussions were held with various participants at the meeting. Visits were made to CIAT headquarters at Palmira and to the CIAT-ICA

experimental area at Carimagua in the Llanos Orientales. At each site, discussions were held with project leaders on the objectives, accomplishments and problems encountered in their research. In Guatemala, conferences were held with local soil scientists, the regional director of NCSU's International Soil Fertility Evaluation and Improvement Program and local AID mission personnel. Tentative plans were developed to involve personnel from the Ministry of Agriculture, the agronomy faculty of the University, and the local mission in 211(d) related activities of North Carolina State University.

Cost: $718.26

Name: C. B. McCants

Travel Points: Colombia and Guatemala

Date: August 28 - September 8, 1971

Purpose of Trip: (1) To present paper and participate in the meeting of the Colombian Society of Soil Scientists; (2) to visit experimental sites in Colombia and discuss with Colombian soil scientists matters of mutual interest on the characteristics, fertilization and management of tropical soils; and (3) consult with Guatemalan soil scientists and AID mission personnel on soils related problems.

Accomplishments: A paper "Nitrogen Movement in Soils" was presented at the Colombian Society of Soil Scientists and numerous informal discussions were held during the course of the colloquium with a substantial number of people attending the meeting. Visits were made to the CIAT headquarters and field sites at Palmira and to the CIAT-ICA experimental area at Carimagua in the Llanos Orientales. At each place, discussions

were held with project leaders on the objectives, accomplishments and problems encountered in their research. In Guatemala, conferences were held with local soil scientists, the regional director of NCSU's International Soil Fertility Evaluation and Improvement Program and the local AID mission personnel. Tentative plans were developed to involve personnel from the ministry of agriculture, the agronomy faculty of the University and the local AID mission in 211(d) related activities of North Carolina State University.

Cost: $690.14

Other Expenditures

Salaries and Wages	$5,799.80
Fringe Benefits	79.91
Travel, Domestic	55.20
Telephone Service	156.00
Transportation of Soil Samples	69.60
Supplies	19.79

Budget

Summary of 1970-71 expenditures and projected expenditures for remainder of grant period.

	1970-1971	1971-1972	1972-1973	1973-1974	1974-1975
Salaries and Wages, Total	5,800	73,905	87,568	92,075	103,282
Eligible for fringe benefits	1,075	40,973	45,070	49,577	54,535
Visiting professors	0	8,332	12,498	12,498	18,747
Graduate assistants	4,725	21,600	27,000	27,000	27,000
Subprofessional assistance	0	3,000	3,000	3,000	3,000
Fringe Benefits	80	5,818	6,400	7,040	7,744
Travel, Total	5,304	14,000	17,000	19,000	19,000
Faculty, international	4,604	12,000	12,000	12,000	12,000
Faculty, national	55	1,000	1,000	1,000	1,000
Graduate students, international	645	1,000	4,000	6,000	6,000
Communications	156	600	800	800	800
Contractual	70	1,000	2,500	3,000	3,000
Supplies	20	2,294	3,722	3,094	2,128
Equipment	0	4,000	3,000	3,000	3,000
TOTAL	11,430	101,617	120,990	128,009	137,954