PD-AAA-166
ISN 12.1

AN ADJUNCT TO PROJECT STATEMENT
FOR EXTENSION OF
BENCHMARK SOILS PROJECT--UNIVERSITY OF PUERTO RICO
(AID/ta-c-1158)

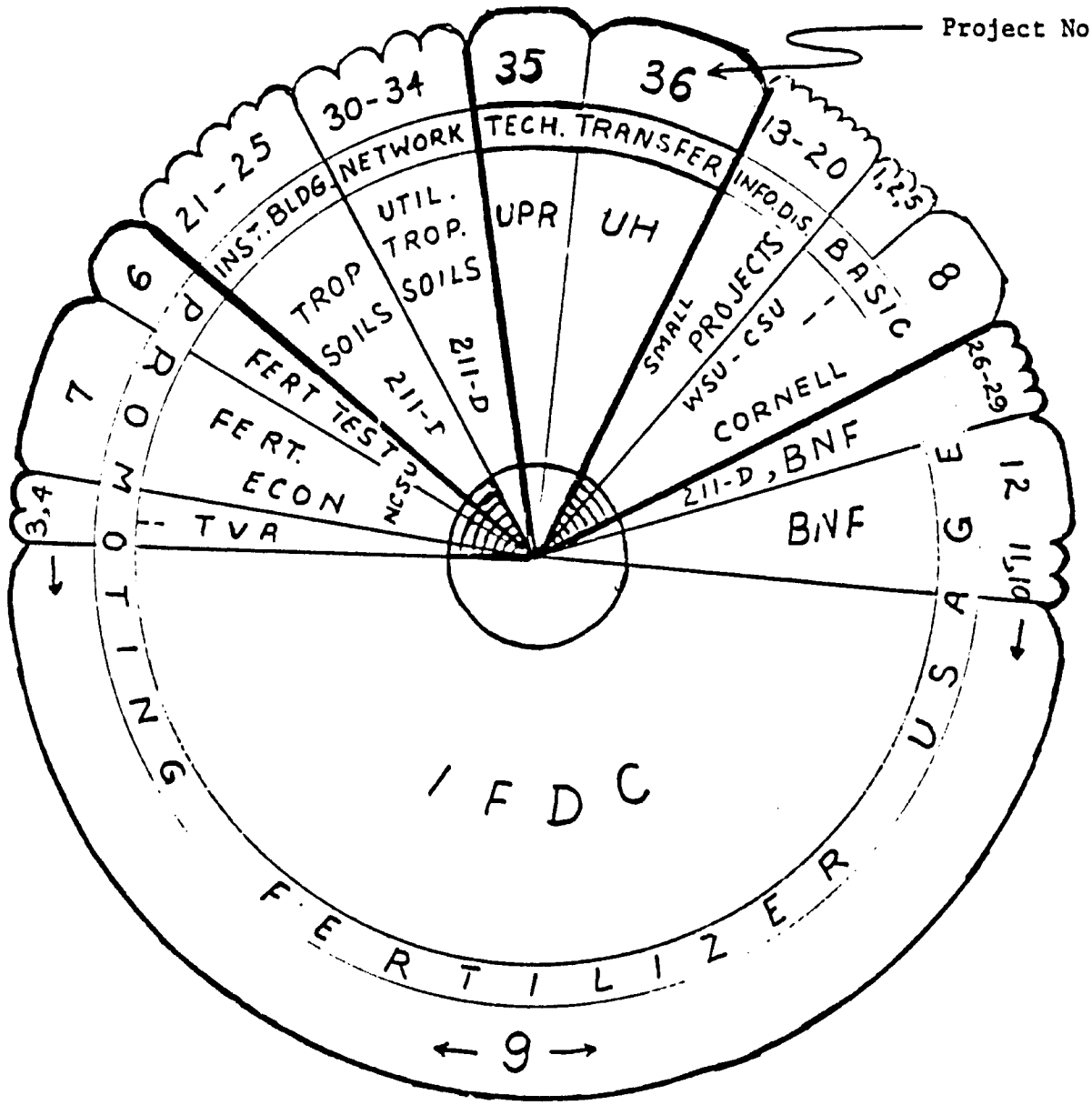
Relationship with other TA/AGR tropical soil projects

The attached Figure and Table briefly relate the University of Puerto Rico (UPR) Benchmark Soils project with other tropical soil projects in the Office of Agriculture. This project is parallel to the University of Hawaii (UH) 'Soil Family' project. The two projects have similar experimental design but they are located in different geographic locations. The UPR project is located in Latin America--Brazil, and Puerto Rico, while UH project is located in Asia--the Philippines and Indonesia, Africa--possibly Cameroon, and Hawaii. The UH project is working on a well defined upland volcanic soil family while UPR is working on a not so well defined upland Oxisol soil family.

UPR project was initially funded on January 1, 1975 and is seeking extension for three years beyond December 31, 1977. UH project was initially funded on May 30, 1974 and, reviewed and approved for 3 year extension by RAC on March 31, 1977.

RDA - TROPICAL SOILS MANAGEMENT

Relative Support and Purpose of Projects*



Completed Projects

Ongoing Projects

*See attached description--Table 1

KEY PROBLEM AREA: TROPICAL SOILS

CLUSTER PROGRAM
TA/AGR

MAJOR THRUST: RAPID AND ECONOMICAL DEVELOPMENT OF LDC LAND RESOURCES FOR AGRICULTURE PRODUCTION AS SUITED TO SMALL FARMER SITUATION

PROGRAM CATAGORY	PROGRAMS	EFFORT*	STATUS**	INST
A. Technology Development	1. Evolving Varieties for Problem Soils	S	C (mostly)	CSU
	2. Lab. Screen of Varieties for Problem Soils	S	C (mostly)	WSU
	3. Fertilizer Development for Tropics	M	C	TVA
	4. Fertilizer for Rice	M	C	TVA
	5. Physical Problems of Clay Soils-Paddy	M	Terminated (V. Nam)	CSU
	6. Soil Fertility Testing	L	C	NCSU
	7. Economics of Fertilization in Latin America	L	C (mostly)	NCSU
	8. Soil Chemical Constraints	L	C (mostly)	Crnl
	9. Improved Fertilizers for Tropics	L	OG	IFDC
	10. Grasses That Make Nitrogen in the Soil	M	OG	UFla
	11. Legumes That Make Nitrogen in the Soil	L	OG	USDA
	12. Legumes That Make Nitrogen in the Soil	L	OG	UH
B. Information Dissemination	13. Text: Mineralogy, Chemistry, and Physics of Soils of the Tropics	S	OG	UH
	14. Text: Soils of Humid Tropics	M	C	NAS
	15. Seminar/Proceedings: Soil Survey and Classification in Planning and Implementing Agricultural Developments	M	C (mostly)	UH/UPR
	16. Seminar/Proceedings: Soil Management in Tropical America	S	C	NCSU
	17. Bibliography of Soils--Africa	S	C	Crnl
	18. Text: Soils of Tropical Dry and Dry-Wet Climatic Areas of W. Africa and Their use And Management	S	C (mostly)	Crnl
	19. Bulletin--Different Systems of Soil Classification--Soil Series of Hawaii	S	C	UH/UPR
	20. Workshop/Proceeding: Adapting Plants to Soil Stress Conditions	S	C (mostly)	Crnl/USDA

PROGRAM CATEGORY	PROGRAMS	EFFORT*	STATUS**	INST
C. Strengthening Institutions	21-25. Tropical Soils: A coordinated program with several U.S. institutions	M	C	UH UPR NCSU PVA&M Crnl
	26-29. Biological Nitrogen Fixation in Soils A coordinated program with several U.S. institutions	M	OG	UH UPR NCSU Crnl
D. Network Development	30-34. Utilization mode in Soil Technology: A coordinated directional program to catalize utilization of soil technology in LDCs for crop production	M	OG	UH UPR NCSU PVA&M Crnl
E. Technology Transferrence (Based on Soil Taxonomy)	35. Testing a hypothesis of agro-technology transferrence among tropical countries (Study in Latin America)	L	OG	UPR
	36. Testing an hypothesis of agro-technology transferrence among tropical countries-- (Study in Asia & Africa)	L	OG	UH

* S = Small (Less than $40,000)
M = Medium ($40,000 to $125,000)
L = Large (Over $125,000)

** C = Completed
OG = On-Going

Crnl - Cornell University
CSU - Colorado State University
IFDC - International Fertilizer Development Center
NAS - National Academy of Sciences
NCSU - North Carolina State University
PVAM - Prairie View A&M
TVA - Tennessee Valley Authority
UFla - University of Florida
UH - University of Hawaii
UPR - University of Puerto Rico
USDA - U.S. Department of Agriculture
WSU - Washington State University

PROJECT STATEMENT

Project Title: Crop Production and Land Potential of Benchmark Soils of Latin America (AID/ta-c-1158)

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PROJECT STATEMENT

1. Statistical

Project Title:	Crop Production and Land Potential of Benchmark Soils of Latin America (AID/ta-c-1158)
Contractor:	University of Puerto Rico College of Agricultural Sciences Department of Agronomy and Soils Mayaguez, Puerto Rico 00708
Principal Investigator:	Dr. F. H. Beinroth, Professor of Soils Department of Agronomy and Soils
Duration:	Current authorization: 1/1/75 - 12/31/77 Proposed extension: 1/1/78 - 12/31/80

Total Estimated Cost:	Through December 31,	1977	$1,093,518
		1978	383,680
		1979	420,920
		1980	398,300
	Total 1978 through	1980	1,202,900
	Cumulative Total		2,296,418

Project Specialist: Dr. T. S. Gill, TA/AGR

2. Narrative

The project entitled "Crop Production and Land Potential of Benchmark Soils of Latin America", popularly known as the Benchmark Soils Project, was implemented to determine if and how agroproduction technology can be transferred among tropical countries. The primary purposes of the Project are: (1) to test the hypothesis that soil management and crop production knowledge can be transferred in the tropics via soil classification, (2) to demonstrate that management characteristics of tropical soils and their potential for crop production can be predicted on the basis of soil taxonomic units, thereby reaffirming the value of soil survey and classification in formulating agricultural development plans, and (3) to develop a methodology and create the required infraxtructure for expeditious agrotechnology transfers. The goal of

the Project is to contribute fast and significantly towards increased quantity and improved quality food production in the tropics and, to enhance nutrition and general well being of small farmers in LDC's.

Attainment of this goal implies that LDC's must utilize their cultivated land more productively and develop new soil resources commensurately with growing food needs. In most LDC's this can be achieved by capitalizing on the concepts and principles of the project. First, the aggregate of the crop and soil management experience accumulated over many years on similar soils in other parts of the world can be directly applied to the corresponding soils in specific LDC's at no cost. Second, wise land use planning and development of crop production schemes can be improved through interpretations of soil surveys involving accurate predictions and realistic production targets. Thus, the methodology of agrotechnology transfers being developed by the Project could become a key agent for significantly accelerating the process of and reducing the costs for agricultural experimentation, planning and development in LDC's within a rather short period of time.

The basis of the hypothesis postulated and studied in the Project is the soil family. The soil family is the lowest category of a comprehensive system of taxonomic soil classification that was developed over the past 25 years by the Soil Conservation Service of the U. S. Department of Agriculture and has been published recently. The soil family constitutes a condensed scientific statement that integrates the knowledge about a soil and its environment. It was conceived with the intent to group soils having similar physical and chemical characteristics that affect their response to management and which are homogeneous in the parameters important to the growth of plants. Soils belonging to the same family should, therefore, have essentially the same management requirements and responses, and should have similar potentials for

crop production. Consequently, the soil family should have the inherent quality of making agrotechnology transfers a possibility.

The University of Puerto Rico has made satisfactory progress to date. It has established a network of five experiment sites in soils classified as Tropeptic Eutrustox of the clayey, kaolinitic, isohyperthermic family. These are strongly weathered but moderately leached red upland soils of subhumid tropical regions. They were selected because they are extensive in Latin America and Africa and because they are common to the islands of Hawaii and Puerto Rico and this provides the required link with a parallel project of the University of Hawaii.

The Project succeeded in negotiating a cooperative agreement with the Empresa de Pesquisa Agropecuaria de Minas Gerais, Brazil, and in establishing excellent rapport and working relations with this agency as well as with the USAID Mission in Brasilia. Under a subcontract by the Project, the University of Kentucky is engaged in the basic statistical research needed to develope a scientifically valid test of the transfer hypothesis. Further collaborative linkages have been evolved with the International Soybean Program (INTSOY) and Utah State University. Close technical coordination is maintained with the University of Hawaii project staff.

The experiment sites in Puerto Rico and Brazil were equipped with complete weather stations and irrigation facilities which, in the case of the Brazil sites, necessitated the drilling of water wells. Field plot work included a uniformity trial, transfer experiments with maize and soybeans as indicator crops, variety trials, and management experiment. A total of 20 experiments were conducted in accordance with detailed guidelines for field procedures and data collection and processing. Earlier, an AID-sponsored workshop refined and assured the depth and quality of the resarch design.

Utilization-related activities involved efforts to publicize the existence of the Benchmark Soils Project and to create an awareness and understanding of its rationals and potentials. An international seminar organized by the University of Hawaii at ICRISAT, India, and the Fifth Latin American Congress of Soil Science held in Medellin, Colombia, provided suitable settings for these efforts.

An on-site review of the Project by an AID panel was conducted in February 1977. The panel recommended a three years' extension of the same scope as the initial Project. During the proposed extension, the original research objectives will be achieved through field experimentation and statistical evaluations. Pursuant to a recommendation by the panel, the Project will also be involved in activities to stimulate and facilitate utilization of the transfer concept. Activities programmed in this area include an international seminar on agrotechnology transfer, the publication and dissemination of results through annual reports, newsletters and other utilization materials, and the characterization of key soils of Latin America for entry in the Soil Data Bank. These activities should be of considerable interest to the Latin American Bureau, field missions and, above all, to LDC's.

EXPANDED NARRATIVE STATEMENT

I. Purposes and Objectives

A. Purpose of the Project

In January 1975 a contract was signed between the U. S. Agency for International Development (AID) and the University of Puerto Rico (UPR) to initiate a project entitled "Crop Production and Land Potential of Benchmark Soils of Latin America"' This project became popularly known as the Benchmark Soils Project; a name coined from UPR's proposal title and subsequently adopted by the parallel project of the University of Hawaii.

The purpose of the Project is to test an innovative approach to agrotechnology transfer designed to assist LDC's in appropriately utilizing their land resources for increased and better quality food production by bypassing three key constraints. The three major constraints prevailing in LDC's are: scarcity of qualified research personnel, insufficient capital, and lack of time to close the widening gap between agroproduction and food requirements. The traditional approach to agricultural research is extremely time-consuming. However, the poor farmers in LDC's need the basic information conducive to higher outputs now and cannot wait until locally generated research results trickle down to them.

The concept under study in the Project is the hypothesis that agrotechnology is directly transferrable among tropical countries on the basis of soil classification, specifically at the family level of the U. S. Soil Taxonomy. (Soil Survey Staff, 1975). This concept has been used effectively in the continental US (DeMent, 1971). If proven correct for the tropics, it may well have a profound impact on agricultural development and increased food production. First, available for immediate tapping will be millions of dollars worth of research information produced by thousands of man-years of effort. Second, it will help

save millions of dollars by avoiding the duplication of agronomic experiments all over the tropics -- a waste of time, money and effort LDC's can ill afford. Third, it should lead to the formation of a worldwide network of expertise and a Crop Production Reference Center by taxonomic soil units. Fourth the concept of agrotechnology transfer is not confined to soil management practices but encompasses all associated experience and knowledge; e.g., information on crops and farming systems, water management, erosion control measures, economic of crop production, etc.

B. Research Objectives

The general objective of the Benchmark Soils Project as stated in the contract is "to correlate food crop yields on a network of tropical benchmark soils and to determine scientifically the transferability of agroproduction technology among countries". More specifically, the primary research objectives of the Project are:

(1) to demonstrate that soil management knowledge can be directly transferred at the soil family level of the U. S. Soil Taxonomy,

(2) to establish that the behavior of tropical soils and their potential for crop production under various levels of management inputs can be predicted on the basis of soil taxonomic units, and

(3) to develop a statistical methodology to verify the concept of agroproduction technology transfers via soil classification.

Secondary objectives of the Project are to evaluate the validity of presently used and additional differentiae of soil classification relative to crop production, and to indicate management alternatives conforming to the economic contraints of small farmers of tropical countries.

II. Progress of the Project

A. Administration

1. General

The Benchmark Soils Project is assigned to the Department of Agronomy and Soils of UPR's College of Agricultural Sciences at Mayaguez, Puerto Rico. It is administered in accordance with established university regulations as regards to authorities, recruitment and remuneration of staff, procurement procedures, and accounting. Since the initiation of the Project, Dr. F. H. Beinroth, Professor of Soil Science, served as Principal Investigator. The organizational set-up of the Project within the university structure is depicted on the chart presented as Appendix A2.

During the first two years the Project has made reasonable progress in creating a functional internal infrastructure conducive to productive research. This required a considerable amount of time and effort as office space was inadequate, laboratory facilities were extremely limited and sufficient qualified staff was not available from the university.

At the time of the award of the contract only one of the present Project staff, the Principal Investigator, held an appointment at the Department of Agronomy and Soils. Since January 1975 five new professionals were recruited for the Project and three more were transferred from the staff of the UPR's Agricultural Experiment Station. In addition, one secretary and three field research aides were hired. At the present time the Project maintains a regular staff of nine professionals and four non-professionals, equivalent to 11.75 man-months of effort per month. The Project personnel and their respective responsibilities are shown in a table contained in Appendix A3.

2. Memoranda of Agreement and Subcontracts

A memorandum of agreement between the University of Hawaii and the University of Puerto Rico regarding the cooperation of the two institutions in

their respective Benchmark Soils Projects and their technical coordination was worked out and became effective on January 1, 1976. Negotiations with the Empresa de Pesquisa Agropecuaria de Minas Gerais (EPAMIG) led to a project agreement which details the Project's involvement in Minas Gerais, Brazil, and specifies EPAMIG's technical and administrative contributions. After consultation with the USAID Mission in Brasilia, this agreement was effectuated by the signatory institutions on January 26, 1976.

In order to secure expert assistance for the statistical work stipulated in the contract, the Project subcontracted the University of Kentucky to conduct basic statistical research relative to a model that will provide a satisfactory test for the transfer hypothesis. This subcontract became effective on August 1, 1976 and has a duration of one year.

B. Planning and Coordination

1. Design Workshop

On the rationale that the experimental design and the research methodology be reviewed and specified prior to initiation of the field work, AID's Research and Advisory Committee suggested that a workshop be held on "Experimental Designs for Predicting Crop Productivity with Environmental and Economic Inputs". This workshop was organized by the University of Hawaii with Assistance from the University of Puerto Rico in coordination with AID and was held in Hawaii in May 1974. Thirty-eight invited participants from the United States and abroad attended the workshop and a total of fourteen papers were presented. UPR staff prepared three position papers for this meeting.

The primary purpose of the workshop was to develop the research strategy and experimental designs best adapted to generate the kind of data required to demonstrate the transferability of agricultural experience on the basis of soil taxonomic units and which will allow economic analyses aiding decision

processes of small farmers in LDCs. The salient results of the discussions at the workshop were that the experimental design should be a 5^2 partial factorial as modified by Escobar (Laird and Turrent, 1974) with three replicates, that the experiments should have two soil family-related variables at five levels each, and that maize is to be the indicator crop at all sites.

It became further evident at the workshop that there exists no statistically adequate methodology for testing the transfer hypothesis postulated in the objectives above. The workshop participants therefore recommended that AID be approached to provide a grant to allow a team of statisticians to develop a proper test for transferability. A detailed account of the workshop is contained in a published report prepared by J. A. Silva and F. H. Beinroth (1974).

As elucidated in the following section on experimental field work, the University of Puerto Rico has incorporated all of the workshop recommendations in its research design. The Project has also acted on the recommendation regarding the need for fundamental statistical research by subcontracting the University of Kentucky to conduct the work described below under "Statistical Research".

2. Project Management and Design Workshop

In January 1976, a management and design workshop for UPR's Benchmark Soils Project was held in Puerto Rico under the direction of Mr. R. Kitchell of AID/Washington. In addition to UPR project staff, Dr. L. Frederick of TAB/AGR and Dr. J. A. Silva of the University of Hawaii participated in this activity. During this workshop all major present and future project activities were identified, associated milestone events were scheduled, and critical assumptions and progress indicators were defined. The results of the workshop were summarized in a 32-page document which proved very useful for the immediate and long-term project management.

3. Coordination Meeting

The first Annual Coordination Meeting of the University of Hawaii's and the University of Puerto Rico's Benchmark Soils Project was held in Puerto Rico in August 1976. Key personnel of the Hawaii project and all Puerto Rico project staff were in attendance, also present were Dr. T. S. Gill of TAB/AGR and Drs. F. B. Cady and L. A. Nelson, statistical consultants.

The meeting provided the first opportunity for the technical staff of both projects to discuss problems and their solutions, exchange experiences, and plan and coordinate present and future activities. Particular attention was given to management experiments and their relevance to the need of small farmers and plans for utilization. It was the consensus of all present that the meeting was extremely useful to both Benchmark Soils Project. The papers presented at the meeting and a summary of the discussions have been prepared for publication and will be contained in a report now in the press at the University of Hawaii.

C. Network of Experiment Sites

1. Soils Selected

The soils selected for experimentation are well-drained, red upland soils occurring under savanna or deciduous forest vegetation in subhumid tropical regions. They are slightly acid to neutral, have an appreciable supply of bases and moderate to high base saturation in the subsoil. Among their adverse properties are a limited water holding capacity, a tendency to compact when cultivated with heavy equipment, and phosphorus deficiency. Their main constraint for agricultural use is the insufficiency of soil moisture for more than three months per year.

These soils belong to the group that has been called Laterites, Soils Ferrallitiques of Latosols in recent years and is now referred to as Oxisols

in the U.S. Soil Taxonomy. The particular kind of Oxisol chosen for the Project are Tropeptic Eutrustox of the clayey, kaolinitic, isohyperthermic family. This family was selected because it is common to both Puerto Rico and Hawaii and thus provides the required link between the two Benchmark Soil Projects. Although not the most common kind of Oxisols, they are extensive in tropical South America and Africa. They represent important soil resources preferred for immediate development over other Oxisols on account of their high base saturation status.

2. Establishment of Experiment Sites

On the basis of preliminary investigations involving literature surveys and consultations, the search was concentrated in Brazil, Colombia, the Dominican Republic, Jamaica and Venezuela. All other countries of tropical America were excluded because the chances of locating the desired soil family there were nil or because of political considerations, as in the case of Cuba. While Oxisols are extensive in the Llanos Orientales of Colombia, the on-site and analytical studies revealed that Eutrustox did not occur in that area. Several classes of Oxisols were also noted in Dominican Republic, Jamaica, and Venezuela, none belonged to the family required by the project.

In the light of the results of the soil investigations and search for the same family, the establishment of experiment sites on Tropeptic Eutrustox in tropical America had to be thus confined to Puerto Rico and Brazil. Two types of sites were established in these countries, primary and secondary sites. The characteristics of each of these kinds of sites are explained in the following section.

In Puerto Rico, one primary and one secondary site were installed on the grounds of the Isabela Agricultural Experiment Substation of the University of Puerto Rico in 1975. This 120-hectare research station is located in the northwestern corner of the island and was founded in 1928 to serve the Isabela Irrigation District. Since then a vast amount of research has been conducted there on sugarcane, vegetable crops, grains, fruit crops and subsistence crops.

In Brazil, one primary and two secondary sites were established in 1976 and 1977, respectively, in an area adjacent to the San Francisco River in northern Minas Gerais known as the "Distrito Agro-Industrial de Jaiba". This 300,000-hectare irrigation scheme was recently developed and is now being opened for colonization by small farmers. The Project sites are thus well located from the point of view of local impact and utilization. The primary site near Jaiba is on a new experiment farm operated by the Project's cooperating agency, EPAMIG. The two secondary sites are on private land nearby. A preliminary survey and soil sampling for an additional primary site near Janauba in Minas Gerais has been completed. It is expected that the pending soil analyses will be affirmative and that lease arrangements will be negotiated in the near future.

The contract called for the establishment of three primary sites during the initial contract period of three years. At this point in time, two primary sites have been established and are operative in Puerto Rico and Jaiba, Brazil, respectively. A third primary site near Janauba, Brazil will be added to the network during 1977.

The contract further stipulated the establishment of three "satellite" sites for each primary site. However, in view of statistical and pedological considerations the concept of satellite sites was subsequently modified. In consultation with two statisticians it was decided at the annual coordination meeting that a combines total of eight sites per soil family, including primary and secondary sites, will suffice to adequately test the transfer hypothesis. The Project has presently established five sites and will add another site this year. Since the parallel project of the University of Hawaii is in the process of establishing two sites on the Eutrustox family, a total of eight sites will be in operation by 1977 as required for statistical reasons.

Although a wider geographical spread of the experiment locations involving more countries would have been desirable, this was physically impossible to achieve in Latin America. However, through the linkage with the project of the University of Hawaii, the Eutrustox network encompasses clusters of experiment sites in three widely separated regions—Oceania, South America and the Caribbean.

D. Experimental Field Work

1. Research Design and Methodology

The research design and methodology was developed in concurrence with the recommendations of the Workshop on Experimental Designs (Silva and Beinroth, 1974) and in close coordination with the University of Hawaii. In the Project design distinctions are made between two types of experiment sites, designated primary and secondary sites, and three kinds of experiments referred to as transfer experiments, variety trials and management experiments, respectively.

Primary sites are experiment locations where all of the three kinds of experiments are conducted and which are completely instrumented for collection

of pertinent weather data. At each primary site the following weather parameters are monitored: (1) ambient temperature and relative humidity recorded continuously with standard hygrothermographs, (2) daily maximum and minimum ambient temperatures, (3) rainfall recorded continuously or daily, (4) accumulated daily solar radiation, (5) daily wind run, (6) pan evaporation (optional), and (7) maximum-minimum soil temperatures at 5, 15, 20 and 50 cm depths. In so far as possible, instrumentation is according to U. S. Weather Bureau Standards.

Secondary sites are experiment locations where only transfers experiments are conducted. They are required to increase the number of experiment sites per soil family in order to have sufficient data for a statistically valid estimate of the effect of uncontrolled variables on crop yields. Secondary sites may differ from primary sites in that they exhibit variations in soil properties important to plant growth, such as pH or base saturation, within the range permitted by the definition of the soil family. If located at some distance from the primary site, secondary sites may also have different weather conditions. In this case they are equiped with the standard instrument shelter, hygrothermograph, raingauge and solar radiometer. At other secondary sites, situated closer to the respective primary sites, only rainfall is recorded, as other weather parameters are not likely to vary significantly over short distances.

Transfer experiments are soil fertility trials designed especially to generate the data necessary to test the hypothesis set forth in the purpose of the project. Their design is the 5^2 partial factorial modification by Escobar as described in a paper by Laird and Turrent and presented at the Workshop on Experimental Designs. Currently on Eutrustox the two variables are phosphorus and potassium at 5 levels each with 13 of the 25 total possible treatment

Table 1. Treatment Combination for Maize and Soybeans

High Base Status Soils

	Coded Levels 1/		Actual Levels 2/			
			Maize		Soybeans	
Treatment	P	K	P in Sol'n ppm	K kg/ha	P in Sol'n ppm	K kg/ha
A	-0.85	-0.85	.01	19	.02	19
B	-0.85	+0.85	.01	231	.02	231
C	+0.85	-0.85	.09	19	.19	19
D	+0.85	+0.85	.09	231	.19	231
E	-0.40	-0.40	.03	75	.06	75
F	-0.40	+0.40	.03	175	.06	175
G	+0.40	-0.40	.07	75	.14	75
H	+0.40	+0.40	.07	175	.14	175
J	"Optimum"	"Optimum"	.05	125	.10	125
K	-0.85	"Optimum"	.01	125	.02	125
L	+0.85	"Optimum"	.09	125	.19	125
M	"Optimum"	-0.85	.05	19	.10	19
N	"Optimum"	+0.85	.05	231	.10	231
O	Complete control --- No fertilizer applied ----------					
P	Partial control ---- Blanket application only ---------					

Blanket Application for all plots except Complete control

Element	kg/ha	Source
Mg	100	$MgSO_4 \cdot 7H_2O$
Zn	15	$ZnSO_4 \cdot 7H_2O$
B	2	Borax
Mo	0.5	$Na_2MoO_4 \cdot 2H_2O$
N (on Maize only)	200	Urea

1/ Coded levels are based on middle or "optimum" levels. The assumed "optimum" levels of P in solution for maize and soybeans are 05 ppm and .10 ppm, respectively and the "optimum" level of K for both crops is assumed to be 125 kg/ha at Isabela. Other treatment levels are "optimum"levels plus or minus 0.40 or 0.80 x "optimum" levels.

2/ "Actual" levels of P are determined by the phosphorus sorption isotherm technique (Fox and Kamprath, 1970).

combinations and 2 "control" treatments as shown in table 1. These 15 treatments are replicated 3 times; thus, in each experiment there are 45 plots. Such transfer experiments are conducted on all primary and secondary sites. In order to eliminate or at least minimize the effect of the natural moisture variable, trickle irrigation systems are installed for all transfer experiments. Tensiometers are used to determine the frequency of water applications. This way soil moisture is maintained at or near optimum levels throughout the growth period. Maize and soybeans are used as test crops with well adapted varieties planted in the transfer experiments at each location.

Variety trials are conducted at the primary sites to assure that a well adapted variety is grown in the transfer experiments. Also, to make the yield data among sites more comparable, the test crop varieties of each site of the network are included in the variety trials at each primary site.

In the variety trials a split-plot design is employed, each variety being grown with phosphorus treatments at two levels, "optimum" and -0.85 (see table 1). This provides a measure of each variety's requirement for and capacity to respond to applied phosphorus.

Management experiments have the purpose to provide information on economic and efficient practices, and information for subsequent soil interpretations and land capability classification. Whereas the procedures for conducting the transfer experiments must be virtually identical at all sites, management experiments are more flexible and allow the project to respond to host country priorities and to local farmer needs. A philosophic frame work for the management experiments was developed at the first annual coordination meeting of the UH and UPR projects in 1976. Particular attention is paid to experiments on costly inputs and high energy use cultural practices, such as irrigation and tillage.

Field operations, and data collection and processing follow standardized procedures to ascertain compatibily of results throughout the network. Working in close cooperation with the University of Hawaii, a set of guidelines has been developed and continues to be revised so that laboratory and field experiment procedures can be as nearly identical as possible within the constraints confronted at the various experiment sites of each project. These guidelines are sufficiently detailed to insure comparability of data obtained at all sites. All field operations such as land preparation, pest control, irrigation, cultivation and harvesting are considered, as well as field plot designs and data observations. Special attention has been given to make standarization of climatological data collection. Each of the experiments is statistically analyzed in consultation with the Project's statistics experts. The University of Hawaii assumed the responsibility for the overall analyses.

2. Progress and Status of Field Experiments

a. Puerto Rico

Transfer experiments. Prior to initiating transfer experiments a uniformity trial using soybeans (variety Woodworth) as the test crop was established in July 1975 on the primary site at Isabela, Puerto Rico. The main purpose of this planting was to observe the apparent uniformity of the soil in the field selected and to delineate areas unsuitable for experimental plots. Several such areas were located and can now be avoided when subsequent experiments are installed. A secondary purpose was to "draw down" the fertility to a more nearly common level before establishing transfer experiments. Soybean yields appeared to be relatively uniform across the field but samples from 10 m x 10 m plots indicated a range in yields from 1,141 kg/ha (17 bu/A) to 2,249 kg/ha (33.5 bu/A) with no fertilizer. A large part of this variation could be

attributed to soil moisture differences resulting from the use of an inadequate sprinkler irrigation system.

Trickle irrigation systems were designed and installed on the primary and secondary sites at Isabela. This required the laying of several thousand feet of PVC tubing to provide an adequate supply of water to the sites.

As illustrated on the chart in Appendix B1, four transfer experiments with maize and soybeans have been completed, one with each crop at both the primary and the secondary sites. On the primary site maize (variety X306B) yield means over 3 replicates ranged from 6,590 kg/ha (105 bu/A) to 1,1515 kg/ha (183 bu/A). There was a marked increase in yield with the first increment of phosphorus, a further increase with the next increment but no further increase with higher levels of phosphorus. There appeared to be no response to applications of potassium. Maize yields with the same variety were lower on the secondary site but trends were similar to those found on the primary site.

Soybean (variety Jupiter) yields at the primary site were severely reduced by an unexpected attack of Anthracnose (Colletotrichum dematium var. truncata) which caused complete defoliation of the plants about 2 weeks before physiological maturity. At the secondary site soybean (variety Hardee, late selection) yields ranged from 2361 kg/ha (35 bu/A) to 2872 kg/ha (43 bu/ha). These data are now being analyzed statistically at the statistics section of UPR's Agricultural Experiment Station.

Both maize and soybeans have shown a marked early positive growth response to phosphorus applications, as is evidenced by plant height measurements at 30 days after planting. This effect was less apparent in later observations. Low-phosphorus and "control" plots in the maize experiments exhibited weak stalk development and considerable lodging. Moderate to high phosphorus treatments resulted in severe lodging of the Jupiter variety of soybeans grown in the

first transfer experiment on the primary site. Because of this and the previously mentioned Anthracnose attack, subsequent plantings have been with an INTSOY selection of the soybean variety, Hardee.

Four transfer experiments, one with maize and one with soybeans at each site are approaching maturity. These will be harvested late in March and early in April.

Variety trials. Two maize variety x phosphorus level experiments have been completed at the primary site at Isabela. These trials included twenty varieties from Australia, Central America, Hawaii and the Philippines which were studied at two levels of phosphorus. The mean grain yields from the first of these trials ranged from 4,395 kg/ha (70 bu/A) up to 10,210 kg/ha (162 bu/A) with the Pioneer hybrid X304C. The two more commonly grown local open pollinated varieties, Mayorbela and Diente de Caballo yielded 6,719 kg/ha (107 bu/A) and 7,010 kg/ha (112 bu/A), respectively, at the lower level of phosphorus and did not respond to the heavier application rate.

Management experiments. A phosphorus level x variety x plant population factorial experiment with soybeans was conducted in cooperation with INTSOY. In another management experiment plots were plowed at different soil moisture levels to find ways to improve seedbed preparation for soybean plantings. The data from all of these experiments are still being analyzed statistically.

b. Brazil

In May 1976 Mr. C. E. Seubert, UPR agronomist, was transferred to Brazil and now resides near the primary site at Jaiba, Minas Gerais. He succeeded in establishing excellent rapport with the cooperating institution, EPAMIG, and the USAID Mission in Brasilia. The cooperation and support of both EPAMIG and USAID/Brasilia have been exceptionally favorable to the development of the Jaiba site.

The establishment, preparation and instrumentation of the primary site was essentially completed by September 1976. Through the intercession of EPAMIG, the Project obtained two small houses from RURALMINAS, a local development agency. These are used for offices and a laboratory, and for storage of fertilizer and equipment. The required weather instruments and laboratory and field equipment was imported with the help of USAID/Brasilia. Arrangements are under way with EPAMIG and Brazilian customs authorities for the shipment of additional materials and equipment. EPAMIG provided the Project with a jeep-like vehicle and a surplus Chevrolet Carryall was made available by USAID/Brasilia.

A contract was signed in June 1976 for the drilling of an irrigation well on the primary site on the EPAMIG experiment station at Jaiba. The well was finally completed in September. Water tanks and a trickle irrigation system were installed with the assistance of Dr. J. Keller of Utah State University who served as a consultant to the Project. The drilling of a well at the secondary site has been contracted and should be completed soon. Water from this well will be piped to the other secondary site at Jaiba.

Transfer experiments. The first transfer experiment with maize (variety IAC Phoenix 1110) was planted in October 1976. A soybean experiment was established one month later with the same variety used in Puerto Rico (Jupiter).

Variety trials. A maize variety trial including 46 varieties was planted in October 1976. Thirty-six of these varieties were recommended and provided by the Centro Nacional de Pesquisa de Milho e Sorgo (SNPMS) in Sete Lagoas, Minas Gerais, as they constitute the national corn trial tested throughout Brazil. The other ten varieties have been selected from those included in the variety trial conducted in Puerto Rico and material suggested for the area by SNPMS. In addition, the standard INTSOY variety trial which comprises sixteen soybean varieties was planted in November 1976.

Management experiments. Two management experiments with maize were installed at the primary site in October 1976. They were designed in close cooperation with EPAMIG and respond to local research needs. In one experiment the interactions between row spacing, maize variety and plant population are studied at three levels of each variable and replicated four times. The second trial is a maize variety x phosphorus experiment with five varieties and four levels of phosphorus.

At this time no yield data are available from the various maize and soybean experiments conducted at the primary site in Jaiba.

E. Statistical Research

From a statistical point of view, the success or failure of the project rests heavily upon whether a transferability test can be developed and applied. However, as indicated above it transpired at the Workshop on Experiment Design that a statistically satisfactory method to test the transfer hypothesis was not available.

In recognition of this problem, AID provided financial support for a meeting of three statisticians, Drs. R. L. Anderson, F. B. Cady and L. A. Nelson, to discuss an appropriate approach to this problem. At this meeting progress was made on developing the nucleus of what promises to be a procedure for a transferability test. A tentative statistic was formulated the main elements of which are the prediction sum of squares, the prediction sum of squares with expectation and the mean square residuals. However, considerable work remains to be done regarding the mathematical details of the test to evaluate some of its properties.

In concurrence with a recommendation by AID's Research and Advisory Committee, the University of Puerto Rico therefore subcontracted with the University of Kentucky to conduct the theoretical studies needed. Under this subcontract, Dr. Anderson and associates are engaged in the research outlines below:

A. Method of Prediction

1. Investigate biasis estimators (of regression parameters) concerning their usefulness in prediction.

2. Applications to actual data sets

B. Develop a Valid Test of Transferability Hypothesis

C. Statistical Properties of the Proposed Test Statistic

1. Distribution under null hypothesis

2. Power of the proposed test against some specific alternatives

D. Applications of the Test Procedure to Project Data.

Since the development and evaluation of the test of the transferability hypothesis depends on the form of the estimator used, actual yield data generated by the Project are needed to verify the model now being developed. A first evaluation will be possible when yield data from both the Brazilian and Puerto Rican sites become available next month.

F. Linkages

Linkages are considered an essential element of the Benchmark Soils Project and their establishment has been actively pursued since its inception. In the course of site selection, contacts were established with numerous institutions and individuals in LDC's and in the U. S. These have already been mentioned in the previous section on Network of Experiment Sites.

In addition to the basic linkage with the parallel project of the University of Hawaii, collaborative agreements and/or formal linkages have been effectuated with the following institutions:

Empresa de Pesquisa Agropecuaria de Minas Gerais (EPAMIG). This agency is the project's principal cooperator in Brazil. In coordination with the national research institution, EMBRAPA, EPAMIG is responsible for all aspects of agricultural research in the state of Minas Gerais. The president of EPAMIG, Dr. H. Mattana Saturnino, fully concurs with the principles and approach of the Project

and realizes the potential benefits for the agricultural development of the state of Minas Gerais. Dr. Mattana Saturnino was personally involved in the initial negotiations, reflecting his interest in the Project. The administration and staff of EPAMIG have given the project excellent cooperation.

Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA). The Project has established very effective working relationships with the Servicio Nacional de Levantamento e Conservacao de Solos (SNLCS) of EMBRAPA. SNLCS has expressed interest in getting more directly involved in the Project. As yet informal contacts are maintained with the EMBRAPA administration in Brasilia.

USAID/Brasilia. Efficient rapport has been developed with the AID Mission in Brasilia. Although under no obligation to do so, the Mission provided the Project with valuable cooperation and support which greatly facilitated Project implementation in Brazil.

International Soybean Program (INTSOY). Since soybeans are used as an indicator crop in the experiments, viable linkages have been developed with UPR's AID 211(d)-soybean grant and the AID-sponsored INTSOY program. Superior working relationships exist between INTSOY's plant breeder stationed in Puerto Rico, Dr. E. H. Paschal II, which resulted in joint field research of mutual benefit.

North Carolina State University. Dr. L. A. Nelson, Professor of Statistics at NCSU, serves as a permanent consultant to the Benchmark Soils Project for matters of statistics and experimental design.

University of Kentucky. The project subcontracted the University of Kentucky Research Foundation to conduct basic statistical research relative to a model that will provide a satisfactory methodology to verify the concept of soil management knowledge transfers on the basis of soil taxonomic units. (See preceeding section)

Utah State University. The Department of Agricultural and Irrigation Engineering is assisting the project in the design and installation of trickle

irrigation systems. Dr. Jack Keller serves as a consultant and visited the experiment sites in Brazil and Puerto Rico.

Consortium on Soils of the Tropics (CST). The Project has a common goal and works closely with CST. The Principal Investigator is also the UPR representative on the CST Executive Committee.

University of Puerto Rico's AID Grant. The Project is closely linked to and complemented by UPR's 211(d) grant AID/csd-2857 entitled "Classification and Microbiology of Tropical Soils". Under this grant efforts have been initiated to identify and evaluate the advantages and deficiencies of Soil Taxonomy relative to tropical soils. (This state-of-the-art study is carried out with assistance from the sister universities comprised in the Consortium on Soils of the Tropics.) It will also be determined which systems of soil classification are currently used in the tropical countries and how these systems relate to Soil Taxonomy. It is anticipated that the grant will create a keener awareness of the advantageous attributes of Soil Taxonomy among LDC soil scientists which should expedite the utilization of project results.

Informal linkages further exist with CIMMIT, FAO of the United Nations, the Office de la Recherche Scientifique et Technique Outre-Mer (ORSTOM), the Soil Conservation Service of the USDA, and the University of Ghent, Belgium.

G. Utilization-Related Activities

In its current phase, the Project is in the process of generating the field data needed to test the transfer hypothesis. Dissemination of results is, therefore, premature at this time. However, efforts were made to publicize the existence of the Benchmark Soils Project and to create an understanding of its rationales and potential utilization. To date these attempts were directed mainly at the scientific community.

The Benchmark Soils Projects of the Universities of Hawaii and Puerto Rico and the concept of agrotechnology transfer on the basis of soil classification received wide publicity during an international Seminar in the Use of Soil Survey and Classification in Planning and Implementing Agricultural Development in the Tropics held at ICRISAT in Hyderabad, India, in January 1976. The seminar was organized by the University of Hawaii and co-sponsored by the University of Puerto Rico mainly for planners and soil scientists from LDC's in Asia and Africa. It provided opportunities for eighty soil scientists and land use planners from tropical countries in Africa and Asia to report, discuss and learn about the practical usefulness of the U. S. Soil Taxonomy in relating soil classes to crop production and agricultural development. The Principal Investigator presented a paper at this seminar (Beinroth, 1976).

Another paper describing the Project was read at the Fifth Latin American Congress of Soil Science held in Medellin, Colombia, in August 1975 (Beinroth and Spain, 1975). This presentation met with a very favorable response and generated interest in the Project. The Principal Investigator also addressed the Work Planning Conference of the National Cooperative Soil Survey held in Orlando, Florida, in January 1977 in a short exposition of the Project.

Several distinguished scientists and educators who visited the Mayaguez Campus were briefed about the Project and discussed various aspects with the staff. Among the visitors were Dr. O. Anderson, Federal University, Vicosa, Brazil; Dr. E. Barragan, University of Navarra, Spain, Dr. R. Howell, University of Illinois; Dr. A. Leon, CIAT, Colombia; Dr. J. W. Peltason, Chancellor, University of Illinois; Dr. P. Quilt, Overseas Development Ministry of the United Kingdom, Trinidad; Dr. J. M. Scholl, University of Wisconsin; Dr. W. N. Thompson, Director, INTSOY, University of Illinois; Dr. G. F. Walton, Dean, Cook College, Rutgers University; and Dr. K. L. Wells, University of Kentucky.

PROPOSED EXTENSION

I. Purpose and Objectives

The purpose of the proposed three years' extension of the University of Puerto Rico's Benchmark Soils Project from January 1978 through December 1980 is to provide time and funds to achieve the goals and objectives stipulated in the contract. As originally conceived and set forth in the university's proposal of March 15, 1973, the Project was to have a duration of five years. However, subsequent changes in the research design which resulted from the Workshop on Experiment Design, a Workshop on Project Design and Management and the experience gained in the course of the first two years of the Project showed that a minimum of six years is required to adequately establish the validity of the transfer hypothesis.

A three years' extension was, therefore, recommended by the AID-appointed panel which conducted an on-site review of the Project in February 1977. Termination of the Project at the end of 1977 would not only obliterate three years of investigative effort and a considerable capital investment but would, above all, jeopardize the development of what promises to be an effective shortcut to increased food production in the tropics.

The specific objectives of the proposed extension are:

1. To test the hypothesis of agrotechnology transfer,
2. To conduct crop and soil management experiments,
3. To hold a seminar and initiate utilization, and
4. To evaluate criteria of soil classification.

The scope of these objectives and the specific activities required to accomplish them are particularized in the workplans contained in the following section.

II. Workplans

During the current contract period, the Project will have completed its network of experiment sites on Tropeptic Eutrustox. This network will comprise one primary and one secondary site in Isabela, Puerto Rico, and two primary and two secondary sites in Minas Gerais, Brazil.

Field work at these locations and associated laboratory and statistical studies will follow the research design and methodology developed during the first two years of the Project that has been described previously. However, one modification is under consideration for the experiment design of the transfer experiments. Since a trend is becoming apparent that there is no significant response to K in the Eutrustox of both Brazil and Puerto Rico, N will be introduced as a variable instead of K, if the lack of response to K is substantiated.

Close coordination with the parallel project of the University of Hawaii will continue to be a major concern. Equal importance will be given to the strengthening of existing liaisons and the development of new linkages.

The major activities projected for the extension phase are geographically shown on the chart presented as Appendix B2.

A. Objective 1: Test hypothesis of agrotechnology transfer.

The conduct of transfer experiments with maize and soybeans will be continued in the manner described above at the six experiment sites established under the current contract in Puerto Rico and Brazil. A reduced number of variety trials will be carried out to obtain a basis for comparison of the particular varieties used at the Brazil, Hawaii and Puerto Rico sites. By the end of 1980, the experiment results amassed will suffice to allow an adequate statistical test of the transfer hypothesis.

The basic statistical research performed by the University of Kentucky will be continued and completed during the extension phase. This will provide the methodology for the transferability test. An expert in the field of agroclimatology will be consulted to ensure appropriate treatment of the climatic variables.

At achievement of objective 1, the hypothesis of agrotechnology transfer will have been tested. If it is shown that agroproduction technology can be transferred on the basis of soil classification, countries with similar soil resources will be able to share the aggregate of knowledge generated worldwide for the particular soils for overcoming soil management problems. The exchange of information and experience should significantly accelerate optimum utilization of soil resources for increased food production.

2. Activities and schedules

a. Transfer experiments

At each of the six primary and secondary sites of the network, one transfer experiment with maize and one with soybeans will be conducted during each "dry" season and each "wet" season of 1978, 1979 and 1980. The schedule of these experiments as planned for Puerto Rico and Brazil is shown in Appendix B3 .

Including the experiments presently completed (Appendix B1), there will be an accumulated total of 92 transfer experiments completed by December 1980; 36 in Puerto Rico and 56 in Brazil.

Besides evaluating conventional grain yield data, the plant development is closely monitored throughout the experiment. This is accomplished by tissue sampling and analysis, plant height measurements at 30 days and at maturity, and periodic observations of phenological development using a system described by Hanway (1971) and Hanway and Thompson (1971) from emergence to maturity. Total stover

yield and grain yield are determined as well as certain grain yield parameters such as ear weight and length, 100-seed weight, ears per stalk or pods per plant etc. Although pest control measures will be administered as necessary, in the event damages do occur, visual ratings will be made as a measure of their extent. A total of 18,000 plant and soil samples will be collected and analyzed during the extension phase.

b. Variety trials

In addition to the transfer experiments; variety trials will initially be conducted with a number of promising varieties to assure that a well adapted variety is utilized in the transfer experiments at each location. Subsequent trials including only those varieties having been selected for use in transfer experiments, will provide a better basis for the comparison of data from the various locations. In order to make an initial assessment of the varietal potential for responding to applied phosphorus, all variety trials will be of a split-plot design with two levels of phosphorus applied. Variety trials will be planted only at primary sites but will be conducted during both the "wet" and "dry" seasons each year as scheduled in Appendix B3.

Data collection from variety trials will concentrate on grain yield and other agronomic characteristics such as time to maturity, stalk or root lodging and susceptibility to disease and insect attacks.

c. Statistics

The basic statistical research relative to a methodology to test the transfer hypothesis conducted by the University of Kentucky under a subcontract will be continued into the extension phase. It is expected that a preliminary model will have been developed during 1978.

By April 1979 sufficient data from both maize and soybean transfer experiments will be available to make a first approximation of the test of the validity of the agrotechnology transfer concept. A final test of the hypothesis

will be possible by December 1980. Statistical tests for treatment effects will be made for each experiment as the data become available throughout the period of field experimentation.

d. Agroclimatologic Studies

The monitoring of climatologic parameters pertinent to crop production will continue as described in section II.D.1. The climatologic data, crop phenology observations, yields and all other parameters relevant to the development of production models or to the testing of the agrotechnology transfer hypothesis will be entered on standard data cards. The entries will be made in exactly the same manner by both the UPR and UH Benchmark Soils Projects. The accumulated data will be processed by the University of Hawaii's statistics section upon termination of the field experimentation for the Eutrustox family.

In order to ascertain the appropriate evaluation of the climatologic parameters, an authority in agricultural meteorology will be consulted by the Project in 1978.

3. Inputs

The activities under objective 1 require sizeable inputs with regard to work-months of effort on the part of the Principal Investigator, the Senior Agronomist, field agronomists in Puerto Rico and Brazil, a soil and plant analysist and laboratory technicians, statistical and clerical staff, and field laborers. Funds are needed for the salaries of the mentioned professional and non-professional personnel, consultant services of a statistician and agrometeorologist, a sub-contract with the University of Kentucky, site leases, analytical services by the University of Hawaii, field and laboratory equipment, agricultural and laboratory supplies and materials, office and statistical supplies and materials, utilities, computer time, shipping costs, and travel and per diem for supervision and coordination.

B. Objective 2: Conduct crop and soil management experiments.

1. General

Management experiments will be designed to develop information on management practices requiring low capital and low energy inputs. The main variables to be studied in experiments with maize and soybeans will be irrigation, tillage and fertilizers. Other commodities and practices may be added if the host country so desires.

The data of the management experiments will complement and enhance the information obtained through the transfer experiments. In conjunction with the results of fifty years of agronomic research available for the primary site at the Isabela Agricultural Experiment Station in Puerto Rico and the work conducted by EPAMIG at the site in Jaiba, Brazil, the findings of the management experiments will constitute a sizeable package of transferable technology.

2. Activities and schedules

a. Field experiments

Line source sprinkler experiments with maize for continuous variable irrigation-crop production studies as designed by Hanks et al (1976) are schedules for the next several cropping seasons in both Brazil and Puerto Rico. The levels of applied water will range from zero to that quantity required to maintain soil moisture at or near optimum. Soil moisture will thus range from near optimal to the natural level provided by rainfall. In order to generate sufficient data to allow reliable conclusions, it is considered that at least three years of data be obtained during the 'wet" season at each location. These "wet" season experiments will provide information required for making economic decisions as well as for soil classification verification. Conducting similar experiments during the "dry" season, results

in more complete control of soil moisture levels, as most of the water reaching the soil will be that prescribed in the experiment design. Irrigation experimentation during that season will be designed to give more detailed information as to requirements of the crops during their various critical stages of development as well as water application sc[illegible]les.

Field experiments designed to evaluate phosphorus application techniques such as banding vs. broadcasting are planned for the 1977-78 cropping seasons. Further experimentation in the areas of crop and soil management will include residual P and tillage studies and others that will depend on the results of the above experiments, problems that are seen during the conducting of transfer and variety trials, and host country interests and support.

b. Statistics and data interpretation

Statistical tests of significance of treatment effects will be made by the UPR Agricultural Experiment Stations' Statistics Section at Rio Piedras. These tests and their interpretation will be accomplished as experiments are completed and the data become available. Running progress summaries of results will be prepared. When sufficient data are accumulated to permit conclusions to be drawn with confidence, information and recommendations will be disseminated in various forms to facilitate maximum utilization.

3. Inputs

The inputs required for this objective are the same in kind as those enumerated under objective 1 but less in magnitude. The conduct of management experiments will add relatively little to the overall cost of establishing and operating the primary sites.

C. Objective 3: Hold a seminar and initiate utilization.

1. General

Although utilization per se is beyond the scope of the present Project, considerable efforts will be made during the extension phase to facilitate future utilization. These concerns will be focused on creating an awareness and understanding of the principles and concepts involved in the Benchmark Soils Project and to instigate their acceptance, and on initiating the development of an infrastructure conducive to effective transfers.

Prominent among the activities contemplated is an international seminar on soil classification and agrotechnology transfer to be held in Latin America in 1979. As detailed in the following workplans, other activities include the development of an information and reference center, the publication of a newsletter, and the dissemination of Project results through published reports and technical papers.

2. Activities and schedules

a. An international seminar to disseminate Project principles and results among soil scientists and land use planners of Latin America will be conducted in 1979. Tentatively, this seminar is entitled "Agrotechnology Transfer via Soil Classification" and will be held at CIAT in Colombia. It will be similar to the seminar held at ICRISAT in 1976 in that 30 to 40 participants from various countries will be invited and that proceedings will be published.

The seminar is scheduled for the spring of 1979. By that time sufficient experimental data will be available to allow a first approximation of the transfer hypothesis.

b. In an effort to relate crop production experience to soil families, the soil of the major agricultural experiment stations of tropical America will be analyzed and classified according to Soil Taxonomy. This will identify transferable information by soil families.

The soil characterization study will be initiated in 1979 after the international seminar has stimulated interest in the concepts of the Benchmark Soils Project.

c. The analytical and environmental data will be coded and entered into the Soil Data Bank developed by the University of Hawaii. Key soils of tropical America can thus be readily related to similar soils elsewhere in the tropics.

These activities will be carried out simultaneously with the soil characterization efforts in 1979.

d. Jointly with the University of Hawaii, a quarterly newsletter informing about the Benchmark Soils Projects will be published and distributed in tropical America. Other publications including progress reports, research articles and utilization materials will be prepared to divulge Project results and to encourage utilization of the concepts of the Benchmark Soils Project.

e. In order to take maximum advantage of available experience, the farm practices and results of experiment stations on the same kinds of soils near the Project sites will be recorded and fed into the data processing system. A similar attempt will be made to gather data from the surrounding farmer fields.

f. The national institutions will be encouraged to become involved in Project operations to the greatest possible extent so as to facilitate logistic support and to ensure a long term continuation of the research and trials even after AID support is terminated.

These utilization-related activities will be conducted throughout the extension phase but will be intensified in the latter two years.

3. Inputs

The seminar on "Agrotechnology Transfer via Soil Classification" will require considerable inputs in terms of man-months of effort by the Principal Investigator and other professional and clerical Project staff. Funds are needed for travel and per diem for the organizers and invited participants, simultaneous translation, and preparation and publication of the proceedings. The soil characterization and data processing activities will involve the efforts of the Principal Investigator, a soil chemist and laboratory technician, and a statistical assistant. Financial support will be needed for travel and per diem for soil sampling and data collection, laboratory equipment, and materials. The dissemination and utilization documents will be prepared by senior and clerical Project staff and will necessitate funds for salaries, printing costs and communication expenses.

D. Objective 4: Evaluate criteria of soil classification.

1. General

Soil Taxonomy is the most detailed, comprehensive system of soil classification developed to date and incorporates and reflects the present state of knowledge about soils. The knowledge about tropical soils, however, is still incomplete and the classification of these soils, particularly Oxisols, is consequently less refined than that of soils of the temperate region. The criteria and definitions of Oxisols are, therefore, still subject to change and improvement and it is likely that some relevant deficiencies will be identified in the course of the Project.

The experiment sites established by the Project in Tropeptic Eutrustox of the clayey, kaolinitic, isohyperthermic family sample the range permitted

in this family as regards to certain parameters important to plant growth. The present criteria and definitions can, therefore, be analyzed with respect to their relevance and appropriateness for agricultural interpretations.

The research proposed under objective 4 relates closely to similar studies but of broader scope conducted by the University of Puerto Rico under an AID 211(d) grant. The combined project and grant results should further increase the value of Soil Taxonomy for agrotechnology transfers in the tropics.

2. Activities and schedules

a. The range in value of those classification criteria that are important to plant growth will be determined for surface and subsurface soil horizons for all primary and secondary sites of the network. The parameter to be studied include soil texture, pH value and degree of base saturation. These variables will be correlated by multiple regression analyses with crop yield data from plots with equal fertility treatments of the transfer experiments.

The necessary analytical characterizations will commence in 1978; the statistical analysis and its evaluation will be completed by 1980.

b. The ustic soil moisture regime as defined in Soil Taxonomy will be scrutinized with respect to its propriety for agroproduction interpretations on the basis of climatic considerations and the results of the management experiment. It appears that the present definition is too broad and does not adequately distinguish between ustic soil moisture regimes in maritime and continental ecosystems.

This study will be initiated in 1979 and the conclusions will be finalized during the extension phase.

c. The definition of the Tropeptic subgroup of Eutrustox will be evaluated from pedologic and agronomic points of view. It is felt that a refinement of the present definition would enhance the value of Soil Taxonomy for purposes of

agricultural interpretations and knowledge transfers. Relevant recommendations for changes will have been formulated by 1980.

3. Inputs

Funds will be required mainly for the salaries of the Principal Investigator, a soil chemist and laboratory technician, statistical and agro-climatological consultants, and a statistical assistant. Additional funds are needed for laboratory and statistical materials and for computer time.

III. Overall Cost Estimate

The estimated cost of the proposed three years' extension is $1,202,900. Budget information supporting this estimate is provided on three appended tables. Appendix C2 contains an analysis of the costs by budget categories and line items.

The cost estimates are based on the experience gained during the first two years of the Project. Since the majority of the activities projected for the extension phase are a continuation of the work presently in progress, these estimates are realistic.

Approximately $45,000 will be required to organize and conduct an international seminar on agrotechnology transfer in Latin America. A large portion of this amount will be for travel and per diem for invited participants. This activity is an essential component of the utilization-related part of the Project extension as discussed under objective 3 above.

The proposed budget is as follows:

Budget Category	1978	1979	1980	Total
Salaries & Wages	159,000	167,500	174,700	501,200
Consultants	3,500	4,000	3,500	11,000
Fringe Benefits	27,030	28,475	29,700	85,205
Overhead Costs	83,050	96,845	101,100	280,995
Travel & Subsistence	19,500	51,000	27,500	98,000
Equipment, Vehicles, Supplies & Services	78,100	64,100	57,300	199,500
Publication Costs	3,500	9,000	4,500	17,000
Subcontracts	10,000	--	--	10,000
Total	383,680	420,920	398,300	1,202,900

IV. Plans beyond 1980

As shown on the chart on Appendix B2 all field experiments will have been completed during the first extension of the Benchmark Soils Project. However, a second extension with a reduced level of funding but of major importance to the attainment of the goals of the Project will be required to bring the Project to fruition. The second extension will have two objectives: First, to complete the theoretical part of the transferability test and, second, to create a suitable infrastructure to expedite agroproduction technology transfers within and to tropical America.

In 1981 the Project will have tested the postulated hypothesis of agro-technology transfer on the strength of six years of field experimentation and associated statistical research. The results of these efforts are expected to provide a sound basis for the activities contemplated for the Project's second extension.

These activities can be summarized as follows:

1. Complete the theoretical test of and develop a model for the transfer of agroproduction technology on the basis of soil taxonomic units.
2. Formulate recommendations on the management of Tropeptic Eutrustox on the basis of information obtained from the transfer, variety and management experiments.
3. Prepare a comprehensive final report on the Benchmark Soils Project and develop utilization materials.
4. Continue analysis and classification of the soils of all major agricultural experiment stations in tropical America according to Soil Taxonomy, the FAO Legend and the French Soil Classification System, and characterize environmental conditions.
5. Compile and cross-index pertinent crop production information from these stations and establish a reference center for agronomic research in tropical America by families of Soil Taxonomy.
6. Identify the major soil resources of all countries in tropical America by classes of Soil Taxonomy.
7. For each country in tropical America, prepare a worldwide of agricultural experiment stations that have soils corresponding to the soil resources identified under (5).
8. Instigate the utilization of this information by motivating scientists and decision makers in individual countries to capitalize on the crop production knowledge gained elsewhere.
9. Assist LDC agronomist in tropical America in conducting research to adapt the information generated in similar soils and ecosystems in other countries to local conditions.

V. Special Terms and Conditions

a. Role of Women:

The project will arrange, whenever feasible, for participation of women in operating capacities in contract activities; e.g., in administrative and technical staffs to be utilized in carrying out related project objectives. These actions would serve to demonstrate the role of women to the LDCs.

b. Initial Environmental Examination (IEE)

The entire intent of this project is to research and develop techniques for wiser careful management of resources. The activities of this project fall into the area described as "Analyses, studies, academic and investigative research, workshops and meeting" and thereby do not require the filing of an Environmental Impact Statement or the preparation of an Environmental Assessment.

The general effect of the contract should enhance AID's capacity to help LDCs make sound environmental decisions regarding land and water resource planning and utilization. The positive environmental impact would be gained through better appreciation of the potential of the upland soils, their high production capacity when properly managed and knowledge of the ease with which this potential can be irreversibly lost through mismanagement. The concept of the project suggests that it will be possible to disclose or predict potentially adverse consequences of given lines of agronomic activity that can be guarded against on upland soils.

VI. Internal and External Evaluation

At TA/AGR's request, an on-site review of the contract was conducted by a panel in Brazil and Puerto Rico during Febraurv 1977. The three-man panel consisted of the Team Leader, Mr. William M. Johnson, Deputy Administrator, Technical

Services (Soil Survey and Field Services), Soil Conservation Service, U.S. Department of Agriculture; Dr. R. Dudal, Director, Land and Water Development Division of the Food and Agriculture Organization of the United Nations, in Rome, Italy; and Mr. J. R. Moffett, Food and Agriculture Officer, USAID, LaPaz, Bolivia.

The panel commended the project leadership for developing a clear linkage between this project and the University of Hawaii's project TA-c-1108 as well as UPR's 211-d soil classification grant, AID/csd-2857. They commended the leadership for organizing a soil classification conference to be held in Brazil in June 1977, which should result in substantial advances in the classification of soils of the tropics. The panel noted that the project leadership has also developed a commendable working relationship with EMBRAPA, the Brazilian national agency in-charge of agricultural research and EPAMIG, the Project collaborating agency in the State of Minas Gorais.

The panel recommended that the project be approved for continuation for another three years after the initial period is completed. It suggested that emphasis be given in future activities to consolidation of the experimental work in progress and establishment of another site, preferably in Brazil. It recommended that a workshop be held in Latin America about mid-1978 to disseminate project results and to promote awareness of the value of soil classification for technology transference.

TA/AGR concurs with the panel recommendations.

At the initial review of the project during 1973, RAC recommended that a workshop review the project design. The workshop entitled, "Experimental Designs for Predicting Crop Productivity with Environmental and Economic Inputs" was held in Hawaii during May 1974. As a result the project has an efficient experimental design. The project continues to consult with outside experts on the

statistical analysis of the hypothesis. During December 1975 the Contractor with the help of an AID Consultant developed a comprehensive work plan schedule which has helped them to predict more efficiently manpower and budget needs in relation to activities and outputs over the projectd period.

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AID1020 2802 7/73

PROJECT DESIGN SUMMARY
LOGICAL FRAMEWORK

Life of Project:
From FY 1978 to FY 1980
Total U. S. Funding $1,202,900
Date Prepared: 3-22-77

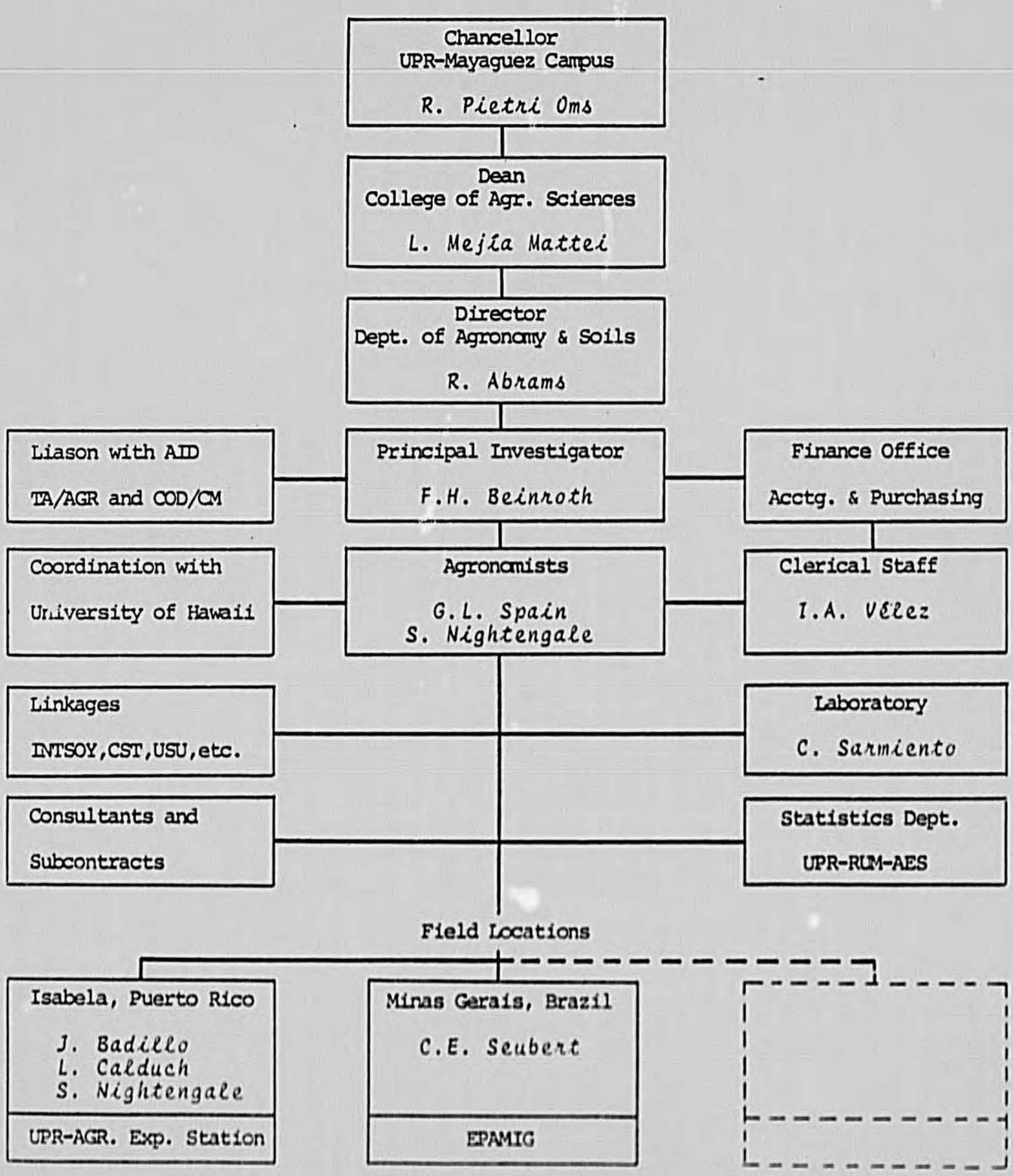
Project Title: Crop Production and Land Potential of Benchmark Soils of Latin America, AID/ta-c-1158

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Program or Sector Goal: The broader objective to which this project contributes: 1. To increase quantity and improve quality of food production for the rural and urban underprivileged in tropical LDC's 2. To reduce time and cost of agricultural experimentation, and to accelerate agricultural planning and development in LDC's through agrotechnology transfers	Measures of Goal Achievement: 1-2. Transfer model utilized by LDC's LDC utilization of Soil Data Bank Agrotechnology transfers effectuated	1-2. National surveys AID Missions Soil Data Bank records Communication with goverment institutions	Assumptions for achieving goal targets: 1-2. Agrotechnology transfer hypothesis proven Transfer model widely accepted Soil Data Bank functional and utilized
Project Purpose: 1. Test agrotechnology transfer hypothesis 2. Conduct crop and soil management experiments 3. Evaluate Soil Taxonomy 4. Facilitate utilization through seminar and Soil Data Bank	Conditions that will indicate purpose has been achieved: End of project status. 1. Hypothesis of agrotechnology transfer tested 2. Experiments completed 3. Criteria of Soil Taxonomy analyzed 4. International seminar conducted, participants motivated, key soils analyzed	1-3. Annual reports, on-site reviews, newsletters, records and data of experiments 4. Seminar proceedings, utilization materials, entries in Soil Data Bank, communication with individuals and institutions in LDC's	Assumptions for achieving purpose: 1. Principles of Soil Taxonomy valid 2. Suitable management practices conceivable and feasible 3. Deficiencies identifyable 4. Project concepts and principles accepted
Outputs: 1. Data to test agrotechnology transfer hypothesis 2. Model for agrotechnology transfer 3. Data for crop and soil management recommendations 4. Data for soil classification evaluation 5. Data for Soil Data Bank 6. Soil scientists and planners informed about project	Magnitude of Outputs: 1. Data from 129 experiments at 6 sites 2. Transfer model for universal use 3. Data from 41 experiments at 3 sites 4. Soil and climatic data from 6 sites 5. 15 pedons 6. 40-60 individuals from LA	1-6. Project records, annual reports, experimental records, technical papers, newsletters, on-site visits, Soil Data Bank	Assumptions for providing outputs: 1. No unusual wather conditions 2. Adequate statistical model conceivable 3. Local fatmers and institutions willing and able to provide inputs 4. Adequate soil and climatic data 5. Cooperation of LA experiment stations 6. Sufficient number of seminar participants
Inputs: University of Puerto Rico 1. Professional staff 2. Technical and administrative staff 3. Field, office, laboratory, computer and library facilities; administrative services EPAMIG, Brazil 4. Professional staff and counterpart 5. Nonprofessional staff 6. Land, office and lab. facilities AID 7. Financial support 8. Project management, TAB/AGR	Implementation Target (Type and Quantity) 1. 217 man-months 2. 306 man-months 3. Adequate for project 4. 36 man-months 5. 252 man-months 6. Rentals and purchasing 7. $1,202,900 in 3 years 8. Adequate	1-6. Project records, annual reports, on site reviews, newsletters 7-8. AID and contractor records UPR Finance Office records	Assumptions for providing inputs: 1-2. Qualified personnel available on continuing basis 3. UPR facilities and services accessible to project 4-6. EPAMIG willing and able to cooperate 7-8. AID funding and project management provided

Appendix A1

University of Puerto Rico - Benchmark Soils Project

ORGANIZATION CHART



Appendix A2

Personnel Employed by Benchmark Soils Project

Name	Title	Project Position Responsibilities
Home Office Professional		
F. H. Beinroth, Ph. D.	Professor	Principal Investigator Administration and fiscal management of Project, liaison with AID/W, Univ. of Hawaii and cooperators; pedologic aspects and site selection
G. L. Spain, Ph. D.	Assoc. Professor	Senior Agronomist Planning, design and organization of field experiments; coordination and supervision of field work in the UPR network; coordination with Univ. of Hawaii; data organization and processing
L. C. Sarmiento, MS.	Ass't. Professor	Chemist In charge of analytical laboratory, soil and plant analyses
L. Costa Mayoral, BS.	Research Ass't.	Research Assistant Soil and plant analyses
J. A. Vega López, BS.	Research Ass't.	Research Assistant Soil physical analyses
Home Office Nonprofessional		
I. A. Vélez	Secretary	Secretary Clerical work, typing and accounting
- - - - -	Grad. Students	Student help Routine laboratory assistance

Field Staff Professional		
J. Badillo, Ph.D.	Assoc. Agronomist	Project Leader, Isabela Sites Conduct and supervision of field experiments
S. P. Nightengale, MS.	Ass't. Agronomist	Ass't. Project Leader, Isabela Sites Conduct and supervision of field experiments, data organization and processing, liaison with Senior Agronomist
L. Calduch, BS.	Research Ass't.	Research Assistant, Isabela Sites Conducting field experiments, supervision of laborers, data collection
C. E. Seubert, M. S.	Ass't. Agronomist	Project Leader, Brazil Sites Planning, design and conduct of all experiments in Brazil; administration of Brazil operations; liaison with EPAMIG
Field Staff Nonprofessional		
F. Mercado Badillo	Research Aide	Field Aide, Isabela Sites Assistance in all phases of field work; maintenance of experiments
N. de Sa	Research Aide	Field Aide, Jaiba Sites, Brazil Assistance in all phases of field work; maintenance of experiments
M. A. Caldeira Torres	Research Aide	Field Aide, Jaiba Sites, Brazil (ditto)
- - - -	Laborers	Field Laborers, Isabela and Brazil Sites

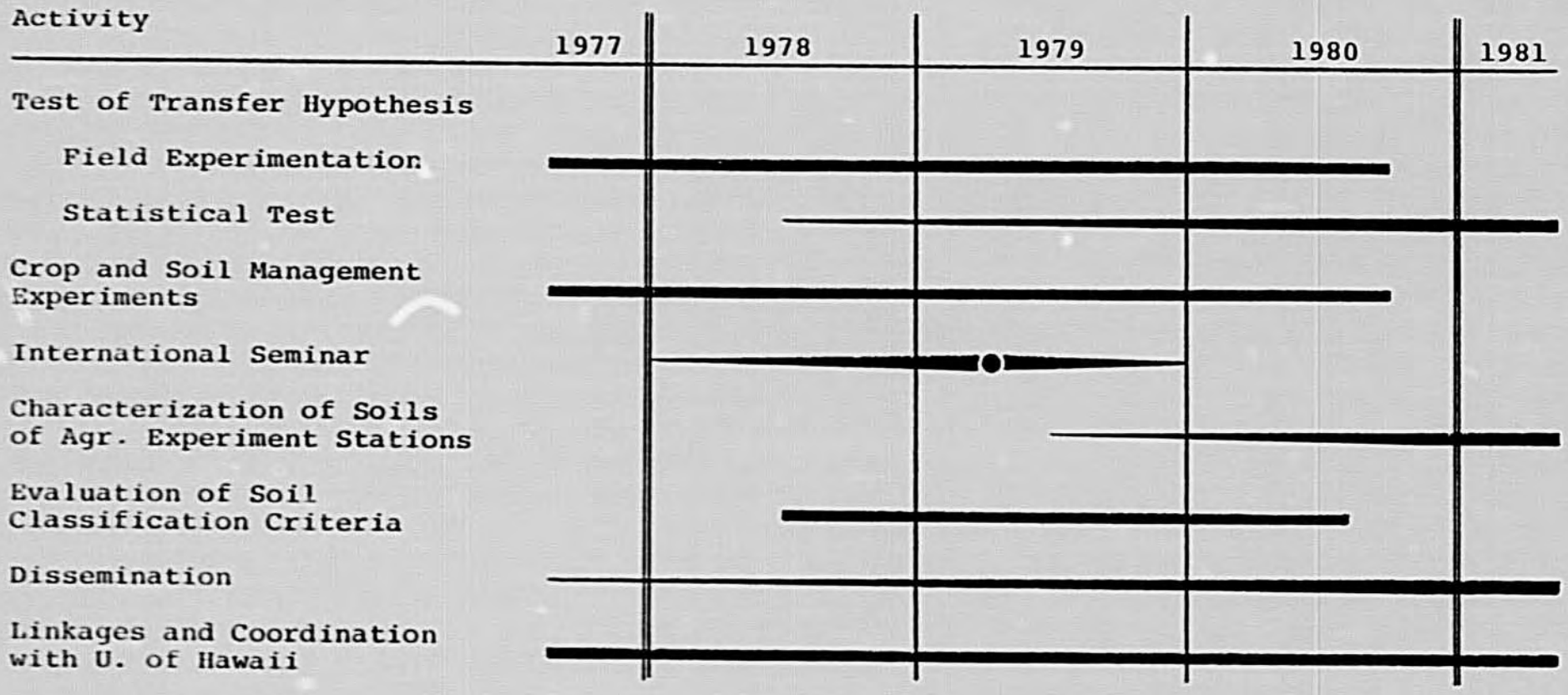
Appendix B1

Schedule of Experiments Completed by December 1977

Experiments		1975	1976		1977
Puerto Rico	Primary Site				
	Uniformity	Soybean			
	Transfer		Soybean	Soybean	Soybean
	Transfer		Maize	Maize	Maize
	Variety		Maize (2)		Maize
	Management		Soybean (2)		
	Management				Maize
	Secondary Site				
	Transfer		Soybean	Soybean	Soybean
	Transfer		Maize	Maize	Maize
Brazil	Primary Sites				
	Transfer			Maize	Maize
	Transfer			Soybean	Soybean
	Variety			Maize	Maize
	Variety			Soybean	Soybean
	Management			Maize (2)	Maize
	Management			Soybean	
	Secondary Sites				
	Transfer				Maize
	Transfer				Soybean

Appendix B2

Schedule of Major Activities during Project Extension



Appendix B3

Schedule of Experiments Projected for Completion by December, 1980

Experiments	Puerto Rico					Brazil					Combined Totals
	1976-77	1978	1979	1980	Country Totals	1976-77	1978	1979	1980	Country Totals	
Primary Sites											
Transfer											
Maize	3	2	2	2	9	2	4	4	4	14	23
Soybean	3	2	2	2	9	2	4	4	4	14	23
Variety											
Maize	3	2	2	2	9	2	4	4	4	14	23
Soybean	0	0	0	0	0	2	4	4	4	14	14
Management											
Maize	2	3	3	3	11	3	3	3	3	12	23
Soybean	2	2	2	2	8	1	3	3	3	10	18
Secondary Sites											
Transfer											
Maize	3	2	2	2	9	2	4	4	4	14	23
Soybean	3	2	2	2	9	2	4	4	4	14	23
Totals	19	15	15	15	64	16	30	30	30	106	170

Appendix C 1

BUDGET SUMMARY -- Estimated Costs by Years and Totals

Budget Category	1978	1979	1980	Total
Salaries & Wages	159,000	167,500	174,700	501,200
Consultants	3,500	4,000	3,500	11,000
Fringe Benefits	27,030	28,475	29,700	85,205
Overhead Costs	83,050	96,845	101,100	280,995
Travel & Subsistence	19,500	51,000	27,500	98,000
Equipment, Vehicles Supplies & Services	78,100	64,100	57,300	199,500
Publication Costs	3,500	9,000	4,500	17,000
Subcontracts	10,000	-	-	10,000
TOTAL	383,680	420,920	398,300	1,202,900

Appendix C 2

Analysis of Costs for Extension Proposal
(Budget categories according to form AID 1420-18)

Budget Category	1978		1979		1980		TOTAL
	Man Months	Est. Cost	Man Month	Est. Cost	Man Month	Est. Cost	
I. Salaries							
A. U. S. Personnel							
1. Home Office Professional							
Principal Investigator	9	18,000	9	19,000	9	19,700	
Senior Agronomist	12	18,500	12	19,200	12	19,800	
Assoc. Soil Chemist	3	4,000	3	4,300	3	4,500	
Research Assistant	12	9,000	12	9,400	12	9,700	
Statistician	3	4,500	3	4,700	3	4,900	
Economist			3	4,600	3	4,800	
Home Office Professional	39	54,000	42	61,200	42	63,400	
2. Home Office Nonprofessional							
Secretary	12	6,000	12	6,400	12	6,800	
Typist	6	2.200	12	4,800	12	5,200	
Lab. technician	12	4,400	12	4,800	12	5,200	
Student help	6	3,000	6	3,200	6	3,400	
Home Office Nonprofessional	36	15,600	42	19,200	42	20,600	

3. Field Staff Professional							
Assistant Agronomists	22	27,200	18	22,700	18	23,600	
Research Assistant	12	9,400	12	9,600	12	9,800	
Field Staff Professional	34	36,600	30	32,300	30	33,400	
4. Field Staff Nonprofessional							
Field technician	12	6,200	12	6,500	12	6,800	
Field laborers	50	22,000	50	22,500	50	23,000	
Field Staff Nonprofess.	62	28,200	62	29,000	62	29,800	
Total U. S. Salaries	171	134,400	176	141,700	176	147,200	423,300
B. Third Country Nationals							
1. Field Staff Professional							
Research Assistant	12	8,500	12	8,500	12	9,000	
Field Staff Professional	12	8,500	12	8,500	12	9,000	26,000
2. Field Staff Nonprofessional							
Field technician	24	10,100	24	10,500	24	11,000	
Field laborers	60	6,000	60	6,800	60	7,500	
Field Staff Nonprofess.	84	16,100	84	17,300	84	18,500	51,900

Budget Category	Estimated Cost						
	1978		1979		1980		Total
Total Third Country Nat.	96	24,600	96	25,800	96	27,500	77,900
Total Salaries	267	159,000	272	167,500	272	174,700	501,200
II. Consultants							
Statistician		2,000		2,000		2,000	
Agrometeorolcgist		500				500	
Irrigation Specialist		1,000					
Fao Expert						1,000	
Editor				2,000			
Total Consultants		3,500		4,000		3,500	11,000
III. Fringe Benefits (17%)		27,030		28,475		29,700	85,205
IV. Overhead							
On campus (55%)		75,350		91,245		95,150	
Off campus (35%)		7,700		5,600		5,950	
		83,050		96,845		101,100	280,950

V. Travel and Subsistence				
A. Domestic travel	4,500	4,200	3,500	12,200
B. International travel				
Location travel	6,500	4,300	6,000	
Supervision	3,200	3,300	3,300	
Coordination meeting	1,700	7,000	6,000	
Soil sampling		2,500	4,500	
International Seminar		25,000		
Training course		2,000		
Other travel	1,000	2,000	1,000	
International travel	12,400	46,100	20,800	79,300
C. Consultant travel	2,600	700	2,200	5,500
Total Travel and Subsistence	19,500	51,000	26,500	97,000
VII. Publication Costs	3,500	9,000	4,500	17,000
VIII. Equipment, Vehicles, Materials and Supplies				
A. Expendable equipment				
Books, maps, periodicals	1,200	1,200	1,200	3,600

B.	Non-expendable equipment			
	Office equipment	2,000	2,000	500	
	Laboratory equipment	4,000	3,000	2,500	
	Agric. equipment	2,500	2,000	2,000	
	Climatologic equipment	1,500	1,500	1,500	
	Irrigation equipment	8,000	3,000	1,500	
	Non-expendable equipment	18,000	11,500	8,000	37,500
C.	Materials and supplies				
	Office supplies	2,200	3,000	1,200	
	Laboratory supplies	6,000	6,000	6,000	
	Agric. supplies	8,000	7,000	7,000	
	Irrigation supplies	6,000	6,000	4,000	
	Fencing and storage fac.	4,000	800	800	
	Gasoline and utilities	11,000	10,000	10,000	
	Analytical services	5,000	5,000	6,000	
	Rentals	1,700	1,600	1,600	
	Other supplies and services	6,000	8,000	5,500	
	Materials and supplies	49,900	47,400	42,100	139,400
D.	Vehicles	3,000			3,000
E.	Freight Costs	6,000	4,000	6,000	16,000
	Total Equipment and Materials	78,100	64,100	57,300	199,500
X.	Subcontracts	10,000			10,000
	TOTAL COST	383,680	420,920	398,300	1,202,900

PROJECT APPRAISAL REPORT (PAR)

1. PROJECT NO.	2. PAR FOR PERIOD:	3. COUNTRY	4. PAR SERIAL NO.
AID/ta-c-1158	1/75 TO 2/77	Worldwide	

5. PROJECT TITLE "Crop Production and Land Capability of Benchmark Soils in Latin America"

6. PROJECT DURATION: Began FY 1975 Ends FY 1978	7. DATE LATEST PROP	8. DATE LATEST PIP	9. DATE PRIOR PAR

10. U.S. FUNDING	a. Cumulative Obligation Thru Prior FY: $ 380,000	b. Current FY Estimated Budget: $ 420,000	c. Estimated Budget to completion After Current FY: $ --

11. KEY ACTION AGENTS (Contractor, Participating Agency or Voluntary Agency)

a. NAME	b. CONTRACT, PASA OR VOL. AG. NO.
University of Puerto Rico	AID/ta-c-1158

I. NEW ACTIONS PROPOSED AND REQUESTED AS A RESULT OF THIS EVALUATION

A. ACTION (X) USAID	AID/W	HOST	B. LIST OF ACTIONS	C. PROPOSED ACTION COMPLETION DATE
	TA/AGR		1. Accept the Review Panel's report and recommendations.	4/77
	TA/AGR		2. Recommend that the contract be revised and extended for a period of three years in accordance with this PAR.	
		UPR	3. The University administration and the principal investigator take prompt steps with regards to PAR items b through f, which are detailed in the panel recommendations (panel report pp. 17-19).	

D. [illegible] REVISED [illegible] ☐ PROP ☐ [illegible] ☐ [illegible] ☐ [illegible] ☐ PIO/T ☐ [illegible] | E. DATE OF [illegible] 4/12/77

PROJECT [illegible]	[illegible]	[illegible]
Tejpal S. Gill	[illegible]	Leon F. Hosner

No.	Item	Recommendation	TA/AGR Position
a	Project extension	Extend the project for another 3 years to realize its objective	Concurs
b	Administrative support and services	UPR strengthen its support and services to the project	Concurs
c	Technical Management	UPR pay closer attention to the field and laboratory work	Concurs
d	Project design	Implement suggestions made on pages 18-19 of the report	Concurs
e	Workshop	Hold a workshop about mid-1978 to promote project-awareness	Concurs
f	Involvement with National Institutions	Encourage involvement to the greatest possible extent to facilitate logistic support and to ensure long term continuation of the project	Concurs

PROJECT APPRAISAL REPORT - PART III NARRATIVE

Research Contract entitled "Crop Production and Land Capability of Benchmark Soils in Latin America", with the University of Puerto Rico, AID/ta-c-1158.

An on-site review of the contract was conducted by a panel in Brazil and Puerto Rico during the period February 13 to February 23, 1977. TA/AGR is satisfied with the professional objectivity of the panel and the cooperation of the University of Puerto Rico in the conduct of the review. The panel report is attached.

The panel commended the project leadership for: developing close working relationship between the University of Puerto Rico and the University of Hawaii especially with respect to centralized processing of experimental data; developing a clear linkage between this project and the UPR 211-d soil classification grant (AID/csd-2857) with resulting benefits to both; and organizing a soil classification international conference in Brazil in June 1977 which should result in substantial advances in classification of soils of the tropics.

The panel noted with satisfaction the excellent cooperation to the project that is being provided by the principal Brazilian entity, Empresa de Pesquisa Agropecuaria de Minas Gerais (EPAMIG). Both the administrative staff as well as the technical staff of this entity showed a very high level of interest in and knowledge of the project and have been very supportive of the site activities that are being conducted there. Despite the limited size of the USAID mission in Brazil, it has been and continues to be very supportive of the project activities.

The potential value of the transfer mechanism being tested is considered by the panel to warrant an effort by the project leadership to sensitize agricultural planners and soil scientists in the LDCs of Latin America and keep them appraised of the related developments.

The panel made a number of recommendations to TA/AGR for consideration and possible action. These are stated briefly in the following table with corresponding TA/AGR position notations.

ON-SITE REVIEW AND EVALUATION

Benchmark Soils Research Project

Department of Agronomy and Soils

College of Agricultural Sciences

University of Puerto Rico - Mayagüez

Contract No. AID/ta-c-1158

March 1977

Report Prepared by

William M. Johnson, SCS/USDA
R. Dudal, FAO
J. Robert Moffett, USAID/Bolivia

FOREWORD

The Review Panel appreciates the assistance of the University of Puerto Rico Benchmark Soils Research Project research team in Puerto Rico and in Brazil, personnel of the Servicio Nacional de Levantamento e Conservaçao de Solos (SNLCS) of the Empresa Brasileira de Pesquisa Agropecuaria (EMBRAPA), and personnel of the Empresa de Pesquisa Agropecuaria de Minas Gerais (EPAMIG) in collecting the information needed for this report. The many courtesies provided, and the careful preparations and arrangements made for the Review are greatly appreciated.

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VIII.	References	20
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LIST OF APPENDICES

A. Review Panel Schedule

B. Review Outline - Benchmark Soils Research Project

C. International Seminar on Uses of Soil Survey and Classification in Planning and Implementing Agricultural Development in the Tropics - excerpts from program.

ON-SITE REVIEW AND EVALUATION
BENCHMARK SOILS RESEARCH PROJECT
UNIVERSITY OF PUERTO RICO

Department of Agronomy and Soils
College of Agricultural Sciences
University of Puerto Rico - Mayagüez

Contract No. AID/ta-c-1158

March 1977

I. INTRODUCTION

A Review Panel consisting of William M. Johnson, Team Leader; R. Dudal; and J. Robert Moffett conducted an on-site review, with related conferences, of the Benchmark Soils Research Project in Brazil and Puerto Rico in February 1977. Mr. Johnson is Deputy Administrator, Soil Conservation Service, U. S. Department of Agriculture, where he has charge of Technical Services (including Soil Survey and Field Services). Dr. Dudal is Director, Land and Water Development Division of the Food and Agriculture Organization of the United Nations, in Rome, Italy. Mr. Moffett is Food and Agriculture Officer, USAID, in La Paz, Bolivia.

In addition, Dr. Tejpal Gill, Senior Program Manager, TAB/AGR, USAID, the Project Monitor, accompanied the Review Panel throughout the entire review in Brazil and Puerto Rico. The Project Principal Investigator, Dr. Fred Beinroth, also participated in the field conference and all of the on-site review activities both in Brazil and Puerto Rico.

The Review Panel and Drs. Gill and Beinroth assembled in Rio de Janeiro on Sunday, 13 February 1977. An entry conference was held, during which there was discussion of the objectives of the review, the review outline, and plans for the field excursion in Brazil.

The review party met with EMBRAPA officials at the headquarters of the Servicio Nacional de Levantamento e Conservaçao de Solos (SNLCS) in Rio de Janeiro.

The review party travelled northward to Jaíba, accompanied by scientific workers of SNLCS and the State of Minas Gerais. The on-site review was conducted on and near the agricultural experiment station operated by the Empresa de Pesquisa Agropecuaria de Minas Gerais (EPAMIG). A representative of the Federal University at Viçosa participated in the review, as did the Benchmark Soils Research Project Leader for Brazil Sites, Mr. Chris Seubert. In addition, ongoing research at two nearby research stations was reviewed and discussed with resident scientists. A technical seminar which included discussion of the Project design and objectives was held at EPAMIG headquarters in Belo Horizonte.

The review party next travelled on to Mayagüez, Puerto Rico. One day was spent examining the Project office and laboratory facilities at the University of Puerto Rico and in field review of experimental sites at the Isabela Agricultural Experiment Substation. Another day was devoted to discussions of project design, operations, and results with the principal investigator and project agronomist and in writing parts of the review report.

The review concluded with a discussion of findings and recommendations with the University of Puerto Rico staff in Mayagüez. The Panel assessed the Project design, status, progress, accomplishments and management. Recommendations were made on many aspects of the current and future project activities.

PROJECT TITLE

The full title of the project is "Crop Production and Land Capability of Benchmark Soils of Latin America." Throughout this report it will be referred to as the Benchmark Soils Project.

PROJECT OBJECTIVES

(1) To correlate food crop yields on a network of tropical benchmark soils.

(2) To determine scientifically the transferability of agroproduction technology among tropical countries.

PURPOSE OF 1977 ON-SITE PROJECT REVIEW

The purpose of the review was to assess the status and progress of the research in order to (a) facilitate the achievement of Project objectives; (b) to assist TAB/AGR in improved management of the Project, and (c) to help AID in utilization of the Project outputs for the benefit of LDC's. In addition, TAB/AGR required recommendations for future programming in respect to this project. With these objectives in mind, the Panel prepared a review outline in advance of the field trip (See Appendix B).

REFERENCE DOCUMENTS

Dr. Gill provided background papers to all the Panel members prior to the beginning of the review. These documents are:

a. The original AID Project Statement approved May 10, 1973.

b. Project review report - RIGC (4/23/76).

c. Copy of the RAC minutes of May 9-10, 1973, dealing with the Project.

d. Copy of Benchmark Soils Project Report No. 1 on experimental designs for predicting crop productivity.

e. Project Scope of Work statement (undated).

g.-f. Project progress reports June 1975 and June 1976.

h. Copy of paper on soil classification and the transfer of soil management experience by Beinroth and Spain.

i. Copy of Project agreement between EPAMIG and the University of Puerto Rico - Mayagüez.

j. Copy of Project design paper, January 1976.

k. Copy of minutes of RAC review of Soil Families Project (U.H.) and Benchmark Soils Project (UPR), 23 March 1976.

l. Copy of memorandum of agreement between University of Hawaii and University of Puerto Rico.

m. Copy of University of Hawaii Annual Report of the Benchmark Soils Project, 1975-1976.

II. ON-SITE REVIEW: Itinerary, Field Trips, Meetings

A. Brazil

Panel arrived Rio de Janeiro Sunday, 13 February 1977 and departed Rio de Janeiro Friday, 18 February 1977.

The Panel and Drs. Beinroth and Gill held an orientation and planning meeting on 13 February.

The review party (Panel plus Drs. Gill and Beinroth) visited Brazil's national soil survey headquarters in Rio de Janeiro. They talked with Dr. Marcello Camargo, Soil Classification Officer, and Mr. Luzberto Achá, Soil Survey Officer, about the progress in soil survey in Brazil. They also discussed EMBRAPA's interest in the Benchmark Soils Project. The soil survey organization, SNLCS, is not engaged in agronomic research and therefore has not assigned anyone to the Project up to now. Dr. Camargo said, though, that the administration of SNLCS is thinking of detailing a scientist to the Project so as to become more directly involved. SNLCS officials expressed particular interest in the use of Project outputs and their extension to the less-known parts of Brazil. They expressed an awareness of the support that a successful benchmark soils project would lend to the national and state soil survey programs. Mr. Achá was assigned to accompany the review party to Minas Gerais and to provide expert counsel on the soils and geology. Mr. Achá is thoroughly familiar with the soil resources of Minas Gerais, having been in charge of soil surveys of several areas there for many years. Following the conference at SNLCS headquarters, Dr. Camargo guided the review party on a field excursion in the environs of Rio de Janeiro to get an overview of soils, geology, vegetation, topography, and land-use problems.

The review party then travelled by air and ground to Janaúba, in northern Minas Gerais. They were joined there by Chris Seubert, Brazil Project Leader; Dr. Mauro Resende, Professor of Soils at Viçosa Federal University; and Derli Prudente Santana, Executive Officer of EPAMIG. The Director of EPAMIG's Gorutuba Agricultural Experiment Station guided the review party on a tour of the Station, which provided a preview of the common crops and of soil and crop management problems in areas of sandy alluvial soils of this region.

The review party next moved to Jaíba, headquarters for the Project in Brazil. The Project office and laboratory were seen, and the administrative assistant and staff technicians introduced. The party travelled a few miles to the Project primary experimental site on EPAMIG's Jaíba Agricultural Experiment Station. Experimental plots reviewed and discussed here were the following:

1. Maize transfer experiment, planted October 1976, drip-irrigated.

2. Maize variety experiment, drip-irrigated (5 varieties).

3. Brazil National Maize Variety trials, 36 varieties, non-irrigated.

4. Maize management experiments; 3 each density x spacing x variety; 4 replications; drip-irrigated.

5. Soybean transfer experiment, planted November 1976, drip-irrigated.

6. INTSOY soybean variety trails, 16 varieties, drip-irrigated.

The experimental work here is well organized and implemented. Growing crop plots are clearly delineated and well tended. Ample records are kept. The Brazil project leader is thoroughly familiar with details of the Project objectives, design, organization, and operation, and is clearly in command of the work. He is capable in all aspects of Project operations, including the operation and maintenance of equipment, supervision of technical staff, and interpretation of experimental results.

A large, deep pit alongside the maize transfer plot enabled the review party to examine and study the profile of the soil on which these experiments are being conducted. This extraordinary pit makes possible an evaluation of both vertical and lateral variability in soil characteristics, distribution of plant roots, and distribution of soil moisture. The soil has been tentatively classified as Tropeptic Eutrustox, clayey, kaolinitic, isohyperthermic family.

Project Personnel at Jaíba:

Project Leader	-	Chris Seubert
Administrative Assistant	-	Carol Seubert

One office/laboratory assistant

Three technicians (local high-school graduates)

Five WAE field laborers

EPAMIG provides administrative services, including transport of things, telephone, mail, loan of vehicles, fertilizer. EPAMIG does not provide any personnel, except occasional emergency field assistance.

Between Jaíba and the Experiment Station where the Project plots are located is a new colonization project being developed and supervised by Rural Minas, an agency of state government. The review party noted a considerable range in crop thriftiness and attention to soil management from field to field on the colonists' holdings.

A proposed secondary site was examined and discussed. This site, off the Experiment Station but rather near, appears to duplicate rather well the soil aspects of the primary site. A question was raised about its close proximity for a comparison of technology transfer.

The review party had a chance to visit the San Francisco River irrigation project, just under construction. This project is to irrigate 100,000 ha. when completed. The main canal, a portion of which has been built, will have a capacity of 80 cu.m./second.

Another nearby agricultural experiment station of EPAMIG was visited next. This station, Centro de Experimentos, Pesquisa Trenamento de Irrigante Experimental (CEPTIE) is devoted primarily to fruit and truck crops, such as papaya, fig, mint, tomato, and beans.

Before leaving the Jaíba area another field excursion provided opportunity to view the wood-gathering, charcoal cooking local industry. Also, a laterite pit was seen, where hardened plinthite is mined for use as road metal. Several contrasting kinds of local soils were also seen and discussed.

After leaving Jaíba, the field party drove to the city of Montes Claros, then flew to Belo Horizonte, capital of Minas Gerais and the headquarters of EPAMIG. Here the party met Mr. Navarete, the FAO officer from Brasilia, and Frank Campbell AID Program Officer from Brasilia.

The President of EPAMIG, Dr. Helvecio Saturnino, arranged a formal seminar for discussion of the Project and related matters. About 35 EPAMIG employees and several guests met with the field review party for three hours. Dr. Beinroth explained the objectives and design of the Project. The Review Panel discussed the principle of technology transfer based on soil classification and soil surveys. Dr. Dudal talked about world food production potential, the problems of agricultural development in LDC's, and the use of Project output in guiding crop production in remote areas. Following the seminar, the review party participated in a luncheon meeting with Dr. Saturnino, Paulo Caldeira Brant, Associate Secretary of Agriculture of Minas Gerais, and the EPAMIG scientists who participated in the on-site review.

After completion of the conferences at Belo Horizonte, the review party flew to Rio de Janeiro and on the evening of Friday, 18 February, embarked for Puerto Rico via Miami.

On Saturday, 19 February, the team transited Miami and San Juan and continued to Mayagüez.

A planning conference was held in Mayagüez on Sunday, 20 February. The Review Panel and Dr. Gill participated. On-site review findings in Brazil were discussed and plans made for preparation of the review report.

Monday, 21 February, was devoted mainly to field work. The review party visited Project Offices and laboratories at the Mayagüez Campus of the University of Puerto Rico. Besides Dr. Beinroth, the following Project personnel were present: Dr. G. L. Spain, Sr. Agronomist; L. C. Sarmiento, Chemist; José Badillo, Associate Agronomist; L. Calduch, Research Assistant; and S. P. Nightengale, Assistant Agronomist.

The party examined the soil profile at the type location of Matanzas Clay. Enroute to the Isabela Substation, observations were made of indigenous vegetation, crops, and cropping patterns, physiographic features, and land use.

A general tour was made of the Isabela Substation. The soil pit and sample site of Coto soil was examined and discussed in detail. The visual contrast with the Jaíba soil is obvious. The Coto exhibited rather wide cracks, extending to the soil surface. Clay skins are distinct in Coto at a depth of less than 1 meter. The Jaíba soil showed neither cracks nor clay skins. Vegetation on and around the Isabela site is evergreen whereas Jaíba is characterized by deciduous vegetation. Finally, bananas and sugarcane grow well without irrigation at Isabela, but not at Jaíba. There was discussion of the classification of the Coto soil.

Corn and soybean transfer experiments at the primary site were discussed and evaluated.

Corn and soybean transfer experiments were examined and discussed at the Coto secondary site; also on the Isabela Substation.

Following the on-site review, Mr. Badillo presented a slide show of crops at various stages of growth and with different treatments. There was discussion of the irrigation technique being used and of some of the irrigation problems experienced. The downy mildew problem of soybeans was noted, but no solution other than resistant varieties was offered.

Corn fertilization was discussed, particularly the question of fertilizer placement.

The Panel assembled with Dr. Gill at the University of Puerto Rico on Tuesday, 22 February. Findings of the on-site review were discussed. Dr. Beinroth and Dr. Spain joined the Panel and discussed project operations and problems. Then Dr. Gill outlined AID/W concerns about the Project. The Panel then continued the Project evaluation discussion by itself.

Panel members spent the remainder of the day writing portions of the report.

The report writing continued on the morning of Wednesday, 23 February. An exit conference was held about midmorning. The Dean of Agriculture, Dr. L. A. Mejia-Mattei, welcomed the Panel and gave a brief introduction. Director of Agronomy and Soils, Dr. Raul Abrams, represented the administration during most of the conference. Besides Dr. Gill and the Review Panel, the Puerto Rico Project scientific staff were all present. The procedure followed during the review was explained. Significant findings were briefly discussed. Then the parts of the report on commendations and recommendations were read, discussed, and accepted by the Project's Principal Investigator.

Following the exist conference, the Panel Chairman departed for Washington. Other members of the Panel departed Mayagüez on the following day.

III. PROJECT DESIGN AND OPERATION

A. Present Design

Experimental sites for corn and soybeans have been set up at Jaíba (Brazil) and Isabela (Puerto Rico) on Tropeptic Eutrustox, clayey, kaolinitic, isohyperthermic family. In both locations primary sites are in operation, and a secondary site is also planted at Isabela. Up to now, the work has essentially focussed on transfer experiments, with soil fertility trials designed to generate the data necessary to test the transferability hypothesis. On all sites trickle irrigation is employed in order to ensure comparability of results with regard to moisture conditions. The design of the trials is the 5^2 partial factorial modification by Escobar (1) with 5 levels of P and K each with 13 of the 25 possible treatment combinations and 2 control treatments. Each of the 15 treatments is being replicated thrice. Except for the complete control, blanket applications for all plots consist of 200 kg N and a package of trace elements (Mg, Zn, B, Mo). The layout of the trials and the organization of the project are set out in more detail in two reports prepared by F. H. Beinroth (2) and G. L. Spain (3).

B. Findings

1. Although the soils at the Jaíba and Isabela sites are classified in a same family of the Tropeptic Eutrustox, it appears that a number of their characteristics vary rather widely so that the transferability of experimental results between these sites may prove difficult. Whereas Jaíba is located in typically ustic moisture regime (annual rainfall 700 mm) the Isabela site tends toward udic conditions (annual rainfall 1720 mm) (reflected by deciduous and evergreen natural vegetation respectively). The Jaíba soil has a thick (over 2 meters) oxic horizon which is eutrophic in the upper part, but the Isabela soil is characterized by a thin (45 cm) oxic horizon which in places is dystrophic in its upper part. It furthermore appears that the Isabela site as such suffers from heterogenity which could jeopardize the interpretation of results. No data were available to the Panel on the Eutrustox sites in Hawaii.

2. Both sites are trickle irrigated, but it is difficult to ascertain how much water is actually being used and at which average soil moisture condition the experiments are being conducted. No data were available to the Panel on the water quality and composition. No control plots have been laid out for nonirrigated crops.

3. The fertilizer materials used at Jaíba are ammonium sulphate and single superphosphate. At Isabela applications were made of urea and triple superphosphate.

4. On the basis of the yield results already available at Isabela, it is not yet possible to evaluate a trend in the responses to different levels of P and K. It appears, however, that K is not a limiting factor in these soils and the question was raised if the testing of different levels of K should not be replaced by experimentation with N as a second variable.

5. Variety trials have shown that the "best adapted varieties" used for the experiments are not necessarily the highest yielding ones, the reason being that project consultants in plant breeding had advised against using commercial varieties of which the genetic composition is not well known.

IV. INSTITUTIONAL RELATIONSHIPS

In the course of Project implementation, linkages have been established with a number of institutions and are summarized and described in a report prepared for the Panel by Beinroth (2). In the course of the Panel's review trip, however, it was possible only to investigate and discuss effects of the relationships involving the related Brazilian entities, including the local USAID Mission.

Findings

1. Excellent cooperation to the Project is being provided by the principal Brazilian cooperating entity, Empresa de Pesquisa Agropecuaria de Minas Gerais (EPAMIG). Both the administrative staff as well as the technical staff of this entity demonstrated a very high level of interest in and knowledge of the Project and have been very supportive of the site activities being conducted there. This support has included the assignment of two vehicles and housing, laboratory and storage facilities as well as a broad range of administrative support. This interest and support appeared to be based on a genuine acknowledgement of the potential embodied in the hypothesis under investigation and the value it would have for agricultural planning and development in the Brazilian context.

2. Despite the limited size of the USAID Mission in Brazil, it has been and continues to be very supportive of Project activities there. The Mission's Program Officer, Mr. Frank Campbell, met with the Panel and attended a related Project seminar with Brazilian counterparts held in Belo Horizonte. In addition to basic administrative support related to visas of the Project personnel, assistance with customs clearances, etc., the Mission has also been providing needed logistic support in the form of household furnishing and under current plans, the transfer of a grant-in-aid vehicle to EPAMIG for Project support. In view of the phasing-out being planned for this Mission, it is anticipated that increased administrative support will be provided by EPAMIG. However, it would only be prudent to assume that a part of this vacuum will have to be shouldered by the UPR Project administration.

3. Given the stage of Project implementation and results achieved to date, the Panel sees no immediate need for developing specific linkages with AID Missions not directly related to field site activities. Nevertheless, the potential value of the transfer mechanism being tested herein is considered to warrant a parallel effort by the Project leadership to sensitize agricultural planners and soil scientists in the LDC's to the potential of this Project and keep them appraised of the related developments.

V. TRAINING

The major activities in this Project up until the present are those of planning, designing, staffing, installing, and implementing the research. The educational aspects have been reflected in learning while working on the Project and in training new professionals and technicians as they come on board. As EPAMIG and SNLCS personnel are associated with the Project, they will gain an understanding of the technology transfer rationale and of the experimental design and procedures. The Project has no specified training component. Until Project results have been collected, verified, and analyzed, training of outside scientists and technicians is not feasible.

VI. COMMENDATIONS

1. The Project Principal Investigator is commended for excellent planning, preparation, and arrangements for the on-site review.

2. The Project leadership is commended for developing a clear linkage between this Project and the UPR 211-d soil classification grant (AID/csd-2857) resulting in benefits to both.

3. The Project leadership is commended for the close working relationship between the University of Puerto Rico and the University of Hawaii, especially in respect to centralized processing of exerimental data.

4. The Project leadership is commended for organizing a soil classification conference to be held in Brazil in June 1977, which should result in substantial advances in the classification of soils of the tropics.

5. EMBRAPA, the Brazilian national agency in charge of agricultural research and EPAMIG, the Project collaborator in the state of Minas Gerais, are commended for their foresight into the potential of the Project, their support of this research, and their own advances in soil classification and survey activities.

6. The AID Mission, Brazil, is commended for its interest in the Project and its assistance in providing logistical support.

VII. RECOMMENDATIONS

A. On Management and Administration.

The Panel recommends:

1. That the Project be extended for another three years in order to realize its objectives.

2. That the University of Puerto Rico strengthen its support of the Project, particularly in logistics, administrative services, and allocation of space. (The ongoing assistance and support of the Project by the AID Mission is appreciated, but this assistance must end when the Mission is phased out.)

3. That emphasis be given in future activities to consolidation of the experimental work, including especially the implementation of secondary sites, the operation of management experiments, and the establishment of another site in Brazil.

4. That close attention be given to scientific and technical management of the experimental work in field and laboratory at all sites in both countries so as to ensure maximum accuracy, reliability, and comparability of experimental results.

5. That an on-site workshop be held about mid-1978 to disseminate Project results and to promote awareness of the value of soil classification for technology transfer.

6. That a continuing effort be maintained by the contractor to keep appropriate LDC institutions and scientists, as well as related interested and potential donor and assistance agencies, informed of the Project and developments therein in order to set the stage for utilization of affirmative Project results.

7. That national institutions be encouraged to become involved in Project operations to the greatest possible extent so as to facilitate logistic support and to ensure a long term continuation of the research and trials even after AID support is terminated.

8. That headquarters staff and space be enlarged by addition of the following:

   A. Additional staff

      1 Project Administrative Officer
      1 Bilingual executive secretary

   B. Additional rooms

      3 Offices
      1 Storage room

   Project operations currently suffer from delays caused by the necessity for scientific personnel to spend excessive time on procurement, fiscal, and personnel matters. The present secretarial staff is weak in English, making for delays and inefficiency in communications. Present headquarters staff is crowded. That situation added to the proposed increase of two people underlines the need for more offices.

B. On Project Design.

9. Taking into account the work already carried out, it is recommended that the experimental program in the existing sites be pursued and that an eighth site be added, preferably in Brazil, in order to meet the statistical requirements. Considering its range of variability, the Tropeptic Eutrustox may not be the most appropriate subgroup on which to test transferability of agrotechnology at the family level.

10. The Panel recommends that the Project's geographic extent not be enlarged to Africa and/or Sri Lanka.

11. It is recommended that management experiments on levels of irrigation and fertility be added, at least on primary sites. It is noted that large areas of Eutrustox are not likely to be irrigated.

12. It is recommended that consideration be given to deleting K and using P and N as the variables in transfer experiments. It was noted that K does not appear to be a limiting factor in plant nutrition on the soils under study. It is recognized that the University of Hawaii investigators would have to agree to this same alteration in the design of their Soil Families Research Project.

13. In order to ensure maximum comparability of experiments at all the sites it is recommended that:

    - irrigation be uniform both in amount and method of application. (Continuation of drip irrigation is recommended.)

    - fertilizer materials applied be the same

    - irrigation water be analyzed and its composition be taken into account in interpretation of experimental results

    - variety trails include the different varieties used in the transfer experiments at all three locations (Hawaii, Puerto Rico and Brazil).

    - the determination of phosphorus application by the phosphate sorption isotherm method (4) be checked by assessing actual phosphorus levels in the soil following fertilizer application.

14. In order to take maximum advantage of available experience it is recommended that farm practices and results of experiment stations on the same kinds of soils near the Project sites be recorded and fed into the data processing system.

15. As the Project proceeds, it is recommended that first priority be given to consolidating the ongoing transfer experiments on primary and secondary sites with special emphasis on ensuring full comparability (see Rec. 13). In addition, management experiments should be added for irrigation and fertility. Extension activities under the Project should await a positive outcome of these experiments and the economic evaluation of recommended inputs.

16. It is recommended that work not be initiated on a second soil family at this time. The Panel considered extension of the Project to include a second family, preferably of Vertisols in Central and South America and Puerto Rico. Linkages with Vertisols in Hawaii and Africa might then be developed. Extension of the Project on Oxisols or Ultisols is not recommended.

VIII. REFERENCES

(1) Silva, J. A. and Beinroth, F. H., 1975. Report of the Workshop on Experimental Designs for Predicting Crop Productivity with Environmental and Departmental Paper 26. Hawaii Agr. Exp. Sta., Col. of Trop. Agr. Univ. of Hawaii.

(2) Beinroth, F. H., 1977. Progress and Planning Review, Benchmark Soils Project. Univ. of Puerto Rico.

(3) Spain, G. L. 1977. Report on Field Research, Benchmark Soils Project. Univ. of Puerto Rico.

(4) Fox, R. L. and Kamprath, E. J., 1970. Phosphate Sorption Isotherms for Evaluating the Phosphate Requirements of Soils. SSSA Proceedings Vol. 34, No. 5.

This report respectfully submitted this 31st day of March 1977 in Washington, D. C.

REVIEW PANEL SCHEDULE

Sunday	13 Feb		Panel assemble in Rio de Janeiro
		1600	Review planning and orientation meeting: Panel, Gill, Beinroth
Monday	14 Feb	0900	Meeting at Servicio Nacional de Levantamento e Conservacao de Solos, EMBRAPA
		1100	Field trip in Guanabara area
Tuesday	15 Feb	0605	Lv Rio de Janeiro, VP #036
		0645	Ar Belo Horizonte
		1025	Lv Belo Horizonte, NE #
		1130	Ar Montes Claros
		1330	Lv Montes Claros by vehicle
		1640	Ar Janaúba - Visit Gorutuba Agricultural Experiment Station
Wednesday	16 Feb	0730	Lv Janaúba by vehicle
		0855	Ar Jaíba.- Visit Project Office and Laboratory. Field trip to visit experimental sites and nearby features, including San Francisco River Irrigation Project and Jaíba Colonization Project.
Thursday	17 Feb.	0710	Lv Jaíba by vehicle - Visit charcoal operation, Laterite pit, and soil profiles
		1230	Ar Janaúba
		1345	Lv Janaúba
		1645	Ar Montes Claros
		1900	Lv Montes Claros, NE#
		2010	Ar Belo Horizonte
Friday	18 Feb	0830	Seminar at EPAMIG headquarters, Belo Horizonte
		1230	Luncheon with EPAMIG Officials and Associate Secretary of Agriculture
		1915	Lv Belo Horizonte, Varig #455
		2020	Ar Rio de Janeiro
		2300	Lv Rio de Janeiro, PA #440
Saturday	19 Feb	0525	Ar Miami
		0930	Lv Miami EA #915
		1250	Ar San Juan
		1410	Lv San Juan PQ #
		1440	Ar Mayaguez

Sunday	20 Feb	1000	Review report planning meeting
Monday	21 Feb	0900	Visit Project facilities on UPR - Mayagüez campus
		1030	Lv Mayaguez by vehicle for tour of Isabela Substation and on-site review of experimental sites.
		1800	Return to Mayagüez
Tuesday	22 Feb	0740	Review Panel meeting with Project Principal Investigator and Senior Agronomist.
		1300	Write report
Wednesday	23 Feb	0745	Write report
		0900	Exit conference. Review findings, commendations, and recommendations with Project Staff and UPR Administration
		1045	Adjourn

REVIEW OUTLINE

SOIL FAMILIES RESEARCH PROJECT

January 1977

I. General Conditions and Objectives, Problems, and Needs.

II. Previous Reviews, Audits, Meetings, and Trip Reports.

III. Management.

A. Plans of Operation
Adequacy, progress, use.

B. Work Organization
Planning and scheduling; productivity.
Progress in reaching milestone events.

C. Administrative Services
Contracting; equipment management; procurement.

D. Budgeting
Operating budgets: currency, adequacy, relevancy to plans.
Planning budgets: future adjustments.

E. Personnel
Organization and staffing, adequacy; balance.
Supervision.
Training program.

IV. Project Design.

A. Present Design
Adequacy.

B. Proposed Project Design Changes

C. Methodology of Verifying Success of Techology Transfer
Statistical models.
Technical guides and on-site testing.

V. Project Operations.

A. Progress on Site Selection and Installation of Equipment

B. Progress on Soil Survey Phases
Soil classification and identification of experimental areas.
Field and laboratory characterization of representative pedons.

C. Progress on Crop Experiments

D. Progress on Soil Interpretations
   Assistance to LDC's in land-use planning.
   Relationship to Hawaii Benchmark Soils Project.

E. Status of Extension to Other Countries

F. Status of Model Development at University of Kentucky

VI. Relations to AID Missions in LDC's.

Linkage with mission-funded and LDC-funded research.
Possibility of network approach, using existing tropical research stations around the world.
Relation of AID country missions to centrally funded research projects such as this.

VII. Relations to Host Country, and to International Research Institutions.

Relations in Brazil.
Relations to EPAMIG, CIAT, ICA, IICA, and FAO/UNDP Projects (LAT 70/32 and LAT 70/457).

VIII. Training Component.

Adequacy of present plan and operations.
Additional needs.
Progress.

IX. Utilization of Project Output.

Implications of project results to AID and LDC's: ways of using outputs, scope of extension activities, timetable.
Implications of project results to soil classification.
Future information dissemination and utilization activities.

X. Panel Recommendations - Summary.

Appendix C

INTERNATIONAL SEMINAR ON USES OF SOIL SURVEY AND CLASSIFICATION IN PLANNING AND IMPLEMENTING AGRICULTURAL DEVELOPMENT IN THE TROPICS

JANUARY 18-23, 1976

HYDERABAD
INDIA

CONTENTS

1. List of Participants

2. "Keynote Address", William Panton, International Bank for Reconstruction and Development, Washington, D.C., U.S.A.

3. "Modern Soil Classification Fundamentals", W.M. Johnson, Soil Conservation Service, USDA, Washington, D.C., U.S.A.

4. "Some Fundamentals of Soil Classification - U.S. Soil Taxonomy", F.H. Beinroth, University of Puerto Rico, Mayaguez, Puerto Rico, U.S.A.

5. "The Occurrence and Significance of Climatic Parameters in the U.S. Soil Taxonomy", H. Ikawa, University of Hawaii, Honolulu, Hawaii, U.S.A.

6. "Agro-technology Transfer and the Soil Family", G. Uehara, University of Hawaii, Honolulu, Hawaii, U.S.A.

7. "The Contribution of Soil Survey Interpretation in Land Appraisal", A.J. Smyth, Ministry of Overseas Development, Surbiton, Surrey, United Kingdom.

8. "Soil Survey, Classification, and the Transfer of Agricultural Information", A.W. Moore, Cunningham Laboratories, CSIRO, Brisbane, Australia.

9. "Developments in Soil Surveys for Improved Rubber Production in Peninsular Malaysia", Chan Heun Yin, Rubber Research Institute, Kuala Lumpur, Malaysia.

10. "Land Evaluation for Agricultural Land Use planning", J. Bennema University of Agriculture, Wageningen, Netherlands.

11. "Use of Soil Data in Land Use Planning - Techniques for Displaying Soil Data to Planners and Decision Makers", G.A. Nielsen, Montana State University, Bozeman, Montana, U.S.A.

12. "Uses of Soil Resources Data in Land Use Planning", M. Vakilian, Soil Institute of Iran, Teheran, Iran.

13. "Use of Soils Data in Land Use Planning - A Case Study from Karnataka (India)", R.S. Murthy, All India Soil and Land Use Survey, New Delhi, India.

14. "Use of Soils Data in Regional and National Development", M.L. Dewan, Regional Bureau for Asia and Far East, F.A.O., Rome, Italy.

15. "Use of Soils Data in National and Regional Agricultural Development in Ghana", H. Obeng, Soil Research Institute, Kwadaso-Kumasi, Ghana.

16. "Use of Soil Data in Regional and National Development - A Case Study of Tropical Alfisols from Sri Lanka", C.R. Panabokke, Central Agricultural Research Institute, Peradeniya, Sri Lanka.

17. "Use of Soil Survey Data for Agricultural Development in Korea: Land Selection for the Introduction of Newly-Bred High Yielding Rice Variety, "Tongil", Yong Hwa Shin, Institute of Agricultural Science, Suweon, Korea.

18. "Interpretation of Small and Large Scale Maps for Land Use Planning in Semi-Arid and Arid North Indian Plains", H.S. Shankaranarayan, Indian Agricultural Research Institute, New Delhi, India.

19. "A Need for an International Research and Technology Network in Tropical Soils", G.B. Baird, United States Agency for International Development, Washington, D.C., U.S.A.

20. "A Soil Research Network through Tropical Soil Families", L.D. Swindale, University of Hawaii, Honolulu, Hawaii, USA.

21. "Soil and Water Management in the Semi-Arid Tropics", B.A. Krantz and Associates, ICRISAT, Hyderabad, India.

22. "Soil and Water Management in Rain-Fed Agriculture", Dr. Ch. Krishnamoorthy, All India Coordinated Research Project for Dryland Agriculture, Hyderabad, India.

23. "Use of Soils Information for Planning Agricultural Development in the Semi-Arid Tropics", B.A. Krantz and Associates, ICRISAT, Hyderabad, India.

24. "Soil Taxonomy - Indian Style", T.R. Srinivasan, Indian Photo-interpretation Institute, Dehra Dun, India.

25. "Translocation of Clay in Soils of NW India and Implications involved in using this criterion for glassifying soils" J.L. Sehgal, Punjab Agricultural University, Ludhiana, India.

26. "Soil Survey Interpretations for Watershed Development Programs", Y.P. Bali & Associate, All India Soil and Land Use Survey, Department of Agriculture, New Delhi, India.

27. "A New Approach in the Study of Vertisol Morphology", J.C. Bhattacharjee & Associates, Directorate of All India Soil and Land Use Survey Regional Centre, Nagpur, India.