9310525 (6)

RESEARCH (On-going) -11

PD-AAC-887

PROJECT SUMMARY

Major Type of Activity: Key Problem Area, Water and Tropical Soils Management

Project Title: Agronomic-Economic Research on Tropical Soils

Contractor: North Carolina State University

Contract Number: AID/csd-2806

Contract Liaison Officer: Dr. W.D. Toussaint, Dr. R.J. McCracken, Dr. J.A. Rigney
Title: Prof. Agr. Econ, Prof. Soils, Dean Intl. Pro.

Project Number: 931-17-120-525 — 525
Present: 73-3102731

Project Duration: Started 6/30/70 Termination Date 6/30/75

Budget:
a) Funds obligated through FY 69 : $ -0-
b) Funded for FY 70 : 339,000
c) Funds requested for FY 71 : -0-
d) Estimated fund requirement FY 72: 375,000

TA/AGF Project Monitor: Dr. Alvin D. Ayers

Purpose: Basic soil chemistry-soil fertility relationships have not been keyed to agronomic-economic studies in LDCs. The objectives of this research are (1) to develop methodology for an economically sound system of making fertilizer recommendations based on information gained from soil analyses and fertilizer crop response data, primarily from Latin America, for developing countries in tropical regions and (2) to obtain basic soil fertility-soil chemistry data as needed to support (1) above.

Description of the Project: Economic and agronomic soil activities in the project are to be integrated and interrelated as one program. The specific work plan for each area follows:

1) Agronomic-economic yield evaluation: (a) Existing soil fertility-yield response data will be processed in a manner suitable for analyses; (b) analytical models for extracting information from limited data will be evaluated on basis of theoretical and operational acceptability; (c) analytical model (s) selected will be used to examine the collected data; (d) experiments will be designed to fill in critical data gaps.
2) Agronomic soils aspects: (a) Basic soil fertility-soil chemistry studies will be initiated only as needed to support the agronomic-economic studies. It is expected these studies may include (1) nitrogen fertilization, (2) phosphorous fertilizers, (3) liming (4) micronutrients. (b) Basic soil characterization in support of agro-economic evaluation may include: (1) soil mineralogy data from key sites and (2) soil physical properties. (c) Contractor shall obtain soil moisture and climatic data as needed to aid in explaining and interrelating yield potential and fertilizer response.

Future Plans: This project will be coordinated with the AID/Cornell University fertility project, TVA, CIAT, CIMMYT and other AID-sponsored activities relating to tropical soils management and crop production.

TA/AGF:D.Blake: 7/15/70; revised 8/10/70

9310525 (7)

PD-AAC-887

PROJECT AUTHORIZATION AND REQUEST FOR ALLOTMENT OF FUNDS

PART II

ENTITY: DS Bureau

PROJECT: Agro-Econ Research on Tropical Soils-NCSU

PROJECT NUMBER: 931-0525.11

I hereby authorize $85,000 in grant funds for a three month extension (from January 1, 1979 to March 31, 1979) of the project "Agro-Economic Research on Tropical Soils" with North Carolina State University. This extension will provide the time necessary to develop adaptation and application activities based on past research findings. This extension and future adaptation and application activities are in direct support of the A.I.D. Missions and Governments in Peru and Bolivia.

for Sander Levin
Assistant Administrator
for Development Support

Date: 12-30-78

Clearance:
DS/AGR/TSWM:JMalcolm 11/30/78
DS/AGR/TSWM:GCorey 12/6/78
DS/AGR:MMozynski
DS/AGR:DPeterson 11/3-/78
DS/PO:MRechcigl 12/1/78
DS/PC:RSimpson 12/21/78
DAA/FN/DS:TBabb
LA/DR:JBalis
Reference:
1. Action Memo: Peterson to AA/DS

AGENCY FOR INTERNATIONAL DEVELOPMENT

PROJECT AUTHORIZATION AND REQUEST FOR ALLOTMENT OF FUNDS PART I

1. TRANSACTION CODE: [A] A ADD C CHANGE D DELETE — PAF

2. DOCUMENT CODE: 5

3. COUNTRY/ENTITY: DS/AGR RDA-4
Type a. Research

4. DOCUMENT REVISION NUMBER: 2

5. PROJECT NUMBER (7 digits): [931-0525.11]

6. BUREAU/OFFICE: A. SYMBOL: DSB; B. CODE: [10]

7. PROJECT TITLE (Maximum 40 characters): [Agro-Econ Research on Tropical Soils-NCS]

8. PROJECT APPROVAL DECISION — ACTION TAKEN: [ ] A APPROVED D DISAPPROVED DE DEAUTHORIZED

9. EST. PERIOD OF IMPLEMENTATION: YRS. [0 0] QTRS [1]

10. APPROVED BUDGET AID APPROPRIATED FUNDS ($000) (For 3-month extension)

A. APPROPRIATION	B. PRIMARY PURPOSE CODE	PRIMARY TECH. CODE C. GRANT	PRIMARY TECH. CODE D. LOAN	E. thru 9/31/78 F. GRANT	E. thru 9/31/78 G. LOAN	H. 1st FY 79 I. GRANT	H. 1st FY 79 J. LOAN	K. 2nd FY 80 L. GRANT	K. 2nd FY 80 M. LOAN
(1) FN	141J	953	–	2,751	–	85	–	0	–
(2)									
(3)									
(4)									
TOTALS				2,751	–	85	–	0	–

A. APPROPRIATION	N. 3rd FY 81 O. GRANT	N. 3rd FY 81 P. LOAN	Q. 4th FY 82 R. GRANT	Q. 4th FY 82 S. LOAN	LIFE OF PROJECT T. GRANT	LIFE OF PROJECT U. LOAN
(1) FN	0	–	0	–	2,836	–
(2)						
(3)						
(4)						
TOTALS	0	–	0	–	2,836	–

11. PROJECT FUNDING AUTHORIZED (ENTER APPROPRIATE CODE(S)) 1 - LIFE OF PROJECT 2 - INCREMENTAL, LIFE OF PROJECT

A. GRANT	B. LOAN
2	–

C. PROJECT FUNDING AUTHORIZED THRU FY [7 9]

12. INITIAL PROJECT FUNDING ALLOTMENT REQUESTED ($000)

A. APPROPRIATION	B. ALLOTMENT REQUEST NO. C. GRANT	B. ALLOTMENT REQUEST NO. D. LOAN
(1) N.A.		
(2)		
(3)		
(4)		
TOTALS		

13. FUNDS RESERVED FOR ALLOTMENT

TYPED NAME (Chief, SER/FM/FSD)

SIGNATURE

DATE

14. SOURCE/ORIGIN OF GOODS AND SERVICES: [X] 000 [ ] 941 [ ] LOCAL [ ] OTHER _____

15. FOR AMENDMENTS, NATURE OF CHANGE PROPOSED

This amendment provides for a three month extension, thru March 31, 1979, requiring $85,000 in additional funds for the subject project. The scope of work and other conditions of the project remain the same.

FOR PPC/PIAS USE ONLY	16. AUTHORIZING OFFICE SYMBOL	17. ACTION DATE MM DD YY	18. ACTION REFERENCE (Optional)	ACTION REFERENCE DATE MM DD YY

NOV 30 1978

ACTION MEMORANDUM FOR THE ASSISTANT ADMINISTRATOR FOR DEVELOPMENT SUPPORT

THRU: DAA/FN/DS, T. Babb

FROM: DS/AGR, Dean F. Peterson

SUBJECT: Three month Administrative Extension requiring $85,000 for the research project "Agro-Economic Research on Tropical Soils" with North Carolina State University

Problem: Your approval is required for a three month $85,000 extension of this soils research project. This extension and future adaptation/application activities together will allow the Latin America Bureau, USAID La Paz and USAID Lima to program for continuation of these activities currently funded by DS/AGR.

Discussion: North Carolina State University (NCSU) initiated the subject A.I.D. funded research activities in FY 1970. A total of $2,751,000 have been obligated for this project since then. This project is currently being implemented by NCSU under contract AID/ta-c-1236 which DS/AGR originally intended to terminate in June 1978. A six month unfunded contract extension was recently made which now carries the project through December 31, 1978.

When the two A.I.D. missions in La Paz, Bolivia and Lima, Peru became aware of DS/AGR's serious intention to terminate this project, they requested that the project be continued with DS/AGR funding until such time (hopefully by early FY 80) when they would have budgeted funds and developed their own projects to continue NSCU's soil research and related activities in their respective countries. The future plans of these two missions reflect the strong interest and involvement of the governments of Bolivia and Peru in NCSU's past, current and future work on soils in their countries.

Currently NCSU has active field research in progress at Yurimaguas, Peru along the upper reaches of the Amazon, at San Ignacio, Bolivia, and at Planaltina near Brazilia. The work in the Peruvian jungle dates back to 1973 and demonstrates a viable pattern for development of permanent agriculture on the acid soils of the upper Amazon. The research

plots at San Ignacio, in a mixed savannah and jungle region, have shown the potential of these soils but have not been followed long enough to uncover second and third generation problems which will almost certainly arise.

The work in Brazil will be taken over by EMBRAPA scientists. Continued research is needed in the other two regions but there is also an urgent need to carry research results to farmer's fields and test them under the local physical and economic constraints. Settlement of both areas is now taking place and will continue. If it is guided along lines which will protect the soil and assure consistently good production, permanent communities will flourish. If uncontrolled land clearing and exploitive farming become the pattern, fields will yield two or three crops and revert to jungle. NCSU's soil research has established that yields can be sustained with lime, fertilizer and systematic crop rotation. The optimum mix of practices given the farmer's resources has yet to be worked out.

The missions in La Paz and Lima have forwarded requests from their host governments that this project be continued. The missions are equally supportive and the contractor, North Carolina State University is prepared to continue. There is no other contractor with field research experience in the two areas under consideration. No other contractor has established ties with the host governments in general and the officials on site in particular.

In order to facilitate the two mission's needs for time to budget and develop their own projects in conjunction with NCSU and also to avoid a break in continuity of NCSU's soil activities in Latin America, DS/AGR feels that two actions are appropriate at this time. First is a final three month funded project extension ($85,000) through March 31, 1979 of NCSU's research work on soils as currently approved and spelled out in the existing contract. Second is a nine-month funded project extension from April 1, 1979 through December 31, 1979 ($355,000 approx. costs) of NCSU's soils activities which would be specifically adapted and applied for direct support of future Peru and Bolivia USAID's funded projects/programs which hopefully will in effect by January 1, 1980. The scope of work for the nine month DS/AGR funded adaptation and application extension will be developed for, and spelled out in, a separate action to be submitted for your approval in early January 1979.

KPA-4
525

PROJECT STATEMENT COPY 9310525 ①

PD-AAC-887

A. Project Summary

1. Statistical

Project Title: Agronomic-Economic Research on Tropical Soils

New or Extension: Extension

Contractor:
Soil Science Department
North Carolina State University
P.O. Box 5907
Raleigh, North Carolina 27607

Principal Investigator: Dr. Pedro Sanchez

Duration:
Current RAC authorization - June 30, 1972 to June 30, 1975
Interim review by RAC - December 3, 1973
Proposed extension - June 30, 1975 to June 30, 1978

Total Estimated Cost:

Through June 30, 1975		$1,226,337
Current Year	FY 1975	524,873
	FY 1976	552,092
	FY 1977	582,646
Estimated 3 year total		$1,659,611
Cumulative total		$2,885,948

Project Manager: John L. Malcolm

2. Narrative

Work on this project has been divided into two phases. First, an assessment of pertinent work was summarized in a Review of Soil Research in Tropical Latin America, published in both English and Spanish. Second, based on the assessment and opportunities for constructive cooperation, field work was begun in three areas: on the Oxisols of the Campo Cerrado of Brazil, on the Ultisols of the Amazon jungle at Yurimaguas, Peru and on Andosols in Central America,-- Guatemala, El Salvador, and Costa Rica.

Control of active aluminum is clearly the key to managing the soils of the Campo Cerrado. The multiple interactions among crops, soils and treatments have been demonstrated. Liming at low rates with deep incorporation was superior to "optimum" rates restricted to the plowed layer. Lime without zinc induced zinc deficiency. Phosphates were most effective when part was broadcast and part banded. Deep liming permitted roots to penetrate using both soil water and nutrients more efficiently.

In the Amazon jungle traditional slash and burn gave better results than mechanical clearing, was more economical and fitted the resources of small farmers. With slash and burn rainfall infiltration rates were higher, nitrification more rapid and nutrient recovery better. Even at the highest rates of fertilizer application, yields on bulldozed plots did not reach those cleared by the traditional method after three crops.

In Central America multiple cropping received principal attention. Highest total food production per acre per year was obtained by mixed cropping but crop, variety, timing and management were all critical. The use of forage sorghum for winter feed was demonstrated in El Salvador and is being actively promoted by the extension service there.

Economic analysis of accumulated fertilizer trial data showed the value of a simple plot of responses and basing recommendation on a simplified soil classification system. With this technique no complex calculations are required.

Throughout, this project has cooperated actively with other universities, especially Cornell at Brasilia, host government institutions, CATIE at Turrialba, Costa Rica and the international agricultural research centers, notably CIAT, CIP and CIMMYT.

This project was reviewed on October 23, 1974. Technical progress has been highly satisfactory and the commitment of the North Carolina faculty far exceeds the budgeted time. The involvement of foreign nationals in research on problems of the developing countries was recognized as a particular contribution toward AID's longterm objectives. Twenty-five graduate students, representing 14 countries have taken part in the research so far. Nine have served for extended periods in Brazil or Peru.

Extension of the project for at least another three years is critical. The residual effects of liming and fertilizer appli-

cations should be measured. The interactions of soil and trea
ment must be studied further. New work in new areas will only
delay these answers. More economical ways to achieve similar
results must be found now that the potential of these soils ha
been demonstrated. Finally, test demonstrations are needed to
transfer the best technology from experiments to field scale
farming. This utilization promotion effort will constitute th
third phase.

B. EXPANDED NARRATIVE AND BUDGET

CONTENTS

B. EXPANDED NARRATIVE AND BUDGET

1. BACKGROUND

1.1 Introduction

The ability of the world to feed its human population has been a major concern during the past two hundred years. The recent successes in increasing wheat and rice production during the late sixties provided the impression that world food production could increase at the same rate as population. The current energy and fertilizers shortage has dispelled this cautious optimism and once more the need to increase world food production at a faster rate than population growth is a top concern of mankind.

Plants grow on soils. Therefore, the field of soil science has played and will continue to play a critical role in increasing world food production. It has been well established that the greatest potential for increasing world food production lies in vast regions of the tropics. Tropical agriculture developed first on soils with high native fertility, mostly in alluvial plains, both in coastal and inland areas. Examples of these are the rice bowls of Southeast Asia, the Central Plateau of Mexico, the Cauca and Mantaro Valleys of the Andes, the Ethiopian highlands, etc. The impact of the "green revolution" is very much limited to these high base status soils, particularly those which are irrigated.

Agricultural development in the temperate region initially followed the same pattern of settling on high base status soils. When farmers ran out of such soils, they started farming low-base status soils, like those of southeastern United States, with fertilization and liming. The extent of a similar pattern in the tropics is limited to small areas, like southern Brazil. Only about 10% of the tropics

(approximately 503 million hectares) are presently under cultivation, most of it on high base status soils. The President's Science Advisory Committee estimated that an additional 1200 million hectares are potentially arable in the tropics. These presently unused or underutilized areas consist of highly weathered Oxisols and Ultisols presently under rainforest or savanna vegetation. It is widely acknowledged that one of the main limiting factors preventing full-scale agricultural development in these regions is the inadequate knowledge of how to manage these highly weathered soils under rainforest or savanna vegetation. The development of soil management systems in these regions should be based on an understanding of what farmers are presently doing, and be aimed at improving the present systems with practices such as fertilization and liming which require the minimum inputs due to high cost of materials and its transportation.

To a lesser degree, food production can be increased in presently highly populated areas characterized by intercropped subsistence agriculture. Farmers in hilly volcanic areas have grown more than one crop at a time for centuries. The fertility management of intercropped systems has been virtually ignored by soil scientists until very recently. Most of the thrust of improving small-sized farming systems are related to high base status soils and monocultures such as paddy rice. An improvement of the productivity of intercropped systems should result in a marked increase in the well-being of such farm communities and increases in food production to local markets.

From its beginning, the Soil Science Department of North Carolina State University has been involved in program related to studies of soil-

ical regions. Noteworthy among these are its graduate program, has trained many tropical soil scientists who now occupy key ership positions in their countries, the Agricultural Mission to ; the 211(d) Institutional Development Grant Program and the Inter- tional Soil Fertility Evaluation and Improvement Program (ISFEIP). the latter program developed soil testing laboratories in several countries, it became apparent that additional constraints needing research answers were required. The present Tropical Soils Research Program was established to answer such a need.

1.2 Program History

The Technical Assistance Bureau of AID organized a concerted attack on solving the previously mentioned soil management constraints in the tropics by awarding two research contracts to Cornell and North Carolina State Universities. Contract AID/csd 2806 was awarded to North Carolina State University on July 1, 1970 for a five year period. The project objectives were "to develop methodology for an economically sound system of making fertilizer recommendations based on information gained from soil analysis, fertilizer response, soil chemistry and soil fertility data primarily from Latin America for developing countries in tropical regions". The work plan consisted of two phases. Phase I involved a review and analysis of present knowledge, identification of priority research problems and development of a research strategy to solve these problems. Phase II consisted of generating the needed information from field and laboratory studies and devising means for extrapolating the results to other areas with similar ecological conditions

The objectives of Phase I were achieved in the first two years. A comprehensive review of the literature and other sources was prepared by

roject staff and published in English and Spanish as "A Review of s Research in Tropical Latin America". Travel to several countries determine potential areas for field research and cooperation of tional and international research institutions took place within this period. As a result of the literature review, travel, suggestions for LDC scientists as well as ISFEIP staff, a research strategy developed. The most crucial research needs not likely to be solved by other ongoing projects were to improve food production via improved soil management in the tropical rainforests presently under shifting cultivation, the acid Oxisol savannas virtually unused, and in the highly populated highland areas affected by volcanic activity. A search for representative sites to conduct the necessary field work was made and cooperative agreements were signed with local research indtitutions in each of the three major ecological regions.

Field research programs were initiated in August 1972 in: 1) Yurimaguas, Peru at the Campo Experimental de Yurimaguas of the Ministry of Agriculture in cooperation with that institution, as a representative site for the Amazon Jungle, 2) Brasilia, Brazil at the Centro de Pesquisas Agropecuarias de Brasilia in cooperation with EMBRAPA (formerly DNPEA) and the Cornell University contract, as a representative site of the acid Oxisol savannas and, 3) Throughout Central America with headquarters in CATIE, Turrialba, Costa Rica in cooperation with that institution and the Ministries of Agriculture in Costa Rica, El Salvador and Guatemala.

Campus based activities concentrated on 1) supporting the field programs through soil characterization, soil and plant analyses for certain experimental plots, 2) conducting laboratory and greenhouse research to answer questions posed by the field problems or how far the

could be extrapolated, 3) Economic analysis of crop response to lizers and methodology for optimizing recommendations and 4) Develop- and testing of a Fertility-Capability Classification System as a ns for grouping soils with similar fertility problems which could be sed as a tool for data extrapolation and interpretation.

.3 Progress to Date

The accomplishments of these activities are described in detail in the technical Annual Reports for 1971, 1972 and 1973. The administrative aspects are described in semiannual administrative reports for the periods of July 1970 to June 1972 and in annual administrative reports for FY 1972-73 and 1973-74.

A summary of such accomplishments follows:

Phase I:

The compilation of available research information for Latin America was published as a "Review of Soils Research in Tropical Latin America" in English and Spanish. Definitions of research priorities and research strategy was accomplished during this period. Cooperative agreements with LDC institutions for the initiation of field research were also established

Phase II:

1) Amazon Jungle. Characterization studies of the Amazon Jungle soils indicate that Ultisols rather than Oxisols are the predominant well-drained soils of the Amazon Basin outside of the geological influence of the Guyana and Brazilian shields. These soils have management characteristics quite different from the Oxisols. Phosphorus fixation capacity is much lower than in Oxisols due to coarser topsoil texture and different mineralogy. Experiments on land clearing methods in Ultisols in Yurimaguas showed that the traditional slash and burn practice was superior to

clearing with a bulldozer. Yields of upland rice, cassava, corn, sorghum, and beans were consistently higher in the nd burn systems at several fertility levels. The fertilizer of the ash, the severe compaction measured in the bulldozed s and the movement of the topsoil by the bulldozer blade are the ctors thought to be responsible for these differences. Continuous cropping in this jungle Ultisol is feasible with moderate applications of lime, nitrogen, phosphorus, potassium, and in some instances sulfur, boron, and molybdenum. High yields were obtained with upland rice, cassava, and Panicum maximum pastures. Corn and beans seem to be more sensitive to pests, aluminum toxicity and micronutrient deficiencies. Results to date indicate that the economics of continuous crop production in these shifting cultivation areas will depend largely on the transportation costs of fertilizers and lime.

2) Acid Savannas. Studies in the Campo Cerrado of Brazil indicate that the management of these Oxisols is primarily a matter of fertility and subsoil moisture interactions. Liming to raise the pH to 5.5 in the top 30 cm of the soil increased corn yields and decreased moisture stress during critical short-term droughts that occur during the rainy season. Only a moderate rate of 2 tons/ha when incorporated in the top 30 cm was necessary to produce high corn yields in the first two crops. The estimated investment in lime, about U. S. $20/ha is less than previously thought necessary to eliminate aluminum toxicity to corn in these very acid soils

Although applications of nitrogen, potassium, and zinc are also necessary, the amounts required are also within the economic range. The management of phosphorus, however, is the primary fertility problem due

remely high phosphorus fixation capacity of these Oxisols. Red Latosol" on which the experiments were conducted requires valent of about 2800 kg P_2O_5/ha to provide the desired amount sphorus in the soil solution. Broadcast applications were superior nded applications during the first rainy season crop because they moted more root development which in turn attenuated the effects of hort-term droughts. In the subsequent irrigated dry season crop, banded applications were superior. These results suggest that a corrective level of broadcast phosphorus supplemented by banded applications with each crop may be the best management scheme. The high cost of such phosphorus applications using ordinary superphosphate raises serious economic questions. Other sources such as rock phosphates plus ammendments designed to decrease fixation such as silicates are being evaluated.

Outreach studies on the properties and distribution of Campo Cerrado soils indicate a remarkable uniformity in terms of low fertility, and point out the areas where different results might be expected due to soil or climatic properties.

3) Central American Highlands. A fertilization program for intensive forage sorghum production during the rainy season in northern El Salvador became a simple solution for counteracting the severe weight losses of dairy cattle during the dry season. Heavily fertilized forage sorghum is preserved in inexpensive trench silos and used as the principal source of food during the dry season.

Experiments with upland rice fertilization in Costa Rica indicate that the inorganic nitrogen content in the profile at planting time was related to the type nitrogen response observed. Under these conditions, sulfur-coated urea was not superior to conventional sources.

fort was placed on the fertility-related aspects of multiple ng systems for small farms on soils affected by volcanic ash. al experiments are underway in identifying how to manage ferti- zer applications when more than one crop is grown at the same time. Greenhouse experiments indicate that a large proportion of Costa Rican soils are deficient in sulfur. Initial studies are also underway aimed at eliminating copper toxicity to rice in lands formerly operated as banana plantations.

4) Region-wide Extrapolative Studies. Substantial progress was made in the development of a fertility-capability soil classification system which groups soil having similar fertility management limitations. The first formal version of this system was prepared for presentation at the Tropical Soils Seminar held in Columbia in February, 1974. Initial assessment of the system in a world-wide, country-wide, and a county sample showed that large numbers of soil mapping units can be grouped in a small number of fertility-capability units. For example, most of the 678 soil profiles described in the soil survey reports of Brazil could be grouped into 23 fertility-capability units. All the 145 mapping units of the soil survey of Wake County, North Carolina, were grouped into 15 units.

Preliminary evaluation of this system was made using a series of potato fertilization experiments previously conducted in the Sierra of Peru. All 73 sites could be grouped into five fertility-capability units and each group produced a different response to phosphorus applications. When fertilizer recommendations were made by each group, the economic returns to fertilization increased dramatically. It was also found that this classification system supplements positively soil test criteria.

dence of its u fulness in other areas and pos ble.modi-
are being investigated.

economists refined their concept of profit-prediction cri-
and applied it to various models used in the analysis of corn
ce fertilizer responses in Costa Rica and corn in Minas Gerais,
il. The graphic linear response and plateau model proposed by
gh, Cate, and Nelson gave the best recommendations without the use
a computer or complex calculations. Soil test information appeared
to be of no value when incorporated as Cate-Nelson critical levels
into the linear response and plateau or in the general quadratic model
for the Minas Gerais corn data. The use of soil tests in both models
was useful in increasing the profitability of corn response in the
Costa Rica data.

Additional research projects were conducted throughout the region to supplement the data from priority areas and/or to investigate at depth some critical issues. Soil characterization studies in relation to landscape position were initiated in an Oxisol-Ultisol area in western São Paulo, Brazil, in an Andept area in central Costa Rica, in the Llanos Orientales of Colombia and in the Maracaibo Basin of Venezuela.

Laboratory and greenhouse studies have shown that the lime-phosphorus interactions in certain Oxisols of Panama reflect the field observations in Brasilia. Low soil phosphorus availability is believed to be the principal factor responsible for the low rates of organic matter mineralization in Andepts from Colombia. Diffusion was identified as a major factor accounting for the increased availability of phosphorus in flooded rice soils in India and Peru. The potassium release proper-

of certain Ult. ..ls from Guyana confirm the ex ence of a strong ase of non-exchangeable sources of potassium. More complicated il testing methods than the dilute double acid extractant were not ecessary for estimating available potassium in these soils and in their North Carolina counterparts.

Special emphasis has been made in disseminating these results as quickly as feasible to about 450 tropical soil scientists, institutions, and libraries throughout the world. The first edition of the "Review of Soils Research in Tropical Latin America" was quickly exhausted. A second English printing and a Spanish version were made in order to satisfy the demand.

1.4 Present Status and Outlook

Considerable progress has been made in attaining the contract's objectives. The Phase 1 activities which defined the "State of the Art", specified priorities and formulated the research strategy have been satisfactorily completed. Its impact on present research was greater than anticipated because of the wide use of the publication by many individuals and institutions throughout the world.

Many of the research activities included in Phase II require long term research for adequate completion. No economically sound recommendations can be made for the management of tropical soils based on two years of field results. The basic issues on how to develop continuous cropping in jungle areas under shifting cultivation, how to economically apply phosphorus, lime and micronutrients to savanna Oxisols, and how to apply fertilizers in intercropping systems require the evaluation of residual effects and the initiation of other experiments.

Certain research projects of this contract have been satisfactorily

ed. They include the micronutrient survey in Guatemala, the of Cerrado soil properties in Brazil, the effects of land ring methods in Peru, forage sorghum fertilization in El Salvador upland rice fertilization in Costa Rica. They have either been erminated or have been transferred to local institutions for follow-up ctivities.

During the last two years, both North Carolina State University and the Technical Assistance Bureau have recognized the necessity of formulating more specific objectives for this contract, since the original objective cannot be quantified objectively and does not specify indicators for its satisfactory completion.

Considering that three years of field research is insufficient for making firm conclusions, and the satisfactory performance of the contract, the Soil Science Department of North Carolina State University requests that this contract be revised for an additional three years with more specificity in its objectives and end-of-project indicators. This projected extension does not imply that all objectives can be achieved in three additional years because of the long term nature of certain specific projects.

In the following proposal a third phase of the program is proposed. Phase III would involve extrapolative research in other areas to verify whether or not the results obtained at specific representative locations can be extrapolated to other tropical regions with similar ecological conditions, and the degree of local adjustments needed.

2. RESEARCH PURPOSE AND EXPECTED PRODUCTS

Purpose

To increase food production at minimum cost and improve well-being of small farm families through improved soil fertility and management practices in three important ecological tropical regions.

The contract aims at developing a "package" of economically-sound soil management practices for increasing food production in 1) jungle soils presently under shifting cultivation, 2) acid savanna Oxisols and 3) intercropping systems in volcanic highlands. Such practices could be extrapolated to areas other than where the research is conducted.

The end-of-project status indicators are: the verification that economically-sound soil management practices do increase food production significantly in areas mentioned above and that extrapolation of such packages to other areas within the same ecological regions is possible.

2.2 Objectives: Expected Products

Objective 1): To develop a package of economically-sound soil and fertilizer management practices for increasing food production via continuous cultivation of Jungle soils presently under shifting cultivation. The result of such a set of recommendations when applied at the farm level would be to open large new areas of tropical rainforests for food crop production, on an ecologically-sound basis.

Objective 2): To develop a package of economically-sound soil and fertilizer management practices for increasing food production in acid Oxisol tropical savannas. The result of such a set of recommendations when applied at the farm level would bring into production huge areas of tropical savannas presently not utilized.

Objective 3): To develop a package of economically-sound soil and fertilizer management practices for increasing food production in subsistence intercropped systems small farming operations in highland areas affected by volcanic activity. The result of such a set of recommendations, when applied at the farm level would be to markedly increase the productivity of intercropped systems and the well-being of such farmers.

Objective 4): To develop means for interpreting and extrapolating the products of Objectives 1 to 3 to other areas via economic interpretations, additional greenhouse and laboratory work on campus and through cooperative field trials in other areas. The result of such studies would be the verification (or lack of) of the extrapolability of data from intensive study sites to other jungle and savanna or intercropped volcanic areas.

3. SIGNIFICANCE AND RATIONALE OF RESEARCH

Significance

The need for increasing world food production and improving the quality of life of the poor farmers has been recognized by AID and other donors as a major one. The fact that the greatest potential for increasing world food production lie in vast underdeveloped regions in the tropics is also well recognized. The fact that man's knowledge on how to fertilize and manage such tropical soils is very limited is also well recognized throughout the world. Direct adaptation of the basic principles of soil science developed in non-glaciated temperate regions to tropical soils is possible. Direct adaptation of soil fertility and management practices developed in the temperate regions is seldom possible because of the drastically different climatic economic and social constraints. Improvement in soil management practices for these regions must draw both from the basic principles of soil science (for example, the chemistry of exchangeable aluminum) and from an understanding of the traditional tropical soil management systems per se. Due to the high costs of outside inputs such as fertilizers, lime, pesticides and in many cases farm machinery, the strategy for increasing soil production should be aimed at determining the minimum levels of inputs needed for adequate yields rather than the optimum levels needed for maximum yields.

The recent successes of the "green revolution" programs are limited to the small minority of the tropics with soils of high native fertility and often available irrigation. Before the impact of the new improved varieties can be felt on these vast tropical areas, much more

ledge of how to manage these basically infertile, unirrigated humid ical soils is needed.

The three tropical regions on which this research contract focuses over a large proportion of the tropics. Tropical rainforests cover approximately 30% of the tropical land mass. The largest areas are in the Amazon and Congo Basins and in the hill country of Southeast Asia. A large proportion of the tropical rainforests have similar soil properties and rainfall regime to that found in the Yurimaguas Station. Tropical savannas with acid soils such as those of Brasilia cover approximately 31 percent of the tropical land mass. The largest areas are in the Cerrado and Llanos of South America as well as in central and eastern Africa surrounding the Congo Basin. The areal extent of subsistence intercropping tillage in volcanic areas is difficult to estimate. It is propably less than 5% of the tropics, but the numbers of people involved is substantially larger. In addition to the Central American highlands, similar conditions exist in parts of Indonesia and the Philippines and in the Rift Valley of Africa.

3.2 State of the Art

1)* Although research on shifting cultivation has been conducted for many years in Africa, particularly Belgian, French and British scientists in colonial days, no specific recommendations on how to transform these systems into continuous cropping when population pressures increase have been developed. When this question was asked to African scientists at a meeting on Tropical Soils Research in Ibadan, Nigeria in 1972, none present could say that they had a set of packages which they could recommend to solve this problem. Since 1971, IITA's Farming

---

*These numerals refer to the objectives stated in section 2.

Program has b' n attacking this problem in a ·stematic fashion sonal forested areas with high base status Alfisols. To our knowge, the only other ongoing systematic soils research program on ifting cultivation is this Yurimaguas project. It is also the only ne working on acid soils and the only one in the Amazon basin. The available knowledge on soil management under shifting cultivation was summarized as a chapter in the "Review of Soils Research in Tropical Latin America". Since then significant progress has been made by the IITA and Yurimaguas projects. Neither one is yet advanced enough to provide an answer to Objective 1.

2) The management of acid savanna Oxisols is primarily a matter of determining economic application rates of phosphorus, lime, other nutrients and its interactions with moisture stress. A large body of research information has accumulated particularly in the southern part of the Brazilian Cerrado, the Llanos Orientales of Colombia and parts of Africa. The available knowledge was summarized in various chapters of the "Review of Soils Research in Tropical Latin America" dealing with the individual nutrient problems. A comprehensive review of soil fertility research in the Campo Cerrado appears in Alfredo Lopes' thesis. Several papers presented at the Seminar on Soil Management and the Development Process in Tropical America and in the Simposio sobre Suelos de Sabana, published by Prairie View A & M University have also added further knowledge. Most of the African research on tropical savannas relate to high base status soils, particularly in West Africa and Kenya. Most of the knowledge gathered is limited to short-term experiments with perhaps one or two harvests. Such data is unsuitable for determining the residual effects of lime, phosphorus and micronutrient

tions required for an adequate economic interpretation. Although are many organizations with ongoing soils research in acid tropical nnas, two other programs have produced significant advances: CIAT's ivities in Carimagua on the selection of varieties and species tolent to acid soil conditions and Dr. Dobereiner's group in Brazil orking on nitrogen fixation in tropical grasses. The present knowledge on this subject, including the results of the joint Cornell-NCSU project in Brasilia is insufficient to provide an answer to Objective No. 2.

3) Very little is presently known on how to manage soils and fertilizer applications in intercropped systems. This is undoubtedly one of our greatest gaps in tropical soil science. Attention to this subject was sparked by Bradfield's work on multiple cropping in IRRI. His results, however are limited to systems which involve growing flooded rice during the rainy season. A description of the various systems in practice was summarized by Dalrymple in a "Survey of Multiple Cropping in Less Developed Nations". A bibliography on the subject was published by Turrialba early this year. Ongoing work at IRRI under the direction of Richard Harwood, at Turrialba by our staff and CATIE, in Yurimaguas and in northern Nigeria is beginning to provide good leads. The state of the art of the third objective is way behind the other objectives.

4) Considerable progress has been made in the art of developing a sound methodology for interpreting and extrapolating soil fertility and management research results to other areas. The methods developed by the International Soil Fertility Evaluation and Improvement Program (Cate-Nelson graphs, Linear Plateau and Response Model) have considerably simplified the process of making fertilizer recommendations based on field data. Such techniques do not require complicated economic and

tical analysis and recommendations can be arrived at without the f a computer. An economic evaluation of these techniques in comison with the classic quadratic equations, conducted as part of this search contract, showed no differences in profitability between the o methodologies.

Prior to the initiation of this contract, no systematic procedures were available to extrapolate field fertility data from one region to the other. Natural soil classification systems, including the new U. S. Soil Taxonomy, does not provide for such groupings because they focus on subsoil parameters and essentially ignore the plowed layer where most of the fertility interactions take place. The Fertility Capability Classification System, developed under this contract, was designed to group soils with common fertility-management problems. It pays the desired attention to topsoil properties without ignoring important subsoil parameters. Its initial evaluation shows substantial promise but also the need for some modification of the original scheme. In the extrapolation process additional soil characteristic data is needed, as well as certain laboratory and greenhouse procedures. Considerable progress has been made in characterizing soils in our areas of emphasis, but more work is needed particularly when extrapolation-type field resea: :h requests come in from the LDC's.

4. PLANS TO COORDINATE AND LINK RESEARCH

Since its inception, all activities conducted by this contract are actual cooperative projects between this University and one or more institutions from developing countries, international institutions or members of the Tropical Soils Consortium. The 1973 Technical Annual Report shows that the number of actual cooperators exceeds the numbers of North Carolina State University employees working on the program. These cooperators are involved in the planning, execution, reporting and dissemination phases of the research activities in various degree. A large proportion of the activities supporting Objective 4 involve the cooperation and partial financial support of several other institutions. In addition to these physical linkages, several discussions are presently in progress to establish cooperative field extrapolation sites with other institutions. Several requests have been received in this regards. Meaningful contacts with other individuals and institutions not involving cooperative research have been established through publication exchanges, visits to the field sites and to campus and participation in many conferences and symposia throughout the world.

4.1 Other AID Activities and Networks

Within the Soil Science Department activities of this research contract are closely coordinated with the two other AID-sponsored programs: the 211(d) Institutional Development Grant and the International Soil Fertility Evaluation and Improvement Program (Contract 1a 646). The same individual serves as project leader for Contract csd/2806 and the 211(d) grant.

North Carolina State University is a member of the Tropical Soils

tium sponsored by the 211(d) grants. In addition to strong working ages within the Consortium members, plans are also underway to malize the network on tropical soils research already in existence. lose coordination exist with TAB/AGR in AID Washington, the USAID Missions in Peru, Brazil and Central America, CUSUSWASH and TVA's AID supported activities.

4.2 LDC Activities

1) Research work in Peru is a joint project with the Dirección General de Investigaciones Agropecuarias of the Ministry of Agriculture. The International Potato Center in Lima provides administrative and logistical support. Several institutions such as CIAT, IITA, CATIE, the Purdue Sorghum Project and others have provided germplasm for testing in Yurimaguas. Requests for extrapolative work to other areas of the jungle have been received from the following institutions: the Universidad Nacional Agraria de La Molina for work in Iquitos and Pucallpa, Peru. The Universidade Federal Rural do Estado de Rio de Janeiro for cooperative work in their Rondon Project in Amapá, at the eastern end of the Amazon Jungle, INIAP in Ecuador, and ICA and CIAT in Colombia. Through visits to mutual field sites strong contacts exist with the IITA Farming Systems Program in Nigeria. Close contact in also expected with the proposed Cornell project in Ghana. NCSU personnel have participated in policy decisions regarding the development of the jungle of Peru and have been invited to present the results of this project to policy making groups of the Amazon countries Humid Tropics Programs sponsored by IICA.

2) Research work in Brazil is a joint project with the Cornell University research contract and the Empresa Brasileira de Pesquisas Agropecuarias (EMBRAPA). The USAID Mission provides logistical and

strative support. Close linkages and seed interchange exist with CIAT Llanos Orientales Project, and with other EMBRAPA-USAID national modity programs. A request for extrapolation of results have been eceived from EMBRAPA for the entire Cerrado of Brazil. Also CIAT and the Ministry of Agriculture of the Dominican Republic are interested in cooperative work. Contract staff have participated in policy decisions regarding the development of the Campo Cerrado of Brazil.

3) Research work in Central America is conducted in close cooperation with CATIE, the Ministries of Agriculture of Costa Rica and El Salvador, CENTA and the U. S. Peace Corps. CATIE provides administrative and logistical support at its Turrialba headquarters. Requests for future research in the soil aspects of intercopping are under consideration.

4) Agronomic-economic interpretations on extrapolation studies have been conducted in cooperation with the following institutions:

Instituto Geográfico Agustin Codazzi-CIAT (Colombia)
Instituto Colombiano Agropecuario (Colombia)
CIAT (Colombia)
Ministerio de Agricultura y Ganadería (Panama)
Ministerio de Agricultura y Ganadería (Costa Rica)
Ministerio de Agricultura y Ganadería now ICTA (Guatemala)
CATIE (Costa Rica)
Universidad de Costa Rica
Universidad Nacional Agraria (Perú)
Ministerio de Agricultura (Perú)
Oficina Nacional de Evaluación de Recursos Naturales (Perú)
Instituto Agronómico de Campinas (Brazil)
Universidad Federal de Vicosa (Brazil)
Centro de Pesquisas Pedológicas (Brazil)
EMBRAPA (Brazil)
Ministerio de Obras Públicas (Venezuela)
Ministry of Agriculture (Guyana)

4.3 Other donors

The Rockefeller and Ford Foundation and FAO have sponsored graduate students who participate in the research program related to this contract.

[redacted]ed travel grants or consultantships from those sources have indirectly served to further the contract objectives.

Due to his involvement in this contract Dr. R. K. Perrin has taken a leave of absence to join the CIMMYT staff in Mexico and conduct similar agronomic-economic research.

5. PLANS TO FACILITATE UTILIZATION OF RESULTS

A research contract of this nature should be ultimately judged by the degree of farmer adoption of the research results. Although the delivery of these results to farmers is beyond the scope of the contract, substantial efforts will be directed towards the dissemination and utilization of these results.

The strategy of dissemination will continue as present: To publish as quickly as possible new significant research results, first in the Technical Annual Reports and when appropriate in scientific articles. Significant results will be published in English and Spanish. This information will be then distributed to recipients in our mailing list and also to additional personnel by the cooperating institutions in their country.

In addition, it is proposed that a third phase in the work plan of the contract be initiated. Phase III would consist of establishing cooperative agreements with other institutions to conduct applied-type field research in other areas in order to test the degree of extrapolation possible within the three ecological regions. As previously mentioned, requests for such work has been received from several other countries. If implemented Phase III would in effect establish a small research network specifically concerned with the objectives of this contract. Figure 1 shows the potential sites for Phase III operations.

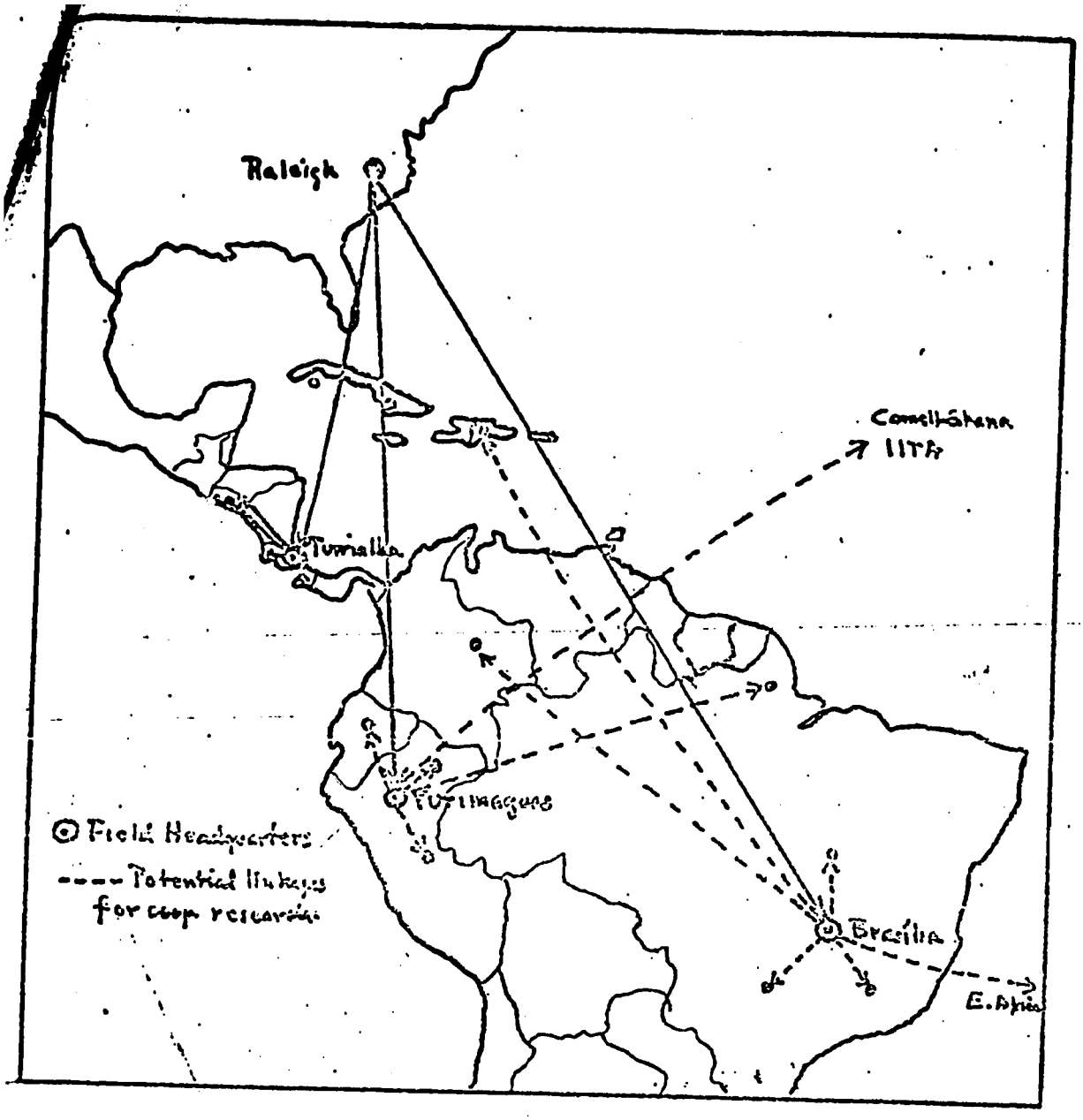


Figure 1. Potential sites of field extrapolation and utilization of results under discussion.

6. MANAGEMENT CONSIDERATIONS

Like any other activity of the Soil Science Department, Dr. C. B. McCants, the Department Head is responsible for this research contract. The operational and technical aspects of the programs are under the direction of Dr. Pedro A. Sanchez, the tropical soils project leader. Dr. Sanchez coordinates the activities of the NCSU staff members in campus and overseas. He is also responsible for the 211(d) grant programs and linkages with developing country cooperating institutions.

Experience in the past suggests strongly that a blanket country clearance to travel to Latin America countries is essential for the functioning of this contract. The following faculty who travel frequently overseas under this contract require such clearances: C. B. McCants, P A. Sanchez, S. W. Buol, E. J. Kamprath, R. E. McCollum, G. S. Miner, R. K. Perrin, F. R. Cox, M. A. Granger, G. C. Naderman, Jr. Approval of this request does not waive the responsibility of informing the USAID Missions of their travel plans.

Since a large part of the field operations are joint with local institutions, appropriate non-AID funding of such institutions is crucial for the field operations. In Brasilia, continuation of the Cornell contract activities is considered essential.

TECHNICAL REVIEW

Objective 1: No adequate information exists on the changes in pH, O.M., N, Ca, Mg, K. Al, available P and micronutrients of jungle Ultisols to quantify the fertility depletion process and ways to correct it. Such a gap can properly be filled only with the continuation of the continuous cropping experiment. The need for determining specific fertilizer and lime requirements for each major crop or pasture needs to be fulfilled. The final phase would be to put the entire information into actual model farms. Assistance from other areas particularly pasture evaluation through animal nutrition is needed.

Objective 2: The question on how to economically apply P to these soils remain in the main limiting factor. The strategy of evaluating long term residual effects of rates and placement, reduce fixation by lime, silicate and rock phosphate applications and select varieties and species tolerant to low levels of available P is appropriate. The residual effects of lime, micronutrients and other amendments are also needed. Putting a "package" together would be the final stage of this research.

Objective 3: This is almost virgin territory. The movement of nutrients in the profile, its relative uptake by two root systems, their relative distribution in relation to rates, sources, timing and placement of the fertilizers needs to be quantified through the research proposed.

Objective 4: The Fertility-Capability Classification System looks promising but requires further evaluation. Supplementary soil characterization work, greenhouse and laboratory and economic research is essential to backstop the project adequately.

8. PROJECT DESIGN AND METHODS

A specific list of research projects are outlined on Table 1 as a ns for accomplishing the research objectives. Each activity involves e or several experiments. The starting dates, "milestones" and expecte completion appear in Table 1. The narrative of each activity follows. Activities under each objective are interdependent. Additional activities might be identified in the course of research as needed for accomplishing the objectives. A certain amount of flexibility is needed when interpreting this table, because research contracts cannot be planned with as much precision as the table might imply. Unless otherwise specified field activities are to be conducted in Yurimaguas, Perū, for Objective 1, in Brasilia, Brazil for Objective 2, in Central America for Objective 3 and on campus on Objective 4.

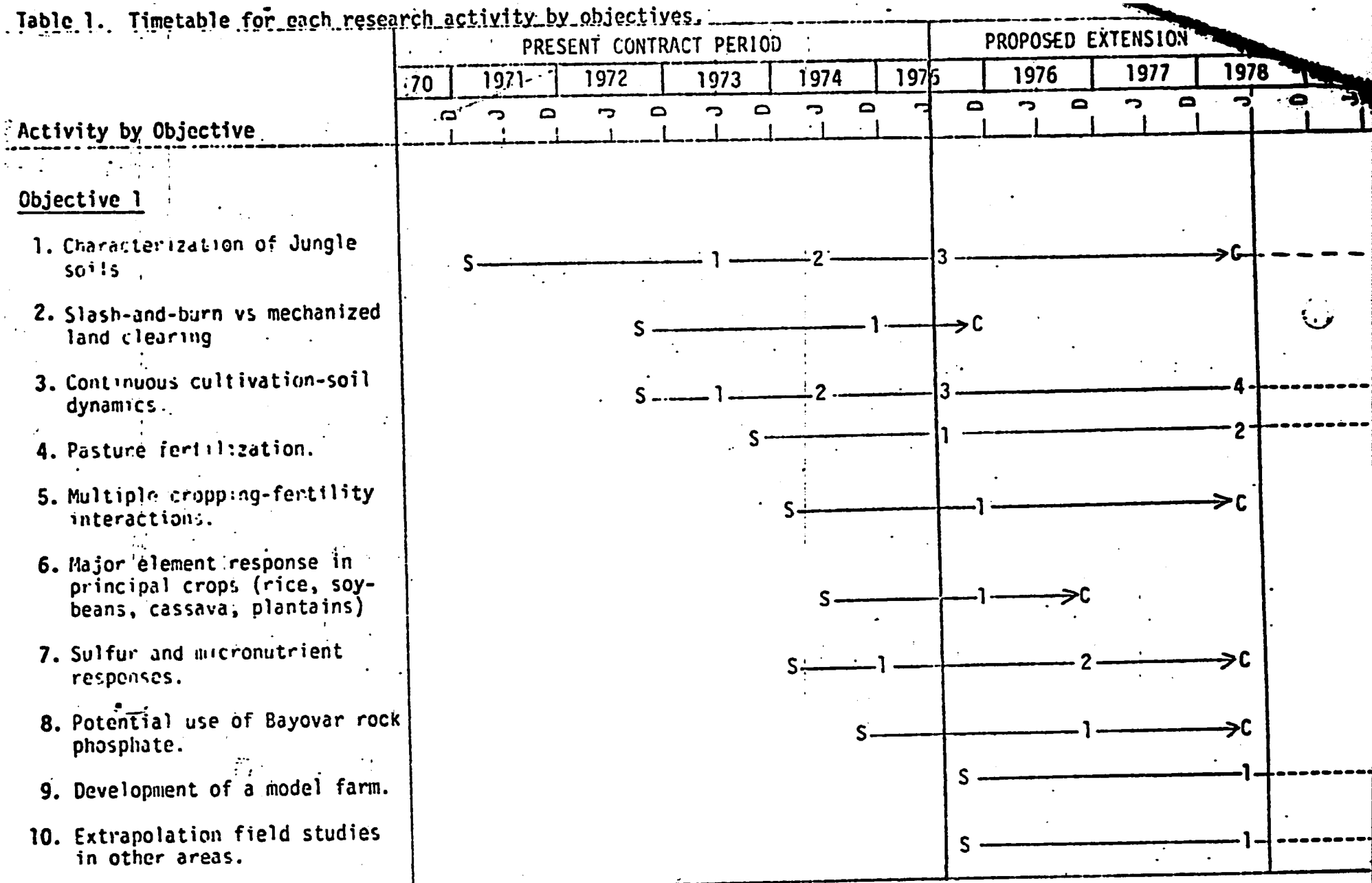
8.1 Objective 1. (As stated in Section 2).

1. Characterization of Amazon Jungle Soils. 1* Studies on Colombian Amazon finished January 1973. 2. Field studies on Peruvian Amazon Jungle completed. 3. Detailed soils map of Yurimaguas Station expected to be completed by September 1975. Further activities contemplated include characterization of potential extrapolation sites. Requests for cooperation received from Pucallpa and Iquitos (Perū), Amapā (Brazil), eastern Ecuador. Project personnel involved in characterization study of soils in the Venezuela Amazon with financial support from Venezuelan government. Personnel: S. W. Buol, E. J. Tyler. LDC cooperators: S. T. Benavides, C. Valverde, C. Zamora, M. Camargo.

---

*These numbers refer to the "milestones" of Table 1.

Table 1. Timetable for each research activity by objectives.



2. Depth of liming and residual effects

3. Phosphorus rates, placement and residual effects.

4 Zinc rate, and residual effects.

5. Phosphate sources - silicate applications.

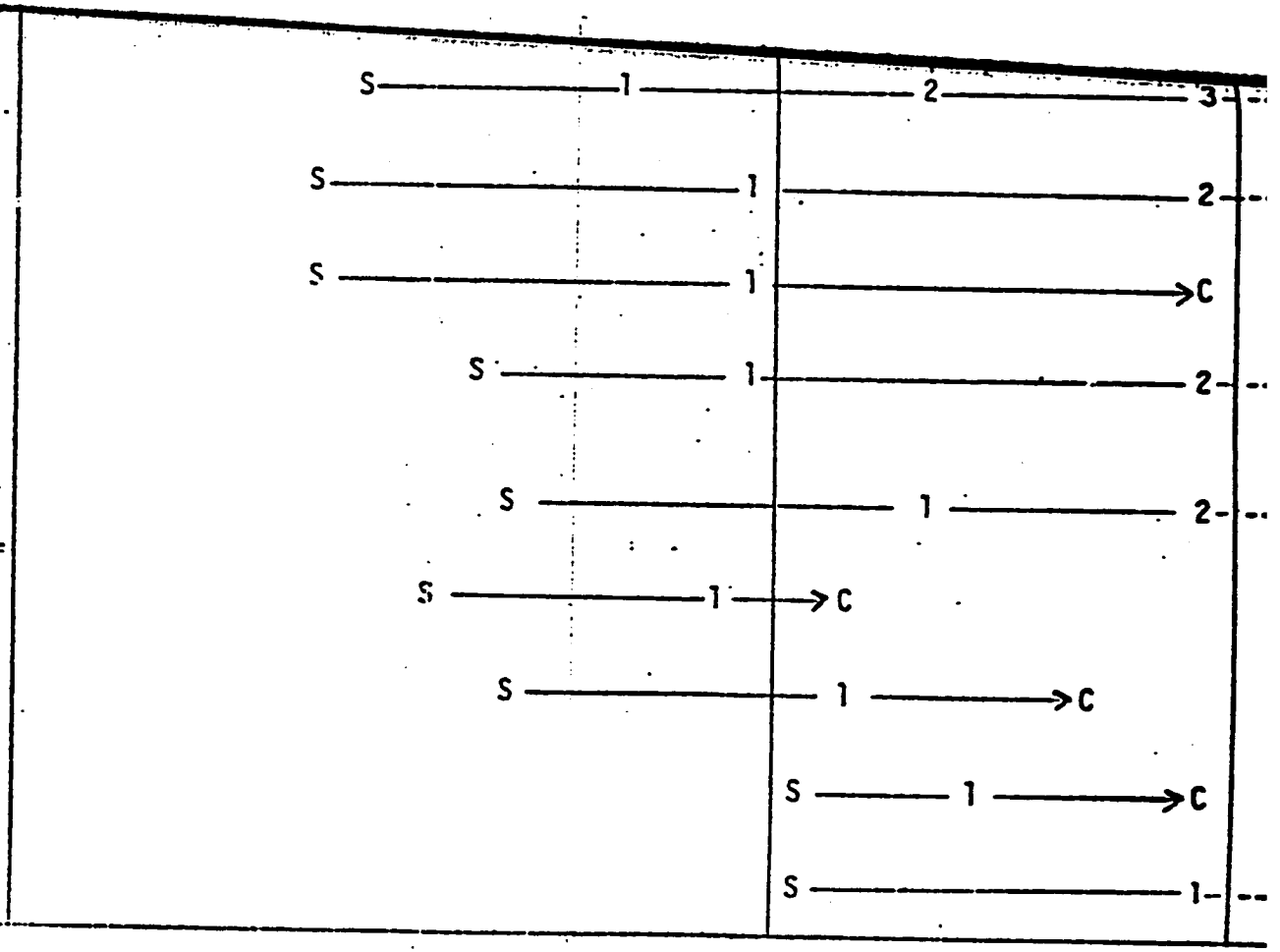
6. Varietal and species differences in tolerance to high Al and low P

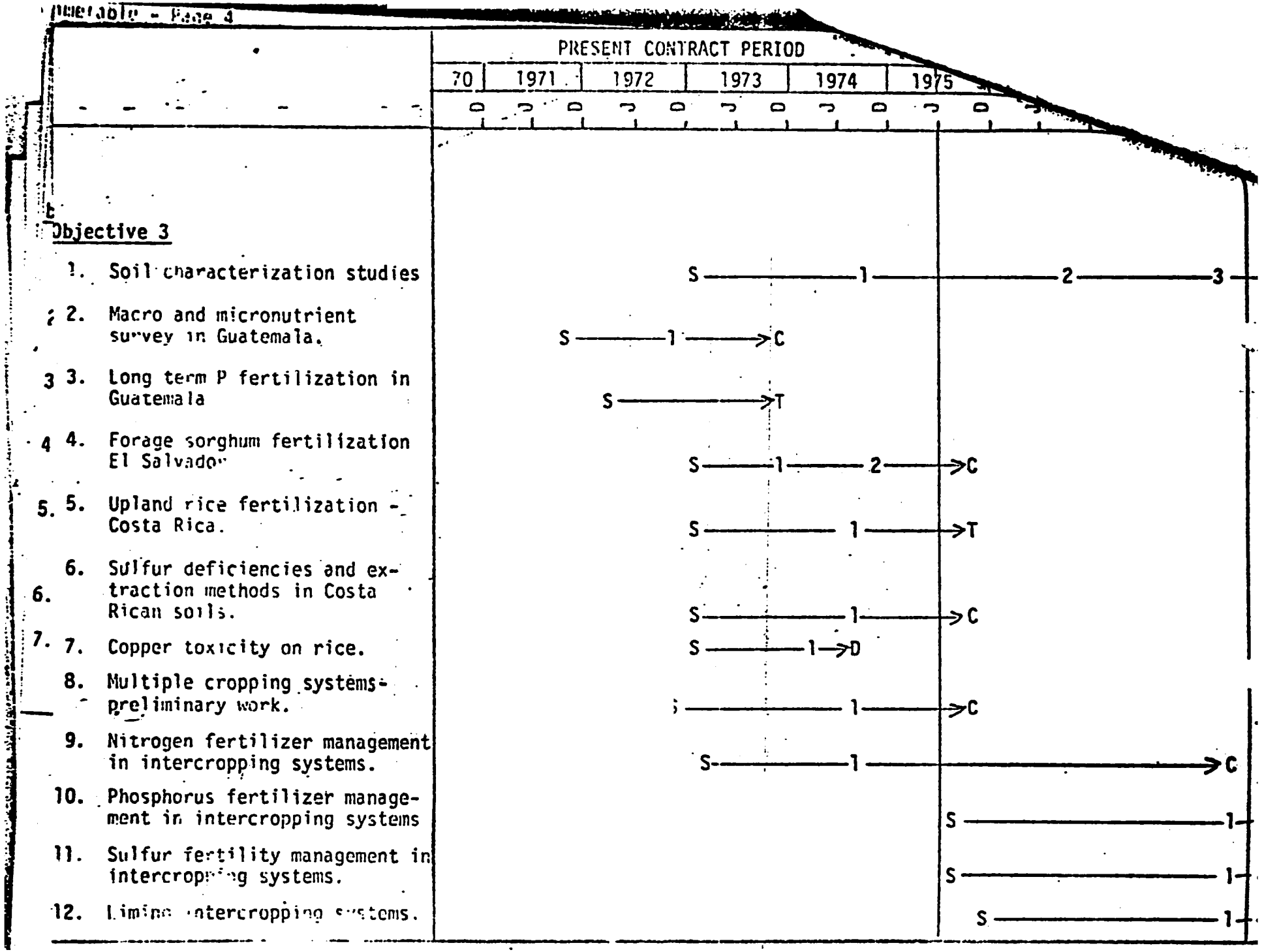
7. Distribution of properties of Cerrado soils.

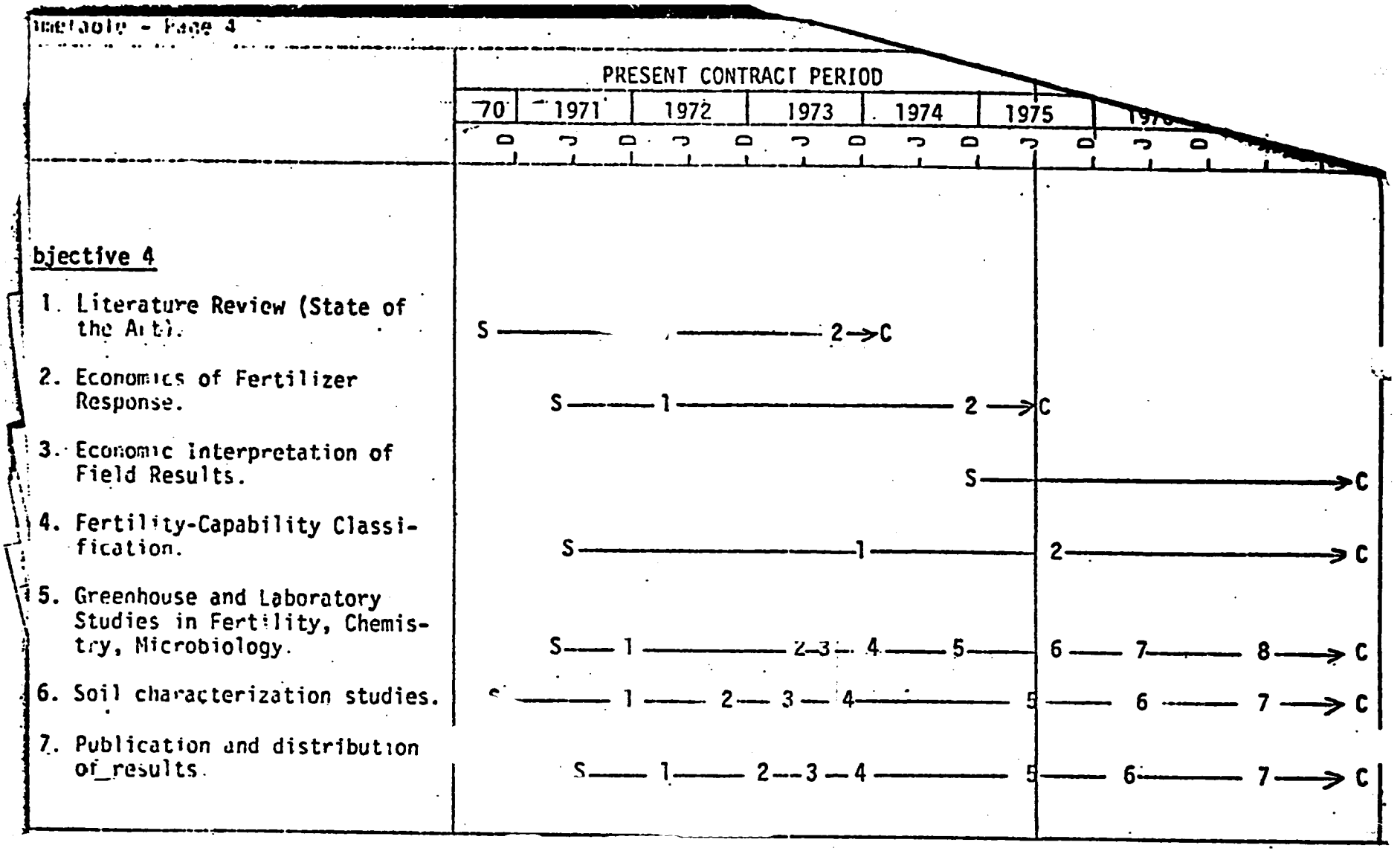
8. Chemistry and mineralogy of phosphorus fixation.

9. Sulfur, potassium and magnesium studies.

10. Extrapolation field studies to other areas.




PRESENT CONTRACT PERIOD
70
1971
1972
1973
1974
1975
Objective 3
1. Soil characterization studies
2. Macro and micronutrient survey in Guatemala.
3. Long term P fertilization in Guatemala
4. Forage sorghum fertilization El Salvador
5. Upland rice fertilization - Costa Rica.
6. Sulfur deficiencies and extraction methods in Costa Rican soils.
7. Copper toxicity on rice.
8. Multiple cropping systems - preliminary work.
9. Nitrogen fertilizer management in intercropping systems.
10. Phosphorus fertilizer management in intercropping systems
11. Sulfur fertility management in intercropping systems.
12. Liming intercropping systems.
S
1
2
3
C
T
D


PRESENT CONTRACT PERIOD
70
1971
1972
1973
1974
1975
Objective 4
1. Literature Review (State of the Art).
S
2→C
2. Economics of Fertilizer Response.
S
1
2
C
3. Economic Interpretation of Field Results.
S
C
4. Fertility-Capability Classification.
S
1
2
C
5. Greenhouse and Laboratory Studies in Fertility, Chemistry, Microbiology.
S
1
2
3
4
5
6
7
8
C
6. Soil characterization studies.
1
2
3
4
5
6
7
C
7. Publication and distribution of results.
S
1
2
3
4
5
6
7
C

Effects of [illegible]d clearing methods on soil pr[illegible]ctivity. 1. Field [illegible]h at Yurimaguas completed. Results show the advantage of the [illegible]tional slash and burn system over mechanized land clearing. Report [illegible]eparation. Expected completion December 1975. Personnel: P. A. [illegible]hez, C. E. Seubert, C. E. Lopez. LDC collaborators: C. Valverde, M. [illegible]eña.

3. Continuous cropping systems and changes in soil properties. [illegible]tarted August 1972. Expected completion: 10 years. Experimental design consists of four consecutive yearly land clearings with four cropping systems and fertilization strategies to be tested as a function of age after clearing. Changes in soil properties associated with fertility depletion are measured. This is the central, long term experiment to develop cropping systems. To date, the first three land clearings have been carried (Milestones 1, 2, 3). The fourth is planned for July 1975. In addition to yield data collection, intensive soil and plant sampling taken at regular intervals monitors changes with time. Results so far indicate that continuous cropping is economically feasible in these jungle Ultisols and that adequate to excellent yields of upland rice, soybeans, cassava and pastures have been obtained with moderate amounts of fertilizers and lime. Personnel: P. A. Sanchez, C. E. Seubert, C. E. Lopez, H. Villachica, C. Langley. LDC collaborators: C. Valverde, M. Nureña.

4. Fertility requirements for pasture production in the Jungle: Two forage experiments with Panicum maximum are evaluating the nitrogen, phosphorus, and lime requirements, including an evaluation of urea, sulfur-coated urea and Stylosanthes guyanensis as the source of nitrogen, superphosphate and several rock phosphates including Bayovar rock.

ults of first 10 months indicate high yield levels with low P and rates and a promising response of sulfur-coated urea applications y six months. Feeding quality of forage determined by nutrient lysis and in-vitro digestibility in cooperation with the Animal Science partment. A third experiment comparing methods of lime and phosphorus ncorporation in exhausted pastures was initiated in 1974. 2. Expected completion of this phase in the field. An additional phase consisting of animal evaluation is needed. Personnel: P. A. Sanchez, C. E. Lopez, C. Langley. LDC cooperators: C. Valverde.

5. Fertility requirements of multiple cropping system for food production: This project aims at developing information for the second component of the "model farm": intensive food production for subsistence purposes and local marketing. Experiments in progress in: 1. Intercropping effect on nitrogen fertilization x spacing in corn-soybeans-cassava intercropping. 2. Residue management at different fertility levels in corn-soybeans-cassava intercroppings. 3. Residue management at different fertility levels in corn-soybeans-rice succession. 4. Lime response and depth of liming in corn-cowpea intercropping and monocultures. 5. Fertility requirements for intensive cropping systems ranging from one to five crops a year. 6. Germplasm introduction and testing of materials received from CIAT, IITA, CATIE, and other sources. Preliminary results to date indicate a highly beneficial effect of incorporating Kudzu as green manure on yields and nodulation by soybeans. Personel: M. K. Wade, P. A. Sanchez.

6. Major element responses in principal food crops: Responses to P, K, and lime by upland rice, soybeans, cassava and plantains. The purpose is to establish the needed application rates and critical soil

test levels. Termination of field experiments expected by September 1975. Completion of work expected by December 1975. Personnel: G. S. Miner, D. Anderson.

7. Sulfur and micronutrient requirements: The initial continuous cropping experiment demonstrated the existence of sulfur, boron and molybdenum deficiencies in these soils. 1. Greenhouse tests in Raleigh confirmed these deficiencies and identified zinc and copper deficiencies. Field trials expected to start in March 1975. Data suggests that sulfur and micronutrient deficiencies might be crucial limiting factors. If so their solution with small quantities of inputs transportable at low costs seems economically feasible. Personnel: H. Villachica, P. A. Sanchez. LDC collaborators: C. Valverde.

8. Potential use of Bayovar rock phosphates in the Jungle: Perū is recently beginning to mine huge rock phosphate deposits in Bayovar on the Coast. Its potential is naturally believed to be for acid soils, most of which are in the jungle. Although Bayovar rock is included as treatments in certain experiments in projects 4 and 5, a systematic evaluation of its reactivity fineness and residual effects is needed to ascertain whether this product could be used effectively in the Jungle. Government officials have keen interest and partial financial support has been obtained by Dr. Valverde from MINEROPERU. Preliminary greenhouse experiments are in progress in Raleigh and in Lima by counterpart personnel. Field experiments are expected to be planted by March 1975. Personnel: H. Villachica, G. S. Miner, P. A. Sanchez. LDC collaborators C. Valverde, J. Davelouis, M. Cano.

9. Developing of a "model farm" for continuous cropping in the Amazon: To be started in 1976. A synthesis of all findings into a model

based on annual slash and burn of 2 hectares of which 80% would be in pastures and 20% in intensive multiple cropping. To be done with actual farmers from the Yurimaguas cooperative. Complete agronomic and economic records will be kept of both crop and animal production. Personnel: To be hired.

10. Extrapolation of Studies

It is proposed that the third phase of this contract involve a series of field extrapolation studies to adapt the results already available from the jungle and savanna stations to other tropical areas with similar environmental conditions. The expected results of such work would further this contract's and AID's objectives because (1) it would test the degree of extrapolation possible of the results and the necessary local modifications and (2) it would encourage direct utilization by farmers in other regions.

Unlike previous arrangements developed with LFC's in this contract, no active seeking of appropriate locations will be done by NCSU staff. It is preferable to respond to requests from LDC institutions or USAID missions for collaboration. Only those institutions that show a high priority interest and willingness to make solid financial and personnel commitments on their part will be considered.

To date, indications of such an interest have been received from the following institutions:

1) - Universidade Federale Rural do Estado do Rio de Janeiro, Amapā, Brazil
2) - INIAP, Ecuador
3) - IVITA, Pucallpa, Peru
4) - Universidad Nacional Agraria La Molina, Peru
5) - Universidad de Panama

The following mode of operation is envisioned:

1) Selection and evaluation of the sites will be made jointly by NCSU and the host institution's staff. This will involve soil characterization studies.
2) A series of applied-type experiments will be designed. These will synthesize the principal results from the main stations.
3) The experiments will be conducted by personnel from the cooperating institutions. When appropriate they may serve as thesis topics for graduate studies at NCSU or other institutions. All operating expenses must be borne by the cooperating institutions.
4) NCSU staff will serve as advisors, and will cooperate on execution and interpretation of the work. Certain soil

and plant analysis may be conducted at Raleigh to supplement results.

5) The cooperating institutions will conduct appropriate field days, demonstrations and other extension functions.

Personnel: S. W. Buol, P. A. Sanchez, vacant: to be hired. LDC collaborators: to be identified.

8.2 Objective No. 2 (As stated in Section 2)

1. Soil Characterization. 1. Determination of the potential area of extrapolation in the Campo Cerrado by Cline and Buol. 2. Work continuing in Llanos Orientales in collaboration with CIAT. 3 and 4. Expected additional studies in sites for potential extrapolation. Personnel: S. W. Buol, L. Mejia. LDC collaborators: M. Camargo, J. Spain, R. Guerrero and others.

2. Depth of Liming and Residual Effects. A long term experiment was initiated in December 1972, to evaluate the effect of different lime applications and the potential benefits of liming to 30 cms. depth. Results to date (1) indicate that deep liming is superior to shallow lime application because it increases root development and allows plants to withstand dry periods better. Two crops are grown per year and preliminary indications of the residual effects (2) indicate that relatively low rates are adequate. Several more years are needed to evaluate this

fect in economic terms. Personnel: Kamprath, Gonzalez, Salinas, Naderman. LDC staff: Soares, Lobato, Galrão.

3. Phosphorus Rates, Placement and Residual Effects: A long term experiment was planted in October 1972 to evaluate the effect of rates, placement and timing methods. Results to date suggest that large applications have a marked residual effect and that a combination of an original broadcast application followed by banded applications at each successive planting might be recommendable, but these suggestions are not economically sound yet. Considerable progress is expected by mid 1975 (1) although a much longer time span is needed for a thorough evaluation. Personnel: Kamprath, Yost, Naderman, Langley. LDC staff: Soares, Lobato, Galrão.

4. Zinc Rates and Residual Effects: A third set of long term experiments was planted in Brasilia in October 1972. They are designed to evaluate the rates, variety and pH interactions of zinc applications. Results to date (1) indicate that about 3 kg Zn/ha is essential to obtain yields and that liming of pH 6.4 induces additional zinc deficiencies. The residual effects of such applications should be adequately established by early 1978. Personnel: Cox, Lopes.

5. Phosphate Sources - Silicate Applications: Field experiments were established in October 1973 to evaluate cheaper sources of phosphorous including native rock phosphate and fused phosphate silicates (Termofosfato) on a pasture grass and legume at three lime levels. Two greenhouse experiments are also evaluating the interaction between lime, phosphorus and silicates with emphasis in decreasing phosphorus fixation. No preliminary results are available but considerable progress is expec. by mid 1976 (1) and 1978 (2). Personnel: Kamprath, Yost, Naderman, Smyth, Sanchez.

6. Varietal and Species Differences in Tolerance to Al and low P. A series of culture solution studies in Raleigh were conducted to characterize varietal differences in corn, rice and beans. Results to date quantified such varietal differences and related them to differential ability to take up and translocate phosphorus. A series of experiments are in the process of being installed in Brasilia to test a large number of germplasm for Brazilian sources at three levels of P and three of exchangeable aluminum. Collaboration with Cornell plant breeder, C. O. Grogran is expected. Personnel: Salinas, Sanchez, Naderman, Jackson.

7. Distribution of Properties of Cerrado Soils: A total of 565 samples were taken throughout the Cerrado in order to quantify the variability in chemical properties. Results to date (1) indicate a very good correlation between several fertility parameters and native vegetation. Extreme low fertility characterizes the large majority of the samples. Work will serve as a guide for extrapolation of experimental results. Expected completion in late 1975. Personnel: Lopes, Cox.

8. Chemistry and Mineralogy of Phosphorus Fixation: Basic studies, using modern techniques are needed to better understand the process of phosphorus fixation by iron and aluminum oxides and hydroxides which is the main fertility limiting factor in these savanna Oxisols. Basic laboratory experiments were initiated in Raleigh to understand the process. Considerable progress is expected by late 1975 and completion by mid 1977. Personnel: Buol, Bingham.

9. Sulfur, Potassium and Magnesium Studies: These elements are also limiting in these soils and information in their behaviour and requirements are needed. A proposed series of experiments starting in October 1975 and terminating in 1978 would provide the necessary data. Personnel: Kamprath, others.

10. EXTRAPOLATION STUDIES: The operating pattern will be essentially the same as for item 10. Objective 1. NCSU will examine the situation and help design the best limited number of management combinations which will lead to economical field recommendations. Actual tests will be financed and conducted by the local cooperators. Only those willing and capable of conducting satisfactory adaptive research trials will be considered.

Management of the Oxisols under savanna ecology is critical in many countries.

Collaborators:

1) EMBRAPA, Brazil
2) CIAT, Carimagua, Colombia
3) Ministry of Agriculture, Dominican Republic
4) Universidad de Panama, Panama

Upon approval of this contract extension, discussions will be held with the institutions and where agreement can be reached cooperative projects will be established.

Personnel: NCSU - S. W. Buol, E. J. Kamprath, Naderman and others. Local cooperators to be identified.

8.3 Objective 3. (As stated in section 2)

1. Soil Characterization: Soil soposequence relationship in volcanic areas of Costa Rica completed by mid 1974 (1). Additional studies for new experimental areas planned. Personnel: Buol and assistants.

2 to 8. experiments in the process of completion of termination by the end of present contract period.

9. Nitrogen Management in Intercropping Systems: A series of corn-soybeans systems were compared with monocultures at different nitrogen levels to estimate efficiency of utilization and other parameters. Results of first set of experiments (1) indicate significant intercropping effect in Turrialba. Other experiments programmed for other regions. Expected completion by mid 1978. Personnel: Oelsligle, McCollum, Rossiter and others.

10 to 12. Phosphorus, Sulfur, and Liming Management in Intercropping Systems: A proposed series of experiments to be conducted in important intercropped areas of Central America to determine the dynamics of P, S, Ca, Mg and Al in intercropped systems and what are the best ways to apply these nutrients or amendments. Long term experiments in which considerable progress is expected by mid 1978 but economically-sound interpretations at a later date. Personnel: McCollum, Rossiter, Oelsligle and others.

8.4 Objective 4: (As stated in section 2.b)

1 and 2. Essentially completed during the present contract period.

3. Economic Interpretation of Field Results: Economic research has shifted from the analysis of data gathered prior to the contract to analyzing the data produced by the field research activities.

It involves translating the agronomic research results in economic terms and additional related data such as transportation costs. Personnel: Perrin and assistants.

4. Fertility-Capability Classification System: The system presented in 1971 went through preliminary evaluation in 1973 (1) and the first formal version (2), is expected to be published in 1975. Evaluation of Brazilian data is also finished. Additional evaluation and interpretation is planned using existing data for experiment stations in the tropics as well as in the U.S. Personnel: Granger, Pope, Buol, Sanchez. LDC Cooperators: Benavidez, Bejarano and others.

5 and 6. Greenhouse, Laboratory and Soil Characterization Studies: Needed to answer basic question passed by the field research or estimate degree of data extrapolation. Personnel: Kamprath, Buol, Cox, McCollum, Sanchez, Wollum, Perrin and assistants.

7. Publication and Distribution of Results: Annual technical reports and reprints of publications mailed to over 450 individuals and institutions. Personnel: Sanchez, Monar.

8.5 Resources Required:

Personnel:

	Man-months
Campus:	
P. A. Sanchez, Project Leader	6

Campus (cont.)	Man-months (cont.)
C. B. McCants, Department Head	3
S. W. Buol, Soil Genesis	3
E. J. Kamprath, Soil Fertility	3
M. A. Granger, FCC System	12
R. E. McCollum, Soil Fertility	3
Research Assistants (3)	18
C. Langley, Research Technician	12
B. Monar, Bilingual Secretary III	6
D. McDonald, Bilingual Secretary II	6
Total on Campus	72 = 6 man-years
Yurimaguas:	
Faculty Vacant, Coordinator	12
Research Assistants (3)	36
Brasilia:	
Faculty Vacant, Soil Fertility	12
Research Assistants (3)	36
Central America:	
Faculty Vacant, Coordinator	12
Research Assistants (3)	36
Total Overseas	144 = 12 man-years

Total Man-Year equivalent = 18.0 man-years

Major equipment needs: Project Vehicle for Brazil and Yurimaguas, Radio transmitter for Yurimaguas.

Overseas stations and working relationships: described previously.

Total estimated costs: $1,659,611

9. OVERALL COST ESTIMATES

The following is an estimate for the three year period. No breakdown by objective is presented as per instructions of Mr. M. Rechcigl of RIG. See p. 45.

Revised Budget for Proposed Tropical Soils Research Program North Carolina State University July 1, 1975 - June 30, 1978

Object	Estimated Cost per FY 1975-76	1976-77	1977-78
1. Salaries 4 man-years, home office professional 2 man-years, home office non-professional 12 man-years, field professional 18 man-years, total	227,393	238,763	250,701
2. Fringe Benefits	29,660	31,143	32,700
3 Overhead	77,320	81,186	85,245
4. Travel and Transportation	64,500	67,000	70,000
5. Supplies and Equipment	80,400	85,000	90,000
6. Quarters Allowance	30,600	32,000	34,000
7. Other Direct Costs	15,000	17,000	20,000
Total	$524,873	$552,092	$582,646
Estimated Three-Year Total		$1,659,611	

10. WORK PLAN: April 1, 1975 - June 30, 1978.*

OBJECTIVE 1.	Starting Date	Expected Completion
1. Characterization of Amazon Jungle soils.	June 71	June 78
2. Slash-and-burn vs mechanized land clearing methods.	Aug. 72	Dec. 75
3. Continuous cropping systems and changes in soil properties.	Aug. 72	June 78
4. Nitrogen, phosphorus and lime requirements of grass and grass-legume pastures.	Sept. 73	June 78
5. Fertility requirements of intensive multiple cropping system for food crop production.	Jan. 74	June 78
6. Major element response by upland rice, soybeans, cassava and plantains.	Aug. 74	Dec. 76
7. Sulfur and micronutrient requirements.	Feb. 74	June 78
8. Potential use of Bayovar rock phosphates in the Amazon Jungle.	Aug. 74	June 78
9. Development of a model farm for continuous cropping in the Amazon Jungle.	Sept. 75	June 78+
10. Extrapolation of results to other jungle areas via field experiments with cooperating institutions.	Sept. 75	June 78+
OBJECTIVE 2.		
1. Characterization of savanna soils.	Sept. 71	June 78+
2. Residual effects of liming applications (including depth) in relation to crop requirements and soil moisture.	Dec. 72	June 78+
3. Residual effects of phosphorus fertilization in Oxisols of Brasilia.	Oct. 72	June 78+
4. Residual effects of zinc fertilization.	Oct. 72	June 78
5. Comparison of different phosphorus sources and silicon applications to reduce fixation. Residual effects.	Oct. 73	June 78+

*See also Time Table on pp. 28-31 for graphic display of beginning course, and ending of activities.

	Starting Date	Expected Completion
6. Varietal and species differences in tolerance to high exchangeable aluminum and low available phosphorus.	Jan. 74	Jan. 78+
7. Distribution of soil properties in the Cerrado of Brazil.	May 73	Dec. 75
8. Basic chemistry and mineralogy of phosphorus fixation reactions in highly weathered soils.	Jan. 74	June 77
9. Extrapolation of results to other Oxisol savanna areas via field experiments with cooperating institutions.	Oct. 75	June 78+
OBJECTIVE 3.		
1. Characterization of soils and climatic regimes of areas affected by volcanic ash in Central America.	March 73	June 78
2. Macro and micronutrient survey in Guatemala (concluded).	Aug. 71	Dec. 73
3. Long term P fertilization in Guatemala (transferred to ICTA)	Jan. 72	Dec. 73
4. Intensive forage sorghum fertilization for dry season cattle feeding in six sites of northern El Salvador.	March 73	Dec. 75
5. Fertility management for upland rice production in Costa Rica.	April 73	Dec. 75
6. Sulfur deficiencies and development of sulfur extraction methods in Costa Rica.	April 73	Dec. 74
7. Copper toxicity in upland rice soils in Costa Rica.	April 73	Dec. 74
8. Intensive multiple cropping systems at three fertility levels in volcanic soils of Turrialba, Costa Rica.	Dec. 72	Dec. 75
9. Nitrogen fertilization in intercropping and multiple cropping systems. Four locations in Costa Rica, possible in El Salvador.	July 73	June 7[illegible]

	Starting Date	Expected Completion
10. Phosphorus fertilizer management in intercropping and multiple cropping systems. At several locations in Central America.	Sept. 75	June 78+
11. Sulfur fertility management in intercropping and multiple cropping systems At several locations in Central America.	Sept. 75	June 78+
12. Liming intercropping and multiple cropping systems. At several locations in Central America.	Jan. 76	June 78+
OBJECTIVE 4.		
1. Literature Review (State of the art) completed May, 1974.		
2. Economic analysis of methods for estimating fertilizer recommendations.	June 70	Dec. 74
3. Economic interpretation of experimental results and data extrapolation.	Jan. 75	June 78
4. Development and evaluation of the fertility-capability classification system (World Wide).	June 71	June 78
5. Greenhouse and laboratory studies to help interpret field data and to estimate possibilities of extrapolation of results to soils of other countries or regions (Fertility, chemical, and microbiological studies).	June 70	June 78
Location:		
6. Characterization studies of other tropical regions to help interpret and extrapolate data.	June 70	June 78
7. Publication and distribution of research results in two languages.	Dec. 71	June 78

11. BUDGET PROPOSAL

The revised budget as submitted appears to be a major increase over the current level. The request is justified, however. The overall funding level of this project was set in 1969. The program evolved gradually, starting well below the projected levels in the first years. The full operating level was reached only in the current year. Estimated expenditures for the 12 months March 31, 1975 amount to $380,000.

The current budget was scaled down at A.I.D. request after review by the Research and Development Committee. Total reduction was about $150,00 over three years.

Three factors have contributed to increased costs which are not directly related to the program. One is increased salaries. Faculty and staff are entitled to and have received increases in recognition of increased competence and value to the program. The university has also found it necessary to adjust salaries to offset the eroding effects of the rising cost of living. The second is general inflation. The cost of all goods and services has increased. This has been a greater problem overseas than in the U.S., where it is severe enough. Yurimaguas has been especially hard hit because of its isolation. The third is reduction in services from AID, specifically USAID/Brasilia which is gradually phasing out its support.

Modest program expansion is also planned and is needed. Four years' service above the 1972 level are programmed for the field. On-campus professional time has decreased and secretarial support increased only six months. The new position of Faculty Coordinator at Yurimaguas is probably the most urgently needed of the field additions. The additional research assistants in the field will make the senior staff more effective. Since the assistants are also students and most often from a developing country, they serve both to conduct research and to promote the use of the results obtained.

12. GENERAL APPRAISAL

TA/AGR finds this a wholly reasonable proposal for extension of a productive project. The objectives are concisely stated in terms of usable packages of practices to fit the probable farming patterns in three clearly defined ecological zones. Specific activities contributing toward these objectives are briefly but understandably described and personnel to be involved identified.

A timetable has been drawn up for the commencement and termination of each activity and shown graphically so that the sequence and overlap can be appreciated readily. The variety of activities represents a true assessment of the complexity of the systems under study, the inter-related and interacting factors, rather

than a dispersion of effort or a loss of focus. Soil and crop management systems are complex. There is no panacea for success.

The Research and Development Committee of A.I.D. supported the objectives of the project in their meeting of December 17, 1974. The budget has been tightened at their request. The extrapolation, adaptive research, plan pp. 35 and 40, were also amplified at their request but remains tentative since no commitments to local institutions were possible without the contract extension.

Approval of extension of this project for three years until June 30, 1978 is recommended. The budget request is reasonable and should be accepted subject to the availability of A.I.D. and TA/AGR funds.

9310525

PD-AAC-887

EXCERPTS FROM A.I.D. RESEARCH ADVISORY COMMITTEE - FORTY-EIGHTH MEETING

March 20 - 21, 1975

Review of Agronomic Economic Research on Tropical Soils - N.C. csd-2806

This project was strongly supported by the subcommittee for its agronomic work. As in earlier reviews, the integration of the economic component was still judged to be incomplete and as the extension proposal was written quite insufficient.

The motion of approval was: The project Agronomic Economic Research on Tropical Soils be approved for extension for three years subject to the following conditions: (1) That the project statement and work plan be revised to show the economic component before any new activities are undertaken; (2) that staff time be allocated to this required integration; (3) that a comprehensive review of the project be conducted before the end of the second year and a full report made to RAC.

Motion was unannimously approved.

AGRONOMIC-ECONOMIC RESEARCH ON TROPICAL SOILS

North Carolina State University

csd-2806

1. SCOPE OF WORK

The contract aims at developing a "package of economically-sound soil management practices for increasing food production in 1) jungle soils presently under shifting cultivation, 2) acid savanna Oxisols and 3) intercropping systems in volcanic highlands. Such practices could be extrapolated to areas other than where the research is conducted.

2. OBJECTIVES: EXPECTED PRODUCTS

Objective 1): To develop a package of economically-sound soil and fertilizer management practices for increasing food production via continuous cultivation of jungle soils presently under shifting cultivation. The result of such a set of recommendations when applied at the farm level would be to open large new areas of tropical rainforests for food crop production, on an ecologically-sound basis.

Objective 2): To develop a package of economically-sound soil and fertilizer management practices for increasing food production in acid Oxisol tropical savannas. The result of such a set of recommendations when applied at the farm level would bring into production huge areas of tropical savannas presently not utilized.

Objective 3): To develop a package of economically-sound soil and fertilizer management practices for increasing food production in subsistence intercropped systems small farming operations in highland areas affected by volcanic activity. The result of such a set of recommendations, when applied at the farm level would be to markedly increase the productivity of intercropped systems and the well-being of such farmers.

Objective 4): To develop means for interpreting and extrapolating the products of Objectives 1 to 3 to other areas via economic interpretations, additional greenhouse and laboratory work on campus and through cooperative field trials in other areas. The result of such studies would be the verification (or lack of) of the extrapolability of data from intensive study sites to other jungle and savanna or intercropped volcanic areas.

3. PLANS TO FACILITATE UTILIZATION OF RESULTS

A research contract of this nature should be ultimately judged by the degree of farmer adoption of the research results. Although the delivery of these results to farmers is beyond the scope of the contract, substantial efforts will be directed towards the dissemination and utilization of these results.

The strategy of dissemination will continue as present: To publish as quickly as possible new significant research results, first in the Technical Annual Reports and when appropriate in scientific articles. Significant results will be published in English and Spanish. This information will be then distributed to recipients in our mailing list and also to additional personnel by the cooperating institutions in their ountry

In addition, it is proposed that a third phase in the work plan of the contract be initiated. Phase III would consist of establishing cooperative agreements with other institutions to conduct applied-type field research in other areas in order to test the degree of extrapolation possible within the three ecological regions. As previously mentioned, requests for such work has been received from several other countries. If implemented Phase III would in effect establish a small research network specifically concerned with the objectives of this contract. Figure 1 shows the potential sites for Phase III operations.

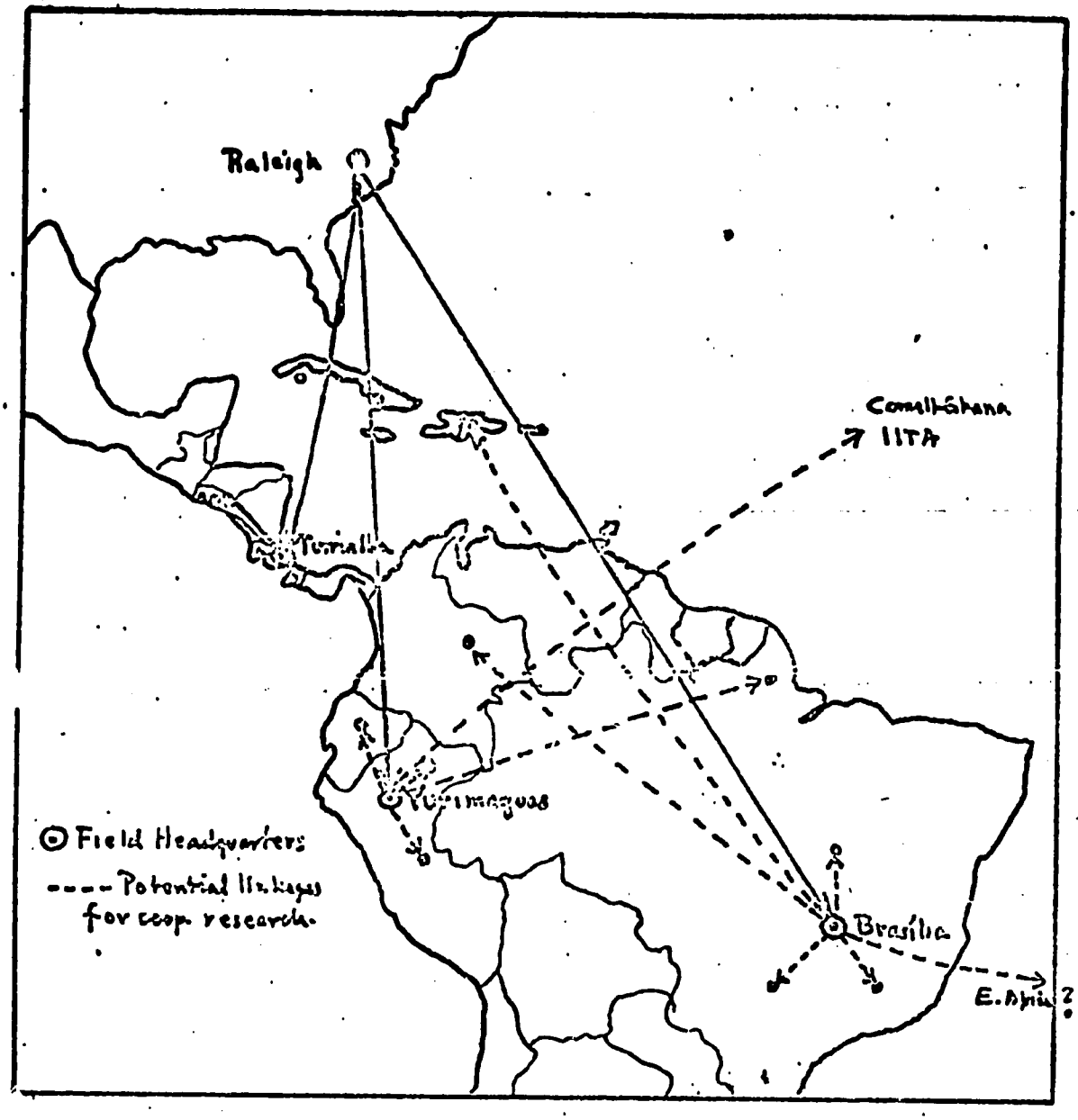


Figure 1. Potential sites of field extrapolation and utilization of results under discussion.

4. PROJECT DESIGN AND METHODS

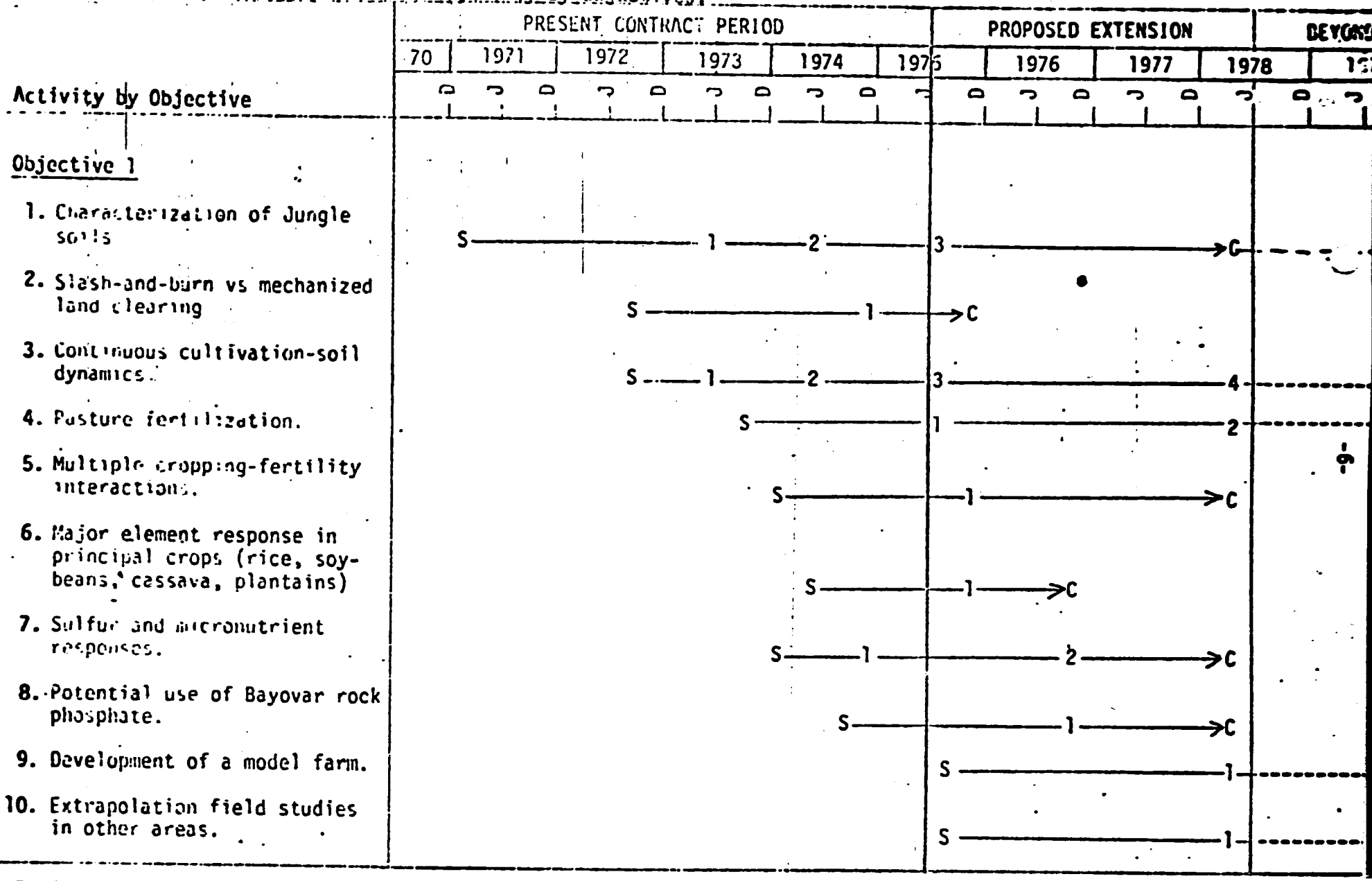
A specific list of research projects are outlined on Table 1 as a means for accomplishing the research objectives. Each activity involves one or several experiments. The starting dates, "milestones" and expected completion appear in Table 1. The narrative of each activity follows. Activities under each objective are interdependent. Additional activities might be identified in the course of research as needed for accomplishing the objectives. A certain amount of flexibility is needed when interpreting this table, because research contracts cannot be planned with as much precision as the table might imply. Unless otherwise specified field activities are to be conducted in Yurimaguas, Perú, for Objective 1, in Brasilia, Brazil for Objective 2, in Central America for Objective 3 and on campus on Objective 4.

4.1 Objective 1. (As stated in Section 2).

1. Characterization of Amazon Jungle Soils. 1* Studies on Colombian Amazon finished January 1973. 2. Field studies on Peruvian Amazon Jungle completed. 3. Detailed soils map of Yurimaguas Station expected to be completed by September 1975. Further activities contemplated include characterization of potential extrapolation sites. Requests for cooperation received from Pucallpa and Iquitos (Perú), Amapá (Brazil), eastern Ecuador. Project personnel involved in characterization study of soils in the Venezuela Amazon with financial support from Venezuelan government. Personnel: S. W. Buol, E. J. Tyler., LDC cooperators: S. T. Benavides, C. Valverde, C. Zamora, M. Camargo.

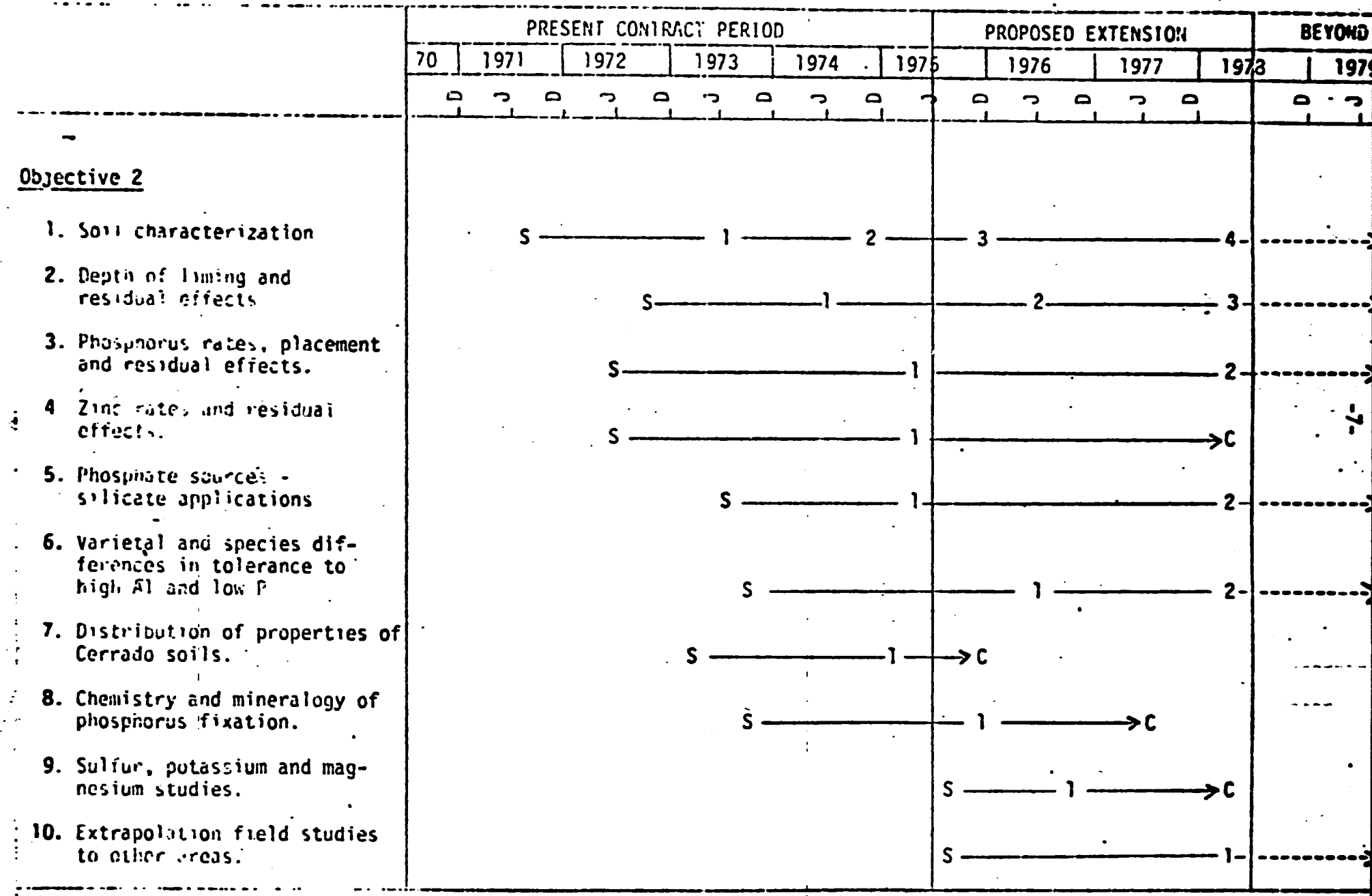
*These numbers refer to the "milestones" of Table 1.

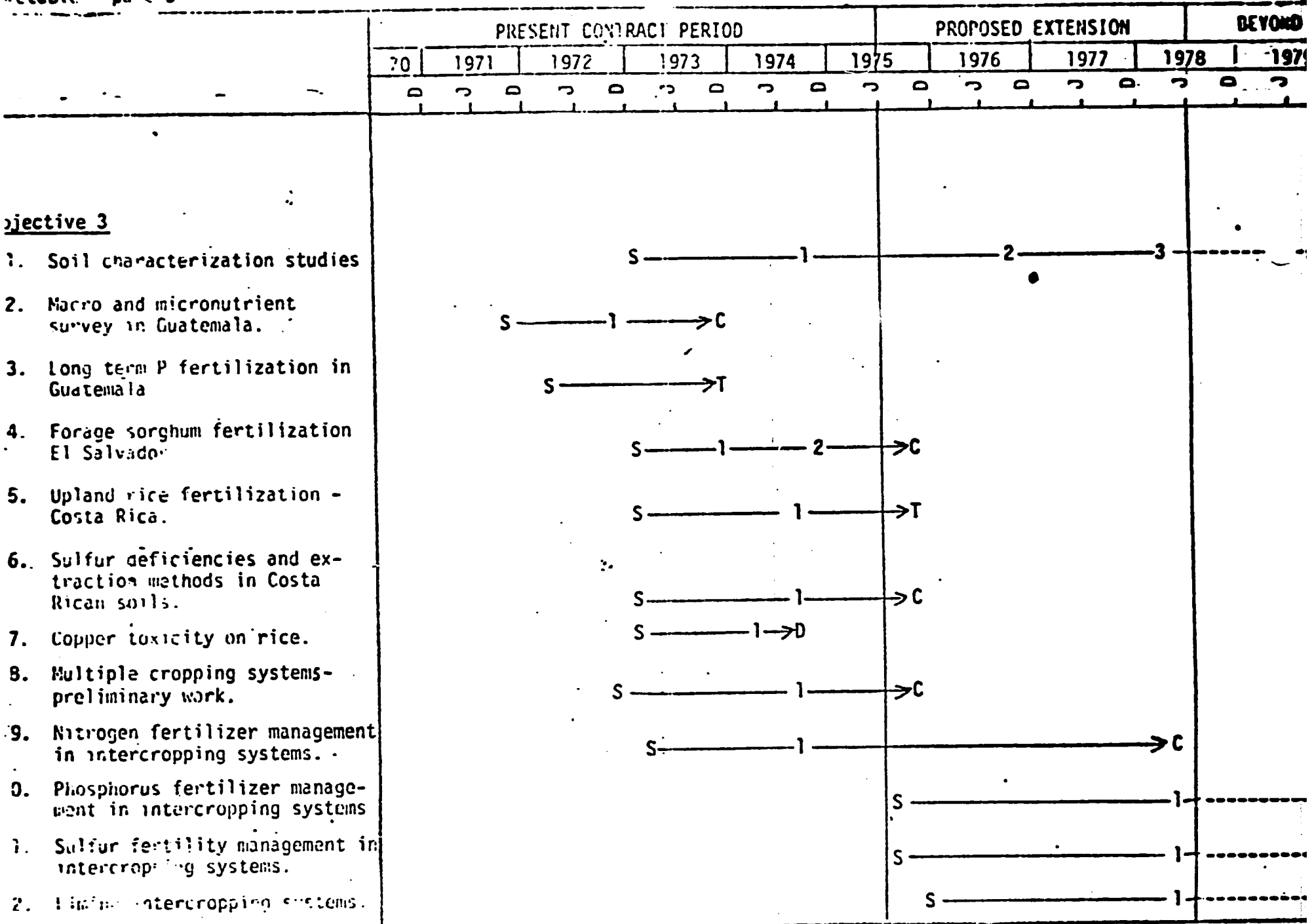
Table 1. Timetable for each research activity by objectives.



S = Project start
1 = Significant accomplishment
C = Project concluded

T = Transferred to cooperating national institution; limited advisory activities afterwards.


PRESENT CONTRACT PERIOD
PROPOSED EXTENSION
BEYOND
70
1971
1972
1973
1974
1975
1976
1977
1978
1979
Objective 2
1. Soil characterization
2. Depth of liming and residual effects
3. Phosphorus rates, placement and residual effects.
4 Zinc rates and residual effects.
5. Phosphate sources - silicate applications
6. Varietal and species differences in tolerance to high Al and low P
7. Distribution of properties of Cerrado soils.
8. Chemistry and mineralogy of phosphorus fixation.
9. Sulfur, potassium and magnesium studies.
10. Extrapolation field studies to other areas.
S
1
2
3
4
C


PRESENT CONTRACT PERIOD
PROPOSED EXTENSION
BEYOND
70
1971
1972
1973
1974
1975
1976
1977
1978
1979
Objective 3
1. Soil characterization studies
S 1 2 3
2. Macro and micronutrient survey in Guatemala.
S 1 C
3. Long term P fertilization in Guatemala
S T
4. Forage sorghum fertilization El Salvador
S 1 2 C
5. Upland rice fertilization - Costa Rica.
S 1 T
6. Sulfur deficiencies and extraction methods in Costa Rican soils.
S 1 C
7. Copper toxicity on rice.
S 1 D
8. Multiple cropping systems- preliminary work.
S 1 C
9. Nitrogen fertilizer management in intercropping systems.
S 1 C
0. Phosphorus fertilizer management in intercropping systems
S 1
1. Sulfur fertility management in intercropping systems.
S 1
2. Limi... intercropping systems.
S 1

	PRESENT CONTRACT PERIOD ('70, 1971, 1972, 1973, 1974, 1975)	PROPOSED EXTENSION (1976, 1977, 1978)	BEYOND (19..)
Objective 4			
1. Literature Review (State of the Art).	S — 1 — 2 → C		
2. Economics of Fertilizer Response.	S — 1 — 2 → C		
3. Economic Interpretation of Field Results.	S —	→ C	
4. Fertility-Capability Classification.	S — 1 —	2 → C	
5. Greenhouse and Laboratory Studies in Fertility, Chemistry, Microbiology.	S — 1 — 2 — 3 — 4 — 5 —	6 — 7 — 8 → C	
6. Soil characterization studies.	S — 1 — 2 — 3 — 4 — 5	6 — 7 → C	
7. Publication and distribution of results	S — 1 — 2 — 3 — 4 — 5	6 — 7 → C	

2. Effects of land clearing methods on soil productivity. 1. Field research at Yurimaguas completed. Results show the advantage of the traditional slash and burn system over mechanized land clearing. Report in preparation. Expected completion December 1975. Personnel: P. A. Sanchez, C. E. Seubert, C. E. Lopez. LDC collaborators: C. Valverde, M. Nureña.

3. Continuous cropping systems and changes in soil properties. Started August 1972. Expected completion: 10 years. Experimental design consists of four consecutive yearly land clearings with four cropping systems and fertilization strategies to be tested as a function of age after clearing. Changes in soil properties associated with fertility depletion are measured. This is the central, long term experiment to develop cropping systems. To date, the first three land clearings have been carried (Milestones 1, 2, 3). The fourth is planned for July 1975. In addition to yield data collection, intensive soil and plant sampling taken at regular intervals monitors changes with time. Results so far indicate that continuous cropping is economically feasible in these jungle Ultisols and that adequate to excellent yields of upland rice, soybeans, cassava and pastures have been obtained with moderate amounts of fertilizers and lime. Personnel: P. A. Sanchez, C. E. Seubert, C. E. Lopez, H. Villachica, C. Langley. LDC collaborators: C. Valverde, M. Nureña.

4. Fertility requirements for pasture production in the Jungle: Two forage experiments with Panicum maximum are evaluating the nitrogen, phosphorus, and lime requirements, including an evaluation of urea, sulfur-coated urea and Stylosanthes guyanensis as the source of nitrogen, superphosphate and several rock phosphates including Bayovar rock.

1. Results of first 10 months indicate high yield levels with low P and lime rates and a promising response of sulfur-coated urea applications every six months. Feeding quality of forage determined by nutrient analysis and in-vitro digestibility in cooperation with the Animal Science Department. A third experiment comparing methods of lime and phosphorus incorporation in exhausted pastures was initiated in 1974. 2. Expected completion of this phase in the field. An additional phase consisting of animal evaluation is needed. Personnel: P. A. Sanchez, C. E. Lopez, C. Langley. LDC cooperators: C. Valverde.

5. Fertility requirements of multiple cropping system for food production: This project aims at developing information for the second component of the "model farm": intensive food production for subsistence purposes and local marketing. Experiments in progress in: 1. Intercropping effect on nitrogen fertilization x spacing in corn-soybeans-cassava intercropping. 2. Residue management at different fertility levels in corn-soybeans-cassava intercroppings. 3. Residue management at different fertility levels in corn-soybeans-rice succession. 4. Lime response and depth of liming in corn-cowpea intercropping and monocultures. 5. Fertility requirements for intensive cropping systems ranging from one to five crops a year. 6. Germplasm introduction and testing of materials received from CIAT, IITA, CATIE, and other sources. Preliminary results to date indicate a highly beneficial effect of incorporating Kudzu as green manure on yields and nodulation by soybeans. Personel: M. K. Wade, P. A. Sanchez.

6. Major element responses in principal food crops: Responses to P K, and lime by upland rice, soybeans, cassava and plantains. The purpose is to establish the needed application rates and critical soil

test levels. Termination of field experiments expected by September 1975. Completion of work expected by December 1975. Personnel: G. S. Miner, D. Anderson.

7. Sulfur and micronutrient requirements: The initial continuous cropping experiment demonstrated the existence of sulfur, boron and molybdenum deficiencies in these soils. 1. Greenhouse tests in Raleigh confirmed these deficiencies and identified zinc and copper deficiencies. Field trials expected to start in March 1975. Data suggests that sulfur and micronutrient deficiencies might be crucial limiting factors. If so their solution with small quantities of inputs transportable at low costs seems economically feasible. Personnel: H. Villachica, P. A. Sanchez. LDC collaborators: C. Valverde.

8. Potential use of Bayovar rock phosphates in the Jungle: Perū is recently beginning to mine huge rock phosphate deposits in Bayovar on the Coast. Its potential is naturally believed to be for acid soils, most of which are in the jungle. Although Bayovar rock is included as treatments in certain experiments in projects 4 and 5, a systematic evaluation of its reactivity fineness and residual effects is needed to ascertain whether this product could be used effectively in the Jungle. Government officials have keen interest and partial financial support has been obtained by Dr. Valverde from MINEROPERU. Preliminary greenhouse experiments are in progress in Raleigh and in Lima by counterpart personnel. Field experiments are expected to be planted by March 1975. Personnel: H. Villachica, G. S. Miner, P. A. Sanchez. LDC collaborators: C. Valverde, J. Davelouis, M. Cano.

9. Developing of a "model farm" for continuous cropping in the Amazon: To be started in 1976. A synthesis of all findings into a model

based on annual slash and burn of 2 hectares of which 80% would be in pastures and 20% in intensive multiple cropping. To be done with actual farmers from the Yurimaguas cooperative. Complete agronomic and economic records will be kept of both crop and animal production. Personnel: To be hired.

10. Extrapolation of Studies

It is proposed that the third phase of this contract involve a series of field extrapolation studies to adapt the results already available from the jungle and savanna stations to other tropical areas with similar environmental conditions. The expected results of such work would further this contract's and AID's objectives because (1) it would test the degree of extrapolation possible of the results and the necessary local modifications and (2) it would encourage direct utilization by farmers in other regions.

Unlike previous arrangements developed with LFC's in this contract, no active seeking of appropriate locations will be done by NCSU staff. It is preferable to respond to requests from LDC institutions or USAID missions for collaboration. Only those institutions that show a high priority interest and willingness to make solid financial and personnel commitments on their part will be considered.

To date, indications of such an interest have been received from the following institutions:

1) - Universidade Federale Rural do Estado do Rio de Janeiro, Amapā, Brazil
2) - INIAP, Ecuador
3) - IVITA, Pucallpa, Peru
4) - Universidad Nacional Agraria La Molina, Per
5) - Universidad de Panama

The following mode of operation is envisioned:

1) Selection and evaluation of the sites will be made jointly by NCSU and the host institution's staff. This will involve soil characterization studies.
2) A series of applied-type experiments will be designed. These will synthesize the principal results from the main stations.
3) The experiments will be conducted by personnel from the cooperating institutions. When appropriate they may serve as thesis topics for graduate studies at NCSU or other institutions. All operating expenses must be borne by the cooperating institutions.
4) NCSU staff will serve as advisors, and will cooperate on execution and interpretation of the work. Certain soil

plant analysis may be conducted at Raleigh to supplement results.

5) The cooperating institutions will conduct appropriate field days, demonstrations and other extension functions

Personnel: S. W. Buol, P. A. Sanchez, vacant: to be hired. LDC collaborators: to be identified.

4.2 Objective No. 2 (As stated in Section 2)

1. Soil Characterization. 1. Determination of the potential area of extrapolation in the Campo Cerrado by Cline and Buol. 2. Work continuing in Llanos Orientales in collaboration with CIAT. 3 and 4. Expected additional studies in sites for potential extrapolation. Personnel: S. W. Buol, L. Mejia. LDC collaborators: M. Camargo, J. Spain, R. Guerrero and others.

2. Depth of Liming and Residual Effects. A long term experiment was initiated in December 1972, to evaluate the effect of different lime applications and the potential benefits of liming to 30 cms. depth. Results to date (1) indicate that deep liming is superior to shallow lime application because it increases root development and allows plants to withstand dry periods better. Two crops are grown per year and preliminary indications of the residual effects (2) indicate that relatively low rates are adequate. Several more years are needed to evaluate this

effect in economic terms. Personnel: Kamprath, Gonzalez, Salinas, Naderman. LDC staff: Soares, Lobato, Galrão.

3. Phosphorus Rates, Placement and Residual Effects: A long term experiment was planted in October 1972 to evaluate the effect of rates, placement and timing methods. Results to date suggest that large applications have a marked residual effect and that a combination of an original broadcast application followed by banded applications at each successive planting might be recommendable, but these suggestions are not economically sound yet. Considerable progress is expected by mid 1975 (1) although a much longer time span is needed for a thorough evaluation. Personnel: Kamprath, Yost, Naderman, Langley. LDC staff: Soares, Lobato, Galrão.

4. Zinc Rates and Residual Effects: A third set of long term experiments was planted in Brasilia in October 1972. They are designed to evaluate the rates, variety and pH interactions of zinc applications. Results to date (1) indicate that about 3 kg Zn/ha is essential to obtain yields and that liming of pH 6.4 induces additional zinc deficiencies. The residual effects of such applications should be adequately established by early 1978. Personnel: Cox, Lopes.

5. Phosphate Sources - Silicate Applications: Field experiments were established in October 1973 to evaluate cheaper sources of phosphorous including native rock phosphate and fused phosphate silicates (Termofosfato) on a pasture grass and legume at three lime levels. Two greenhouse experiments are also evaluating the interaction between lime, phosphorus and silicates with emphasis in decreasing phosphorus fixation. No preliminary results are available but considerable progress is expected by mid 1976 (1) and 1978 (2). Personnel: Kamprath, Yost, Naderman, Smyth, Sanchez.

6. Varietal and Species Differences in Tolerance to Al and low P. A series of culture solution studies in Raleigh were conducted to characterize varietal differences in corn, rice and beans. Results to date quantified such varietal differences and related them to differential ability to take up and translocate phosphorus. A series of experiments are in the process of being installed in Brasilia to test a large number of germplasm for Brazilian sources at three levels of P and three of exchangeable aluminum. Collaboration with Cornell plant breeder, C. O. Grogran is expected. Personnel: Salinas, Sanchez, Naderman, Jackson.

7. Distribution of Properties of Cerrado Soils: A total of 565 samples were taken throughout the Cerrado in order to quantify the variability in chemical properties. Results to date (1) indicate a very good correlation between several fertility parameters and native vegetation. Extreme low fertility characterizes the large majority of the samples. Work will serve as a guide for extrapolation of experimental results. Expected completion in late 1975. Personnel: Lopes, Cox.

8. Chemistry and Mineralogy of Phosphorus Fixation: Basic studies, using modern techniques are needed to better understand the process of phosphorus fixation by iron and aluminum oxides and hydroxides which is the main fertility limiting factor in these savanna Oxisols. Basic laboratory experiments were initiated in Raleigh to understand the process. Considerable progress is expected by late 1975 and completion by mid 1977. Personnel: Buol, Bingham.

9. Sulfur, Potassium and Magnesium Studies: These elements are also limiting in these soils and information in their behaviour and requirements are needed. A proposed series of experiments starting in October 1975 and terminating in 1978 would provide the necessary data. Personnel: Kamprath, others.

10. EXTRAPOLATION STUDIES: The operating pattern will be essentially the same as for item 10. Objective 1. NCSU will examine the situation and help design the best limited number of management combinations which will lead to economical field recommendations. Actual tests will be financed and conducted by the local cooperators. Only those willing and capable of conducting satisfactory adaptive research trials will be considered.

Management of the Oxisols under savanna ecology is critical in many countries.

Collaborators:

1) EMBRAPA, Brazil
2) CIAT, Carimagua, Colombia
3) Ministry of Agriculture, Dominican Republic
4) Universidad de Panama, Panama

Upon approval of this contract extension, discussions will be held with the institutions and where agreement can be reached cooperative projects will be established.

Personnel: NCSU - S. W. Buol, E. J. Kamprath, Naderman and others. Local cooperators to be identified.

Objective 3. (As stated in section 2)

1. Soil Characterization: Soil soposequence relationship in volcanic areas of Costa Rica completed by mid 1974 (1). Additional studies for new experimental areas planned. Personnel: Buol and assistants.

2 to 8. experiments in the process of completion of termination by the end of present contract period.

9. Nitrogen Management in Intercropping Systems: A series of corn-soybeans systems were compared with monocultures at different nitrogen levels to estimate efficiency of utilization and other parameters. Results of first set of experiments (1) indicate significant intercropping effect in Turrialba. Other experiments programmed for other regions. Expected completion by mid 1978. Personnel: Oelsligle, McCollum, Rossiter and others.

10 to 12. Phosphorus, Sulfur, and Liming Management in Intercropping Systems: A proposed series of experiments to be conducted in important intercropped areas of Central America to determine the dynamics of P, S, Ca, Mg and Al in intercropped systems and what are the best ways to apply these nutrients or amendments. Long term experiments in which considerable progress is expected by mid 1978 but economically sound interpretations at a later date. Personnel: McCollum, Rossiter, Oelsligle and others.

4.4 Objective 4. (As stated in section 2.b)

1 and 2. Essentially completed during the present contract period.

3. Economic Interpretation of Field Results: Economic researc has shifted from the analysis of data gathered prior to the contract to analyzing the data produced by the field research activities.

It involves translating the agronomic research results in economic terms and additional related data such as transportation costs. Personnel: Perrin and assistants.

4. Fertility-Capability Classification System: The system presented in 1971 went through preliminary evaluation in 1973 (1) and the first formal version (2), is expected to be published in 1975. Evaluation of Brazilian data is also finished. Additional evaluation and interpretation is planned using existing data for experiment stations in the tropics as well as in the U.S. Personnel: Granger, Pope, Buol, Sanchez. LDC Cooperators: Benavidez, Bejarano and others.

5 and 6. Greenhouse, Laboratory and Soil Characterization Studies: Needed to answer basic question passed by the field research or estimate degree of data extrapolation. Personnel: Kamprath, Buol, Cox, McCollum, Sanchez, Wollum, Perrin and assistants.

7. Publication and Distribution of Results: Annual technical report and reprints of publications mailed to over 450 individuals and institutions. Personnel: Sanchez, Monar.

4.5 Resources Required:

Personnel:

Campus:	Man-months
P. A. Sanchez, Project Leader	6

Campus (cont.)	Man-months (cont.
C. B. McCants, Department Head	3
S. W. Buol, Soil Genesis	3
E. J. Kamprath, Soil Fertility	3
N. A. Granger, FCC System	12
R. E. McCollum, Soil Fertility	3
Research Assistants (3)	18
C. Langley, Research Technician	12
B. Monar, Bilingual Secretary III	6
D. McDonald, Bilingual Secretary II	6
Total on Campus	72 = 6 man-years
Yurimaguas:	
Faculty Vacant, Coordinator	12
Research Assistants (3)	36
Brasilia:	
Faculty Vacant, Soil Fertility	12
Research Assistants (3)	36
Central America:	
Faculty Vacant, Coordinator	12
Research Assistants (3)	36
Total Overseas	144 = 12 man-years

Total Man-Year equivalent = 18.0 man-years

Revised Budget for Proposed
Tropical Soils Research Program
North Carolina State University
July 1, 1975 - June 30, 1978

Object	Estimated Cost per FY 1975-76	1976-77	1977-78
1. Salaries			
4 man-years, home office professional	227,393	238,763	250,701
2 man-years, home office non-professional			
12 man-years, field professional			
18 man-years, total			
2. Fringe Benefits	29,660	31,143	32,700
3. Overhead	77,320	81,186	85,245
4. Travel and Transportation	64,500	67,000	70,000
5. Supplies and Equipment	80,400	85,000	90,000
6. Quarters Allowance	30,600	32,000	34,000
7. Other Direct Costs	15,000	17,000	20,000
Total	$524.873	$552,092	$582,646
Estimated Three-Year Total		$1,659,611	

5. WORK PLAN: April 1, 1975 - June 30, 1978.*

OBJECTIVE 1.		Starting Date	Expected Completion
1	Characterization of Amazon Jungle soils.	June 71	June 78
2	Slash-and-burn vs mechanized land clearing methods.	Aug. 72	Dec. 75
3	Continuous cropping systems and changes in soil properties.	Aug. 72	June 78
4	Nitrogen, phosphorus and lime requirements of grass and grass-legume pastures.	Sept. 73	June 78
5	Fertility requirements of intensive multiple cropping system for food crop production.	Jan. 74	June 78
6.	Major element response by upland rice, soybeans, cassava and plantains.	Aug. 74	Dec. 76
7.	Sulfur and micronutrient requirements.	Feb. 74	June 78
8.	Potential use of Bayovar rock phosphates in the Amazon Jungle.	Aug. 74	June 78
9.	Development of a model farm for continuous cropping in the Amazon Jungle.	Sept. 75	June 78+
10.	Extrapolation of results to other jungle areas via field experiments with cooperating institutions.	Sept. 75	June 78+
OBJECTIVE 2.			
1	Characterization of savanna soils.	Sept. 71	June 78+
2	Residual effects of liming applications (including depth) in relation to crop requirements and soil moisture.	Dec. 72	June 78+
3.	Residual effects of phosphorus fertilization in Oxisols of Brasilia.	Oct. 72	June 78+
4.	Residual effects of zinc fertilization.	Oct. 72	June 78
5.	Comparison of different phosphorus sources and silicon applications to reduce fixation. Residual effects.	Oct. 73	June 78+

	Starting Date	Expected Completion
6. Varietal and species differences in tolerance to high exchangeable aluminum and low available phosphorus.	Jan. 74	Jan. 78+
7. Distribution of soil properties in the Cerrado of Brazil.	May 73	Dec. 75
8. Basic chemistry and mineralogy of phosphorus fixation reactions in highly weathered soils.	Jan. 74	June 77
9. Extrapolation of results to other Oxisol savanna areas via field experiments with cooperating institutions.	Oct. 75	June 78+
OBJECTIVE 3.		
1. Characterization of soils and climatic regimes of areas affected by volcanic ash in Central America.	March 73	June 78
2. Macro and micronutrient survey in Guatemala (concluded).	Aug. 71	Dec. 73
3. Long term P fertilization in Guatemala (transferred to ICTA)	Jan. 72	Dec. 73
4. Intensive forage sorghum fertilization for dry season cattle feeding in six sites of northern El Salvador.	March 73	Dec. 75
5. Fertility management for upland rice production in Costa Rica.	April 73	Dec. 75
6. Sulfur deficiencies and development of sulfur extraction methods in Costa Rica.	April 73	Dec. 74
7. Copper toxicity in upland rice soils in Costa Rica.	April 73	Dec. 74
8. Intensive multiple cropping systems at three fertility levels in volcanic soils of Turrialba, Costa Rica.	Dec. 72	Dec. 75
9. Nitrogen fertilization in intercropping and multiple cropping systems. Four locations in Costa Rica, possible in El Salvador.	July 73	June 7[illegible]

	Starting Date	Expected Completion
10. Phosphorus fertilizer management in intercropping and multiple cropping systems. At several locations in Central America.	Sept. 75	June 78+
11. Sulfur fertility management in intercropping and multiple cropping systems At several locations in Central America.	Sept. 75	June 78+
12. Liming intercropping and multiple cropping systems. At several locations in Central America.	Jan. 76	June 78+
OBJECTIVE 4.		
1. Literature Review (State of the art) completed May, 1974.		
2. Economic analysis of methods for estimating fertilizer recommendations.	June 70	Dec. 74
3. Economic interpretation of experimental results and data extrapolation.	Jan. 75	June 78
4. Development and evaluation of the fertility-capability classification system (World Wide).	June 71	June 78
5. Greenhouse and laboratory studies to help interpret field data and to estimate possibilities of extrapolation of results to soils of other countries or regions (Fertility, chemical, and microbiological studies).	June 70	June 78
Location		
6. Characterization studies of other tropical regions to help interpret and extrapolate data.	June 70	June 78
7. Publication and distribution of research results in two languages.	Dec. 71	June 78

Project Review:

Food and Nutrition

Agronomic-Economic Research on Tropical Soils - North Carolina State University

Dr. Whitney, Chairman of the Subcommittee composed of Drs. D. Peterson, M. Peterson, and Heady, reported as follows:

This project was initiated in 1970 by the Soil Science Department of the North Carolina State University. The purpose was to find ways to increase the productivity of the highly weathered soils of the Latin America tropics. The main thrust was to find the best soil management methods that can meet the desired production goals. Considerable progress has been made. The volume of publications and data is significant.

Some of the issues concerning the extension are: (1) What new information will be obtained? Technical problems for varient sites, longer term implications, and economic analyses are needed before making recommendations to farmers. (2) Are the goals acceptable and obtainable? The original objectives and studies were quite diverse and diffused. Objectives for the extension are more specific, being focused toward continuous cropping, intercropping systems, and further evaluation of nutrient needs, ways to overcome toxicities, and evaluation of longer-term carryover effects of previous fertilizer applications. The goals are feasible. Attention needs to be given to the supply and economics of the high phosphorus fixing capacity and fertilizer requirements. How will the economic inputs be handled? At what stages; and how analyzed? (3) Are the staff and budget adequate? The staff has abundantly demonstrated its competence. The budget represents a major increase over present levels. This is attributed to increased salaries, inflationary costs, and a reduction in services from USAI/Brasilia which is gradually phasing out its support.

The Subcommittee is in general agreement that the extension of this project is desirable.

Dr. M. Peterson stated that the project is well prepared, is long range in concept, and should be funded as long as it is productive.

Dr. Heady agreed that the project is important and should continue. However, it should be better integrated with the other soil projects. It appears to be primarily of help to the big plantation owners, and shows no methods for getting to the poor farmers. The title says economic, but there is little or no evidence of this in the design. Economic considerations should be a part of the ongoing project, and not added on at the end of the project. In the allocation of senior manpower there is none shown for economist. The concepts referenced are naive, and the alternatives are not as limited as stated. There should be a better statement.

Dr. D. Peterson was impressed with the tremendous potential resource of tropical soils as a source of food. He was favorable to the project. The soil classification system may be very significant for transfer of information. He urged improved interaction among researchers on the environmental and economic parameters necessary for extrapolation of recommendations to other areas. He suggested the development of an agreement on minimal data to be collected from all studies for the extension of analyses. He urged AID staff to attempt the development of field trial research standards with the objective of multiple purpose data collection and analysis.

Dr. Ervin Long expressed his concern for the issues raised by Dr. Heady's comments. NCS was originally selected for its competence in both soils and economics, and the 1967 soils testing project was essentially an economics project. However, there is a tendency for the different disciplines to work in their own fields concurrently, rather than as integrated interdisciplinary team research on a common problem. The Agency staff has worked at this problem as a sine qua non of good research.

Dr. John Malcolm, TA/AGR, expressed his appreciation to Dr. Heady for an opportunity to review his comments in advance and for the other comments. He reviewed the staffing as it has evolved, concluding that it is a well balanced staff in terms of the amount of senior staff time on campus compared to their time in the field. The idea that the phosphorus problem is the over-riding problem of the oxisols of the savannah is certainly correct. It cannot be solved with phosphates, but only by complex interactions. The least/cost combination may involve processing to depth mechanically thereby using less but treating more soil volume. He referred to the selection of plants for tolerance as a significant factor in working out successful combination treatments. The economic component of the project has been a problem, and this is reflected in the write-up. Dr. James Seagraves has been nominated from the Economics Department to the project. The Brazilian agency problems are not known, but at the technical level there are good relationships. NCS and Cornell are working together at Brasilia getting double use of a single set of experiments. He reported on a meeting last May in which the work of NCS and Cornell was made available to Hawaii and Puerto Rico. This February in Washington there was a meeting for information exchange among all Soils and Water projects.

Dr. Adams inquired if ecologists were present in the seminars described. No, if specialization is the criterion, but many others are also aware of the problems. Dr. Plucknett commented that range-management specialists who are trained as ecologists were participants in the Soils and Water Conference.

Motion: (a) That the project be approved essentially as presented; (b) that the project scope of work be revised to assure that economic, soil management, and agronomic factors are considered in planning, coordination, and budgeting, and that due consideration is given to environmental variables; and (c) that a progress report, cross referenced by objectives and utilization strategies, be submitted to RAC for review at the end of the second year of the extension.

Moved by Dr. Whitney, seconded by Dr. Heady.
Vote: Approved by unanimous voice vote.

RAC Feb 20-21, 1975

Inheritance and Improvement of Protein Quality/Content in Maize - Purdue University

Dr. M. Peterson, Chairman of the Subcommittee composed of Drs. Milner, Schweigert and Whitney, reported as follows:

The primary objectives of this project was to utilize the Opaque-2, Floury-2 or any other genes of maize still to be discovered to improve protein content and quality of maize. The principle quality limitations of maize nutritionally are lysine and tryptophane. Transfer of these genes to superior hybrids is a simple matter. The difficulties which led to the research project are the characteristics associated with these genes that are undesirable and that are transferred along with the Opaque-2 and Floury-2 genes. Research has concentrated on the Opaque-2 and on the search for other sources of high lysine. The problem as yet unsolved is how to overcome the undesirable characteristics associated with the high lysine mutants. Goals are to increase seed size, improve yields, gain better disease and insect resistance, and develop a more acceptable starch.

Issues involved appear to be these:

1. Obtainment of objectives: Obtainment has proven far more difficult than originally envisioned. Progress is being made slowly and with difficulty. Full goals are not likely to be reached in the next three years. Work on the double mutants is promising and probably should be completed.

2. Progress of the Purdue project: Reports indicate large effort and slow progress. It does not appear that Purdue can be faulted for the fact that the initial goal is still not within their grasp.

3. Is the Purdue project needed? Alternatives are CIMMYT and the commercial breeders. CIMMYT is on a paralled course but aiming at tropical hybrids; commercial breeders in the U.S. will be working on hybrids for temperate regions.

Conclusion: Genetic and breeding programs are by their nature long-range activities. It is not surprising that a major goal is not reached in 5 years. However, the initial idea that Purdue would concentrate on genetic and biochemical studies and CIMMYT on breeding has not been the primary division of effort. The extension is reasonable but with the goal that the project should be phased out at a specific time, not to exceed three years. Materials developed should be made freely available, as they are, and maximum effort devoted to the genetic studies of double and multiple combinations of endosperm mutants and the possible benefits of modifier genes. Responsibility for the breeding work should be shifted to CIMMYT for tropical varieties, to commercial breeders for temperate varieties, and to the regular ongoing research of ARS and the state agricultural experiment stations for the U.S.

COST REIMBURSEMENT CONTRACT WITH AN EDUCATIONAL INSTITUTION

PD-AAC-887 9310525

AGENCY FOR INTERNATIONAL DEVELOPMENT NEGOTIATED CONTRACT NO. AID/ta-C-1236

28p.

NEGOTIATED PURSUANT TO THE FOREIGN ASSISTANCE ACT OF 1961, AS AMENDED, AND EXECUTIVE ORDER 11223	TOTAL ESTIMATED CONTRACT COST $1,658,368. (See Article IV)
CONTRACT FOR: Discovery of Economic Systems for Management of Tropical Soils PROJECT NO: 931-17-120-525-73	CONTRACTOR (Name and Address) North Carolina State University NAME
ISSUING OFFICE (Name and Address) Agency for International Development Central Operations Division Office of Contract Management Washington, D.C. 20523	STREET ADDRESS Raleigh, North Carolina 27607 CITY, STATE, AND ZIP CODE
ADMINISTRATION BY SER/CM/COD, TAB	COGNIZANT SCIENTIFIC/TECHNICAL OFFICE TA/AGR
MAIL VOUCHERS (Original and 3 copies) TO: Agency for International Development Office of Financial Management Washington, D.C. 20523	ACCOUNTING AND APPROPRIATION DATA PIO/T NO. 3157580 APPROPRIATION NO. 72-11X1023 ALLOTMENT NO. 402-31-099-00-2251
EFFECTIVE DATE	ESTIMATED COMPLETION DATE 06-29-78

The United States of America, hereinafter called the Government, represented by the Contracting Officer executing this Contract, and the Contractor, an educational institution chartered by the State of North Carolina with its principal office in Raleigh, North Carolina, agree that the Contractor shall perform all the services set forth in the attached Schedule, for the consideration stated therein. The rights and obligations of the parties to this contract shall be subject to and governed by the Schedule and the General Provisions. To the extent of any inconsistency between the Schedule and the General Provisions and any specifications or other provisions which are made a part of this contract, by reference or otherwise, the Schedule or the General Provisions shall control. To the extent or any inconsistency between the Schedule and the General Provisions, the Schedule shall control.

CERTIFIED A TRUE COPY THIS
28th DAY OF July, 75
BY Robin Grindstaff

This Contract consists of this Cover Page, the Table of Contents, and the Schedule consisting of 22 pages, the General Provisions (Form AID 1420-23C), dated 9-74, and Additional General Provisions (Form AID-1420-D) Dated 9-74

NAME OF CONTRACTOR North Carolina State University	UNITED STATES OF AMERICA AGENCY FOR INTERNATIONAL DEVELOPMENT
BY (Signature of authorized individual)	BY (Signature of Contracting Officer)
TYPED OR PRINTED NAME T. Felix Joyner	TYPED OR PRINTED NAME V. C. Perelli
TITLE Vice-President - Finance	CONTRACTING OFFICER
DATE JUN 30 1975	DATE JUN 30 1975

AID 1420-23A (6-73)

SCHEDULE

COST REIMBURSEMENT CONTRACT WITH

AN EDUCATIONAL INSTITUTION

Contract No. AID/ta-C-1236

TABLE OF CONTENTS

The Schedule, on pages 1 through 22 , consists of this Table of Contents and the following Articles:

GENERAL PROVISIONS

1. The General Provisions applicable to this contract consist of form AID 1420-23C entitled "General Provisions - Cost Reimbursement Contract with an Educational Institution", dated 9-74, which includes provisions 1 through 38; and form AID 1420-23D entitled "Additional General Provisions - Cost Reimbursement Contract with an Educational Institution," dated 9-74, which includes provisions 1 through 18.

ARTICLE I - STATEMENT OF WORK

A. For a period hereinafter set forth in the Schedule, the Contractor agrees to develop a "package of economically-sound soil management practices for increasing food production in 1) jungle soils presently under shifting cultivation, 2) acid savanna Oxisols and 3) inter-cropping systems in volcanic highlands. Such practices could be extrapolated to areas other than where the research is conducted.

This work is a continuation of the research formerly carried out under Contract No. AID/csd-2806. The following objectives and products shall reflect the work previously done and incorporate those results into this scope of work.

B. Objectives: Expected Products

Objective 1): Contractor agrees to develop a package of economically-sound soil and fertilizer management practices for increasing food production via continuous cultivation of jungle soils presently under shifting cultivation. The result of such a set of recommendations when applied at the farm level will be to open large new areas of tropical rainforests for food crop production, on an ecologically-sound basis.

Objective 2): Contractor agrees to develop a package of economically-sound soil and fertilizer management practices for increasing food production in acid Oxisol tropical savannas. The result of such a set of recommendations when applied at the farm level will bring into production huge areas of tropical savannas presently not utilized.

Objective 3): Contractor agrees to develop a package of economically-sound soil and fertilizer management practices for increasing food production

in subsistence intercropped systems small farming operations in highland areas affected by volcanic activity. The result of such a set of recommendations, when applied at the farm level will be to markedly increase the productivity of intercropped systems and the well-being of such farmers.

Objective 4): Contractor agrees to develop means for interpreting and extrapolating the products of Objectives 1 to 3 to other areas via economic interpretations, additional greenhouse and laboratory work on campus and through cooperative field trials in other areas. The result of such studies will be the verification (or lack of) of the extrapolability of data from intensive study sites to other jungle and savanna or intercropped volcanic areas.

C. Strategy of Dissemination

The strategy of dissemination shall be as follows: To publish as quickly as possible new significant research results, first in the Technical Annual Reports and when appropriate in scientific articles. Significant results shall be published in English and Spanish. This information shall then be distributed to recipients on Contractor's mailing list and also to additional personnel by the cooperating institutions in their country.

D. Project Design and Methods

A specific list of research projects are outlined on Table 1 as a means for accomplishing the research objectives. Each activity involves one or several experiments. The starting dates, "milestones" and expected

completion appear in Table 1. The narrative of each activity follows. Activities under each objective are interdependent. Additional activities shall be identified in the course of research as needed for accomplishing the objectives. A certain amount of flexibility is needed when interpreting this table, because research cannot be planned with as much precision as the table might imply. Unless otherwise specified field activities are to be conducted in Yurimaguas, Peru, for Objective 1, in Brasilia, Brazil for Objective 2, in Central America for Objective 3 and on campus on Objective 4.

Objective 1: (As stated in Section B).

1. Characterization of Amazon Jungle Soils. 1* Studies on Colombian Amazon finished January 1973. 2. Field studies on Peruvian Amazon Jungle completed. 3. Detailed soils map of Yurimaguas Station shall be completed by September 1975. Further activities contemplated include characterization of potential extrapolation sites. Requests for cooperation received from Pucallpa and Iquitos (Peru), Amapa (Brazil), eastern Ecuador. Project personnel involved in characterization study of soils in the Venezuela Amazon with financial support from Venezuelan government. Personnel: S. W. Buol, E. J. Tyler.

2. Effects of land clearing methods on soil productivity. 1. Field research at Yurimaguas completed. Results show the advantage of the traditional slash and burn system over mechanized land clearing. Report in preparation. Shall be completed by December 1975. Personnel: P. A. Sanchez, C. E. Seubert, C. E. Lopez.

*These numbers refer to the "milestones" of Table 1.

3. Continuous cropping systems and changes in soil properties

Started August 1972. Experimental design consists of four consecutive yearly land clearings with four cropping systems and fertilization strategies to be tested as a function of age after clearing. Changes in soil properties associated with fertility depletion are measured. This is the central, long term experiment to develop cropping systems. To date, the first three land clearings have been carried (Milestones 1, 2, 3). The fourth is planned for July 1975. In addition to yield data collection, intensive soil and plant sampling taken at regular intervals monitors changes with time. Results so far indicate that continuous cropping is economically feasible in these jungle Ultisols and that adequate to excellent yields of upland rice, soybeans, cassava and pastures have been obtained with moderate amounts of fertilizers and lime. Personnel: P. A. Sanchez, C. E. Seubert, C. E. Lopez, H. Villachica, C. Langley.

4. Fertility requirements for pasture production in the Jungle:

Two forage experiments with Panicum maximum are evaluating the nitrogen, phosphorus, and lime requirements, including an evaluation of urea, sulfur-coated urea and Stylosanthes guyanensis as the source of nitrogen, superphosphate and several rock phosphates including Bayovar rock.

Results of first 10 months indicate high yield levels with low P and lime rates and a promising response of sulfur-coated urea applications every six months. Feeding quality of forage determined by

nutrient analysis and in-vitro digestibility in cooperation with the Animal Science Department. A third experiment comparing methods of lime and phosphorus incorporation in exhausted pastures was initiated in 1974. An additional phase consisting of animal evaluation shall be initiated. Personnel: P. A. Sanchez, C. E. Lopez, C. Langley.

5. Fertility requirements of multiple cropping system for food production: Contractor agrees to develop information for the second component of the "model farm": intensive food production for subsistence purposes and local marketing. Experiments in progress in: (a) Intercropping effect on nitrogen fertilization x spacing in corn-soybeans-cassava intercropping. (b) Residue management at different fertility levels in corn-soybeans-cassava intercroppings. (c) Residue management at different fertility levels in corn-soybeans-rice succession. (d) Lime response and depth of liming in corn-cowpea intercropping and monocultures. (e) Fertility requirements for intensive cropping systems ranging from one to five crops a year. (f) Germplasm introduction and testing of materials received from CIAT, IITA, CATIE, and other sources. Preliminary results to date indicate a highly beneficial effect of incorporating Kudzu as green manure on yields and nodulation by soybeans. Personnel: M. K. Wade, P. A. Sanchez.

6. Major element responses in principal food crops: Responses to P, K, and lime by upland rice, soybeans, cassava, and plantains. The purpose is to establish the needed application rates and critical soil test levels. Termination of field experiments will be by September 1975.

Completion of work shall be by December 1975. Personnel: G.S. Miner, D. Anderson.

7. Sulfur and micronutrient requirements: The initial continuous cropping experiment demonstrated the existence of sulfur, boron and molybdenum deficiencies in these soils. Greenhouse tests in Raleigh confirmed these deficiencies and identified zinc and copper deficiencies. Field trials started in March 1975. Data suggests that sulfur and micronutrient deficiencies might be crucial limiting factors. If so their solution with small quantities of inputs transportable at low costs seems economically feasible. Personnel: H. Villachica, P. A. Sanchez.

8. Potential use of Bayovar rock phosphates in the Jungle: Peru is recently beginning to mine huge rock phosphate deposits in Bayovar on the Coast. Its potential is naturally believed to be for acid soils, most of which are in the jungle. Although Bayovar rock is included as treatments in certain experiments in projects 4 and 5, a systematic evaluation of its reactivity fineness and residual effects shall be carried out to ascertain whether this product could be used effectively in the Jungle. Government officials have keen interest and partial financial support has been obtained by Dr. Valverde from MINEROPERU. Preliminary greenhouse experiments are in progress in Raleigh and in Lima by counterpart personnel. Field experiments were planted in March 1975. Personnel: H. Villachica, G. S. Miner, P. A. Sanchez.

9. Developing of a "model farm" for continuous cropping in the Amazon: Shall be started in 1976. A synthesis of all findings into a model based on annual slash and burn of 2 hectares of which 80% shall be in pastures and 20% in intensive multiple cropping. Shall be done with actual farmers

10. Extrapolation of Studies

The third phase of this contract shall involve a series of field extrapolation studies to adapt the results already available from the jungle and savanna stations to other tropical areas with similar environmental conditions. The results of such work will further AID's objectives because (1) it will test the degree of extrapolation possible of the results and the necessary local modifications and (2) it will encourage direct utilization by farmers in other regions.

The Contractor will respond to requests from LDC institutions or USAID Missions for collaboration. Only those institutions that show a high priority interest and willingness to make solid financial and personnel commitments on their part shall be considered.

To date, indications of such an interest have been received from the following institutions:

1) - Universidade Federale Rural do Estado do Rio de Janeiro, Amapā, Brazil
2) - INIAP, Ecuador
3) - IVITA, Pucallpa, Peru
4) - Universidad Nacional Agraria La Molina, Peru
5) - Universidad de Panama

The following mode of operation shall be initiated:

1) Selection and evaluation of the sites shall be made jointly by the Contractor and the host institution's staff. This shall involve soil characterization studies.

2) A series of applied-type experiments shall be designed. These will synthesize the principal results from the main stations.

3) The experiments shall be conducted by personnel from the cooperating institutions. When appropriate they will serve as thesis topics for graduate studies at the Contractor's campus or other institutions. All operating expenses shall be borne by the cooperating institutions.

4) Contractor's staff shall serve as advisors, and will cooperate on execution and interpretation of the work. Certain soil and plant analysis shall be conducted at Raleigh to supplement results.

5) The cooperating institutions shall conduct appropriate field days, demonstrations and other extension functions.

Personnel: S.W. Buol, P.A. Sanchez

Objective No. 2 (As stated in Section B)

1. Soil Characterization (a) Determination of the potential area of extrapolation in the Campo Cerrado by Cline and Buol. (b) Work will continue in Llanos Orientales in collaboration with CIAT. (c) and (d). Additional studies in sites for potential extrapolation.

Personnel: S.W. Buol, L. Mejia.

2. Depth of Liming and Residual Effects. A long term experiment was initiated in December 1972, to evaluate the effect of different lime applications and the potential benefits of liming to 30 cms.depth. Results to date (a) indicate that deep liming is superior to shallow lime application because it increases root development and allows plants to withstand dry periods better. Two crops are grown per year and

and preliminary indications of the residual effects (b) indicate that relatively low rates are adequate. Several more years are needed to evaluate this effect in economic terms. Personnel:Kamprath, Gonzalez, Salinas, Naderman.

3. Phosphorus Rates, Placement and Residual Effects: A long term experiment was planted in October 1972 to evaluate the effect of rates, placement and timing methods. Results to date suggest that large applications have a marked residual effect and that a combination of an original broadcast application followed by banded applications at each successive planting might be recommendable, but these suggestions are not economically sound yet. Considerable progress will be made by mid 1975 although a much longer time span is needed for a thorough evaluation. Personnel: Kamprath, Yost, Naderman, Langley. LDC staff: Soares, Lobato, Galrao.

4. Zinc Rates and Residual Effects: A third set of long term experiments was planted in Brasilia in October 1972. They are designed to evaluate the rates, variety and ph interactions of zinc applications. Results to date (1) indicate that about 3 kg Zn/ha is essential to obtain yields and that lining of ph 6.4 induces additional zinc deficiencies. The residual effects of such applications shall be adequately established by early 1978. Personnel: Cox, Lopes.

5. Phosphate Sources - Silicate Applications: Field experiments were established in October 1973 to evaluate cheaper sources of phosphorous including native rock phosphate and fused phosphate silicates (Termofosfato) on a pasture grass and legume at three lime levels. Two

greenhouse experiments are also evaluating the interaction between lime, phosphorus and silicates with emphasis in decreasing phosphorus fixation. No preliminary results are available but considerable progress will be made by mid 1976 and 1978. Personnel: Kamprath, Yost, Naderman, Smyth, Sanchez.

6. Varietal and Species Differences in Tolerance to Al and low P. A series of culture solution studies in Raleigh were conducted to characterize varietal differences in corn, rice and beans. Results to date quantified such varietal differences and related them to differential ability to take up and translocate phosphorus. A series of experiments shall be installed in Brasilia to test a large number of germplasm for Brazilian sources at three levels of P and three of exchangeable aluminum. Collaboration with Cornell plant breeder, C.O. Grogran will be made. Personnel: Salinas, Sanchez, Naderman, Jackson.

7. Distribution of Properties of Cerrado Soils: A total of 565 samples were taken throughout the Cerrado in order to quantify the variability in chemical properties. Results to date (1) indicate a very good correlation between several fertility parameters and native vegetation. Extreme low fertility characterizes the large majority of the samples. Work shall serve as a guide for extrapolation of experimental results. Completion in late 1975. Personnel: Lopes, Cox,

8. Chemistry and Mineralogy of Phosphorus Fixation: Basic studies, using modern techniques are needed to better understand the process of phosphorus fixation by iron and aluminum oxides and hydroxides which is

the main fertility limiting factor in these savanna Oxisols. Basic laboratory experiments were initiated in Raleigh to understand the process. Considerable progress will be accomplished by late 1975 and completion by mid 1977. Personnel: Buol, Bingham.

9. Sulfurm Potassium and Magnesium Studies: These elements are also limiting in these soils and information in their behaviour and requirements are needed. A series of experiments starting in October 1975 and terminating in 1978 shall provide the necessary data. Personnel: Kamprath, others.

10. Extrapolation Studies: The operating pattern shall be essentially the same as for item 10. Objective 1. Contractor will examine the situation and help design the best limited number of management combinations which shall lead to economical field recommendations. Actual tests shall be financed and conducted by the local cooperators. Only those willing and capable of conducting satisfactory adaptive research trials shall be considered.

Management of the Oxisols under savanna ecology is critical in many countries.

Collaborators:

1) EMBRAPA, Brazil

2) CIAT, Carimagua, Colombia

3) Ministry of Agriculture, Dominican Republic

4) Universidad de Panama, Panama

Discussions shall be held with the institutions and where agreement can be reached cooperative projects shall be established.

Personnel: NCSU - S. W. Buol, E. J. Kamprath, Naderman and others.

Objective 3. (As stated in section B)

1. Soil Characterization: Soil soposequence relationship in volcanic areas of Costa Rica completed by mid 1974 (1). Additional studies for new experimental areas planned. Personnel: Buol and assistants.

2 to 8. experiments in the process of completion of termination by the end of present contract period.

9. Nitrogen Management in Intercropping Systems: A series of corn-soybeans systems were compared with monocultures at different nitrogen levels to estimate efficiency of utilization and other parameters. Results of first set of experiments indicate significant intercropping effect in Turrialba. Other experiments programmed for other regions. Completion by mid 1978. Personnel: Oelsligle, McCollum, Rossiter and others.

10 to 12. Phosphorus, Sulfur, and Liming Management in Intercropping Systems: A proposed series of experiments to be conducted in important intercropped areas of Central America to determine the dynamics of P, S, Ca, Mg and Al in intercropped systems and what are the best ways to apply these nutrients or amendments. Long term experiments in which considerable progress is expected by mid 1978 but economically-sound interpretations at a later date. Personnel: McCollum, Rossiter, Oelsligle and others.

Objective 4. (As stated in section 2.b)

1 and 2. Essentially completed during the present contract period.

3. Economic Interpretation of Field Results: Economic research has shifted from the analysis of data gathered prior to the contract to analyzing the data produced by the field research activities. It involves translating the agronomic research results in economic terms and additional related data such as transportation costs. Personnel: Perrin and assistants.

4. Fertility-Capability Classification System: The system presented in 1971 went through preliminary evaluation in 1973 and the first formal version shall be published in 1975. Evaluation of Brazilian data is also finished. Additional evaluation and interpretation shall be planned using existing data for experiment stations in the tropics as well as in the U.S. Personnel: Granger, Pope, Buol, Sanchez.

5 and 6. Greenhouse, Laboratory and Soil Characterization Studies: Needed to answer basic question passed by the field research or estimate degree of data extrapolation. Personnel: Kamprath, Buol, Cox, McCollum, Sanchez, Wollum, Perrin and assistants.

7. Publication and Distribution of Results: Annual technical report and reprints of publications mailed to over 450 individuals and institutions.

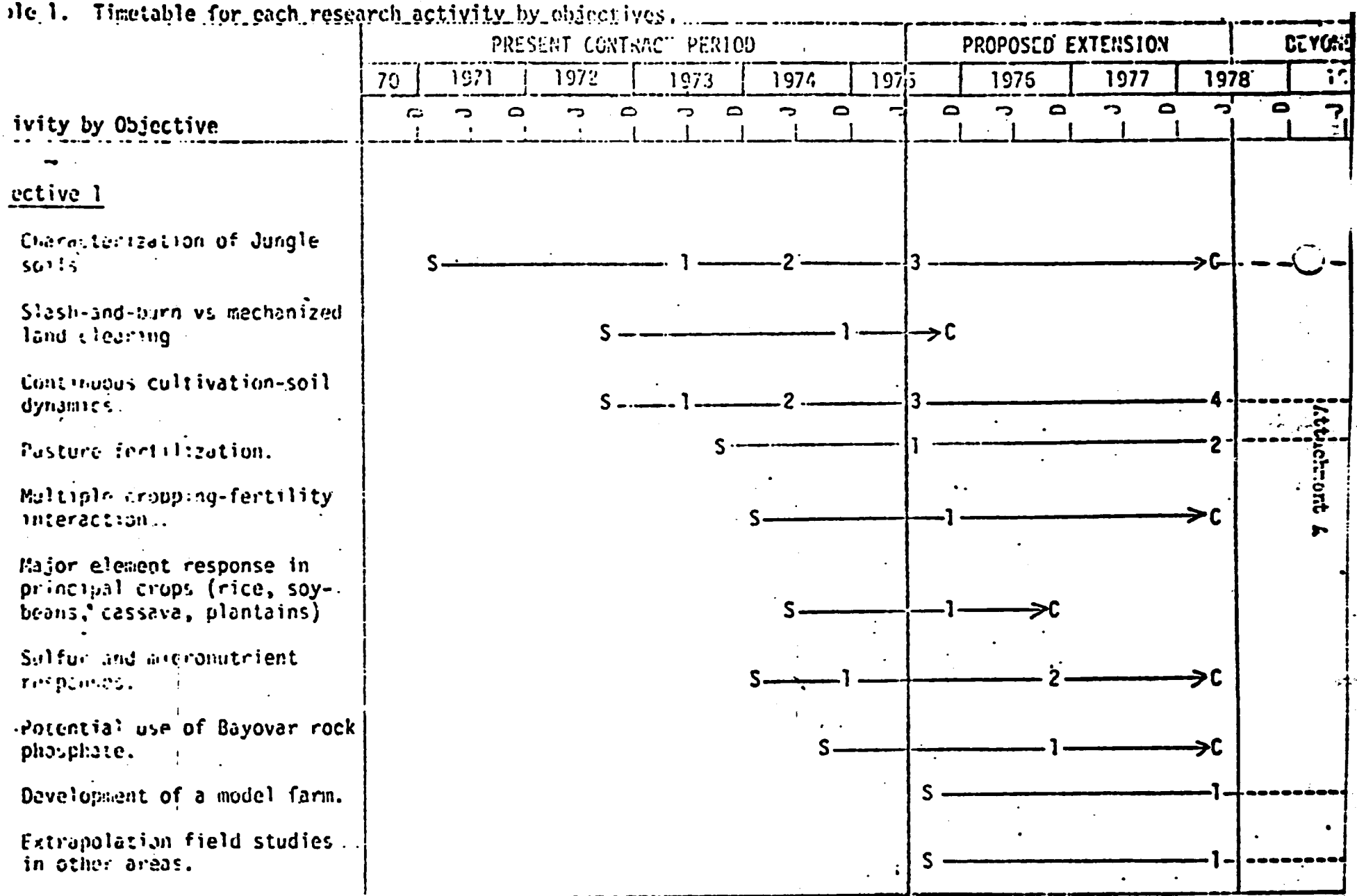
E. WORK PLAN: April 1, 1975 - June 30, 1978.*

OBJECTIVE 1.	Starting Date	Expect Completion
1. Characterization of Amazon Jungle soils.	June 71	June 78
2. Slash-and-burn vs mechanized land clearing methods.	Aug. 72	Dec. 75
3. Continuous cropping systems and changes in soil properties.	Aug. 72	June 78
4. Nitrogen, phosphorus and lime requirements of grass and grass-legume pastures.	Sept. 73	June 78
5. Fertility requirements of intensive multiple cropping system for food crop production.	Jan. 74	June 78
6. Major element response by upland rice, soybeans, cassava and plantains.	Aug. 74	Dec. 76
7. Sulfur and micronutrient requirements	Feb. 74	June 78
8. Potential use of Bayovar rock phosphates in the Amazon Jungle.	Aug. 74	June 78
9. Development of a model farm for continuous cropping in the Amazon Jungle.	Sept. 75	June 78+
10. Extrapolation of results to other jungle areas via field experiments with cooperating institutions.	Sept. 75	June 78+
OBJECTIVE 2.		
1. Characterization of savanna soils.	Sept. 71	June 78+
2. Residual effects of liming applications (including depth) in relation to crop requirements and soil moisture.	Dec. 72	June 78+
3. Residual effects of phosphorus fertilization in Oxisols of Brasilia.	Oct. 72	June 78+
4. Residual effects of zinc fertilization.	Oct. 72	June 78
5. Comparison of different phosphorus sources and silicon applications to reduce fixation. Residual effects.	Oct. 73	June 78+

	Starting Date	Expected Completion
6. Varietal and species differences in tolerance to high exchangeable aluminum and low available phosphorus.	Jan. 74	Jan. 78+
7. Distribution of soil properties in the Cerrado of Brazil.	May 73	Dec. 75
8. Basic chemistry and mineralogy of phosphorus fixation reactions in highly weathered soils.	Jan. 74	June 77
9. Extrapolation of results to other Oxisol savanna areas via field experiments with cooperating institutions.	Oct. 75	June 78+
OBJECTIVE 3.		
1. Characterization of soils and climatic regimes of areas affected by volcanic ash in Central America.	March 73	June 78
2. Macro and micronutrient survey in Guatemala (concluded).	Aug. 71	Dec. 73
3. Long term P fertilization in Guatemala (transferred to ICTA)	Jan. 72	Dec. 73
4. Intensive forage sorghum fertilization for dry season cattle feeding in six sites of northern El Salvador.	March 73	Dec. 75
5. Fertility management for upland rice production in Costa Rica.	April 73	Dec. 75
6. Sulfur deficiencies and development of sulfur extraction methods in Costa Rica.	April 73	Dec. 74
7. Copper toxicity in upland rice soils in Costa Rica.	April 73	Dec. 74
8. Intensive multiple cropping systems at three fertility levels in volcanic soils of Turrialba, Costa Rica.	Dec. 72	Dec. 75
9. Nitrogen fertilization in intercropping and multiple cropping systems. Four locations in Costa Rica, possible in El Salvador.	July 73	June 7[illegible]

	Starting Date	Expected Completion
10. Phosphorus fertilizer management in intercropping and multiple cropping systems. At several locations in Central America.	Sept. 75	June 78+
11. Sulfur fertility management in intercropping and multiple cropping systems At several locations in Central America.	Sept. 75	June 78+
12. Liming intercropping and multiple cropping systems. At several locations in Central America.	Jan. 76	June 78+
OBJECTIVE 4.		
1. Literature Review (State of the art) completed, May, 1974.		
2. Economic analysis of methods for estimating fertilizer recommendations.	June 70	Dec. 74
3. Economic interpretation of experimental results and data extrapolation.	Jan. 75	June 78
4. Development and evaluation of the fertility-capability classification system (World Wide).	June 71	June 78
5. Greenhouse and laboratory studies to help interpret field data and to estimate possibilities of extrapolation of results to soils or other countries or regions (Fertility, chemical, and microbiological studies).	June 70	June 78
Location		
6. Characterization studies of other tropical regions to help interpret and extrapolate data.	June 70	June 78
7. Publication and distribution of research results in two languages.	Dec. 71	June 78

ble 1. Timetable for each research activity by objectives.



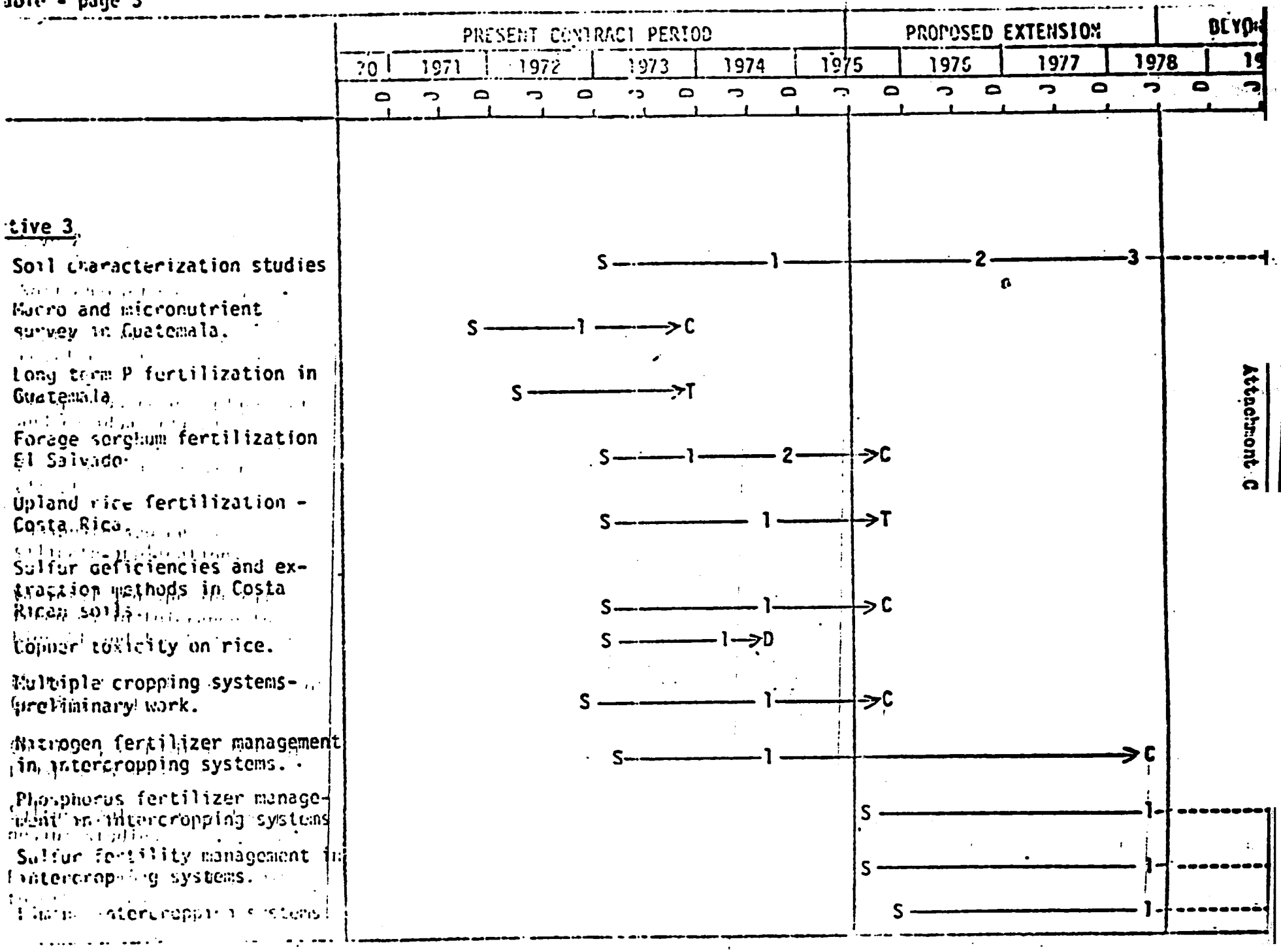
oject start
nificant accomplishment
T = Transferred to cooperating national institution; limited advisory activities afterwards.

Ule.L page ?

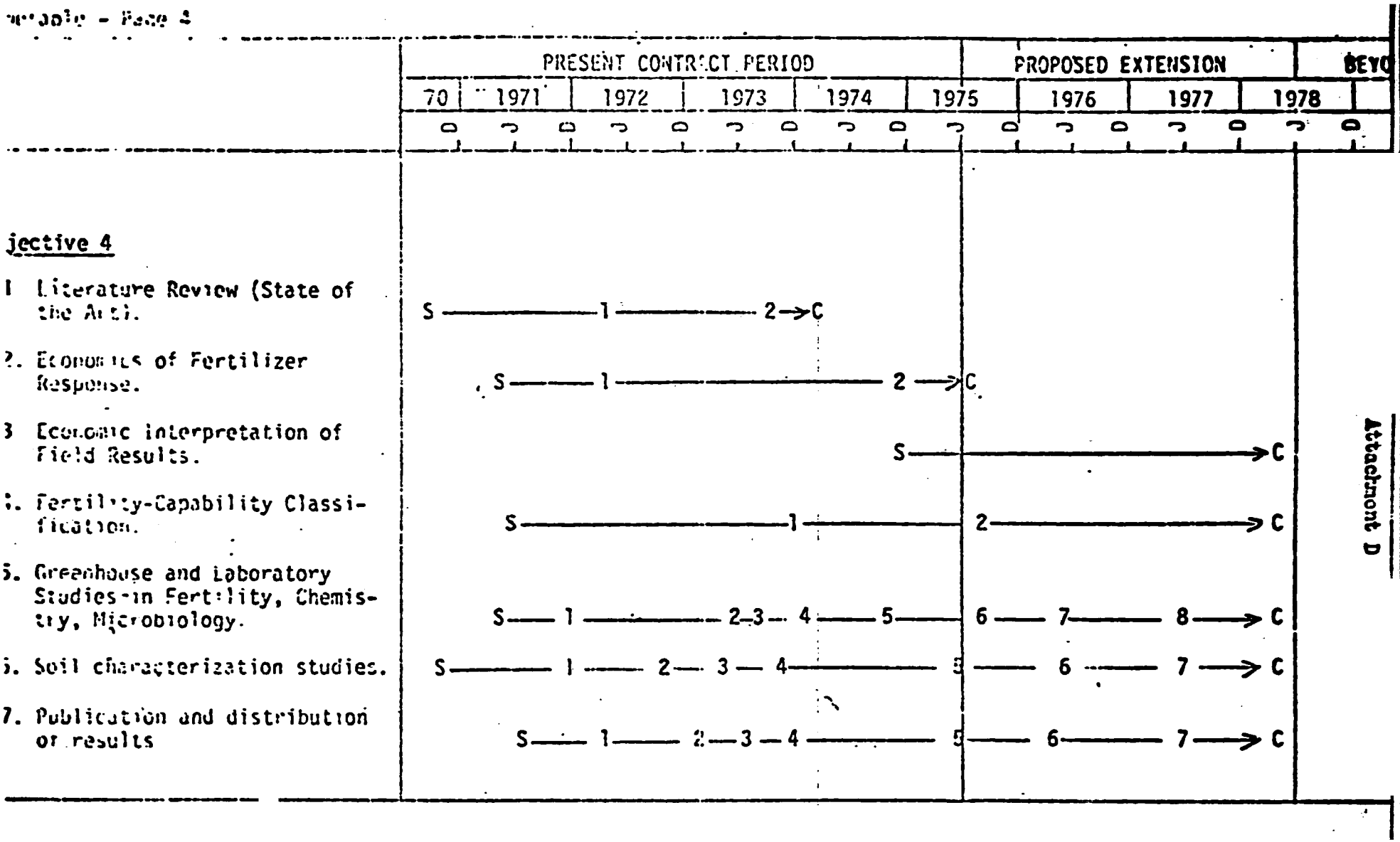
ective 2

	PRESENT CONTRACT PERIOD						PROPOSED EXTENSION			BEYO
	70	1971	1972	1973	1974	1975	1976	1977	1978	19
. Soil characterization		S ——	——	1 ——	2 ——	3 ——	——	——	4	----(circle)
. Depth of liming and residual effects			S ——	——	1 ——	——	2 ——	——	3	--------
. Phosphorus rates, placement and residual effects.			S ——	——	——	1 ——	——	——	2	--------
. Zinc rate, and residual effects.			S ——	——	——	1 ——	——	——	→ C	
. Phosphate sources - silicate applications				S ——	——	1 ——	——	——	2	--------
. Varietal and species differences in tolerance to high Al and low P				S ——	——	——	1 ——	——	2	----(circle)
. Distribution of properties of Cerrado soils.				S ——	——	1 →	C			
. Chemistry and mineralogy of phosphorus fixation.				S ——	——	——	1 ——	→ C		
. Sulfur, potassium and magnesium studies.						S ——	1 ——	——	→ C	
. Extrapolation field studies to other areas.						S ——	——	——	1	--------

Attachment II



Attachment C



Attachment D

ARTICLE II - CHANGES IN RESEARCH METHODS, PROCEDURES, OBJECTIVES OR PHENOMENA UNDER STUDY

A. The Contractor may change the methods and procedures employed in performing the research without making special reports on proposed actions or obtaining A.I.D. approval. However, significant changes in methods or procedures shall be reported to the Government in periodic or final technica reports. In the event the methodology or experiment is stated as a specific objective of the research work, any changes to either fall within the scope of paragraph "B" below.

B. The stated objectives of the research efforts shall not be change except with the prior approval of the Contracting Officer

C. The phenomenon or phenomena under study, i.e., the broad category of research, shall not be changed except with the prior approval of the Contracting Officer

ARTICLE III - PERIOD OF CONTRACT SERVICES

The effective date of this Contract is date of Contracting Officer's signature as shown on the cover page, and the estimated completion date of work, including final report(s), under this Contract is 06-29-78.

ARTICLE IV - ESTIMATED CONTRACT COST AND FINANCING

The Contractor will be reimbursed for the costs incurred by him in performing services hereunder in accordance with the applicable provisions of the Schedule and the General Provisions, subject to the following limitation made in respect thereto:

A.	Total A.I.D. dollar funds available for payment and allotted to this Contract. See the clause of the General Provisions entitled "Limitation of Funds" and the article of the Schedule entitled "Budget", if applicable.	$424,000
B.	Estimated additional funds which may be provided, if funds are available. See the clause of the General Provisions entitled "limitation of Funds" and the article of the Schedule entitled "Budget", if applicable.	$1,234,368
	Total Estimated Contract Cost	$1,658,368.

NOTE: It is estimated that the aforesaid amounts will be sufficient to complete the work required hereunder as set forth in the Schedule article entitled "Statement of Work".

ARTICLE V - BUDGET

Categories	Firm Budget (Obligated Funds) FR:04-01-75 TO:1 -31-76	Projected Budget FR:02-01-76 TO:03-31-78	Total Estimated Cost FR:04-01-75 TO:03-31-78
Salaries & Wages	$ 174,714	$ 559,666	$ 734,380
Fringe Benefits	20,063	64,267	84,330
Overhead	52,710	168,851	221,561
Consultants	- 0 -	- 0 -	- 0 -
Other Direct Costs	31,500	100,905	132,405
Equipment, Materials Supplies	51,000	100,320	151,320
Travel, Transportation Allowances	96,013	240,359	336,372
	$424,000	$1,234,368	$1,658,368.

ANTICIPATORY COSTS

1. The allowable cost of performance of this contract shall include all allowable and allocable costs which have been incurred by the Contractor in anticipation of this contract on or after 4-1-75 but prior to the execution date hereof, and which, if incurred after the date of this contract would have been considered as items of allowable and allocable costs under Article VII; provided, however, that such anticipatory costs shall not exceed $71,555. unless such amount is subsequently increased in writing by the Contracting Officer.

2. Within the terms of the contract and within the grand total of the firm budget the contractor may make expenditures and may make adjustments in line items to achieve the objectives of the contract. With respect to the projected budget periods under the contract and within 6 months before the end of firm budget period Contractor shall submit to A.I.D. for approval a proposed new firm budget for the year (or other agreed upon period).

ARTICLE VI - COSTS REIMBURSABLE TO CONTRACTOR

The United States dollars costs allowable under the contract shall be limited to reasonable, allocable, and necessary costs determined in accordnace with the Clause of the General Provisions of this contract entitled "Allowable Cost, and Payment."

ARTICLE VII - NEGOTIATED OVERHEAD RATES

A. Establishment of Postdetermined Indirect Cost Rates

Pursuant to the clause of the General Provisions of this Contract entitled "Negotiated Overhead Rates - Postdetermined", a rate or rates shall be established for each of the Contractor's accounting periods during the term of the Contract. Pending establishment of final indirect cost rates for the initial period, provisional payments on account of allowable indirect costs shall be made on the basis of the following provisional rates applied to the base(s) which are set forth below:

	Rate	Base	Period
On Campus	47.01%	Salaries & Wages	FROM: 4-1-75 TO : 1-31-76
Off Campus	21.47%	Salaries & Wages	FROM: 4-1-75 TO : 1-31-76

Postdetermined indirect cost rates for subsequent periods shall be established in accordance with the terms of the "Negotiated Overhead Rates - Postdetermined" clause of this Contract.

ARTICLE VIII - REPORTS

One hundred copies of the Annual Report of the project shall be prepared and submitted to AID/W (TA/AGR) within 45 days after the anniversary date of the contract. Preparation and distribution of the Annual Report shall conform to the Guidelines for Preparation of the Research Annual Report (Attachment A).

ARTICLE IX - SPECIAL PROVISIONS

A. Prior to making any visits to LDC's, the Contractor shall review its plans with TA/AGR. Contractor shall keep AID Missions in countries to be visited fully informed of proposed visits, ask them to provide any advice they wish and to participate if they desire, and shall inform the Missions of the outcome of consultations. Contractor shall make its own appointments and logistics arrangements directly.

B. Upon completion of any project funded travel, a copy of the trip report shall be provided to TA/AGR Project Monitor. The report format shall be established jointly by the Contractor and the Project Monitor.

C. In accordance with paragraph (2) of Additional General Provision No. 3 entitled "Personnel", whereunder the Contractor may not send individuals outside of the U.S. to perform work under the contract without the prior written approval of the Contracting Officer, the Contracting Officer does, hereby, provide said approval for those individuals required to travel outside

United States; provided, however, that concurrence with the assignment and/or travel of any and all said individuals outside the U. S. is obtained, in writing, from the Cognizant Technical Office of A.I.D. prior to their assignment and/or travel abroad.

This approval by the Contracting Officer, shall not apply to any other clause or provision of this contract which specifically requires Contracting Officer approval.

After approval of the proposed international travel, the Contractor shall provide the cognizant USAID mission advance notification, with a copy to the Contracting Officer, of the arrival date and flight identifications of AID financed travellers.

PD-AAC-887 9310525 (12)

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

Page 1 of 2

1 AMENDMENT/MODIFICATION NO.	2 EFFECTIVE DATE	3 REQUISITION/PURCHASE REQUEST NO.	4 PROJECT NO. (If applicable)
1	12/1/75		931-17-120-525 Sp.

5 ISSUED BY (Code)
Agency for International Development
Central Operations Division
Office of Contract Management
Washington, D.C. 20523

6 ADMINISTERED BY (If other than item 5) (Code)
Issuing Office

7 CONTRACTOR NAME AND ADDRESS (Code) (Facility Code)
(Street, city, county, state, and ZIP Code)
North Carolina State University
Raleigh, North Carolina 27607

8 ☐ AMENDMENT OF SOLICITATION NO. _____
DATED _____ (See block 9)
☒ MODIFICATION OF CONTRACT/ORDER NO. AID/ta-C-1236
DATED 6-30-75 (See block 11)

9 THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS
☐ The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.
Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods:
(a) By signing and returning _____ copies of this amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

10 ACCOUNTING AND APPROPRIATION DATA (If required)
P10/T 931-17-120-525-73-3107515 ($500,000)
Appropriation No. 72-11x1023 Allotment No. 402-31-099-00-22-61

11 THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS
(a) ☐ This Change Order is issued pursuant to _____
The Changes set forth in block 12 are made to the above numbered contract/order.
(b) ☐ The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12.
(c) ☒ This Supplemental Agreement is entered into pursuant to authority of ~~FAA of 1961, as amended, and E.O. 11223~~
It modifies the above numbered contract as set forth in block 12.

12 DESCRIPTION OF AMENDMENT/MODIFICATION

1. The purpose of this amendment is:

a. Obligate additional funds

b. Incorporate revised General Provisions

CERTIFIED A TRUE COPY THIS 18th DAY OF Dec 75
BY R. D. McIntosh

2. The parties thereto agree to the following:

a. Cover page - Revise the cover page to amend the accounting and appropriation data by adding the data shown in block 10 of this amendment.

b. Article IV - "Estimated Cost and Contract Financing" - In paragraph "A", delete the figure "$424,000" and substitute in lieu thereof "$924,000". In paragraph "B" delete the figure "$1,234,368" and substitute in lieu thereof "$734,368."

Except as provided herein, all terms and conditions of the document referenced in block 8, as heretofore changed, remain unchanged and in full force and effect.

13 ☐ CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT. ☒ CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN 7 COPIES TO ISSUING OFFICE

14 NAME OF CONTRACTOR: N.C. State Univ. at Raleigh
BY L. Felix Joyner (Signature of person authorized to sign)

15 NAME AND TITLE OF SIGNER (Type or print)
L. Felix Joyner
Vice-President - Finance

15 DATE SIGNED 12/5/75

16 NAME OF CONTRACTING OFFICER (Type or print)
S. L. Courembis

16 DATE SIGNED 09 DEC 1975

16 UNITED STATES OF AMERICA
AGENCY FOR INTERNATIONAL DEVELOPMENT
BY S. L. Courembis (Signature of Contracting Officer)

U.S. GOVERNMENT PRINTING OFFICE: 1973 O - 494-100

30-101

c. Article V - "Budget". Delete the budget schedule and substitute in lieu thereof the budget schedule shown as Attachment A hereto.

d. General Provisions and Additional General Provisions. Effective December 1, 1975 the parties agreed to the incorporation of General Provision AID 1420-23c (7-75) and Additional General Provision AID 1420-23d (7-75).

Attachment A
Budget Schedule
Contract AID/ta-C-1236

Categories	Actual Expenditures FR:04-01-75 TO:01-31-76	Projected Budget FR:02-01-76 TO:12-31-76	Total Estimated Cost FR:04-01-75 TO:03-31-78
Salaries & Wages	$174,714	$217,300	$ 734,380
Fringe Benefits	20,063	28,340	84,330
Overhead	52,710	73,880	221,561
Consultants	-0-	-0-	-0-
Other Direct Costs	31,500	15,090	132,405
Equipment, Materials Supplies	51,000	76,500	151,320
Travel, Transportation Allowances	96,013	68,900	336,372
	$424,000	$500,000	$1,658,368

GENERAL SERVICES ADMINISTRATION FPR (41 CFR) 1-16.101

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

PAGE 1 OF 2

1. AMENDMENT/MODIFICATION NO.	2. EFFECTIVE DATE	3. REQUISITION/PURCHASE REQUEST NO.	4. PROJECT NO. (If applicable)
2	3-18-76		931-17-120-525

5. ISSUED BY (City)	CODE	6. ADMINISTERED BY (If other than block 5)	CODE
Central Operations Division Office of Contract Management Agency for International Development Washington, D.C. 20523			

7. CONTRACTOR NAME AND ADDRESS (Street, city, county, state, and ZIP Code)	CODE	FACILITY CODE	8. ☐ AMENDMENT OF SOLICITATION NO. _____ DATED _____ (See block 9) ☒ MODIFICATION OF CONTRACT/ORDER NO. AID/ta-C-1236 DATED 6-30-75 (See block 11)
North Carolina State University Raleigh, N.C. 27607			

9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.

Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods: (a) By signing and returning _____ copies of this amendment, (b) By acknowledging receipt of this amendment on each copy of the offer submitted, or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

10. ACCOUNTING AND APPROPRIATION DATA (If required)

---

11. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS

(a) ☐ This Change Order is issued pursuant to _____

The Changes set forth in block 12 are made to the above numbered contract/order.

(b) ☐ The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12.

(c) ☒ This Supplemental Agreement is entered into pursuant to authority of FAA of 1961, as amended & E.O. 11223.

It modifies the above numbered contract as set forth in block 12.

12. DESCRIPTION OF AMENDMENT/MODIFICATION

The purpose of this amendment is to correct the itemized budget.

This contract as previously amended is hereby further amended as follows:

1. Article V. Budget - Delete the itemized budget shown as "Attachment A" and in lieu thereof insert the following:

Except as provided herein, all terms and conditions of the document referenced in block 8, as heretofore changed, remain unchanged and in full force and effect.

13. ☐ CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT ☒ CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN 8 COPIES TO ISSUING OFFICE

14. NAME OF CONTRACTOR/OFFEROR	15. NAME OF SIGNER (Type or print)	16. DATE SIGNED	17. NAME OF CONTRACTING OFFICER (Type or print)	18. DATE SIGNED
N.C. State Univ. at Raleigh BY _____ (Signature of person authorized to sign)	L. Felix Powell Vice President/Finance	3/30/76	UNITED STATES OF AMERICA AGENCY FOR INTERNATIONAL DEVELOPMENT BY _____ (Signature of Contracting Officer) V. C. Perelli	APR 1976

30-101

U. S. GOVERNMENT PRINTING OFFICE 1973 O - 486-532

"BUDGET

Categories	Funds Available (Obligated Funds) FR: 04-01-75 TO: 01-31-76	Funds Available (Obligated Funds) FR: 02-01-76 TO: 12-31-76	Estimated Additional Cost to Completion FR: 01-01-77 TO: 03-31-78	Total Contract Estimated Cost FR: 04-01-75 TO: 03-31-78
Salaries & Wages	$174,714	$217,300	$342,366	$ 734,380
Fringe Benefits	20,063	28,340	35,927	84,330
Overhead	52,710	73,880	94,971	221,561
Consultants	-0-	-0-	-0-	-0-
Other Direct Costs	31,500	15,080	85,825	132,405
Equipment, Materials, & Supplies	51,000	76,500	23,820	151,320
Travel, Transportation Allowances	94,013	88,900	151,459	334,372
	$424,000	$500,000	$734,368	$1,658,368"

9310525 ①

PD-AAC-887

DEPARTMENT OF STATE
AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D.C. 20523

CERTIFIED A TRUE COPY THIS
5th DAY OF January 1972
BY Pamela L. Simmons

North Carolina State University
Raleigh, North Carolina 27607

Subject: Amendment No. 1 to
Contract No. AID/csd-2806

Pursuant to the authority contained in the Foreign Assistance Act of 1961, as amended, and Executive Order No. 11223, the subject contract is hereby amended, effective December 31, 1971, as follows:

Article VI - Budget, delete the dates "12/31/71" and "1/1/72" and in lieu thereof insert "3/31/72" and "4/1/72" respectively.

Except as hereby expressly amended, the subject contract remains in full force and effect in accordance with its terms.

NORTH CAROLINA STATE UNIVERSITY

BY A H Shepard Jr.

PRINTED NAME A. H. Shepard, Jr.

TITLE Asst. Vice Pres. & Treas.

DATE 12-31-71

UNITED STATES OF AMERICA
AGENCY FOR INTERNATIONAL DEVELOPMENT

BY [signature]

PRINTED NAME N. A. Caticchio

TITLE Contracting Officer

DATE JAN 5 1972

DEPARTMENT OF STATE
AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D.C. 20523

CERTIFIED A TRUE COPY THIS
8th DAY OF March 1972
BY E. L. Amis

North Carolina State University
Raleigh, North Carolina 27607

Subject: Amendment No. 2 to
Contract No. AID/csd-2806

Pursuant to the authority of the Foreign Assistance Act of 1961, as amended, and Executive Order No. 11223, the subject contract, as amended, is hereby further amended as follows:

1. Article VIII - Establishment of Overhead Rate - Delete in its entirety and substitute the following in lieu thereof:

"Article VIII - Overhead

A. Establishment of Overhead Rate

Pursuant to the provisions of General Provision 10 of this contract entitled 'Negotiated Overhead Rates', the following final overhead rates have been negotiated for the period and base set forth below:

Period	On-Campus	Off-Campus
Fr: 7/ 1/70 To: 6/30/71	47.01%*	21.47%*

*Distribution Base: Direct Salaries and Wages including vacation and sick leave.

B. Establishment of Predetermined Indirect Cost Rates

Pursuant to the provisions of Clause 10 of the General Provisions, as amended below, the following predetermined overhead rates

have been agreed to for the period and base set forth below:

Period	On-Campus	Off-Campus
Fr: 7/1/71 To: 6/30/74	47.01%*	21.47%*

*Distribution Base: Direct Salaries and Wages including vacation and sick leave.

C. For the ensuing periods the following provisional rates shall apply:

Period	On-Campus	Off-Campus
Fr: 7/1/74 To: Until Amended	47.01%*	21.47%*

*Distribution Base: Direct Salaries and Wages including vacation and sick leave."

2. General Provisions - Clause 10 - Add the following sub-paragraph:

"(g) Indirect Costs (Overhead) Predetermined

Notwithstanding the provisions of any other clause of this contract, the allowable indirect costs under this contract shall be obtained by applying predetermined overhead rates to bases agreed upon by the parties as specified below:

(1) The contractor, as soon as possible but not later than three (3) months after the expiration of his fiscal year, shall submit to the Contracting Officer, with a copy to the cognizant audit activity, a proposed predetermined overhead rate or rates based on the contractor's actual cost experience during that fiscal year, together with supporting cost data. Negotiations of predetermined overhead rates shall be undertaken as promptly as practicable after receipt of the Contractor's proposal.

(2) Allowability of costs and acceptability of cost allocation methods shall be determined in accordance with the provisions of Subpart 1-15.3 (Principles for Determining Costs Applicable to Research and Development under Grants and Contracts with Educational Institutions) of the Federal Procurement Regulations as in effect on the date of this contract, as amended by Office of Management and Budget Circular A-21, Revised.

(3) The results of each negotiation shall be set forth in a modification to this contract, which shall specify (i) the agreed predetermined overhead rates, (ii) the bases to which the rates apply, (iii) the fiscal year unless the parties agree to a different period for which the rates apply, and (iv) the specific items treated as direct costs or any changes in the items previously agreed to be direct costs.

(4) Pending establishment of predetermined overhead rates for any fiscal year or different period agreed to by the parties, the contractor shall be reimbursed either at the rates fixed for the previous fiscal year or other period or at billing rates acceptable to the Contracting Officer subject to appropriate adjustment when the final rates for that fiscal year or other period are established.

(5) Any failure by the parties to agree on any predetermined overhead rate or rates under this clause shall not be considered a dispute concerning a question of fact for decision by the Contracting Officer within the meaning of the "Disputes" clause of this contract. If for any fiscal year or other period specified in the Schedule of this contract the parties

fail to agree to a predetermined overhead rate or rates, it is agreed that the allowable indirect costs under this contract shall be obtained by applying negotiated final overhead rates in accordance with the terms of the "Indirect Costs (Overhead)" clause set forth in 7-16.952 of the Agency for International Development Procurement Regulations as in effect on the date of this contract.

(6) Allowable indirect costs for the period until the end of the contractor's fiscal year during which performance begins shall be obtained by applying the predetermined overhead rates set forth in the Schedule to the bases set forth therein."

Except as hereby expressly amended, subject Contract remains unchanged.

NORTH CAROLINA STATE UNIVERSITY
AT RALEIGH

BY _____
A. H. Shepard, Jr.
TITLE Asst. Vice-Pres. & Treas.
DATE 2 Mar 72

UNITED STATES OF AMERICA
AGENCY FOR INTERNATIONAL DEVELOPMENT

BY _____
TITLE Contracting Officer
DATE MAR 6 1972

DEPARTMENT OF STATE
AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D.C. 20523

CERTIFIED A TRUE COPY THIS
25th DAY OF April 1972
BY E. L. Annis

North Carolina State University
Raleigh, North Carolina 27607

Subject: Amendment No. 3 to
Contract No. AID/csd-2806

Pursuant to the authority contained in the Foreign Assistance Act of 1961, as amended, and Executive Order No. 11223, the subject contract is hereby amended as follows:

1. Cover Page

A. Cognizant Scientific/Technical Office, delete "TA/AGF" and in lieu thereof insert "TA/AGR".

B. Accounting and Appropriation Data, add the following:

PIO/T No. 931-17-120-525-73-3127568

Appropriation No. 72-1121004

Allotment No. 254-31-099-00-22-91

2. General Provisions, add Supplement No. 4 (November 1970) to AID Form CT/CP/R&D, 3-67 (AID 1420-10), R & D ATTACHMENT A, and General Provision Nos. 52, 53, and 54 (ATTACHMENT B), which are attached hereto and made a part hereof.

3. Article V - Estimated Cost, delete the figures "$339,000" and "$747,000" and in lieu thereof insert "$503,360" and "$566,640", respectively.

4. Article VI - Budget, delete the itemized budget in entirety and in lieu thereof insert the following:

	Actual & Estimated Expenditures Fr: 7/1/70 To: 3/31/72	Firm Budget Fr:4/1/72 To:3/31/73	Projected Budget Fr:4/1/73 To:6/30/75	Total Budget Fr:7/1/70 To:6/30/75
Salaries & Wages	$116,862	$137,763	$259,800	$ 514,425
Fringe Benefits	11,649	18,566	25,074	55,289
Overhead	54,961	54,862	103,914	213,737
Consultants	3,750	- 0 -	23,250	27,000
Other Direct Costs	3,738	15,409	26,853	46,000
Equipment, Materials and Supplies	16,331	26,000	57,834	100,165
Travel & Transportation (including Allowances)	16,069	27,400	69,915	113,384
	$223,360	$280,000	$566,640	$1,070,000

5. Article IX - Personnel Compensation, A. Limitations, delete "5. Consultants" in entirety and in lieu thereof insert the following:

5. Consultants

No compensation for consultants will be reimbursed unless their use is authorized in the Schedule or has the prior written approval of the Contracting Officer; and if such provision has been made or authorization given, compensation shall not exceed (without specific approval of the rate by the Contracting Officer) the current daily compensation or the highest rate of annual compensation received by the consultant during any full year of the immediately preceding three years.

There is a ceiling on reimbursable compensation for any consultant. That ceiling is the current maximum daily salary rate of an FSR-1. A daily rate may be determined by dividing the maximum annual salary by

223,360
280
503,360

days. No consultant may be employed at a rate in excess of the filing nor for more than 90 days in any twelve month period without the advance written approval of the Contracting Officer.

6. Article XI - Reports A., Annual Report, add the following sentence:

The annual report shall be prepared in accordance with the attached "Guidelines for Preparation of the Research Annual Report, January 20, 1972".

7. Article XII - Additional Clauses

A. Under "A." add the following:

1. Whenever the words, "Subpart 1-15.3 appear add the words "and OMB Circular A-21, as revised".

2. Wherever Subpart 1-15.3 and OMB Circular A-21 conflict, OMB Circular A-21 applies.

B. Delete Clauses "G.", "I." and "K." in entirety. These clauses are now incorporated in the attached Supplement No. 4.

C. Delete Clause "J. Government Property" and in lieu thereof insert Attachment C entitled "Government Property Clause for Cost-Reimbursement Contracts with Nonprofit and Educational Institutions (7-13.705)" which is attached hereto and made a part hereof.

D. Add the following new clause:

L. Special Provision Regarding General Provision No. 41

In accordance with paragraph (a) of General Provision No. 41 entitled "Personnel", whereunder the Contractor may not send inviduals outside of the United States to perform work under the contract without

...ior written approval of the Contracting Officer, the Contracting ...cer does, hereby, provide said approval for those individuals required ...travel outside the United States; provided, however, that concurrence with the assignment and/or travel of any and all said individuals outside the United States is obtained, in writing, from the Cognizant Technical Office of A.I.D. prior to their assignment and/or travel abroad.

This approval by the Contracting Officer, shall not apply to any other clause or provision of this Contract which specifically requires Contracting Officer approval.

Except as hereby expressly amended, the subject contract remains in full force and effect in accordance with its terms.

NORTH CAROLINA STATE UNIVERSITY

BY A. H. Shepard, Jr.

PRINTED NAME A. H. Shepard, Jr.

TITLE Asst. Vice-Pres. & Treas.

DATE 14 Apr 72

UNITED STATES OF AMERICA
AGENCY FOR INTERNATIONAL DEVELOPMENT

BY V. C. Perelli

PRINTED NAME V. C. Perelli

TITLE Contracting Officer

DATE APR 20 1972

DEPARTMENT OF STATE
AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D.C. 20523

JUN 29 1970

North Carolina State University
Raleigh, North Carolina 27607

Attention: Jack Rigney
Dean of International Programs

Subject: North Carolina State University
Contract AID/csd-2806
PIO/T 931-17-120-525-73-3102731

Gentlemen:

Reference is made to Article V and Article VI of the Schedule of subject contract.

Pursuant to Article VI of this contract there is hereby allocated to said contract the additional U.S. Dollar sum of Sixteen Thousand Dollars ($16,000), thereby increasing the obligated funds for commitment under subject contract by said amount, and thereby increasing thereunder (in accordance with said Article VI) the total obligated funds for commitment to date from Three Hundred and Twenty-three Thousand dollars ($323,000) to Three Hundred and Thirty-nine Thousand dollars ($339,000).

Sincerely yours,

[signature]
F. D. Moneada
Contracting Officer
Contract Services Division
Office of Procurement

FUNDS AVAILABLE

DATE June 29 1970
3102731
0521-31-097-00-22-01
$16,000.00
[illegible]
C/Acct [illegible]

KPA-4
931-17-120-525-73
CSA 2806
AID-143/001

CERTIFIED A TRUE COPY THIS 8th DAY OF March 1973

DEPARTMENT OF STATE
AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D.C. 20523

North Carolina State University
Raleigh, North Carolina 27607

Subject: Amendment No. 5 to 2806
Contract No. AID/csd-2806

Pursuant to the authority contained in the Foreign Assistance Act of 1961, as amended, and Executive Order No. 11223, the subject contract is hereby amended as follows:

1. Cover Page:

A. Accounting and Appropriation Data, add the following:

PIO/T No.: 931-17-120-525-73-3137568

Appropriation No.: 72-1131004

Allotment No.: 354-31-099-00-22-31

B. Delete the words "and the General Provisions (Form CT/GP/R&D, 3-67)" in entirety and in lieu thereof insert "the General Provisions, Form AID Form AID 1420-41C (7-72) and Additional General Provisions, Form AID 1420-41D (7-72), which are attached hereto and made a part hereof."

2. Table of Contents, the General Provisions, including any modifications and/or revisions thereto, are hereby deleted in entirety and replaced by the above-mentioned General and Additional General Provisions.

3. Article V - Estimated Cost, delete the figures "$503,360" and "$566,640" and in lieu thereof insert "$748,360" and "$321,640", respectively.

4. Article VI - Budget, delete the budget in entirety and in lieu

thereof insert the following:

BUDGET

Category	Actual and Estimated Expenditures Fr: 7-1-70 To: 3-31-73	Firm Budget Fr: 4-1-73 To: 3-31-74	Projected Budget Fr: 4-1-74 To: [illegible]	Total Budget Fr: 7-1-70 To: [illegible]
Salaries & Wages	$221,186	$167,233	$126,006	$ 514,425
Fringe Benefits	19,919	18,308	17,062	55,289
Overhead	97,744	57,736	58,257	213,737
Consultants	3,950	-0-	23,050	27,000
Other Direct Costs	15,467	8,783	21,750	46,000
Equipment, Materials & Supplies	36,621	26,000	37,544	100,165
Travel & Transportation (including Allowances)	35,413	40,000	37,971	113,384
	$430,300	318,060.	$321,[illegible]40	$1,070,000

5. Article XII - Additional Clauses, delete in entirety and in lieu thereof insert the following:

Article XII - Additional Clauses and Modifications to the General and/or Additional General Provisions:

A. All reference to "Fixed Fee" is hereby deleted.

B. Delete all reference to "Subpart 1-15.2 (Principles and Procedures for Use in Cost-Reimbursement Type Supply and Research

Contracts with Commercial Organizations)" of the Federal Procurement Regulations and in lieu thereof insert "Subpart 1-15.3 (Principles for Determining Applicable Cost under Research Contracts with Educational Institutions) and OMB Circular A-21". When there is a conflict between OMB Circular A-21 and Subpart 1-15.3 of the FPR, the provisions of OMB Circular A-21 shall prevail.

C. Delete General Provision No. 23 entitled "Termination for Default or for Convenience of the Government" and in lieu thereof insert Attachment A entitled "Termination for the Convenience of the Government" which is attached hereto and made a part hereof.

D. Salary Adjustment on Termination. In the event Contractor's services are terminated by A.I.D. pursuant to Schedule Article XII-C, or in the event that an employee's services are terminated by the Contractor at the request of A.I.D. or of the Cooperating Country for reasons other than misconduct, Contractor will be reimbursed for salary payments under its agreements with such staff members, provided that such staff members are not otherwise gainfully employed during the compensable period following such termination or, if gainfully employed but at a lesser compensation, payments will be made to equalize the difference between such lesser compensation and the employee's salary (excluding overseas incentive, differential and allowances) and provided further, that such payments shall not extend beyond one year from the date of the employee's termination, or the date on which this contract would have expired but for termination, whichever is earlier. Contractor agrees to exert its best efforts to minimize costs under this provision.

L. Add the "Price Certification" and the "Notice of Maximum Permissible Escalation in Wage and Price Standards" which are attached hereto and made a part hereof.

Except as hereby expressly amended, the subject contract remains in full force and effect in accordance with its terms.

NORTH CAROLINA STATE UNIVERSITY	UNITED STATES OF AMERICA AGENCY FOR INTERNATIONAL DEVELOPMENT
BY A H Shepard, Jr.	BY V C Perelli
PRINTED NAME A. H. Shapard, Jr.	PRINTED NAME V. C. Perelli
TITLE Asst. Vice Pres. & Treas.	TITLE Contracting Officer
DATE 2-14-73	DATE FEB 2 1973

KPA-4 Transcribed

(14)

STANDARD FORM 30, JULY 1966
GENERAL SERVICES ADMINISTRATION
FED. PROC. REG. (41 CFR) 1-16.101

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

PAGE 1 OF 2

1. AMENDMENT/MODIFICATION NO.	2. EFFECTIVE DATE	3. REQUISITION/PURCHASE REQUEST NO.	4. PROJECT NO. (If applicable)
Amendment No. 6	See Block 19	931-17-120-525-73-3147575	

5. ISSUED BY CODE
U.S. Department of State
Agency for International Development
SER/CM/COD/TAB
Washington, D.C 20523

6. ADMINISTERED BY (If other than block 5) CODE

7. CONTRACTOR NAME AND ADDRESS CODE FACILITY CODE
(Street, city, county, state, and ZIP Code)
North Carolina State University
Raleigh, North Carolina 27607

8.
☐ AMENDMENT OF SOLICITATION NO. ______
DATED ______ (See block 9)
☒ MODIFICATION OF CONTRACT/ORDER NO. AID/csd-2806
DATED 6/26/70 (See block 11)

9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.

Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods:

(a) By signing and returning ______ copies of this amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

10. ACCOUNTING AND APPROPRIATION DATA (If required)
APPROPRIATION SYMBOL: 72-1141004 PIO/T No. 931-17-120-525-73-3147575
ALLOTMENT SYMBOL: 454-31-099-00-22-41 ($279,999.84)

11. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS

(a) ☐ This Change Order is issued pursuant to ______
The Changes set forth in block 12 are made to the above numbered contract/order.

(b) ☐ The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12.

(c) ☒ This Supplemental Agreement is entered into pursuant to authority of the Foreign Assistance Act of 1961; E.O. 11223
It modifies the above numbered contract as set forth in block 12.

12. DESCRIPTION OF AMENDMENT/MODIFICATION

The purposes of this amendment are to increase the amount of funds obligated and to provide a Work Plan for the period April 1, 1974, through December 31, 1974. Therefore, the parties agree to the following changes.

CERTIFIED A TRUE COPY THIS 16th DAY OF July 1974
BY [signature]

1. Cover Page

A. Add the following Accounting and Appropriation Data:

PIO/T No. : 931-17-120-525-73-3147575
Appropriation No.: 72-1141004
Allotment No.: 454-31-099-00-22-41

B. Delete the figure $1,070,000 and substitute "$1,226,337.84" in lieu thereof.

2. ARTICLE I - STATEMENT OF WORK

The Statement of Work is supplemented so that the Contractor agrees to utilize the

Except as provided herein, all terms and conditions of the document referenced in block 8, as heretofore changed, remain unchanged and in full force and effect.

13. ☐ CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT ☒ CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN 6 COPIES TO ISSUING OFFICE

14. NAME OF CONTRACTOR/OFFEROR	17. UNITED STATES OF AMERICA
N.C. State Univ. at Raleigh	
BY A H Shepard, Jr. (Signature of person authorized to sign)	BY [signature] (Signature of Contracting Officer)

15. NAME AND TITLE OF SIGNER (Type or print)	16. DATE SIGNED	18. NAME OF CONTRACTING OFFICER (Type or print)	19. DATE SIGNED
A. H. Shepard, Jr. Asst. Vice-Pres. & Treas.	6-21-74	V. C. Perelli	JUN 2[illegible] 197[illegible]

Work Plan shown herein as Attachment A as a guide to the activities performed in the period April 1, 1974 through December 31, 1974.

3. ARTICLE V - ESTIMATED COST

A. Delete the figure $1,070,000 and substitute "$1,226,337.84" in lieu thereof.

B. Delete the figures "$748,360" and "$321,640" and in lieu thereof insert "$1,028,359.84" and "$197,978.00" respectively.

4. ARTICLE VI - BUDGET

Delete the last previous budget, and insert the budget shown herein as Attachment B - Budget Schedule.

Agronomic-Economic Research on Tropical Soils
North Carolina State University
AID/csd-2806

Work Plan April 1, 1974 - December 31, 1974

The following is a summary of the activities to be performed in the nine months beginning April 1, 1974. Completed work on which current subprojects rest is not reported. Likewise, work which is the logical outcome of project activities scheduled for the current year are not described. In most cases the principal investigator is indicated. The exceptions are in those activities which will involve almost all members of the staff on a continuing and predictably AD Hoc basis.

A listing of activities follows. Reference numbers are derived from the FY 1973 work plan.

1.2 Long-term crop response to P in Guatemala: Established. To be conducted by ICTA staff. Project staff limited to advisor role.

1.3 Multiple Cropping in Costa Rica: Tests several cropping sequences involving 2-3 crops per year (beans, corn, rice, soybeans, sorghum, cassava, pastures and forage). This activity has highest priority in Central America; will be stressed for full nine months and beyond (D. D. Oelsligle)

1.4 Forage Fertility Management in El Salvador: Continued as planned. Will test five levels of N, P, and K fertilization on pasture grass and forage sorghum. (D. D. Oelsligle).

1.5 Fertility Management for Upland Rice in Costa Rica: A more intensive study of fertility management with rice in support of small farm activities. Continuous.

1.6 Studies of Toxicity of Residual Copper: Greenhouse studies are in progress. Field experiments planned for Palmar Sur. Treatments and designs hinge on outcome of current research. Nine month activity. (F. R. Cox)

2.1 Liming Cerro Carrado Soils: This will be continued and expanded during the period to include more crops. Liming/phosphorus interactions will be followed under controlled conditions in the greenhouse. (E. Gonzalez and E. J. Kamprath)

2.2 Phosphorus in the Carrado: The present experiment at Brasilia will be continued through the third and fourth crops. Corn, upland rice and possibly wheat will be planned on these plots. A new experiment using less expensive sources of phosphorus and soluble silicates will be followed throughout the period. (R. C. Yost and E. J. Kamprath)

2.3 Zinc for the Cerrado: Laboratory analyses of samples from earlier experiments and from the field survey will be completed during the next nine months. Additional experiments will be started during 1974 to be based on the results of the soil analyses. (A.S. Lopes and F.R. Cox)

2.4 Varietal Differences in Tolerance to Acidity and Drough: Field work is expected to start. CIAT is the principal source of the sorghum selections. (J.G. Salinas and P. A. Sanchez)

2.5 Soil Fertility Management for Upland Rice in Cerrado: Probable beginning in early 1975 but dependent on counterpart support. (J.G. Salinas and P.A. Sanchez)

3.1 Land Clearing Methods in Yurimaguas: In situ and laborary assessment of different methods of land clearing will continue throughout the period. (C. E. Seubert and P. A. Sanchez)

3.2 Characterization of Amazon Jungle Soils: Chemical, physical and instrumental analyses of soils samples from the upper Amazon region will continue throughout the period (E.J. Tyler and S. W. Buol)

3.3 Fertility Requirements for Multiple Cropping Systems in the Jungle: Crop and variety evaluation is in progress and will continue. Field experiments will be started in 1974 and continued until conclusive results have been obtained. (M. K. Wade and P. A. Sanchez)

3.4 Soil Fertility Management for Upland Rice in the Jungle: A cooperative activity largely dependent on Peruvian counterparts. Continuing. (C. E. Seubert, C. E. Lopez and P. A. Sanchez)

3.5 Fertility Requirements for Pasture Production in Jungle Region: Continuing activity and key to permanent land development in zone. (C. E. Lopez and P. A. Sanchez)

4.1 Characterization of Tropical Soils: Ongoing activity is direct support to other research activities and to serve as a guide to the utilization of the results of fertility research. (A. Alvarado, F. Munevar and S. W. Buol)

4.2. Proof and Refinement of Fertility Capability Classification: An ongoing activity grouping and categorizing soils according to their properties and and predictable responses. An activity closely linked with Latin American Soil Testing project la-646. (M. A. Granger, S.W. Buol, P.A. Sanchez and R. B. Cate)

4.3, 4.4 and 4.5 Laboratory Characterization of Soils from Ecological Zones in which Current Experiments are in Progress: These continuing support activities will shed light on micronutrient balances, soil acidity-aluminum, inter-relationships and phosphate reactions within the soils. (All project staff will be involved in some phases)

4.8 and 4.9 Economic Analysis of Crop-Fertilizer Responses: These continuing activities are providing guide lines for current and future research on the project and assessing the probablity of immediate utilization of research results of this project and from other research in the region. Initial phase will be concluded during 1974 but general type of analytical work will continue. (S. Chang and R. K. Perrin)

The work plan as presented is a guide and reflects detailed preplanning. It is not to be considered immutable or as an absolute specification of performance.

ATTACHMENT B
Contract No. AID/csd-2806
Amendment No. 6

BUDGET SCHEDULE

Category	Actual and Estimated Expenditures FR: 7/1/70 TO: 3/31/74	Firm Budget FR: 4/1/74 TO: 12/31/74	Projected Budget FR: 1/7/75 TO: 6/30/75	Total Budget FR: 7/1/70 TO: 6/30/75
Salaries and Wages	$350,208.20	$139,051.00	$92,660.00	$581,919.20
Fringe Benefits	30,249.69	14,345.00	9,562.00	54,156.69
Overhead	147,225.80	49,757.00	33,170.00	230,152.80
Consultants	4,150.00	-0-	-0-	4,150.00
Other Direct Costs	68,293.54	15,000.00	10,000.00	93,293.54
Equipment, Materials, and Supplies	53,547.27	42,205.00	28,136.00	123,888.27
Travel and Transportation (including allowances)	77,652.34	36,675.00	24,450.00	138,777.34
TOTAL	$731,326.84	$297,033.00	$197,978.00	$1,226,337.84

PD-AAC-887 4 9310525

AID 1350-1X (7-71)

PIO/T

DEPARTMENT OF STATE
AGENCY FOR
INTERNATIONAL DEVELOPMENT

PROJECT IMPLEMENTATION ORDER/TECHNICAL SERVICES

1. Cooperating Country: Worldwide 3147573

Page 1 of 1 Pages

2. PIO/T No. 931-17-130-525 73

3. [x] Original or Amendment No.

4. Project/Activity No. and Title: Agronomic-Economic Research on Tropical Soils AID/csd-2806 - North Carolina State Univ

(43)

DISTRIBUTION

5. Appropriation Symbol: 72-1141021 [illegible]

6.A. Allotment Symbol and Charge: [illegible]

6.B. Funds Allotted to: [ ] A.I.D./W [ ] Mission

7. Obligation Status: [x] Administrative Reservation [ ] Implementing Document

8. Funding Period (Mo., Day, Yr.) From 4/1/74 To 3/31/75

9.A. Services to Start (Mo., Day, Yr.) Between 4/1/74 and

9.B. Completion date of Services (Mo., Day, Yr.) 6/30/75

10.A. Type of Action: [x] A.I.D. Contract [ ] Cooperating Country Contract [ ] Participating Agency Service Agreement [ ] Other

10.B. Authorized Agent: AID/W

Estimated Financing $1.00=		(1) Previous Total	(2) Increase	(3) Decrease	(4) Total to Date
11. Maximum A.I.D. Financing	A. Dollars		$280,000		$280,000
	B. U.S.-Owned Local Currency				
12. Cooperating Country Contributions	A. Counterpart				
	B. Other				

FUNDS RESERVED BY [illegible] 2.[illegible].74 POSTED

13. Mission References

14. Instructions to Authorized Agent

The purpose of this PIO/T is to extend funding for Contract AID/csd-2806 with North Carolina State University for twelve months beginning 4/1/74. The basic objectives and Scope of Work of the contract remain unchanged. The Work Plan and Budget are attached, Appendix A.

The due date for the Annual Report should be changed to April 1, 1974 and each April 1st. thereafter during the period of this Contract.

15. Clearances – Show Office Symbol, Signature and Date for all Necessary Clearances.

A. The specifications in the scope of work are technically adequate
TA/AGR, J. Malcolm [signature] Date: [illegible]
TA/AGR, T. Gill [signature] Date: [illegible]

B. Funds for the services requested are available

C. The scope of work lies within the purview of the initiating and approved Agency Programs
TA/AGR, O. Kelley [signature] Date: [illegible]

D. [signature] 2/20/74 TA/RIG, M. Rechcigl [signature] Date: 2/18/74

E. TA/AGR, D. Plucknett [signature]
TA/AGR, J. B. Cordaro [signature] Date: 2/1/74

F.

16. For the cooperating country: The terms and conditions set forth herein are hereby agreed to
Signature and date:
Title:

17. For the Agency for International Development
Signature: [signature] J. K. McDermott, TA/RIG
Title: Director

18. Date of Signature: 2/23/74

AID-1350-1X (7-68)

CONTINUATION SHEET

( ) SYMBOL

DEPARTMENT OF STATE
AGENCY FOR
INTERNATIONAL DEVELOPMENT

TITLE OF FORM
PROJECT IMPLEMENTATION
ORDER/TECHNICAL
SERVICES

[X] Worksheet [ ] Issuance

PAGE 2 OF 2 PAGES

1. Cooperating County: Worldwide

2.a. Code No.

2.b. Effective Date

2.c. [X] Original OR Amendment No:

3. Project/Activity No. and Title
Agronomic-Economic Research on
Tropical Soils - csd-2806

Indicate block numbers.

Use this form to complete the information required in any block of a PIO or PA/PR form.

SPECIAL PROVISION

Prior to making any visits to LDC's the Contractor will review his plans with TA/AGR. He will keep AID Missions in countries to be visited, fully informed of proposed visits, ask them to provide any advice they wish regarding timing and content of the visits and to participate if they desire. He will make his own appointments and logistics arrangements directly. Upon completion of any project funded travel, a copy of the trip report will be provided to the TA/AGR Project Manager. The report format will be established jointly by the Contractor and the Project Manager.

Agronomic-Economic Research on Tropical Soils
North Carolina State University
AID/csd-2806

Work Plan April 1, 1974 - March 31, 1975

Attached is a summary of the activities which will be paid directly from project funds for the next twelve months. Completed work on which current subprojects rest is not reported. Likewise, work which is the logical outcome of project activities scheduled for this year are not described. In most cases the principal investigator is indicated. The exceptions are in those activities which will involve almost all members of the staff on a continuing and predictably AD Hoc basis.

A listing of activities follows. Reference numbers are derived from the FY 1973 work plan.

1.2 Long-term crop response to P in Guatemala: Established. To be conducted by ICTA staff. Project staff limited to advisor role.

1.3 Multiple Cropping in Costa Rica: Tests several cropping sequences involving 2-3 crops per year (beans, corn, rice, soybeans, sorghum, cassava, pastures and forage). This activity has highest priority in Central America ; will be stressed for full twelve months and beyond. (D. D. Oelsligle)

1.4 Forage Fertility Management in El Salvador: Continued as planned. Will test five levels of N, P, and K fertilization on pasture grass and forage sorghum. (D. D. Oelsligle)

1.5 Fertility Management for Upland Rice in Costa Rica: A more intensive study of fertility management with rice in support of small farm activities. Continuous to 1976. (D. D. Oelsligle)

1.6 Studies of Toxicity of Residual Copper: Greenhouse studies are in progress. Field experiments planned for Palmar Sur. Treatments and designs hinge on outcome of current research. Twelve month activity. (F. R. Cox)

2.1 Liming Campo Cerrado Soils: This will be continued and expanded during the year to include more crops. Liming/phosphorus interactions will be followed under controlled conditions in the greenhouse. (E. Gonzalez and E. J. Kamprath)

NCSU Work Plan (cont'd)

2.2 Phosphorus in the Cerrado: The present experiment at Brasilia will be continued through the third and fourth crops. Corn, upland rice and possibly wheat will be planted on these plots. A new experiment using less expensive sources of phosphorus and soluble silicates will be followed throughout the year. (R.S. Yost and E.J. Kamprath)

2.3 Zinc for the Cerrado: Laboratory analyses of samples from earlier experiments and from the field survey will be completed during the next twelve months. Additional experiments will be started during 1974 and 1975 based on the results of the soil analyses. (A.S. Lopes and F.R. Cox)

2.4 Varietal Differences in Tolerance to Acidity and Drough: Field work is expected to start early in 1975. CIAT is the principal source of the sorghum selections. (J.G. Salinas and P.A. Sanchez)

2.5. Soil Fertility Management for Upland Rice in Cerrado: Probable beginning in early 1975 but dependdnt on counterpart support. (J.G. Salinas and P.A. Sanchez)

3.1. Land Clearing Methods in Yurimaguas: In situ and laboratory assessment of different methods of land clearing will continue throughout the coming year. (C.E. Seubert and P.A. Sanchez)

3.2. Characterization of Amazon Jungle Soils: Chemical, physical and instrumental analyses of soils samples from the upper Amazon region will continue throughout the year. (E.J. Tyler and S.W. Buol)

3.3 Fertility Requirements for Multiple Cropping Systems in the Jungle: Crop and variety evaluation is in progress and will continue. Field experiments will be started in 1974 and continued until conclusive results have been obtained. (M.K. Wade and P.A. Sanchez)

3.4 Soil Fertility Management for Upland Rice in the Jungle: A cooperative activity largely dependent on Peruvian counterparts. Continuing. (E.E. Seubert, C.E. Lopez and P.A. Sanchez)

3.5 Fertility Requirements for Pasture Production in Jungle Region: Continuing activity and key to permanent land development in zone. (C.E. Lopez and P.A. Sanchez)

4.1 Characterization of Tropical Soils: Ongoing activity is direct support of other research activities and to serve as a guide to the utilization of the results of fertility research. (A. Alvarado, F. Munevar and S.W. Buol)

4.2 Proof and Refinement of Fertility Capability Classification: An ongoing activity grouping and categorizing soils according to their properties and predictable responses. An activity closely linked with Latin American Soil Testing project la-646. (M.A. Granger, S.W. Buol, P.A. Sanchez and R.B. Cate)

4.3, 4.4 and 4.5 Laboratory Characterization of Soils from Ecological Zones in which Current Experiments are in Progress: These continuing support activities will shed light on micronutrient balances, soil acidity-aluminum, inter-relationships and phosphate reactions within the soils. (All project staff will be involved in some phases)

4.8 and 4.9 Economic Analysis of Crop-Fertilizer Responses: These continuing activities are providing guide lines for current and future research on the project and assessing the probablity of immediate utilization of research results of this project and from other research in the region. Initial phase will be concluded during 1974 but general type of analytical work will continue. (S. Change and R.K. Perrin)

Note: Most of these activities are dependent on many factors not controlled by the contractor. These factors include counterpart performance freedom in personnel assignements, wheather, disease, insect attacks or other natural hazzards. The work plan as presented is a guide and reflects detailed preplanning. It cannot be considered immutable or as an absoluce yardstick against which contractor performance is measured. This performance must be judged on general grounds: the staff time committed to the project, the quality and extent of the findings compared to the funding level.

PROPOSED BUDGET AGRO-ECONOMIC RESEARCH
4/1/74 -- 3/31/75

Category	Cost
Salaries	$ 144,076
Fringe Benefits	15,773
Overhead	55,720
Travel and Transportation	17,000
Allowances	17,462
Other Costs	7,569
Equipment and Vehicles	22,400
Total	$ 280,000

1/11/74

PD-AAC-887 KPA #54

AID 1-50-1X (2-71)

DEPARTMENT OF STATE
AGENCY FOR
INTERNATIONAL DEVELOPMENT

PIO/T

PROJECT IMPLEMENTATION ORDER/TECHNICAL SERVICES

1. Cooperating Country: Worldwide 3157564

Page 1 of 1 Pages 931052516

2. PIO/T No. 931-17-120-525-73

3. ☒ Original or Amendment No. 1

Agronomic Economic Research on Tropical Soils
North Carolina State, AID/csd-2806

DISTRIBUTION

5. Appropriation Symbol: 72-11X1023

6.A. Allotment Symbol and Charge: 402-31-099-00-82-51

6.B. Funds Allotted to: ☒ A.I.D.-W ☐ Mission

7. Obligation Status: 72-11X1023 402-31-099-00-82-51
☒ Administrative Reservation ☐ Implementing Document

8. Funding Period (Mo., Day, Yr.) From 1/1/75 To 3/31/75

9.A. Services to Start (Mo., Day, Yr.) Between 1/1/75 and

9.B. Completion date of Services (Mo., Day, Yr.) 6/30/75

10.A. Type of Action
☒ A.I.D. Contract ☐ Cooperating Country Contract ☐ Participating Agency Service Agreement ☐ Other

10.B. Authorized Agent: AID/W

Estimated Financing $1.00=		(1) Previous Total	(2) Increase	(3) Decrease	(4) Total to Date
11. Maximum A.I.D. Financing	A. Dollars		100,000		100,000
	B. U.S.-Owned Local Currency			FUNDS RESERVED BY	
12. Cooperating Country Contributions	A. Counterpart			POSTED 12/10/74	
	B. Other			SER/FM/CSD	

Mission References

14. Instructions to Authorized Agent

The purpose of this PIO/T is to augment the allotment of funds to sustain full activity under the project for the last three months of the funding yea This supplement was anticipated in original PIO/T 931-17-120-525-73-3147575

This will permit time for review of the project by R & D and RAC prior to negotiating a new contract to extend the work for another three years.

A copy of the breakdown on the budget extension and work plan are attached.

15. Clearances – Show Office Symbol, Signature and Date for all Necessary Clearances.

A. The specifications in the scope of work are technically adequate
TA/AGR, JLMalcolm JLM Date: 11/20/74
TA/AGR, TSGill TSG Date: 11-21-74

B. Funds for the services requested are available
TA/PM, C. Molfetto Date: 11/21/74

C. The scope of work lies within the purview of the initiating and approved Agency Programs
TA/AGR, LFHesser Date: 11/21/74

D. TA/PM, J.M. [illegible] Date: 11/21/74
TA/PM, M. Mozyn Date: 11/21/74

E. TA/AGR, DLPluckett Date: 11-21-74
TA/AGR, RLHolmes RLH Date: 11/21/74

F. TA/RIG, M. Reichel Date:

16. For the cooperating country: The terms and conditions set forth herein are hereby agreed to
Signature and date:
Title:

17. For the Agency for International Development
Signature: John Cunning
Title: Chief, Program Div. TA/PM

18. Date of Signature 12/6/74

GPO 857-266

Agronomic-Economic Research on Tropical Soils
North Carolina State University
AID/csd-2806

Work Plan January 1, 1975 - March 31, 1975

The following is a summary of the activities to be performed in the three months beginning Jan. 1, 1975. Completed work on which current subprojects rest is not reported. Likewise, work which is the logical outcome of project activities scheduled for the current year are not described. In most cases the principal investigator is indicated. The exceptions are in those activities which will involve almost all members of the staff on a continuing and predictably AD Hoc basis.

A listing of activities follows. Reference numbers are derived from the FY 1973 work plan.

1.2 Long-term crop response to P in Guatemala: Established. To be conducted by ICTA staff. Project staff limited to advisor role.

1.3 Multiple Cropping in Costa Rica: Tests several cropping sequences involving 2-3 crops per year (beans, corn, rice, soybeans, sorghum, cassava, pastures and forage). This activity has highest priority in Central America; will be stressed for full three months and beyond (D. D. Oelsligle)

1.4 Forage Fertility Management in El Salvador: Continued as planned. Will test five levels of N, P, and K fertilization on pasture grass and forage sorghum. (D. Oelsligle).

1.5 Fertility Management for Upland Rice in Costa Rica: A more intensive study of fertility management with rice in support of small farm activities. Continuous.

2.1 Liming Cerrado Soils: This will be continued and expanded during the period to include more crops. Liming/phosphorus interactions will be followed under controlled conditions in the greenhouse. (E. Gonzalez and E. J. Kamprath)

2.2 Phosphorus in the Cerrado: The present experiment at Brasilia will be continued through the third and fourth crops. Corn, upland rice and possibly wheat will be planned on these plots. A new experiment using less expensive sources of phosphorus and soluble silicates will be followed throughout the period. (R. B. Yost and E. J. Kamprath)

2.3 Zinc for the Cerrado: Laboratory analyses of samples from earlier experiments and from the field survey will be completed during the next three months. Additional experiments will be started during 1974 to be based on the results of the soil analyses. (A.S. Lopes and F.R. Cox)

2.4 Varietal Differences in Tolerance to Acidity and Drought: Field work is expected to start. CIAT is the principal source of the sorghum selections. (J.G. Salinas and P. A. Sanchez)

2.5 Soil Fertility Management for Upland Rice in Cerrado: Probable beginning in early 1975 but dependent on counterpart support. (J.G. Salinas and P.A. Sanchez)

3.1 Land Clearing Methods in Yurimaguas: In situ and laborary assessment of different methods of land clearing will continue throughout the period. (C. E. Seubert and P. A. Sanchez)

3.2 Characterization of Amazon Jungle Soils: Chemical, physical and instrumental analyses of soils samples from the upper Amazon region will continue throughout the period (E.J. Tyler and S. W. Buol)

3.3 Fertility Requirements for Multiple Cropping Systems in the Jungle: Crop and variety evaluation is in progress and will continue. Field experiments will start in 1974 and be continued until conclusive results have been obtained. (M. K. Wade and P. A. Sanchez)

3.4 Soil Fertility Management for Upland Rice in the Jungle: A cooperative activity largely dependent on Peruvian counterparts. Continuing. (C. E. Seubert, C. E. Lopez and P. A. Sanchez)

3.5 Fertility Requirements for Pasture Production in Jungle Region: Continuing activity and key to permanent land development in zone. (C. E. Lopez and P. A. Sanchez)

4.1 Characterization of Tropical Soils: Ongoing activity is direct support to other research activities and to serve as a guide to the utilization of the results of fertility research. (A. Alvarado, F. Munevar and S. W. Buol)

4.2. Proof and Refinement of Fertility Capability Classification: An ongoing activity grouping and categorizing soils according to their properties and predictable responses. An activity closely linked with Latin American Soil Testing project la-646. (M. A. Granger, S.W. Buol, P.A. Sanchez and R. B. Cate)

4.3, 4.4 and 4.5 Laboratory Characterization of Soils from Ecological Zones in which Current Experiments are in Progress: These continuing support activities will shed light on micronutrient balances, soil acidity-aluminum, inter-relationships and phosphate reactions within the soils. (All project staff will be involved in some phases)

4.8 and 4.9 Economic Analysis of Crop-Fertilizer Responses: These continuing activities are providing guide lines for current and future research on the project and assessing the probablity of immediate utilization of research results of this project and from other research in the region. Initial phase will be concluded during 1974 but general type of analytical work will continue. (S. Change and R. K. Perrin)

The work plan as presented is a guide and reflects detailed preplanning. It is not to be considered immutable or as an absolute specification of performance.

Agronomic Economic Research in Tropical Soils
North Carolina State University AID/csd-2806
Supplementary Budget

Category	Requested 1/1/75 - 3/31/75
Salaries and Wages	$ 38,939
Fringe Benefits	2,796
Overhead	15,735
Consultants	0
Other direct costs	17,527
Equipment and supplies	11,398
Travel and transportation including allowances	13,605
Total	$100,000

AGENCY FOR INTERNATIONAL DEVELOPMENT
RESEARCH ADVISORY COMMITTEE

Minutes of the Thirty-Sixth RAC Meeting
(March 13-14, 1972)

Dr. Brady, Chairman of the Research Advisory Committee, opened the 36th meeting by pointing out that during the last meeting, the RAC made three requests to A.I.D. These were; (1) a directory of meanings of abbreviations of pertinent A.I.D. offices; (2) information and background on RAC and its charter; and (3) background material on A.I.D. centrally sponsored research program.

The information under points 1 and 3 was distributed during this meeting. As to the RAC's second request, Dr. Long explained that the orientation for the new RAC members will take place at tomorrow's lunch at which time Mr. Williams, Deputy Administrator of A.I.D., will discuss the subject. Dr. Long added that during the same time Mr. Williams will discuss briefly the new organization of A.I.D.

Dr. Brady introduced the first item on the agenda and invited the chairman of that subcommittee to present his report.

Project Review:

Agriculture

1. Agronomic Economic Research in Tropical Soils - North Carolina State University

Dr. Whitney, chairman of the subcommittee including M. Peterson, Kramer and Heady, reviewed the project goals and accomplishments. Dr. Whitney stated that the main thrust of the project is to develop the best soil management methods having optimum economic return. He expressed the subcommittee's satisfaction with the strong participation of host countries in this research and stated further that the data obtained from this research will be transferable to other areas having similar environmental conditions and similar management inputs. Dr. Whitney inquired about the following: (1) choice of locations for experimental work; (2) further economic inputs, and (3) level of integration of the program as a whole. He felt that the quantitative data obtained in this research should be compared

with data of other cultivation methods including those of shifting cultivation.

Dr. M. Peterson believed that the project focus could be sharpened and that the project program would benefit from services of an agronomist. Dr. Kramer while agreeing with Drs. Whitney and M. Peterson's evaluation suggested that better coordination of the project is essential to its success.

Referring to the economic research of this program, Dr. Heady expressed a concern that local scientists were not included in the project activity. Therefore, he suggested a stronger cooperation with LA countries especially with their research institutes. He emphasized the fact that the project statement does not quite address itself to the generalization of data so that they could be used more widely. Dr. Heady felt that the economic phase of the work appears to be very general, on one hand, and too specific (work on crop, cropping and fertilizer use interactions) on the other. Dr. D. Peterson contributed an observation that field work seems to be de-emphasized in this program. This is suggested by the fact that only one senior and one junior scientists are scheduled to work full-time in LA. He also thought that investigation of moisture regime is an important part of total plant growth environment, and its inclusion in work plan should be considered. Dr. Ruttan inquired if the research results can be generalized and, if so, then at what level. He also added that plant breeder participation in this activity might benefit the total program. He suggested that attention should be given to monitoring the environment, especially in intensive crop production where nutrient movement to the streams and rivers might be very large. He suggested that the economist assigned to this project should be working in the field and not at N.C. campus.

Drs. Kelley and Malcolm assured the RAC that these critical points would be considered in reformulating the program. Dr. Kelley also suggested, that Dr. Heady's services may be requested by A.I.D. to work with North Carolina State University in improving the program in economics and to integrate all the facets of research into a meaningful research package. Dr. Heady agreed to this.

Dr. Long reflected upon his visit to N.C. State to review this project. He stated that there exists a strong cooperation within the project and that the emphasis on the three soil areas is

relevant because they represent very large areas and have a greater economic potential than was originally thought. Since the complexity of the problem is so large generalization might be difficult, and it would have to have a large effort to become meaningful. Economists will be involved at the beginning of project design so that generalizability will be obtained.

Motion: That: (1) the project be continued essentially as set forth in the project statement at the indicated funding level; (2) the soil management, agronomic and economic phases be carefully planned and closely coordinated throughout the life of the project; and (3) the project be reviewed by the RAC within 18 months.

(Motion carried: 20 for; 1 against)

---

2. Agricultural Diversification and Trade (Philippines) Department of Agriculture

Dr. Ruttan reported for the RAC subcommittee. Members of the subcommittee were Drs. Ruttan, Hagen, Frank and Montgomery. Dr. Ruttan called attention to the initial contract granted to the USDA, North Carolina State University and the East-West Center at the University of Hawaii for project planning purposes approximately one year ago. He called attention to the objectives of the project and the three work phases to be accomplished between the USDA and the Government of the Philippines. He also noted that the Government of the Philippines would provide approximately thirty-three man years and the Department of Agriculture approximately eight man years in collaboration to accomplish the research objectives. Dr. Ruttan also noted that the two proposed research projects agricultural diversification (North Carolina and USDA) and the proposed research project on unemployment in Africa were similar in terms of the planned collaboration between the contractor and the LDC. On this basis, he suggested that the merits of the individual projects be viewed in the total context of these three efforts. Subsequently, the RAC agreed to discuss the Philippines Agricultural Diversification project and the North Carolina project in Latin America before taking action on either one.

Dr. Ruttan speaking for the subcommittee called attention to certain characteristics of these projects considered germane to RAC's consideration. First, he noted that the projects break new ground by the high degree of collaboration planned between the research contractor and the appropriate research and official agencies of the LDCs. Second, he observed that the research