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Report of the First Annual Coordination Meeting of

THE BENCHMARK SOILS PROJECT

of the

Universities of Hawaii and Puerto Rico

on
August 17-20, 1976

at
University of Puerto Rico, Mayaguez Campus

REPORT OF THE FIRST ANNUAL COORDINATION MEETING OF THE BENCHMARK SOILS PROJECT OF THE UNIVERSITIES OF HAWAII AND PUERTO RICO

ON

August 17 - 20, 1976

AT

UNIVERSITY OF PUERTO RICO, MAYAGUEZ CAMPUS

Edited

by

G. Y. Tsuji

University of Hawaii
Honolulu, Hawaii

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INTRODUCTION

This report is the result of the first annual coordination meeting between the Universities of Hawaii and Puerto Rico. It summarizes project accomplishments, project methodologies, modification of project objectives, and future plans. The participants discussed project progress in relation to guidelines set forth by the Experimental Design Workshop in 1974 and recommended establishment of new guidelines on the basis of experiences and contacts gained over the past two years in cooperating countries. The meeting allowed all groups working in different countries to evaluate, in depth, their research obligations and contractual involvement with AID.

The participants wish to extend their appreciation to the generosity of Dr. F. H. Beinroth for accommodating the meeting at University of Puerto Rico's Mayaguez campus and Dr. R. Pietri for the luncheon he hosted at the Mayaguez Hilton.

FIRST ANNUAL COORDINATION MEETING

OF THE

BENCHMARK SOILS PROJECTS

OF THE

UNIVERSITIES OF HAWAII AND PUERTO RICO

(Contracts AID/ta-C-1108 and AID/ta-C-1158)

Mayaguez, Puerto Rico
August 17-20, 1976

AGENDA

Tuesday, August 17

9:00 - 9:15 A.M.	Welcome
9:15 - 9:30 A.M.	Organization of Meeting
9:30 - 12:00 Noon	BRIEFING SESSION
	Moderator: F. H. Beinroth Reporter: C. R. Seubert
	Status of Hawaii Project - L. D. Swindale
	Status of Puerto Rico Project - F. H. Beinroth
	Country Reports
	Hawaii - A. R. Hurdus Philippines - B. G. Cagauan, Jr., A. A. Briones Indonesia - A. R. Hurdus, I P. G. Widjaja-Adhi Puerto Rico - G. L. Spain Brazil - C. E. Seubert
	DISCUSSION SESSIONS
1:30 - 2:45 P.M.	Site Selection and Establishment
	Moderator: L. D. Swindale Reporter: B. G. Cagauan, Jr.
3:00 - 5:30 P.M.	Transfer Experiments
	Moderator: J. A. Silva Reporter: A. R. Hurdus, G. Y. Tsuji

Wednesday, August 18

DISCUSSION SESSIONS

9:00 - 9:45 A.M.	Variety Trials Moderator: A. R. Hurdus Reporter: B. G. Cagauan, Jr.
10:00 - 11:00 A.M.	Weather Data Collection Moderator: G. Y. Tsuji Reporter: A. A. Briones
11:00 - 12:00 Noon	Crop Data Collection Moderator: J. A. Silva Reporter: C. E. Seubert
1:30 - 5:30 P.M.	Management Experiments Moderator: G. L. Spain Reporter: B. G. Cagauan, Jr.

Thursday, August 19

DISCUSSION SESSIONS

9:00 - 12:00 Noon	Statistics Moderators: F. B. Cady, L. A. Nels Reporter: J. A. Silva
1:30 - 3:00 P.M.	Administration and Coordination Moderator: G. Y. Tsuji
3:15 - 5:00 P.M.	Future Plans Moderator: T. S. Gill
5:00 P.M.	Closing Remarks

Friday, August 20

Field trip to the Agricultural Experiment Sub-station of Isabela to view experiments

Leader: J. Badillo

NARRATIVE SUMMARY

Project Objectives and Directions

The key question asked was what does the project intend to transfer? The answer given was (1) soil management inputs which result in similar crop response on common soil families at the different experimental sites and (2) concepts such as KCl-extractable Al to determine lime requirements and P adsorption isotherms to determine P requirements. Project participants from Hawaii and Puerto Rico agreed to expand the number of sites in certain soil families. Project objectives related to in-country utilization of research data, and development of crop management concepts and experiments were emphasized. Participants adopted guidelines for the conduct of soil management experiments as it relates to soil interpretation and land use.

Crops

Both projects will proceed with only one transfer crop, maize, at all sites. The use of a second crop (soybeans) will depend on the availability of funds, personnel, and time within the duration of the project. A third crop is out.

Sites

The minimum number of sites for a particular soil family throughout the network is 8 to 10 which should allow estimation of the effects of site variables. It would be desirable to have prediction equations for the dry season over years and for the wet season over years.

Meteorological Measurements

Relative humidity, temperature, rainfall, solar radiation, and wind speed will be measured at all sites. In addition, soil temperature will be monitored at 4 specified depths in an experimental plot at each site.

Information Dissemination, Coordination and Future Plans

The respective projects will endeavor to disseminate project results to cooperating countries as part of the utilization objectives. Coordination meetings of the project will be held annually to discuss common problems, share new ideas, establish new directions, agree on common goals and serve as a forum to inform project participants of experimental results across the network.

REPORT OF PROGRAM ACTIVITIES AND DISCUSSIONS

August 16, 1976

The Hawaii group spent most of the day resting after flying for more than 13 hours from Honolulu. Toward late afternoon, members of this group organized their material for presentation on the next day.

August 17, 1976

A.M.

I. Opening Remarks

The meeting was called to order by the Principal Investigator of the Puerto Rico Project, Dr. F. H. Beinroth. He also introduced to the participants the following:

a. Chancellor Rafael Pietri, University of Puerto Rico, Mayaguez Campus
b. Dean Louis Mejia-Mattei, College of Agricultural Science, UPR
c. Dr. Raul Abrams, Chairman, Department of Agronomy and Soils, UPR

II. Welcoming Remarks

Chancellor Pietri formally welcomed the participants to the meeting and expressed the hope that the scheduled program of activities would be productive.

Dean Mejia-Mattei conveyed a similar message and wished the group a pleasant stay in Mayaguez.

F. H. Beinroth subsequently expressed the gratitude of the group for the concern that these two University officials expressed on behalf of the Project and its objectives.

III. Briefing Sessions

The following sessions were intended to provide the participants with a perspective of project activities in each country.

a. Status of Puerto Rico Project

F. H. Beinroth, reported difficulties in locating sites on the clayey, kaolinitic, isohyperthermic family of Tropeptic Eutrustox. Other problems encountered were uncertain political situations and inaccessibility of desired soil families. Brazil, Colombia, Venezuela and possibly the Dominican Republic were countries where it was planned to establish sites since this soil family was expected to occur there. Preliminary investigations, however, showed that soils classified as Tropeptic Eutrustox were scarce and that the clayey, kaolinitic, isohyperthermic family of Tropeptic Haplustox will be considered an alternative.

Agronomic experiments have been installed only at the Puerto Rico site at Isabela. The Brazil site has been selected at Jaiba in Minas Gerais and construction of an irrigation system is underway.

Additional information regarding the network of sites in South America which includes Brazil (2 sites), Colombia (not yet established) and Venezuela (still being considered) was presented. Plans to expand the project to the Dominican Republic were also mentioned. (Appendix I)

b. Status of Hawaii Project

The Principal Investigator of the Hawaii Project, L. L. Swindale, summarized the progress to date of the Hawaii, Philippines, and Indonesia efforts. His oral presentation was included in part in a handout (Appendix II). He re-emphasized the project's objectives and discussed the soil families that are currently

being screened for inclusion in the project. He mentioned that countries such as Sri Lanka, Thailand and the Pacific island countries have generally shown great interest in possible participation in the project.

General activities of the project in the Philippines and Indonesia were mentioned with the comment that details would be taken up when country reports were given. The utilization aspect of the project, a principal concern of USAID/Washington was emphasized. Swindale concluded his remarks with the optimistic prediction that the full complement of soil families would be identified before the next annual meeting and that agronomic experiments would be installed soon thereafter.

c. Country Reports

Instead of imposing a rigid time schedule, country reports were allocated a reasonable time to allow adequate discussion.

(i) Hawaii. This report was given by A. R. Hurdus, Hawaii Agronomist. A slide presentation was used to provide participants with a visual history of the project in Hawaii. This portion was augmented by a handout describing the progress of the Hawaii sites up to meeting time (Appendix III).

Treatment effects and harvest results of the first maize crop were reported. Some difficulties with respect to soybeans and cassava were mentioned, with the latter being deleted entirely as an indicator crop on the Hawaii sites. Reasons for the failure in cassava were attributed to cool temperatures and mechanical crop damage by prevailing trade winds.

(ii) Philippines. The progress of the project in the Philippines was reported by both B. G. Cagauan, Jr., University of Hawaii Project Leader for the Philippines, and A. A. Briones, Project Leader-designate of the Philippine Council for Agriculture and Resources Research (PCARR), with color slides and commentaries. This presentation appraised the group of the various operations and progress of the experiments. A. A. Briones described the effect of project introduction in the Philippines, and made recommendations for the immediate future in relation to utilization in the participating country (see Appendix III).

(iii) Indonesia. Project status in Indonesia was reported by A. R. Hurdus with assistance from the Indonesia Project Coordinator, I P. G. Widjaja-Adhi of the Soil Research Institute in Bogor, through a number of slides. A summary of the project activities is presented in Appendix III. No experiments had been installed to date. Soil samples (transfer plots) have been analyzed and planting is scheduled for October-November. The appointment of a UH Project Leader is pending.

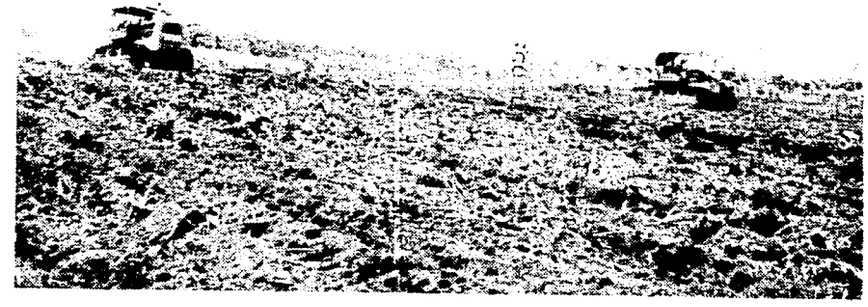
(iv) Puerto Rico. A uniformity trial using soybeans was installed in July 1975 at the Isabela site to delineate areas unsuitable for experimental plots. Two transfer experiments of maize (Pioneer X306B) and soybeans (Jupiter) were harvested in early August. Two additional transfer experiments with maize and soybeans were installed in July at Isabela.

The Puerto Rico Project did not install any variety test for soybeans. This was done by INTSOY within the Isabela station.

(v) Brazil. In May 1976, Chris Seubert, UPR Agronomist, was transferred to Brazil and now resides near the Jaiba, Minas Gerais site. He has worked to

Philippines

Hawaii



ESTABLISHMENT OF EXPERIMENTAL SITES

Indonesia

Philippines

establish rapport with the cooperating institution (EPAMIG) and USAID/Brasilia. At Jaiba, plots for a primary site have been marked and soil samples taken for two transfer experiments with soybeans and maize. Most weather instruments, laboratory, and field equipment necessary have been received in Brazil and other necessary materials have been shipped. A contract has been arranged for the installation of a well for irrigation at the Jaiba primary site. Support and cooperation from EPAMIG has been exceptionally favorable to the development of the Jaiba site.

P.M.

IV. Discussion Sessions

1. Site Selection and Establishment. This discussion was moderated by L. D. Swindale who presented the schedule of events for selecting sites to test the transfer hypothesis. It was mentioned that a given soil family may not necessarily occur in all participating countries and it is possible that a country may have only one of the 4 families being studied.

The number of primary and secondary sites per soil family required to test the transfer hypothesis was discussed. It was decided that a minimum of 2 sites is required, statistically, but the actual number will depend on the number of important site variables. Site variables such as climatological variables which the experimental design cannot account for should be measured.

Two sites per country per soil family were considered acceptable. Eight sites are the minimum number required to complete the network of a particular soil family. Therefore, if a crop is planted twice a year, then over a three year period, we should have results of 48 experiments. Since there are no established statistical models to test the transfer hypothesis, a large population of results, representing the total range of soil properties within a soil family, is desirable.

Field results at one location in one season can be considered a statistical site. If there are 8 locations per soil family in a complete soil family network, then there should be 16 statistical sites per soil family per year which are available for analysis. There is no magic number of sites required. Hence, selected sites should represent known ranges of soil properties and site variables within a particular soil family and the number of sites required should provide confidence in testing the transfer hypothesis.

2. Transfer Experiments. The central concept to be tested by the transfer experiments is the hypothesis of transferability of agrotechnology. This discussion was moderated by J. A. Silva who distributed a handout entitled "Hawaii Transfer Experiments - Analysis of Initial Yield Data" (Appendix IV).

The basic recurring question of what the project intends to transfer was answered in terms of (1) management practices which result in similar crop responses on a particular soil family and (2) concepts such as KCl extractable Al to determine lime requirements and P adsorption isotherms to determine P requirements. Another question raised and not definitely answered, was whether the intercept (minimum effect of variables) should also be considered in testing the transfer hypothesis.

A lively discussion on transfer sites and crops ensued, and the following conclusions were drawn:

1. Concentrate on one crop - maize
2. A second crop may be considered only to gain experience on this crop which is more related to management information for a particular soil.
3. A third crop is not essential.
4. Lower level of fertilizer treatments may be used, e.g., -0.95.
5. Variety trials will be conducted for at least 2 seasons or until a well-adapted variety is decided upon.

The meeting adjourned at 6:00 pm.

August 18, 1976

A.M.

I. Design and Analysis of Experiments and Testing of Transfer Hypothesis

Drs. Nelson and Cady led the discussion during which they explained the calculation of prediction equations for the Kukaiau and Niulii maize yield data. Dr. Cady also demonstrated a preliminary test of the hypothesis of transferability using the P statistic which is being developed for this purpose. Details are presented in Appendix V. It was pointed out that if one to three uncontrolled or site variables are to be included in the regression equations, then 2 to 8 sites having the proper combination of high and low levels of these site variables are required. The minimum number of sites for a particular soil family throughout the network is 8 to 10 which would allow estimation of the effects of site variables. It would also be desirable to have prediction equations for the dry season over years and for the wet season over years.

II. Variety Trials

The moderator, A. R. Hurdus, briefly reported on the work done in Hawaii on soybeans. Although no formal variety trial had been installed several observation trials with soybeans had been conducted in Hawaii. Soybean variety experiments are conducted by INTSOY at the Isabela substation. Sixteen maize varieties were planted at the primary site. Two levels of phosphorus - optimum (0) and low (-.85) - were the treatments used in three replicates. A proposed modification of the variety trial which should assist in screening varieties for their responsiveness to the variables in the transfer experiment was discussed. Two levels of each of the transfer variables at the -0.85 and 0 coded levels would be combined factorially to give 4 fertility treatments. These 4 fertility treatments would be installed as the whole plots and the varieties would be the subplots in a split-plot design. Varieties included in the variety experiment would be the varieties used in transfer experiments throughout the soil family network as well as the top two local "best adapted" varieties (Appendix VI).

During the recent AID review of the Hawaii project in May, 1976, it was the concensus of the review team that the "best adapted" variety used in the transfer experiment should be that which is grown extensively, locally.

Whether the -0.85 and 0 coded levels would provide a sufficient range to establish the response of a given variety was questioned. This was partly answered by the observation that more risks were involved in using higher levels since the optimum ("0") level has caused some lodging in soybeans (Hawaii

sites). The use of different varieties at different sites will not necessarily affect the transfer equation which should hold for a particular variety.

III. Weather Data Collection

This discussion session was moderated by G. Y. Tsuji, who distributed handouts entitled "Meteorological Instrumentation and Measurements" and "Drip Irrigation System for Transfer Experiment" (Appendices VII and VIII).

Slides were presented showing the meteorological instrumentation in the Hawaii project at Kukaiau and Niulii sites. Costs were given of meteorological instruments for primary and secondary sites.

Discussion focused primarily on the number of weather variables to be measured.

Solar radiation, wind speed, and soil temperatures were included as important climatic variables which must be measured at all sites. These are in addition to those (air temperature, rainfall, and relative humidity) recommended at the Experimental Design Workshop in 1974. Measurements of these climatic variables will be used to determine the range of these variables for all sites of a given soil family.

Specific manufacturers of instruments were not selected but the criteria for selecting an instrument was agreed to be efficiency, cost and comparability of data obtained among the various sites. Where a non-recording instrument is used, the minimum interval for reading will be one week. Soil temperature readings will be made at 5, 10, 20 and 50 cm depths. Measurement at these depths will be taken at the physiological pre-emergence and pre-tasseling stages of development of corn. As a guide, temperature readings will be made when tensiometers register 10-20 bars before irrigating. At these critical stages, max and min temperatures will be recorded over a 24-hour period. Thermistors will be imbedded in the soil at the given depths between the two harvest rows of the "0" treatment in any of the replicates.

Time off: 5:30 pm

August 19, 1976

A.M.

I. Crop Data Collection

This topic was not pursued the day before as scheduled due to time constraints. This session was moderated by J. A. Silva, UH Project Agronomist. He presented corn tissue analysis data for experiments conducted in Hawaii (Appendix IX). The discussion centered on how long such data collection must be pursued since they do not enter into any of the transfer objectives. It was explained that tissue analysis data are important in explaining possible yield deviations and would augment our knowledge of nutrient uptake by corn from this group of soil families.

Crop data collection (except yield data) will be pursued for two years and will be re-examined after one year. The overriding considerations are cost, personnel time, and utilization of data relative to project objectives. The following is a synopsis of the more pertinent decisions.

1. The person making additions or modification to the code sheets must notify the other personnel in both projects. (This is especially important in the coding of corn variety names.)

2. Height of maize at the six leaf stage, was dropped in favor of taking the measurement at 30 days.

3. Days at 50% flowering-tasseling should be recorded for all treatments if it does not impose difficulties. At least it should be obtained for the high and low P treatments.

4. Insect, disease, and other animal pest ratings will be made at tasseling-flowering and at harvest. An overall rating will then be made for the total damage to the crop during the growth period.

5. It was decided that separate record keeping (punch cards), by each university would be most logical.

6. Days to physiological maturity should be recorded for both maize and soybeans.

7. The yield parameters of soybeans will be weight of 100 kernels and grain yield.

8. Plant leaf nutrient analysis (Quantometer), should be carried out for all sites and all crops for at least the first year or two. A review of this procedure should be made at the next annual meeting.

9. There was no final decision on whether we should determine total N or nitrate -N in the leaf tissue samples. But, the majority consensus appeared to favor analyzing only for total N.

10. P in the soil solution will be measured for each plot for the transfer experiments or a composite of plots for the variety and management experiments. P fertilization will then be used to adjust P in the soil solution to the desired level.

11. Soil exchangeable bases will be measured in plots 1, 8, and 15 of the transfer experiments before planting. At harvest exchangeable bases, CEC, KCl extractable Al, pH (H_2O) and pH (KCl) will be determined on all plots. This decision should be reviewed at the second Annual Meeting.

12. Soil temperature should be measured at the 5, 10, 20 and 50 cm depth of the J plot of one replication.

13. The following meteorological data are to be totaled on a weekly basis and put on punch cards: max-min air temperature, relative humidity, rainfall, soil temperature, wind run, solar radiation, and pan evaporation (where measured). Daily record sheets will be used at each site.

14. Soil characteristics should be recorded and included with the sets of transfer information.

Codes for IBM cards for yield, plant, soil, and weather data are presented in Appendix X.

A.M. - P.M.

II. Management Experiments

G. S. Spain, UPR Senior Agronomist, introduced the subject for discussion by presenting two possible alternatives:

1) provide information we need in order to conduct transfer trials in the best way; and

2) conduct experiments for the benefit of local farmers in the country.

The contractual obligation of the project with AID surfaced during the discussions. Both contracts state that we are "to establish crop production capabilities and relationship of a network of tropical soils" and to improve the usefulness of soil data to make proper soil interpretation. The projects' funding by AID makes our involvement with LDC's an implicit obligation. Results of the contract must contribute to the present knowledge on the utilization of selected tropical soils.

Specific goals were not defined by the group but the guidelines presented by L. D. Swindale were adopted (Appendix XI). Project leaders in each country would exercise judgement on the type of management experiment to be installed in accordance with the guidelines.

The group also quantified its goals for the crop year 1976-77. When the group meets in the Philippines in July or August of next year every participant is required to bring along a description or results of management experiments conducted for discussion.

J. A. Silva presented the type of management experiment which will be conducted in Hawaii (Appendix XII).

Time off: 6:00 p.m.

P.M.

III. Administration and Coordination

Discussions centered on the interpretation of guidelines set forth in the General and Additional General Provisions of both contracts. Questions that need to be clarified with Contract Management/TAB are those involving the purchase of vehicles and a tractor. For example, Puerto Rico was granted approval to purchase a new vehicle for use in Puerto Rico while a similar request by Hawaii resulted in an approval to buy a used, AID excess property jeep.

It was agreed that approval to purchas items greater than $2500 and requests to waive the Buy American Act usually required more than a month for a response from Contract Management. However, with proper planning this "bottleneck" may be minimized.

Procurement of equipment and supplies for shipment overseas was hindered by a lack of storage facility and some difficulty in obtaining customs clearance in both the Philippines and Indonesia. Government agencies and AID Missions in both countries have aided in facilitating clearance by customs officials.

Any specific problem involving interpretations of the contract and provisions would need to be cleared with Dr. Gill or personnel in Contract Management/TAB.

IV. Future Plans

The next meeting is tentatively scheduled in July or August 1977, in the Philippines.

Prior to the conclusion of the meeting, L. D. Swindale asked each country representative to provide a tentative number of experiments to be installed by next summer. The results are given in Table 1.

Table 1. Tentative Number of Experiments for Crop Year 1976-1977

Type of Experiment	INCEPTISOL Hydric Dystrandepts			ULTISOL		OXISOL Tropeptic Eutrustox			OXISOL Tropeptic Haplustox		Total
	Phil	Hawaii	Indo	Phil	Indo	Hawaii	Puerto Rico	Brazil	Puerto Rico	Brazil	
Transfer, maize	6	6	6	2	-	2	4	6	1	4	37
Variety, maize	2	2	1	0	-	1	2	2	0	1	11
Management, maize	2	2	1	0	-	1	2	3	1	1	13
Transfer, soybean	2	4	3	1	-	1	4	4	1	2	22
Variety, soybean	1	1	1	0	-	0	0	2	0	1	6
Management, soybean	1	0	0	0	-	0	2	1	0	0	4
TOTAL	14	15	12	3	-	5	14	18	3	9	93

F. H. Beinroth summarized the highlights of the First Annual Coordination Meeting. He regretted that Dr. L. D. Swindale will be no longer involved with the projects and expressed the hope that the project will nevertheless continue to benefit from Dr. Swindale's advice and expertise. F. H. Beinroth thanked the participants for their active role in the discussions and adjourned the meeting at 6:15 p.m.

August 20, 1976

A.M. - P.M.

Field Trip

A field trip was scheduled on the last day of the meeting to allow project participants to view the site activities of the Puerto Rico group. Two sites were established on the Coto series of the clayey, kaolinitic, isohyperthermic family of Tropeptic Eutrustox at the UPR Isabela Experiment Station. After a slide presentation of project activities by J. Badillo, the group inspected an exposed profile of the Coto series which was described by F. H. Beinroth.

The group also visited with Dr. E. H. Paschal of INTSOY and discussed the variety experiments in progress.

Appendix I

STATUS OF THE PUERTO RICO PROJECT

F. H. Beinroth

General

The principal objectives of the University of Puerto Rico's Benchmark Soils Project are (1) 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, (2) to demonstrate that principles of soil management knowledge can be directly transferred at the family level of the U.S. Soil Taxonomy, and (3) to develop a statistical model to verify the concept of agroproduction technology transfer via soil classification.

Secondary objectives of the project are to evaluate the validity of presently used and additional differentiae of soil classification for tropical agriculture, to relate crop production to soil taxonomic units and to soil testing data, and to indicate management alternatives conforming to the economic constraints of small farmers of tropical countries.

The underlying rationale of the Benchmark Soils Project is that soil management knowledge is directly transferable in the tropics on the basis of soil classification. If this hypothesis is substantiated, a strategy for mobilizing and utilizing existing soil management information can be conceived and incorporated in the general model of agrotechnology transfer.

The research strategy to scrutinize the stated hypothesis is to select a number of soils belonging to the same soil family as defined in the U.S. Soil Taxonomy in several countries. A series of identical soil fertility and management experiments are conducted at the selected sites with the intent to demonstrate that the soils at all sites respond similarly to these management practices.

The University of Puerto Rico's contract with the U.S. Agency for International Development (AID/ta-c-1158) became effective on January 1, 1975. The project was assigned to the Department of Agronomy and Soils of UPR's Mayaguez Campus. It is administered in accordance with established university regulations as regards authorities, recruitment of staff, purchasing procedures and fiscal management.

The following professional personnel is currently employed by the Project:

F. H. Beinroth	Principal Investigator, Mayaguez, P. R.
G. L. Spain	Senior Agronomist, Mayaguez, P. R.
J. Badillo	Associate Agronomist, Isabela Station, P. R.
C. E. Seubert	Assistant Agronomist, Jaiba, Brazil
L. C. Sarmiento	Assistant Soil Chemist, Mayaguez, P. R.
L. Calduch	Research Assistant, Isabela Station, P. R.
J. A. Vega Lopez	Research Assistant, Mayaguez, P. R.
L. Costa Mayoral	Research Assistant, Mayaguez, P. R.

Network of Experiment Sites

A. Soils

Tropeptic Eutrustox of the clayey, kaolinitic, isohyperthermic family have been selected for initial experimentation. These soils belong to the group that has been called Laterites, Sols Ferralitiques or Latosols and is referred to as Oxisols in the U. S. Soil Taxonomy. Eutrustox 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.

Tropeptic Eutrustox were chosen for the Project because they are common to both Puerto Rico and Hawaii and thus provide a link between the two Benchmark Soils 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.

B. Countries

Puerto Rico. A primary and two secondary sites have been established in Eutrustox on the grounds of the Isabela Agricultural Experiment Substation of the University of Puerto Rico. This research station is located in the northwestern corner of the island.

Brazil. After considerable field and laboratory investigations, Eutrustox of the desired family were identified on an experiment farm of EPAMIG located in the "Distrito Agro-Industrial de Jaiba", a 300,000 ha development scheme recently opened for colonization by small farmers in northern Minas Gerais. A primary site was staked out there and partially prepared for experimentation. Surrounding areas have been scouted and sampled for secondary sites.

Colombia. Justified expectations to corroborate the existence of kaolinitic Haplustox at the CIAT-ICA research station in Carimagua in the Llanos Orientales did not materialize. Detailed mineralogical studies showed these soils to be of mixed rather than kaolinitic mineralogy. The Carimagua soils, therefore, fail to meet the taxonomic requirements for inclusion in the network Colombian pedologists are uncertain whether kaolinitic Haplustox occur elsewhere in the country.

Venezuela. Preliminary studies showed that suitable Haplustox are to be found near Acarigua and probably Calabozo in the state of Portuguesa. However, this lead could not be pursued further as the individual with the proper technical and administrative authority was absent from the country for a prolonged period.

To date, the efforts made to identify the respective Haplustox and/or Eutrustox in Jamaica and in the Dominican Republic were futile. Whereas Jamaica appears to offer no possibilities for the project, the situation in the Dominican Republic warrants further study. Although none of the Dominican soils that were inspected and analyzed so far qualified, more data are needed to make a definite decision.

Progress and status of field experimentation at the sites in Puerto Rico and Brazil is reported in a subsequent chapter by Dr. G. L. Spain

Linkages

In the course of project implementation and site selection, linkages were established with numerous institutions and individuals in LDC's and in the U. S. In addition to the University of Hawaii, collaborative agreements have been in effect 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. A project agreement was negotiated with EPAMIG in early 1976. The administration and staff of EPAMIG have given the Project excellent cooperation.

International Soybean Program (INSTOY). The Project has developed superior working relationships with INTSOY's plant breeder stationed in Puerto Rico, Dr. E. H. Paschal III, 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. This research is conducted under the leadership of Dr. R. L. Anderson.

Utah State University is assisting the Project in the design and installation of trickle irrigation systems. Dr. Jack Keller will serve as a consultant and visit the experiment sites in Brazil and Puerto Rico.

Future Plans

In view of the relative scarcity of Eutrustox outside Brazil, it appears advisable to consider another family of Oxisols. For various reasons it was decided to include the much more extensive acid analog of the Eutrustox family in the network. These soils are Tropeptic Haplustox of the clayey, kaolinitic, isohyperthermic family. While the only taxonomic difference between the Eutrustox and Haplustox is the degree of base saturation, the management of the latter is considerably more problematic due to aluminum-induced toxicities.

Primary and secondary experiment sites on Haplustox are in the process of being established in Puerto Rico and Brazil. Efforts are being made to locate such soils in Venezuela and/or the Dominican Republic.

A progress and planning review of the UPR Project by an AID-appointed team has been scheduled for February 1977. It is anticipated that changes in the research design pursuant to the recommendations of the review panel will be subsequently implemented.

Appendix II

STATUS OF THE HAWAII PROJECT

L. D. Swindale

Introduction and Objectives

The Benchmark Soils Project of the University of Hawaii was initiated in 1974 under a contract with the United States Agency of International Development.

The goals of the project are to assist tropical countries understand the value of soil classification in formulating agricultural development plans, and to realize the potential of upland areas for intensive cropping.

The initial objectives of the project are to correlate food crop yields on a network of benchmark tropical soils and to determine scientifically the transferability of agroproduction technology among tropical countries.

Additional objectives added as the project develops are to train soils experts in participating countries in soil taxonomy and to aid in the establishment of a tropical soil research network.

Soils

Three soil groups are included in the UH Benchmark Soils Project:

A. Hydric Dystrandepts
One family of soils derived from volcanic ash. The thixotropic isothermic family of Hydric Dystrandepts is being used in all countries participating in the project. Primary and secondary sites on this soil family have been established in Hawaii, the Philippines and Indonesia. Soil explorations and analyses have been initiated in Cameroon, Kenya and Rwanda to find suitable sites.

B. Tropeptic Eutrustox
The soil that will be used in Hawaii to link with Puerto Rico are members of the clayey, kaolinitic, isohyperthermic family of Tropeptic Eutrustox. Several suitable locations have been found and negotiations for leases and access to water supplies are underway.

These soils are probably of very limited extent in Asia. They have not yet been located in Africa, but probably occur. Closely related families of Typic Eutrustox and Tropeptic Haplustox have been found in Rwanda and Kenya.

C. Tropohumults and Tropudults
The extensive red upland soils in humid regions of tropical Asia and Africa are Ultisols. In the warmer parts of these regions the soils are Tropudults; in the cooler parts they are Tropohumults.

Experimental sites will be established on one family of these soils common to the Philippines and Indonesia and hopefully also to Hawaii and the participat-

ing countries in Africa. Soil exploration and investigations to find these sites will commence in September in both the Philippines and Indonesia, and later in Cameroon and Rwanda. A clayey mixed isothermic family of Typic Tropohumults has been found at the Nyanoza Agricultural Research Station in Kenya. This soil may occur in the other countries.

Participating Countries

A. The Philippines

A Memorandum of Agreement has been signed between the Philippine Council of Agriculture and Resources Research (PCARR) and the University of Hawaii covering the operation of the Benchmark Soils Project in the Philippines. The Bureau of Soils in the Philippines has been designated as the main cooperating agency.

Dr. Bernardino G. Cagauan, Jr. has been appointed as UH Project Leader and Dr. Aurelio A. Briones as Philippine Project Leader. Both have completed training programs on project operations and methodologies in Hawaii.

Benchmark sites have been established on Hydric Dystrandepts in the Bicol region, and Transfer Experiments on maize or soybeans and Variety and Management Experiments on maize are underway.

Mr. Cris Escano has been appointed to the first graduate fellowship of the Project and has commenced his graduate training at the University of Hawaii.

Drs. Cagauan and Briones will report in detail on the progress of work in the Philippines.

B. Indonesia

An implementation agreement has been signed between the Soils Research Institute of the Government of Indonesia and the University of Hawaii covering the operation of Benchmark Soils Project in Indonesia. The Institute will be the main cooperating agency.

Mr. I Putu Gedjer Widjaja Adhi has been appointed as the Indonesia Project Leader. A UH Project Leader has yet to be appointed. Mr. Gedjer undertook a brief training program on project operations and methods in Hawaii prior to commencing an AID-USDA program on soil fertility research on the US mainland. This latter program is now complete and he will return to Hawaii to complete his training.

Benchmark sites have been established on Hydric Dystrandepts near Bandung and Bogor. Transfer experiments will commence in November 1976.

Mr. Widjaja-Adhi and Mr. Alan Hurdus, Project Agronomist in Hawaii, who assisted in establishing the Indonesian sites will report in detail on progress in the Indonesian project.

C. Other Participating Countries

Soil explorations have been conducted in several other countries. In Africa; Rwanda, Kenya, Ethiopia, the Sudan, Nigeria and the Cameroon have all expressed interest in participating in the project and have provided information about possible soil families.

Sri Lanka and Thailand have expressed interest in participating when the project is extended to the Ultisols.

The Cook Island, Papua-New Guinea and several Pacific Island nations have also expressed interest in participation. Orthoxic Tropohumults in the same family as the Hawaiian Haiku and Pauwela soil series have been located in the Cooks. Suitable Hydric Dystrandepts exist in Papua-New Guinea.

Progress in Hawaii

Site establishment in Hawaii has already been described. On the Hydric Dystrandepts one set of Transfer experiments on maize and soybeans has been completed at two Benchmark sites, and a second set is underway. Some variety trials on soybeans to select adapted varieties have also been conducted.

A laboratory for chemical, physical and mineralogical analyses has been set up with Mrs. Ada Chu, soil chemist, in charge. The laboratory is able to carry out all the analyses required by the project.

Mr. Alan Hurdus will describe progress in Hawaii in detail and Dr. Silva will analyze the experimental results obtained.

Establishing the Tropical Soils Research Network

The utilization of the Benchmark Soils concept and of soil classification in agricultural development can be promoted through the establishment of a tropical soils research network. To serve this purpose, tropical countries have been asked to provide information on the soils of their agricultural research stations. Responses have been received from most of the countries already mentioned in this report.

Soils of these stations are being classified at the family level and the data and classifications are being stored in the UH soil data bank. The soil family data will be compiled and published and countries with similar soils to the Benchmark Soils Project or to each other will be assisted in establishing contacts and cooperative research.

Utilization

The UH Benchmark Soils Project is funded by AID-Washington and is not directly involved in utilization of project results in individual countries. The Project does however undertake activities that will lead to utilization, and the University of Hawaii would undertake utilization projects if they were proposed and funded by either the government of the interested country or by the AID Mission in the country.

To promote utilization, the UH Project with cosponsorship from the UPR Project, the US Consortium for Tropical Soils, ICRISAT and AID conducted a Seminar on Uses of Soil Survey and Classification in Planning and Implementing Development in the Tropics in Hyderabad, India in January 1976. The conference

brought together soil scientists and government planners from 22 tropical nations. The meeting led to increased appreciation and interest in the benchmark soils concept and the usefulness of soils data.

The project has also been described and discussed at two conferences organized by the East-West Food Institute on the efficient use of fertilizers and at a conference organized by the South Pacific Commission on Soil Survey and Land Use in the Pacific Islands.

The Bureau of Soils of the Philippines has proposed to PCARR the establishment of an extended Benchmark Soils program throughout the Philippines. The University of Hawaii has been asked to assist in the development of this program when it is approved.

The Future

In the near future the project will be established in an African country and on the additional soil families described earlier in this report. The full series of transfer, variety and management experiments will be underway.

Demonstration of soil survey interpretation and land classification techniques using experimental results obtained on the benchmark soils will be initiated.

A review of the UH project has recently been completed by an AID team. The review report recommends that the project be continued for at least 3 years after the initial 3 years are completed in 1977. It also recommends additional sites be established on more extensive soils, that the purpose and design of the management experiments be reviewed by the project staff, and that an augmented training program be undertaken in soil classification, soil interpretation and field plot experimentation.

Appendix III

COUNTRY REPORTS

Hawaii

A. R. Hurdus

At the present time transfer experiments have been installed on two secondary sites located on the Island of Hawaii. Both belong to the thixotropic, isothermic family of the Hydric Dystrandepts and are referred to as the Kukaiau and Halawa sites.

The Kukaiau site was the first to be established and is now fully developed. It is one hectare in area, completely fenced, with six "transfer" blocks. A drip irrigation system and a rather sophisticated array of weather instruments are operational. Tsuji's report will go into detail on the irrigation system, meteorological instruments and the utilization of the data collected.

The Halawa site is now almost fully developed. It is two hectares in area, fenced, with an operational irrigation system and weather station. Three transfer blocks are in use, with three more to be installed this winter.

The first experiment in Hawaii was planted a year ago, on August 8, 1975, and since then an additional seven transfer blocks have been installed. Two maize and one soybean block have already been harvested, while two maize and two soybean blocks are presently in the ground. A cassava block, installed in February of this year, has been abandoned because of unforeseen difficulties.

Maize

Our maize program has so far operated rather smoothly. The major insect pests, cutworms and leaf hoppers, have been kept in check with Diazinon and Sevin. Diseases have presented no problems thus far. Weeds have been controlled with Atrazine, although we will be using an Atrazine-Lasso mixture in the future. Moisture status of the blocks has been maintained at near optimum levels with rainfall and irrigation.

Our management practices for maize have evolved over this first year. Our present thinking is reflected in the "Transfer Experiment Management Practices" paper, which is almost in its final form. We now feel confident that our maize program is well conceived and operational with a minimum of problems.

Soybeans

To date, we have had considerably more difficulty with soybeans than with maize. Our first crop, planted on October 16, 1975, was severely affected by powdery mildew. Furthermore, our planting density and planting date were ill advised. Consequently our yields, not yet fully worked up or analyzed will be very poor.

Because of the severe disease epiphytotic, we decided to install a powdery mildew resistance variety trial adjacent to our infected block. Twenty-three

Table 1

SOYBEAN POWDERY MILDEW TRIAL

EVALUATION

Planted February 25, 1976

VARIETY	MILDEX 5/14	MILDEX 6/3	HEIGHT 5/14	HEIGHT 6/3	COMMENTS
Steele	4	4	22		some beans
Hodgson	5	5	18		all immature beans, no yield
Hill	1	1	28		upper leaf chlorosis, rose beetle susceptibility, excellent yield
Ada	1	1	24		early maturity, mod. yield
Ransom	4	4	20		heavy mildew but some yield
Davis	2	2	28		very slight mildew, good yield
Culter 71	1	1	20		mod. yield, many immature pods
Hutton	2	2	12		very slight mildew, poor yield
Calland	3	3-4	17		heavy mildew older leaves, very early maturity, poor yield
Cobb	2	2	19		heavy mech. damage, poor yield
Bragg	2	2	12		heavy mech. damage, poor yield
Lee 68	1	1-2	13		susceptibility to rose beetle, poor yield
Norman	4	4	19		many immature pods, poor yield
Pomona	2	1	23		no mildew, mod. yield
Kahala	3	3	34		heavy mildew older leaves, fair to good yiel
Amsoy 71	4	4-5	13		poor yield
SRF 450	1	1	20		poor to mod. yield
Wayne	2	2	15		many immature pods, poor yield
Williams	1	1	17		moderate--good yield
Evans	2	2	12		no yield
Forrest	2	1	20		upper leaf chlorosis, good yield
SRF 350	1	1	18		early maturity, mod. yield
Wells	3	3-4	17		susceptibility to rose beetle, poor yield

1 = no mildew
5 = severe mildew

Best Yielders*
1. Hill
2. Davis
3. Kahala
4. Forrest
5. Pomona and Culter 71

*Based on visual evaluation only

entries were included in unreplicated two row plots. Best yielders included Hill, Davis, Kahala, Forrest, Pamona and Culter 71. There were no apparent effects from Diazinon on all varieties. A complete evaluation of the trial appears in Table 1.

We have also installed powdery mildew resistance trials adjacent to the two soybean transfer blocks presently in the ground. We have included four varieties with known powdery mildew resistance - Dunn, Swift, Rampage and Chippewa 64 - obtained from the University of Wisconsin. Since the disease has been absent from our plots this summer we will not be able to evaluate resistance. However, these varieties do not seem agronomically suitable for our conditions.

Based upon the results of the INTSOY international soybean variety trials we decided to try the variety Jupiter in a transfer block. We managed to obtain sufficient seed from the University of Florida. The crop is presently growing at our Halawa site and thus far appears to be doing well. We expect to harvest in October.

Our summer planting of Kahala soybean at our Kukaiau site is doing very well. No incidence of powdery mildew has appeared. We applied Benlate as a foliar spray twice thus far as a preventive measure. We expect to harvest this block in September.

Other aspects of our soybean program have proved very successful. Excellent weed control has been obtained with a mixture of Lasso and Lorox applied pre-emerge. Cutworms have been controlled with Diazinon and rose beetle damage has been kept at a minimum with application of Sevin.

Cassava and Irish Potato

Cassava has been abandoned because of our failure with the crop during our first go-round. We strongly suspect a residual herbicide as the cause of the failure, although strong trade winds have not been ruled out.

We have decided to replace cassava with Irish potato. We hope to have a transfer block installed by September or October. We also intend to put in a potato variety trial during this period on our primary Dystrandept site.

We will be using either the variety Kennebeck or Nooksak in our transfer blocks, each of which has been grown successfully in Hawaii. We have decided to go with mainland rather than locally developed varieties because of the more regular seed supply of the former.

Potato, like cassava, is a root crop and gives us the combination - grain, legume, root crop - that we initially thought desirable. Furthermore, Irish potatoes are quite extensively grown on these soils in Indonesia and are also more likely to be given higher levels of inputs by LDC small farmers than cassava.

The foregoing was intended as a brief rundown of where we are in Hawaii right now and how we got here. The final sections of this report deal with our future research plans and site development schedules.

Future Research

Transfer Experiments - We intend to continue with our transfer experiments at each site for at least four cycles per crop, with summer and winter plantings

each year. On our secondary sites we will return to the previous year's block for each crop; we will thus be able to assess residual phosphorus. At our primary sites we will most likely use different blocks each season.

Variety Experiments - Since we developed our secondary Dystrandept sites before our primary site we were unable to follow up on our intention to run variety experiments prior to the transfer experiments. This winter we will begin our variety experiments using two levels of phosphorus (-.85 and 0 ppm P) and low levels of lime (-.85 and 0) in a split-plot design. This type of experiment will insure that the best locally adapted variety is not one that does not respond to our treatments.

Management Experiments - We are also eager to begin our management research as soon as possible. We hope that this meeting will produce a consensus on the approach to this aspect of the Benchmark Soils Project.

Site Development

Hydric Dystrandept - We are presently establishing our primary site, known as Iole. The Iole site is 28 acres in area and is now being fenced. We are also constructing a water way and contour ditch for runoff diversion and finalizing our irrigation system arrangements. We expect to be ready to install our first experiments - variety trials - by September or October of this year.

Tropeptic Eutrustox - Three sites on the clayey, kaolinitic family of the Tropeptic Eutrustox are presently being negotiated for. Two of these sites are on the Island of Oahu and the other is on the Island of Molokai. Our goal is to have at least one of these sites operational by the end of the calendar year followed by the other two in early '77.

Family of Ultisols - The possibility of establishing Ultisol sites in Hawaii exists, although this will no doubt be done after our Oxisol sites are established, if at all.

Indonesia

A. R. Hurdus

The Implementation Agreement between the University of Hawaii and the Soils Research Institute, Bogor, Indonesia was formally signed in April of this year. At that time Mr. I Putu Gedjer Widjaja-Adhi (Project Coordinator) and I spent three hectic weeks selecting experimental sites, working out lease arrangements, laying out plots and collecting soil samples. The results of that activity are summarized below.

The basic principles of the lease arrangements for our primary Hydric Dystrandept site were worked out with the Institut Theologica and Keguruan Advent (I.T.K.A.), a Seventh Day Adventist school outside of Lembang. After field preparation, we staked out two transfer blocks and collected soil samples. Those samples were shipped to Hawaii for P analysis.

Three secondary sites are called for in the Implementation Agreement. In the Lembang area (the vicinity of the primary site), we chose the Pusat Latihan Pertanian, Kayuambon (PLP), Lembang, an agricultural extension in-service

training center as a secondary site. Mr. T. O. Onosumarna, the head of the facility was very eager to have us conduct our research there. Our work would be beneficial to the training of extension workers and generally upgrade the center. A hand tractor with plow and rotovator as well as a pump would be made available for our use. Fields (terraces) are large enough for complete blocks of the transfer experiments and a guest house is available for project personnel. Two terraces at PLP were plowed and rotovated in accordance with our instructions. Plots were staked out and soil samples taken from two transfer blocks. Samples were duplicated, with one set for analysis at the Soils Research Institute and the other set shipped to the University of Hawaii. Analysis of these samples has also been completed.

In the Pengalengan area, about 60 km south of our primary and secondary sites in Lembang, we examined the Malabar Tea Estate as a possible secondary site. Water is available but must be pumped up. Security will be excellent here. However, if the plot turns out to be unsuitable because of a shallow or eroded phase, we will use land in Pengalengan desa (village). Roads to this site are very poor, and water availability in the dry season may be a problem. The desa has agreed to our use of the land if we so desire.

In the Pacet area, about 65 km east of our primary and secondary sites in Lembang, we chose the Segunung Horticultural Research Station as a secondary site. Although terraces are on the small side, irrigation pipes are already set up throughout the station. If this site cannot be secured we will use the Cipanas Horticultural Research Station.

Since that initial burst of activity in April, our Indonesian program has been at a standstill. Mr. Gedjer spent two weeks with us in Hawaii in the middle of May and has been involved in a three month AID sponsored soil testing program on the mainland since then. He will be returning to Hawaii after this meeting for another few weeks training before proceeding to Indonesia.

Mr. Gedjer's absence from Indonesia and our inability to hire a University of Hawaii Indonesia Project Leader are the reasons for our bottleneck. We are now in the final stages of selecting someone for the Project Leader position. We hope, therefore, to begin our experimentation during the fall and have all Hydric Dystrandept sites operational by the end of the year.

Dr. Swindale will spend a few months in Indonesia this Fall looking for likely Ultisol sites on Sumatra and Java.

The "climate" for the operation of the Benchmark Soils Project in Indonesia appears to be good. The Soils Research Institute is enthusiastic about the project and will be of considerable help in its smooth implementation. USAID/Indonesia has agreed to provide logistical support to the project in matters of importation of needed equipment and supplies. Once our staffing has been completed we should be able to operate smoothly.

Philippines

A. A. Briones

The Benchmark Soils Project is now well on its way boosted by the signs of early responses to imposed treatments for the first cropping under the auspices

of this project in the Philippines. Comments of some authorities in agricultural development indicate optimism and expectations of the possible impact the project may make to Philippine agriculture in general and to the Bicol requirements in particular.

Agricultural research in the country was given the major task of answering the more immediate food requirements of a growing population. Such activities are widely recognized and considered one of the country's strengths in developmental efforts. The government structure, including the Departments (Ministries) of Agriculture and Natural Resources with its various bureaus, have contributed their efforts to reach this stage. Of the government institutions that spearheaded agricultural research as far back as more than fifty years ago, the College of Agriculture at University of Philippines, Los Banos is in the forefront. Past administrators and their staff have transformed the University into a leading agricultural institution in Southeast Asia.

The proliferation of agencies and institutes that materialized in the past to take part in agricultural research also resulted to duplication of work and fragmentation of programs. Long range planning although recognized can not gain foothold when planners and implementors from various agencies multiply with only a minimum of coordination among each other. The situation does not only promote dissipation of scarce technical manpower but also of limited funds. At a time when national development has to accelerate in order to keep pace with increase in population, time lost in dissipated efforts is a major drawback.

Recognizing this situation, the government encouraged the formation of another agency whose principal function is to plan agricultural research relevant to the needs of the country, coordinate these activities among various agencies involved, monitor such activities constantly and when necessary, manage directly the research to be undertaken. This agency, formed in 1972, is now known as the Philippine Council for Agriculture and Resources Research (PCARR). To the extent allowed by its present manpower resources, this agency was able to provide direction to research programs and expected coordination in agriculture, forestry, and mining, involving expenditures of about ₱100,000,000 (about $13.33 million) for the present calendar year 1976-1977.[1/]

Skepticism concerning bureaucratic red tape that usually accompany formation of a new agency are now largely dispelled because for the most part PCARR spares no effort to discharge its duties on time and insists on other institutions to minimize delays to facilitate accomplishing set objectives quickly.

This is currently the general situation in the management of agricultural as well as other research in the country. It was also the situation at the time the Benchmark Soils Project was proposed for linkage in the Philippines. The principal project proponent being an academic institution and considering the number of alumni from the University of Hawaii that are presently involved in agricultural work at the University of the Philippines at Los Banos, this institution appears a natural sounding board for the project's initial attempts for connection.

As members of the staff of a Department of Soil Science, response to participate in a proposal on "Crop Production and Land Capabilities of a Network

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1/ Personal communication with Dr. J. C. Madamba, Director-General, PCARR

of Tropical Soil Families" was immediate and enthusiastic. But some of the project's details involving the use of the present concepts of soil taxonomy is one cause to reconsider such proposal. One reason is that the present soil taxonomy has not yet been widely used in this part of the world or has its value in research been tested and appreciated. But more than the impressing meaning that soil taxonomic terms may convey, the objective on technology transfer using soil classification as a base has not yet been tried to the extent proposed, nor has any related proposal by local workers been supported by funding organizations in the country.

When basic classification information as the soil family and its properties is to be used in conjunction with fertilizer and lime application calculated from adsorption isotherms and exchangeable aluminum, respectively, such an approach requires re-orientation for reseachers who are used to conducting conventional agronomic experiments to detect responses of crops to added fertilizer and lime. On the other hand, the proposal offers an opportunity to accelerate expansion of soil research in the country and on a personal basis, a challenge to understand the workable concepts of fertilizer and lime additions in relation to properties of particular soil families.

Soil Science Activities in the Philippines

There are a number of important studies already conducted relating specific properties of certain soils and agronomic responses of crops. Such results have been used and continue to be used as guides in recommending what kind and to some extent, how much fertilizers and lime to apply. Rice and corn are the principal grain crops where substantial local data exist about their management. The accumulation of information allows publication of the Philippine Recommends for Rice, for instance, with the note that such publication is subject to change as new information are gathered.

In this soil science-agronomic activity, both the Department of Soil Science at U.P. Los Banos and the Philippine Bureau of Soils have certain contributions. Important as this work may be, it lacks the structure and the basis that will unify them so that a more permanent and viable reference for agricultural planning and production is established.

The Benchmark Soils Project provides one of the approaches to unification through a proper and workable classification of soils. The proponents however have stressed that the project is in no position to face such soil classification problems singlehanded although it can provide insights on how an adequate classification is conducted for tropical soils and how transfer of technology can be effected within similar category of soils classified. At the time the project is successfully terminated, it is expected that sufficient additional guidelines have been established to conduct national activities in this direction.

There are now an increasing number of persons conversant about specific fields in agriculture including soil science. But these are still few in number and even fewer in the case of persons inclined to soil classification work. For the project to gain a more permanent foothold in cooperating countries and spread its philosophy to a wider scale, one direction is in providing interested persons opportunities to understand the subject matter and along with national agencies that determine allocation of funds, assist to plan multiple projects concerning classification of different groups of soils in that country. This is an assessment of the extent to which the project is capable of accomplishing.

The Project in the Philippines

The Project Leader of the University of Hawaii to the Philippine operations has presented in detail the contrasting behavior of plants responding to the treatments imposed as expected. Favored with continuous fair weather, such field demonstrations are likely to be duplicated by the harvest data expected during the early part of September. Many hands made this possible and even more number of heads allowed such a demonstration to come about.

The Director-General of PCARR as well as other officials of this organization fully supports the objectives of the project. Pictures such as these shown of plant performance in the field can impress planners and PCARR awaits recommendations from the project for a broader scope of application. Caution however demands that such results have to wait further confirmation using, for instance, an increased number of soil families. In addition to this, the present acting Director of the Philippine Bureau of Soils is interested to participate directly in project activities and has allowed the involvement of his two staff members whose station is near our experimental sites in the Bicol area.

The Bureau of Soils or any similar organization is a natural link for projects of this nature in the country of interest. But given the general set-up of what the Bureau is now, the need has been seen to increase competence of its personnel in soil classification work. This is the area of activity where this agency is expected to contribute the needed inputs for an extensive and detailed classification of agricultural soils of the country. At the present time, only a reconnaissance survey of soils had been made while the more recent approximation that attempted to use the concepts of soil taxonomy is not specific enough to be of significant use to agriculture, not to mention the need to review such work more rigorously. Dr. Frank R. Moorman[2/] suggested a revision is not a revamp of the present soil classification of the country.

This situation can not be more tailor-made than what it now appears for the project to have an added impact. It is conceivable that the project can formulate a soil classification training package specific to the country's condition with the results of training to be gauged on actual field application to produce soil maps with interpretation as one form of accomplishment.

The known intention of the project in the Philippines was to have the U.P. at Los Banos participate actively in the work in addition to PCARR as the coordinating agency. While this plan did not materialize to the extent expected, for some unknown reasons or another, it is not construed as the final position of interested personnel of this institution with respect to the project. Also, this writer is still with the University on "loan" part of the day to PCARR to perform the duties of a counterpart Project Leader.

A meeting with Dr. Onofre D. Corpuz, (July 21, 1976) current President of the University of the Philippines Systems, soon after this participant's orientation and training at Honolulu, dealt principally with the project and its past attempts of establishing a relationship with Los Banos. There was no indication of disagreement with the objectives of the project and President Corpuz even confirmed the importance of soil science in an over-all planning for development.

[2/] Invited Professorial Lecturer at UPLB in a seminar-lecture series at the Department of Soils Science, 1st Semester, 1976.

This came about because of the need to provide workable development plans for an expected increase in population for the Greater Manila Area alone reaching the 26 million mark at the year 2000.

No further discussions involving the project interests were made at that time but at least the highest authority in the University is now aware of the presence of the project in the country along with some of its current problems. In this connection, the present Chairman of UPLB Department of Soil Science has indicated willingness to attempt to deal directly with the project for studies that his department is competent to undertake.

In summary, the project is in a position to increase and strengthen linkages necessary to accomplish its objectives and at the same time achieve meaningful contribution towards effective agricultural planning and establish mutually beneficial interchange with soil science workers in particular.

The Project and the Immediate Future

Although less than six months have passed since the actual implementation of the project, necessary understanding with certain government agencies have been established to facilitate customs and tariff matters in compliance with the memorandum of agreement. Administrative and other forms of assistance from the host institution will continue to be extended on behalf of the project in the Philippines. Interest and cooperation of other local institutions have been developing and partially being achieved, respectively, in the expectation of the project. Thus, it may be stated that the way has been paved to consider accelerated implementation of the project in the Philippines. In this, focus may be directed to the following as immediate concerns.

1. Given the state of the art of soil classification in the Philippines and considering the performance of plants in our experiments that will confirm validity of soil family classification and agro-technology transfer, the project can take this opportunity to provide additional directions that will furnish technical training to key personnel responsible for conducting this work in the Philippines. A relationship between the Benchmark Project Philippines-PCARR, and the Bureau of Soils is now being explored. The effectivity of this set-up may be tested in conjunction with the incoming visit of a Soil Survey Consultant of the Project to the Philippines to identify and locate the Ultisol sites.

The training program generated from this relationship and the immediate reaction of all concerned toward conducting classification research after the training will provide further insights to crystallize an improved program on soil classification and interpretation involving the major soils of the country. To do this will require inclusion of a major objective to the project which has to deal with a training program to increase the research capability of concerned institutions to conduct soil classification using the concepts and requirements of soil taxonomy. When this objective is achieved such a group of trained personnel will then be given opportunity by local funding organizations (such as PCARR) to conduct precisely this type of work, considered top priority in soil research of the country.

2. Granting a cooperative weather and other elements, confirmation of the hypothesis of transfer of technology may be obtained within a period of two years for the given soil family. This gain will provide preliminary directions to extend the type of studies to more soil families equally if not more important to the host country. The classification, extent and distribution of these soils

will be established as a result of the training program component of the Project. Whenever possible, experimental sites should be located in other regions such as Southern Luzon, an area expected to absorb a substantial increase in population in the coming years.

3. The management experiments of the project hopes to establish immediate relevance of the project not only to the host institution but also to surrounding interested farmers. For the case of the Philippine operation, PCARR has considered resource recovery and conservation as a research thrust. Given this direction, a soil family requiring high P application, and the presence of local deposits of guano and rock phosphate, the use of these indigenous resources as experimental variables is fairly indicated in addition to trials using manures. This will increase the number of plots which may not be uniform from one participating country to the next. Analytical problems may arise in collating overall data but such a flexibility in the management experiment is one way of insuring relevance of the project.

The concentration of project activities just mentioned focuses both on the sector of national planners and researchers on one hand, and attention to immediate problems of farmers surrounding experimental site on the other. Hopefully a meeting between these sectors is achieved as quickly as feasible in which event, the Project has materially contributed.

Puerto Rico

G. L. Spain

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 recorded, for 10m x 10m plots ranged from 1141 kg/ha (17 bu/A) to 2249 kg/ha (33.5 bu/A) indicating considerable variability across the entire site (2.2 ha). But, in general the area appeared reasonably uniform for use as a primary site.

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.

Two transfer experiments, one with maize (Pioneer hybrid X306B) and the other with soybeans (variety Jupiter), were harvested early in August at the primary site. Yield data from these experiments are shown in tables 1 and 2. Two more transfer experiments were planted to maize (X306B) and soybean (variety Hardee, late selection) in July at the secondary site at Isabela. In May and early in July two maize variety - phosphorus level trials were planted at the primary site.

Certain treatments resulted in considerable lodging in the first two transfer experiments. However, this adverse effect was not brought on by the same treatments for each crop. Lodging of the soybeans was clearly associated with medium to high levels of phosphorus, whereas in the maize experiment severe

Table 1. Maize Yield Data for an Experiment Planted April 2, 1976 at Isabela, Puerto Rico and Harvested August 6. All values are means of three replications.

	Treatment		Ear Measurements						Grain Yield Adjusted to 15.5%H_2O	
	P	K	Total Count no.	Total Weight g	Mean Weight g	Mean Length cm	Grain Index[1/]	100-Seed Weight g	kg/ha	bu/A
A	-0.85	-0.85	34.7	7857	227	13.8	.807	46.2	9400	150
B	-0.85	+0.85	34.3	8142	237	15.1	.803	44.6	9843	157
C	+0.85	-0.85	36.0	8658	240	14.4	.803	45.9	10375	165
D	+0.85	+0.85	35.0	8065	250	13.5	.809	42.2	9750	155
E	-0.40	-0.40	35.7	8704	244	15.2	.798	47.3	10377	165
F	-0.40	+0.40	34.3	9378	273	14.6	.802	46.3	11112	177
G	+0.40	-0.40	35.3	9418	266	15.0	.808	44.0	11287	180
H	+0.40	+0.40	35.0	9465	270	14.6	.809	44.9	11441	182
J	0	0	34.7	8901	257	15.4	.802	48.9	10560	168
K	-0.85	0	34.7	8951	258	15.2	.798	47.2	10565	168
L	+0.85	0	35.3	9257	262	14.9	.808	47.4	11080	176
M	0	-0.85	34.0	9728	286	15.2	.800	47.3	11515	183
N	0	+0.85	36.0	9554	265	14.9	.793	49.0	11134	177
O	Complete Control		34.0	5804	171	11.2	.792	41.2	6590	105
P	Partial Control		34.7	7404	214	13.5	.798	49.4	8526	136

1/ Grain index - grain weight ÷ ear weight.

Table 2. Soybean Yield Data from an Experiment Planted March 5, 1976 at Isabela, Puerto Rico and Harvested August 3. All values are means of three replications

	Treatment		Plant Height	Plant[1/] Weight	Grain Weight	Harvest Index[2/]	100-Seed Weight	Grain Moisture	Grain Yield	
	P	K	cm	g/plot	g/plot		g	%	kg/ha	bu/A
A	-0.85	-0.85	80.3	3419	779	.228	14.07	10.53	1298	19.28
B	-0.85	+0.85	73.4	3321	417	.124	11.10	10.77	695	10.32
C	+0.85	-0.85	87.3	3108	520	.166	13.20	10.53	867	12.87
D	+0.85	+0.85	82.0	3727	490	.132	13.27	10.63	817	12.13
E	-0.40	-0.40	84.9	3515	641	.182	13.47	10.50	1068	15.86
F	-0.40	+0.40	86.0	3772	542	.144	12.00	10.80	903	13.41
G	+0.40	-0.40	88.7	3204	536	.168	13.20	10.53	893	13.26
H	+0.40	+0.40	82.4	3252	431	.134	12.87	11.10	718	10.66
J	0	0	80.3	3194	581	.178	13.57	10.63	968	14.37
K	-0.85	0	78.3	3191	528	.165	12.01	10.90	880	13.07
L	+0.85	0	89.5	3292	410	.124	13.20	10.67	683	10.14
M	0	-0.85	86.0	3155	578	.185	13.53	10.63	963	14.30
N	0	+0.85	84.5	3459	503	.146	12.30	10.67	838	12.44
O	Complete Control		79.9	2889	566	.197	12.97	10.77	943	14.00
P	Partial Control		70.8	3050	531	.174	12.10	10.77	885	13.14

1/ Plant weight includes the total harvest portion of the plants before threshing.

2/ Harvest index = threshed grain weight ÷ plant weight.

early lodging of the plants occurred at low phosphorus levels. Later in the season lodging became more problematic and a single storm at near maturity caused severe lodging throughout the maize experiment. The same storm provided a test for lodging resistance among 16 varieties in one of the maize variety - phosphorus level trials (table 3). The tendency among some varieties to lodge already appears to be a critical factor in their selection for use in transfer trials as well as for commercial use by local growers.

As is evidenced by plant height data there was an early positive growth response to phosphorus applications by both maize and soybeans. This effect,

Table 3. Maize Yield and Lodging Data from a Variety-Phosphorus Level Trial Planted May 14, 1976 at Isabela, Puerto Rico and harvested August 30. Yield values are means of three replications. The percent lodged plants are for three replicates combined.

	"Optimum" Phosphorus (P 0)			"Low" Phosphorus (P -.85)		
	Grain Yield		Plants Lodged	Grain Yield		Plants Lodged
Variety	Rank	kg/ha	%	Rank	kg/ha	%
Pioneer X304C	1	10210	1	1	9354	4
Pioneer X304B	2	9479	7	3	8435	28
Hawaii H638	3	8749	39	5	7880	39
Pioneer X105A	4	8671	28	6	7700	43
Philippines UPCA-1	5	8438	20	11	6861	15
Pioneer X304A	6	8181	51	2	8518	24
Hawaii H652	7	8081	33	4	7957	27
Hawaii H788	8	8051	47	9	7267	59
Mexico INIAH507	9	7718	51	14	6399	48
Pioneer X306B	10	7708	47	7	7667	44
Honduras H5	11	7551	67	13	6506	73
Diente de Caballo	12	6923	48	10	7010	41
Hawaii H610	13	6792	29	8	7396	12
Mayorbela	14	6624	27	12	6719	17
Philippines DMR	15	6621	11	15	6183	32
Oaxaca 179	16	4930	21	16	4395	24

however, was less apparent in later observations. The 30-day and mature plant height data for maize are shown in table 4. In the soybean transfer experiment Anthracnose (Colletotricum dematrium var. truncata) caused complete defoliation of the plants about 2 weeks before physiological maturity resulting in severely reduced pod fill, seed size and total yield. Other disease and insect problems were not so serious or were easily controlled. Insecticides were applied to control southern green stinkbugs (Nezara viridula) lesser cornstalk borer (Elasmopalpus lignosellus), bean leaf bettle (Cerotoma trifurcata) and a sugarcane bettle (Diaprepes abbreviatus).

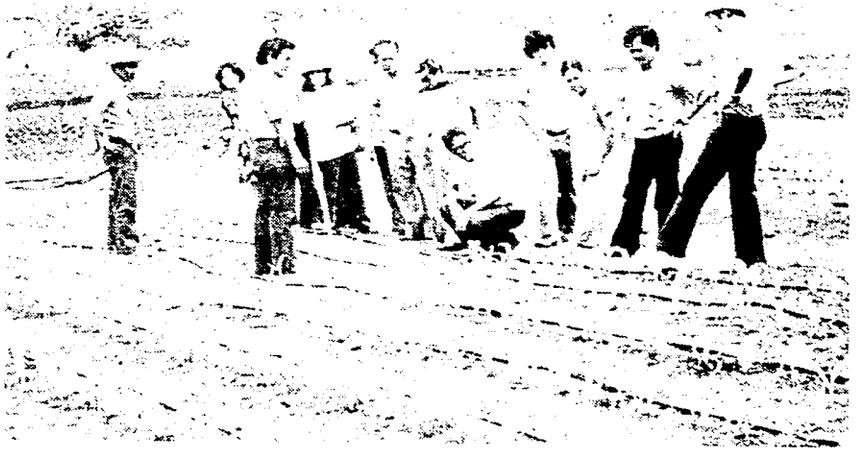
The existing weather station at the Isabela Experiment Substation has been supplemented to include a solar radiometer and a continuous recording hygrothermograph with extra thermometers and a sling psychrometer for its occasional calibration. A rain gauge and soil temperature probes have been located in the field at the primary site.

Table 4. Maize Plant Heights Measured at 30 Days after Planting and at Mature Height at Isabela, Puerto Rico. All values are means of three replications.

	Treatment		Mean Plant Height	
	P	K	30-day	Mature
			cm	
A	-0.85	-0.85	94	310
B	-0.85	+0.85	98	319
C	+0.85	-0.85	124	277
D	+0.85	+0.85	121	316
E	-0.40	-0.40	112	302
F	-0.40	+0.40	118	316
G	+0.40	-0.40	123	303
H	+0.40	+0.40	118	320
J	0	0	123	312
K	-0.85	0	89	286
L	+0.85	0	116	303
M	0	-0.85	109	300
N	0	+0.85	115	281
O	Complete Control		49	275
P	Partial Control		62	307

Puerto Rico

Philippines



CROP RESPONSE IN TRANSFER EXPERIMENTS

Hawaii

Philippines

Appendix IV

HAWAII TRANSFER EXPERIMENTS - ANALYSIS OF INITIAL YIELD DATA

J. A. Silva

Two transfer experiments with maize have been harvested from the Hydric Dystrandept sites in Hawaii to date. The first was a late summer planting (August) on the Kukaiau sites at Honokaa and the other a fall planting (October) on the Niulii site in Halawa 15. These crops were planted as soon as the sites could be prepared so as to gain experience with the experimental approach and the crops in Hawaii. Plantings are being made in May-June for the dry season (summer) crop and in December-January for the wet season (winter) crop once sites are fully established.

A crop of soybeans was planted in the fall (October) on the Kukaiau site and was harvested in March. However, a severe outbreak of powdery mildew greatly reduced growth and yields. In addition, the planting time was less than optimum for soybeans.

Two transfer experiments, one of maize and one of soybeans, have been installed at each of these sites for the dry season crop. They are at or near the tasseling and flowering stage for each crop.

Two transfer experiments, one of maize and one of soybeans, have been installed in the Philippines at the PUC site for the wet season crop and are at the tasseling and flowering stages at present.

The yield results of the two maize experiments harvested already have been punched on IBM cards and preliminary analyses have been completed. Analysis of variance of the data with the original 13 treatments specified by the design of Escobar was carried out as well as with 15 treatments which included the partial control and complete control that were added to provide additional information.

Analysis of Variance

The analyses of variance for grain yields from the Kukaiau site are presented in Table 1 for 13 and 15 treatments. Only the 15 treatment analysis showed significant treatment effects. The means were compared using Bayesian LSD (Table 2) and only treatments which received the lowest P rate (-.85) or no P were significantly different from those which received P with the exception of the -.85 P treatment with +.85 lime which was not significantly different from treatments which received higher levels of P. The -.85 P treatments with the 0 and -.85 lime levels were not significantly different from the controls which did not receive P or lime.

The analyses of variance for grain yields from the Niulii site are shown in Table 3 and there are no significant treatment effects in either the 13 or 15 treatment analysis. It should be noted that a very high coefficient of variation was obtained in the 15 treatment analysis, i.e., 21.6%. However, the C.V. dropped to more normal levels in the 13 treatment analysis, i.e., 13.2% which compares favorably with the C.V. at Kukaiau, 12.1%. There is also

Table 1. ANALYSIS OF VARIANCE OF MAIZE GRAIN YIELDS FROM BLOCK A KUKAIAU SITE PLANTED AUGUST 1975.

13 Treatments				15 Treatments			
Source	df	ms.	cv	Source	df	ms	cv
Reps.	2	319,478		Reps.	2	313,886	
Trtr	12	491,182^{ns}		Trtr	14	1,659,729**	
error	24	507,022	12.1	error	28	509,075	12.7

Table 2. MAIZE GRAIN YIELDS FROM BLOCK A KUKAIAU SITE PLANTED AUGUST 1975

Treatments		Means	
P	Lime	kg/ha*	
+.85	0	6550	a
+.85	-.85	6512	a b
0	0	6136	a b c
-.40	+.40	6102	a b c
+.85	+.85	5953	a b c
+.40	-.40	5949	a b c
-.40	-.40	5916	a b c
0	+.85	5768	a b c
0	-.85	5764	a b c
+.40	+.40	5662	a b c
-.85	+.85	5608	a b c
-.85	-.85	5244	b c d
-.85	0	5217	c d
Partial Control		4064	d
Complete Control		4034	d

* means follows by the same letter are not significantly different from each other at K = 100 (P <.05) by Bayes LSD.

Table 3. ANALYSIS OF VARIANCE OF MAIZE GRAIN YIELDS FROM BLOCK A NIULII SITE PLANTED OCTOBER 1975

13 Treatments				15 Treatments			
Source	df	ms	cv	Source	df	ms	cv
Reps.	2	3,372,478**		Reps.	2	$2,522,345^{ns}$	
Trtr	12	$462,632^{ns}$		Trtr	14	$1,997,607^{ns}$	
error	24	573,150	13.2	error	28	1,404,495	21.6

a large replicate effect at this site which is shown to be significant only in the 13 treatment analysis, largely due to the reduction in the size of the error variance.

Regression Analysis

Preliminary regression analysis was performed on the yield data using the Step-wise Regression Technique. The independent variables considered were P coded, Lime coded, P in solution, P applied in kg/ha, Lime applied in kg/ha as well as the square and square root transformations of P in solution, P applied and Lime applied. The dependent variables were grain yields which are presented here and also stover yields. No attempt was made to construct a "best prediction equation" at this time.

Regression equations were derived for the 13 treatments specified by the design as well as for all 15 treatments. The regression equations for the two sites considering only the 13 design treatments are given below.

Kukaiau

$$Y = 5030.10 + 4001.69\ (\text{P soln})^{\frac{1}{2}} \qquad (1)$$

$$R = 0.423^{**} \quad R^2 = 0.179$$

Niulii

$$Y = 4969.55 + 3652.13\ (\text{P soln})^{\frac{1}{2}} \qquad (2)$$

$$R = 0.327^{*} \quad R^2 = 0.107$$

$$Y = 2795.23 + 9673.54\ (\text{P soln})^{\frac{1}{2}} - 0.00325\ (\text{P kg/ha})^2 + 104.54\ (\text{P kg/ha})^{\frac{1}{2}} \qquad (3)$$

$$R = 0.459^{**} \quad R^2 = 0.210$$

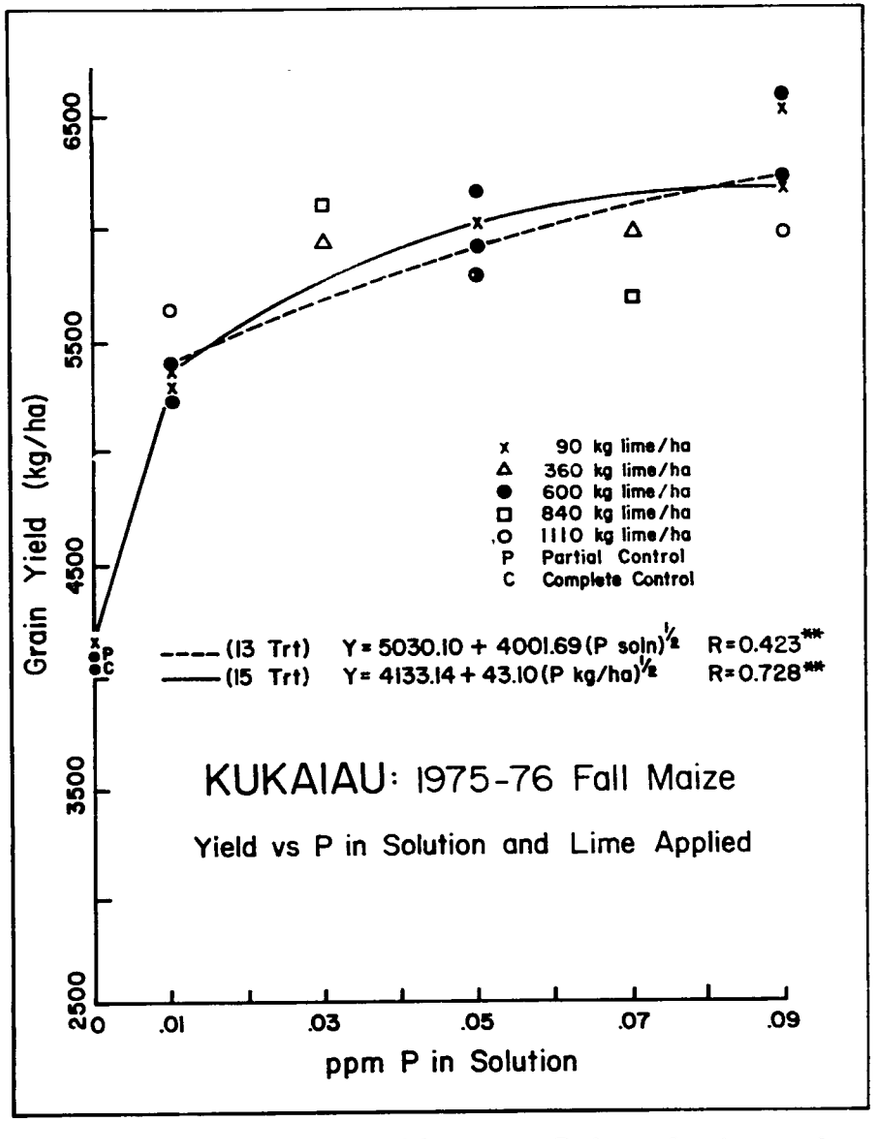


Fig. 1 Maize grain yield versus P in solution and lime applied at secondary site, Kukaiau, Hawaii.

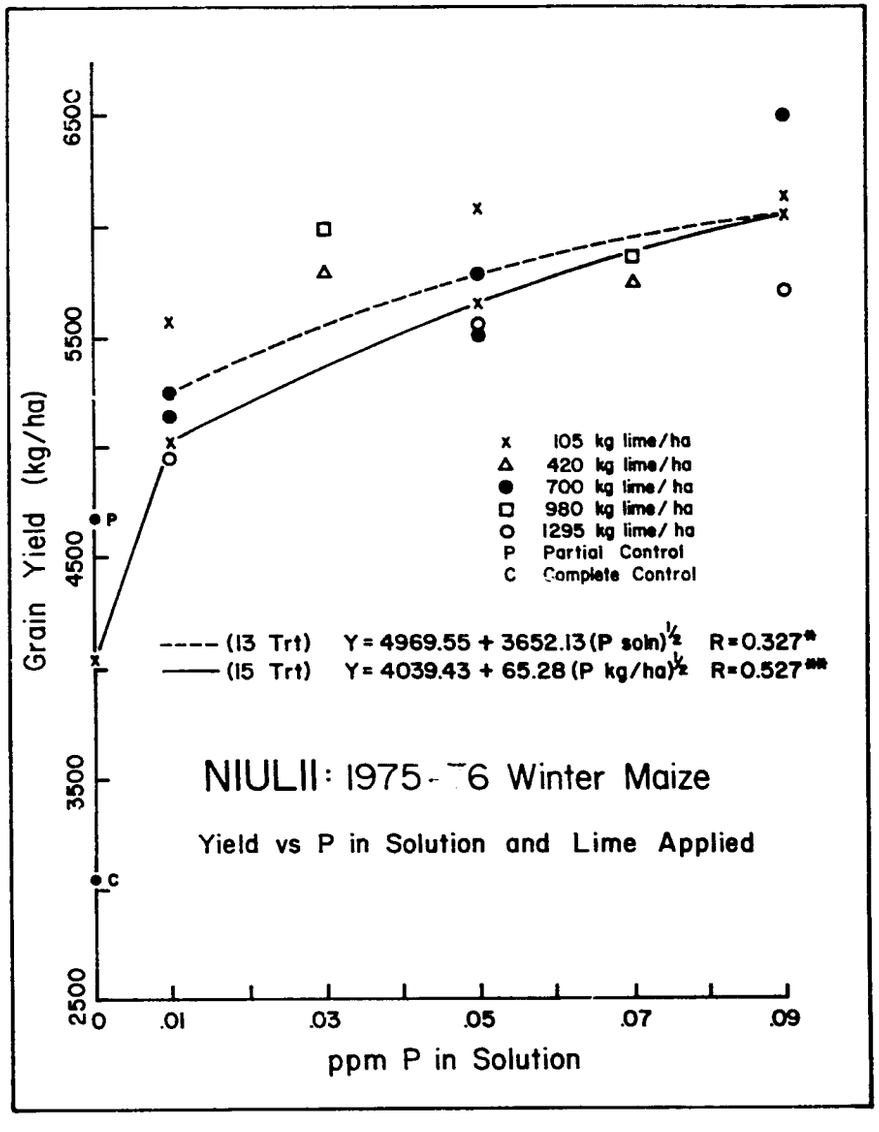


Fig. 2 Maize grain yield versus P in solution and lime applied at secondary site, Niulii, Hawaii.

The first equations for each site include the same number of independent variables and are very similar in the size of the constant and also the coefficient for (P in solution)$^{\frac{1}{2}}$, but they differ somewhat in the correlation coefficient and R^2 values. Niulii has lower R and R^2 values than Kukaiau. If variables were allowed to enter the regression equation only if the "F to enter" was 1.0 or greater, equation (3) for Niulii is obtained. It includes variables for applied P and the correlation coefficient and R^2 increased considerably, although none of the equations accounted for more than 21% of the variation in grain yield.

Regression equations for the two sites which consider all 15 treatments are shown below for 1 variable in the equation.

<u>Kukaiau</u>

$$Y = 4133.14 + 43.10\ (P\ kg/ha)^{\frac{1}{2}} \qquad (4)$$

$$R = 0.728^{**} \quad R^2 = 0.530$$

<u>Niulii</u>

$$Y = 4039.43 + 65.28\ (P\ kg/ha)^{\frac{1}{2}} \qquad (5)$$

$$R = 0.527^{**} \quad R^2 = 0.278$$

Regression equations for the two sites which consider all 15 treatments are shown below for more than 1 variable in the equation.

<u>Kukaiau</u> (F to enter = 0.01)

$$Y = 4351.91 + 66.85\ (P\ kg/ha)^{\frac{1}{2}} - 0.692\ (P\ kg/ha) + 312.38\ (P\ coded) \qquad (6)$$

$$R = 0.740^{**} \quad R^2 = 0.548$$

<u>Niulii</u> (F to enter = 1.00)

$$Y = 5354.29 + 133.79\ (P\ kg/ha)^{\frac{1}{2}} - 0.0046\ (P\ kg/ha)^2 + 1558.24\ (P\ coded) - 22.24\ (lime\ kg/ha)^{\frac{1}{2}} \qquad (7)$$

$$R = 0.602^{*} \quad R^2 = 0.362$$

Correlation coefficients are consistently lower in Niulii than in the Kukaiau site suggesting a poorer relationship between yield and the P and lime variables at Niulii. However, it is encouraging to note that the same independent variables occur in the equations for both sites with the exception of equations 6 and 7. It is also interesting to note that no more than 55% of the yield variation at Kukaiau or 36% of the yield variation at Niulii is accounted for in the equations considered here.

Some basic differences are noted in comparing the equations for the 13 and 15 treatment situations.

1. The most important variable is P in solution with 13 treatments, while the most important variable is applied P with 15 treatments.

2. The correlation coefficients are higher with 15 treatments than with 13 treatments.

These differences are largely due to the fact that the yields for the controls are much lower than for the P treatments which gives them much weight in the equation. This results in a greater effect of P applied and also the increased range of values gives apparently better relationships between the variables being considered.

When only the 13 treatments of the original design are considered, P in solution is the most highly correlated variable with grain yield which fits our preconceived ideas of the relationship between these two factors. However, the increase in yield with increasing P in solution is not overly large, presumably because the initial P level(-.85) is too high and is near the plateau of the yield response curve. This raises a question as to the possible modification of the factors which set the intervals in the design, i.e., $\pm.85$ and $\pm.40$. Some change in range is possible by changing the value chosen as the optimum (0), but it doesn't seem wise to depart too far from the value recommended by Fox. The possibility of using a factor of $\pm.90$ or $\pm.95$ to establish the range of P and lime rates should be considered. With $\pm.90$ and the optimum value of 0.05, the range of P in solution is 0.005 to 0.095 ppm, while with $\pm.95$ the range if 0.003 to 0.097 ppm. If this modification would not change the important characteristics of the design, then it may be worth using it.

Appendix V

DESIGN AND ANALYSIS OF EXPERIMENTS AND TESTING OF TRANSFER HYPOTHESIS

F. B. Cady and L. A. Nelson

The regression model used is the following.

$$\hat{y} = b_0 + b_1P + b_2L + b_{12}PL + b_{11}P^2 + b_{22}L^2 \qquad (1)$$

where $b_0 - b_{22}$ are coefficients

P = Coded level of P in solution

L = Coded level of $CaCO_3$ applied.

When this model was used with data from the Kukaiau sites, equation (2) was obtained.

$$\hat{y} = 5963 + 470P - 40L - 388PL - 34P^2 - 196L^2 \qquad (2)$$

The only coefficient in equation (2) which was significant was that for P. The coefficient for PL was just barely significant. The standard error for the coefficient for P is 17 and standard error for the coefficient for L is 174. The lack of significance appeared to be due to the large variance caused largely by the yields of 2 plots which were higher than yields for the same treatments in other reps. The reason for this should be identified, if possible.

Prediction equation (2) was used to calculate yields for Kukaiau and the data are presented in Table 1.

Table 1

Calculated Maize Grain Yields (kg/ha) for Kukaiau Site Using Equation (2)

Lime Applied					
+.85	5607		5786		5917
+.40		5776		6044	
0	5539		5963		6339
-.40		5700		6185	
-.85	5186		5856		6476
	-.85	-.40	0	+.40	+.85
			P in Solution		

These data form a smooth surface that indicates the response to P at different levels of lime and the response to lime at different levels of P.

The prediction equation for the Niulii Site (Halawa) using the same model is given below:

$$\hat{y} = 5832 + 426P - 229L + 36PL - 83P^2 - 154L^2 \qquad (3)$$

Equations (2) and (3) were used to calculate the predicted yields for the respective sites and the data are shown in Table 2 (columns 5 and 6) along with the observed yields (columns 3 and 4). The deviations between the observed and the predicted yields for Kukaiau ($Yk - \hat{Y}k$) and for Niulii ($Yn - \hat{Y}n$) are recorded in columns 8 and 9, respectively. Since coded values were used, the predicted values for Kukaiau may be considered as the predicted (transfer) yields for Niulii using Kukaiau equation (2) as the transfer equation. Similarly Niulii equation (3) may be considered a transfer equation and the predicted values for Niulii are the transfer yields for Kukaiau. The difference between the observed yields at Kukaiau and the transfer yields for Kukaiau predicted with the Niulii Equation (3) are given in column 7, i.e., 5244 - 5518 = -274, for -.85, -.85. The comparable difference between observed and transfer yields at Niulii are given in column 10 in Table 2. A measure of the variance due to predicting yields with these equations may be obtained by taking the sum of squares of the differences between the observed and predicted yields for columns 7, 8, 9 and 10. These values are shown at the bottom of Table 2. A comparison of the variance due to predicting yields with the transfer equation or with the same site prediction equation may be obtained by dividing the sum of the mean squares ($\frac{SS}{n-1}$) for "transfer data" for Kukaiau and Niulii by the sum of the mean squares for "predicted data" for Kukaiau and Niulii.

$$\frac{106,664 + 114,021}{45,562 + 52,885} = 2.24$$

This indicates that the transfer variance is 2.24 times the same-site variance. This value is called the P-statistic and its interpretation is not clear at this time. It is known to follow the F distribution under certain limited conditions, but its general distribution has not been determined. This comparison of transfer and on-site variances is the proposed test of the hypothesis of transferability. More developmental work is to be done on this test, but this example illustrates the approach that is being followed.

If it is desired to include one uncontrolled or site variable such as mean annual soil temperature at 50cm in the equation, data are needed from at least 2 sites to establish the linear effects of this variable. The equation would be the following:

$$\hat{y} = b_0 + b_1P + b_2L + b_{12}PL + b_{11}P^2 + b_{22}L^2 + b_3\text{Soil Temp.} + b_{13}P\text{Soil Temp.} + b_{23}L\text{Soil Temp.} \qquad (4)$$

With 39 observations per experiment per site (13 treatments x 3 reps), this means 78 observations for the controlled variables are needed for estimating equation 4. If an additional site variable such as solar radiation is included in the equation, then at least 4 sites which have a range of levels of these 2 variables are needed. Coefficients for these site variables are estimated best when the sites have the appropriate combinations of high and low levels of these variables as shown in Table 3.

Table 2

Observed and Predicted Maize Yields for Kukaiau and Niulii Sites

Coded Treatments		Observed Yields*		Predicted Yields Using Transfer Equation for the Same Site*		Yield Deviations			
P	L	Yk	Yn	$\hat{Y}n$	$\hat{Y}k$	$Yk-\hat{Y}k(n)$*	$Yk-\hat{Y}k$	$Yn-\hat{Y}n$	$Yn-\hat{Y}n(k)$*
-.85	-.85	5244	5563	5518	5186	-274	58	45	377
0	-.85	5764	6062	5915	5856	-151	-92	147	206
.85	-.85	6512	6140	6191	6476	321	36	-51	-336
-.40	-.40	5915	5792	5720	5700	195	215	72	92
.40	-.40	5948	5727	6050	6185	-102	-237	-323	-458
-.85	0	5217	5202	5409	5539	-192	-322	-207	-337
0	0	6136	5529	5832	5963	304	173	-303	-434
.85	0	6550	6507	6134	6339	416	211	373	168
-.40	.40	6101	5975	5526	5776	575	325	449	199
.40	.40	5662	5856	5878	6044	-216	-382	22	-188
-.85	.85	5608	5017	5077	5607	531	1	60	590
0	.85	5768	5544	5575	5786	243	-18	19	-242
.85	.85	5952	5715	5853	5917	99	35	-138	-202
					(MS of dev)	106,664	45,562	52,885	114,021

*Yk = Observed yields for Kukaiau site
Yn = Observed yields for Niulii site
$\hat{Y}n$ = Predicted yields for Niulii site using Niulii equation
$\hat{Y}k$ = Predicted yields for Kukaiau site using Kukaiau equation
$\hat{Y}k(n)$ = Predicted yields for Kukaiau site using Niulii equation
$\hat{Y}n(k)$ = Predicted yields for Niulii site using Kukaiau equation

$$P = \frac{106,664 + 114,021}{45,562 + 52,885} = 2.24$$

Table 3. Optimum Combinations of Levels of Soil Temperature and Solar Radiation at 4 Sites

	Soil Temperature V1	Solar Radiation V2
Site 1	0	0
2	0	1
3	1	0
4	1	1

where 0 = low level
1 = high level

Table 4. Optimum Combinations of Levels of Soil Temperature, Solar Radiation and Wind at 8 Sites

	Soil Temperature V1	Solar Radiation V2	Wind V3
Site 1	0	0	0
2	0	0	1
3	0	1	0
4	0	1	1
5	1	0	0
6	1	0	1
7	1	1	0
8	1	1	1

where 0 = low level
1 = high level

Similarly, if 3 site variables are to be included there should be 8 combinations of the low and high levels of these variables for proper estimation of the coefficients. (Table 4)

It is possible to use 1/2 factorial which would require 4 sites, assuming there are no interactions between the site variables. If coefficients for interaction terms were desired, 8 sites would be required.

The minimum number of sites for a particular soil family throughout the network is 8 to 10 which would allow estimation of the effects of site (uncontrolled) variables. It would be desirable to have prediction equations for the dry season over years and for the wet season over years.

There are several types of site variables.

1. Catastrophic - hurricanes, typhoons, etc.
2. Seasonal - temperature, rainfall, etc.
3. Within soil family - base saturation <50% includes 10%-50% base saturation
4. Site variables which are corrected in conduct of experiment, i.e., low potassium so K applied uniformly to all plots

Site variables included in the regression equation would most likely be those within the soil family since seasonal variables would be reflected in the separate equation for the wet and dry season.

It is very important to have a sufficient range and the proper combinations of site variables to allow the best estimates of the coefficients for these variables to be made. More attention must be given in the selection of sites to have those with the proper combinations, i.e., high and low levels, of the important site variables.

Appendix VI

VARIETY EXPERIMENT FOR BENCHMARK SOILS PROJECT

J. A. Silva

In order to screen varieties that may be tolerant and thus unresponsive to lime and phosphorus in the Dystrandepts, a simple fertility differential will be superimposed on the variety trial. Two levels each of lime and phosphorus, i.e., the -.85 and 0 (optimum) levels, will be combined factorially to give the four fertility treatments shown below.

Treatment Combinations

Coded levels		Actual levels for Maize	
P	$CaCO_3$	P(ppm)	$CaCO_3$ (kg/ha)
-.85	-.85	.01	90
-.85	0	.01	600
0	-.85	.05	90
0	0	.05	600

The experimental design used will be a split-plot design with fertility treatments as the main plots and varieties as the subplots. The number of varieties included in a test will vary, depending on what varieties are available. In general, the top two local varieties, including the variety used in the transfer experiments in the country, will be included, along with the varieties used in the transfer experiments in each of the other countries. If there is additional room in the experiment, other promising varieties may also be tested. Three replicates should be used in this experiment. The variety experiment should be installed as close to the installation date of the transfer experiment at the primary site as possible to attain similar climatic conditions in the two experiments.

Each replicate should be divided into four equal parts and the four fertility treatments assigned to one of the parts at random in each replicate. The varieties should then be assigned at random in each whole plot with a separate randomization being used for each whole plot and for each replicate. See figure 1.

Three-row plots will be used for varieties with the middle row only harvested for yield, while the two other rows serve as border rows to minimize shading and competition between varieties. Rows should be 6m long and 75cm apart giving plots that are 2.25m wide with a total plot area of $13.5m^2$. Planting, thinning, maintenance, etc. should be identical to that followed in the transfer experiments and described in Transfer Experiment Management Practices. The fertilizer rates for all nutrients applied in the blanket application should be the same as in the transfer experiment for that season, i.e., summer or winter. Harvesting and data collection will be similar to that described for transfer experiments, with the exception that one row instead of two will be harvested in the variety experiment. If varieties differ greatly in their maturity date, harvest each variety when it is fully mature.

Figure 1.
EXAMPLE OF
VARIETY X FERTILITY EXPERIMENT

F2	V2	V5	V1	V4	V3	V4	V1	V3	V5	V2	F1
											Rep I
F4	V1	V2	V3	V4	V5	V3	V2	V4	V5	V1	F3

F3	V2	V4	V5	V3	V1	V3	V1	V5	V4	V2	F2
											Rep II
F1	V5	V3	V2	V1	V4	V4	V3	V2	V5	V1	F4

F3	V3	V2	V4	V5	V1	V2	V5	V1	V3	V4	F4
											Rep III
F2	V4	V1	V3	V2	V5	V5	V4	V3	V2	V1	F1

Fertility Treatments

No.	P	Lime
F1	-.85	-.85
F2	-.85	0
F3	0	-.85
F4	0	0

Varieties

No.	Variety
V1	1
V2	2
V3	3
V4	4
V5	5

Yield data should be analyzed by analysis of variance techniques for the split-plot design. The analysis of variance table with source and df is given below (Table 1).

Table 1. Analysis of Variance Table for Variety X Fertility Experiment with 5 Varieties, 4 Fertility Levels and 3 Replicates.

Source	df	
Whole plots		
Reps	2	
Fertility (F)	(3)	
Phosphorus (P)		1
Lime (L)		1
PXL		1
Error (a)	6	
Subplots		
Varieties (V)	4	
V X F	(12)	
V X P		4
V X L		4
V X P X L		4
Error (b)	32	
Total	59	

Appendix VII

METEOROLOGICAL INSTRUMENTATION AND MEASUREMENTS

G. Y. Tsuji

In the test of our hypothesis of the transferability of agrotechnology, the Experimental Design Workshop (1974) recommended a monitoring of the uncontrolled variables, specifically the climatic variables.

Two sets of meteorological records were decided as necessary for either our primary or secondary sites. The recommended measurements for a primary sites were as follows:

1. air temperature
2. rainfall
3. relative humidity
4. solar radiation
5. wind speed
6. wind direction
7. evaporation
8. soil temperature

and that for a secondary site were items 1, 2 and 3. However, after my discussions with E. Kanemasu of Kansas State and J. E. Newman of Purdue, solar radiation was added as necessary for each secondary site. Solar radiation measurements provide a measure of solar energy available for photosynthesis at a given site.

Once the climatic variables to be measured were agreed upon, selection of instruments followed. Based on the high probability that electric power at any of our sites would be limiting, battery-operated or mechanically driven instruments with the necessary accuracy and precision were sought.

Primary Site

At the primary site, a battery operated mechanical weather station was installed to simultaneously measure temperature, rainfall, relative humidity, wind speed and wind direction. Solar radiation was recorded on an HSPA wig-wag radiometer. However, the exorbitant increase in price of the Wig-wag from $500 to $1200 forced us to consider another instrument. The heir apparent will be the pyranometer sensor and integrator from Lambda Instruments of Lincoln, Nebraska. However, because the sensor has not been used under tropical conditions where relative humidity and ultraviolet radiation intensity are greater, we are currently subjecting them to tests in comparison to Eppleys. Thus far our records for a one month period indicate that the pyranometer sensors have readings 10% greater than the Eppley pyroheliometer as shown in Table 1.

Secondary Site

Instrumentation selected for secondary sites were those in standard use - the hygrothermograph housed in a U.S. Weather Bureau type instrument shelter and a rain gage with meter stick. In remote areas, a tipping bucket rain gage with event recorder was installed. A max-min thermometer was not used because of likely difficulty in obtaining readings consistently at the same time of

Table 1

COMPARISON OF EPPLEY VS. LAMBDA PYRANOMETER

By P. C. Ekern

Date	Eppley	S_1	S_2	S_3	S_4	S_5	S_{avg}	S_{avg}/Eppley
7/17/76	531.6	558.4	556.4	548.7	545.9	509.1	531.6	1.02
7/18/76	626.5	668.9	645.5	662.1	654.4	616.5	649.5	1.04
7/19/76	519.4	536.9	525.9	588.9	523.8	491.9	533.5	1.03
7/20/76	511.6	534.5	513.9	523.2	520.4	486.5	515.7	1.01
7/21/76	501.8	514.5	494.4	557.5	498.3	468.3	506.6	1.01
7/22/76	512.6	550.1	527.7	538.3	533.9	498.8	529.8	1.03
7/23/76	505.1	518.9	501	510.2	505.1	473.7	501.8	.99
7/24/76	665	711.2	686.3	698.5	688.9	648	686.6	1.03
7/25/76	424.5	432.3	427.8	405.2	413.4	401.8	416.1	.98
7/26/76	542.3	601.7	582.6	586.7	536.7	542.6	570.2	1.05
7/27/76	671.2	714.6	684	703.2	699.9	652.9	690.9	1.03
7/28/76	645.1	657.2	631.9	644.4	692.8	599.7	645.2	1.0
7/29/76	682.7	680	663	680	672	629	665	.98
7/30/76	667.4	628	606.1	624.6	614.5	577.6	610.2	.91
7/31/76	648.3	651.3	629.1	653.3	641.9	619.9	641.1	.99
8/02/76	359.1	364.1	356.5	365.1	363.4	359	361.6	1.01
8/03/76	531.3	586.6	573.7	588.8	583.8	578.1	583.2	1.10
8/04/76	567.5	570.1	553.7	574.2	568	552	563.6	.99
8/05/76	607	610.9	596.7	620	611.7	592.9	606.4	1.0
8/06/76	610.3	575.4	556.8	582.5	577.1	551	568.6	.93
8/07/76	643	644.1	635.2	654.3	650.5	633.2	643.5	1.0
8/08/76	664.3	696.6	678.3	700.6	693.8	673.6	688.6	1.04
8/09/76	602.5	612.8	598.1	614.8	610.2	590.9	605.4	1.00
8/10/76	541.1	528.7	519.3	534.1	528.6	514.1	525	.97
8/11/76	491.6	500.4	490.7	504	500.3	487.5	496.6	1.01

7/31/76 0630: interchanged sensors and integrators, S_1 and S_3; S_2 and S_4; S_5 unchanged

S_1 = PY640-7604 S_3 = PY642-7604 S_5 - PY644-7604

S_2 = PY641-7604 S_4 = PY643-7604

day at each site. An HSPA wig-wag radiometer was initially set to measure incoming solar radiation.

Soil Temperature

Soil temperature measurements have not been made to date. Thermometer-thermistors will be set at all sites at selected depths recommended by the World Meteorological Organization (WMO). Although the role of soil temperature may not be as exaggerated as in temperate regions, it should provide information on temperature effects during germination and during the various stages of development of the transfer crops. Furthermore, soil temperature measurements at the 50 cm depth will be used to substantiate soils belonging to either isohyperthermic, isothermic or isomesic families.

We are currently planning to use the Thermometer-thermistor manufactured by the Yellow Springs Instrument Company with a Rustrak recorder. Sensors would be placed at depths of 5, 10, 20 and 50 cm. Data obtained should provide diurnal soil temperature changes at each depth and would allow determination of thermal flux properties of the soil.

Pan Evaporation

Evaporation pans and tensiometers were installed at the primary sites as a means of scheduling irrigation. The agricultural engineers at the University of Hawaii suggested irrigating a quarter acre inch per day during the dry season. Tensiometers from the Irrometer Company and Soilmoisture Equipment Company are being placed at depths of 15 and 45 cm.

In the absence of pan evaporation data, potential evaporation can be computed from wind speed, temperature and solar radiation data.

Data Collection

One disadvantage of collecting data on a strip chart recorder is the time involved in reading and eventually transferring recorded data onto computer cards. To circumvent this problem, meteorological data outputs in digitized form would be more easily translated to a computer system. This, however, is presently an expensive proposition and one requiring a greater power requirement.

The primary advantage of recorded data, either on strip chart or digital outputs, is the availability of data for comparison purposes at given times at each site. At sites where daily observations are recorded, the data should be logged in at approximately the same time as those recorded at other sites. For example, temperature, relative humidity, and rainfall should be read at 0800 in Hawaii, the Philippines, Indonesia, Puerto Rico, and Brazil.

Daily records of climatological data are currently being logged at sites in both Hawaii and the Philippines. The records will then be transferred to IBM coding forms. However, weekly averages of each variable will be considered initially in relation to the development of the maize and soybean crops. This should allow comparison of climate effects on each crop between sites and between seasons. If further refinement or generalizing is desired, daily or monthly data could be examined.

Cost Analysis

1.	Primary site	
	a. Mechanical Weather Station	$2,995
	b. Pyranometer sensor with integrator	345
	c. Soil thermometer-tensiometer	400
	d. Tensiometer	25 each
	e. Evaporation pan (optional)	450
	Still well and hook gage	
2.	Secondary site	
	a. Hygrothermograph	225
	b. Instrument shelter	200
	c. Rain gage	
	(1) tipping bucket with event recorder	495
	(2) standard	133
	d. Pyranometer sensor with integrator	345
	e. Soil thermometer/thermistor	400
	f. Tensiometers	25

Appendix VIII

DRIP IRRIGATION SYSTEM FOR TRANSFER EXPERIMENT

G. Y. Tsuji

In the design of the transfer experiments, water was not considered a limiting factor. To attain and maintain optimum soil moisture conditions for the transfer crops, a drip irrigation system was installed at each site. Within each site, the design of the system was repeated. However, delivery systems to each site varied with water source.

One of the constraints in using a drip irrigation system, however, is the adequate supply of PVC pipes and component parts at our foreign sites. Basic parts and supplies have been purchased in Hawaii for shipping to all sites.

It would be advantageous to have either an agricultural or civil engineer as a resource person to advise on adequate delivery or conveyance systems from the water source to the experimental site. From our experience, it would be convenient physically and economically if a domestic water source could be used as a supply source. A flow meter would normally be provided and the filtration system need not be sophisticated. The primary concern would be adequate pressure to operate the drip irrigation system which requires 10-20 psi.

If such a water source is not available, we have used water from a reservoir and are planning to use above ground swimming pools as reservoirs at sites where neither of the 2 types of water source is available. These artificial reservoirs could be filled with excess water from natural springs, rainfall catchment, etc. A filtration system would be required at sites where natural or man-made reservoir water is used in order to prevent or reduce plugging of the drip orifice. A fine screen filter (200 mesh) that can be back-flushed for removal of coarse materials has been adequate at our secondary site in Kohala (Halawa). The filter was installed in the main line before the sub-main. Water filters (Wye filters) with screens are also normally installed as a general practice between the main line and sub-main. To minimize clogging problems due to algal or fungal growth, the laterals are flushed frequently by opening the flush valves connected at the end of each lateral after irrigation is completed.

A lateral is placed at intervals equivalent to row spacing to insure an adequate supply of water during the early growing stages of transfer crops. This is especially true up until the crop canopy is fully developed. On the Hydric Dystrandepts, irrigation time per crop is approximately 4 to 6 hours initially. Once the wetting envelope has been developed, irrigation time can be shortened to an hour. Each orifice or emitter of the Anjac Biwall tubing delivers approximately 0.06 gpm at 10-15 psi. Laterals should normally be installed normal to the greatest slope to prevent an uneven distribution of pressure and water emission along the length of the lateral.

Appendix IX

TISSUE ANALYSIS OF MAIZE EAR LEAVES

J. A. Silva

Ear leaves were collected from each plot when the maize was at 50% tasseling. Leaves were cleaned and the entire leaf dried, ground in a stainless steel Wiley mill, and analyzed with the Quantometer. Average nutrient levels for treatments are shown in Table 1 and 2 for Kukaiau, Block A and Niulii, Block A, respectively.

Analyses of variance were carried out for each nutrient and there were significant treatment effects on all nutrients except K, S, and moisture at Kukaiau, and on all nutrients except Al at Niulii. Generally, the largest differences in levels were between the controls and the treated plots. Adequate levels for nutrients in the ear leaf based on data from the Ohio State University Plant Analysis lab are given at the bottom of the table. Most of the nutrients were in the adequate range with the exception of Mg and S which were low, and Ca and Fe which were relatively high at Kukaiau. It is surprising that Mg and S are low since $MgSO_4$ was applied to all plots in the blanket application at the rate of 100 kg Mg/ha.

Nutrient levels at Niulii were generally adequate with the exception of Mg and S which were low, and Ca which was relatively high. This pattern is similar to that found at Kukaiau, however, the absolute levels of nutrients were generally lower at Niulii than at Kukaiau.

These analyses suggest that the $MgSO_4$ application may have to be increased in these fields if the low levels of Mg and S continue to occur in tissues.

Table 1

Nutrient Content of Ear Leaves

Kukaiau Block A
Maize 1975-76

Treatments P	Treatments Lime	N	P	K	Ca	Mg	S	Al	Mn	Fe	Cu	H_2O
		%						PPM				
+.85	+.85	3.46	0.37	2.42	0.72	0.16	0.17	206	89	295	17	79.6
+.85	0	3.37	0.35	2.41	0.62	0.16	0.16	207	113	287	16	79.3
+.85	-.85	3.39	0.36	2.47	0.59	0.16	0.17	261	104	300	16	79.1
+.40	+.40	3.50	0.38	2.51	0.59	0.17	0.16	197	89	274	15	79.8
+.40	-.40	3.50	0.36	2.47	0.59	0.17	0.17	205	105	278	16	79.4
0	+.85	3.41	0.36	2.43	0.57	0.17	0.16	216	90	302	16	79.6
0	0	3.33	0.35	2.53	0.55	0.16	0.16	206	93	294	16	79.2
0	-.85	3.39	0.37	2.40	0.58	0.17	0.17	229	92	309	16	79.3
-.40	+.40	3.50	0.34	2.35	0.59	0.16	0.17	224	93	278	17	78.8
-.40	-.40	3.32	0.33	2.46	0.58	0.17	0.16	196	81	280	16	79.6
-.85	+.85	3.53	0.33	2.35	0.53	0.17	0.16	201	86	284	17	79.1
-.85	0	3.51	0.33	2.38	0.55	0.18	0.16	217	84	301	17	78.3
-.85	-.85	3.47	0.33	2.39	0.53	0.18	0.16	203	91	267	17	79.4
Partial Control		3.68	0.32	2.29	0.45	0.20	0.16	59	57	123	18	79.7
Complete Control		3.59	0.33	2.50	0.45	0.20	0.16	75	49	154	18	80.3
Sig. of F Test		**	**	ns	**	**	ns	**	**	**	**	ns
Sufficient Levels*		2.8-3.5	0.2-0.4	1.7-2.3	0.2-0.5	0.2-0.4	0.2-0.5	<200	20-150	21-250	6-20	

*Jones, J. B., Jr. and H. V. Eck. 1973. Plant Analysis as an Aid in Fertilizing Corn and Grain Sorghum. In L. M. Walsh and J. D. Beaton, (Eds.) Soil Testing and Plant Analysis. Revised Edition p. 349-364. Soil Science Society of America.

Table 2

Nutrient Content of Ear Leaves

Niulii Block A
Maize 1975-76

Treatments P	Treatments Lime	N	P	K	Ca	Mg	S	Al	Mn	Fe	Cu	Zn
		%						PPM				
+.85	+.85	3.15	0.34	1.69	0.58	0.20	0.16	84	25	129	13	22
+.85	0	3.17	0.33	1.79	0.55	0.19	0.16	48	25	121	14	24
+.85	-.85	3.26	0.35	1.81	0.57	0.20	0.16	42	32	125	14	31
+.40	+.40	3.25	0.33	1.82	0.53	0.18	0.15	34	24	116	15	25
+.40	-.40	3.17	0.34	1.82	0.55	0.18	0.16	95	28	125	15	28
0	+.85	3.19	0.33	1.80	0.57	0.18	0.16	41	23	138	15	26
0	0	3.17	0.31	1.77	0.52	0.18	0.15	39	28	114	14	26
0	-.85	3.21	0.33	1.81	0.50	0.18	0.16	34	33	117	14	29
-.40	+.40	3.15	0.32	1.74	0.59	0.19	0.16	44	24	129	16	25
-.40	-.40	3.07	0.31	1.70	0.55	0.18	0.16	46	25	116	16	25
-.85	+.85	3.15	0.30	1.84	0.49	0.17	0.16	26	25	110	15	25
-.85	0	3.33	0.31	1.78	0.56	0.18	0.17	47	26	120	17	29
-.85	-.85	3.16	0.30	1.87	0.53	0.20	0.17	49	26	112	16	26
Partial Control		3.64	0.28	2.07	0.50	0.20	0.18	63	26	122	18	32
Complete Control		3.14	0.26	1.39	0.76	0.23	0.15	76	20	188	17	14
Sig. of F Test		**	**	**	**	*	**	ns	*	**	**	**
Sufficient Levels*												20-70

Appendix X

DATA COLLECTION AND RECORDING

J. A. Silva

It is necessary to collect data on climate, soil and plant nutrient levels as well as on yield in order to help interpret differences in yield potential at the different sites. Consideration of the appropriate data to collect at this time will insure that we measure as many of the important variables as we can afford. With the number of sites and crops involved in this project, the amount of data collected will be large and therefore will necessitate the use of IBM punch cards or magnetic tape for recording and storing the data. It is not essential that both Puerto Rico and Hawaii use the same format and code system for their data as the computer can be instructed to modify the formats to make them compatible. However, if a little thought and discussion can be given at this time, it will be possible to arrive at one format and code for both groups and thus simplify data processing considerably. To this end, preliminary Formats have been designed for weather, yield, plant nutrient, and soil data. These should be discussed and the suggested modifications made will be included in the report of this annual meeting.

The key portion of all cards is the identification section which consists of the first group of columns which identify each plot or bit of data uniquely This identification must separate data from all plots and from the same plot collected at a different time. Therefore, considerable thought must be given to set up a system that will fulfill the needs of the project. For the yield, soil and plant nutrient data cards, this is essentially done in the first 29 columns. In addition, with the yield data cards for maize and soybeans, treatment descriptions are given in columns 30 to 46. A numeric code has been worked out for the first several categories, countries, series, site, block in site, crop, variety, and season. These are identified on the attached code sheet. A few comments about the codes may be in order. It was decided to assign numbers 1 to 49 to the University of Hawaii and countries in its network and numbers 50 to 99 to the University of Puerto Rico and countries in its network. The codes for families, series, crops and varieties can be expanded as the need arises so long as all parties involved are informed. It was decided to include the week planted to allow weather data to be related to yield information since weather data are to be recorded by weeks of the year.

The year planted is being recorded by the last digit only to conserve space on the card. Both coded and actual P and $CaCO_3$ treatment are given to assist in regression analysis of the data. The coded levels for the two control plots are to be recorded as the actual ppm P in solution expressed as a fraction of the P range considered in the experiment. The actual ppm P in solution for the control plots and the treatment levels in ppm P in solution will be recorded in columns 36 to 38 without punching the decimal. This means that when these data are analyzed, the format statement must indicate the position of the decimal for these values. The pest rating scale serves for insect, disease, other animal pests and the overall pest rating which is a summary of the damage done by all pests throughout the crop. Insect and disease rating will be done at tasseling or flowering and at harvest as described in the Management Practices. However, only the average of the two ratings will be recorded on the card. Card identification codes can be used to separate the various data cards after analysis.

The format for recording weather data, designed by G. Y. Tsuji, is compatible with the other cards.

The format for the plant analysis card is identical to the yield cards for the first 29 columns. A code for stage sampled is given to identify the particular sample the data refers to not only for tissue samples, but also for soil samples. The plant part code identifies the plant part sampled for both maize and soybeans. Position of decimals is indicated in the format.

The format for the soil data card is identical to the yield cards for the first 29 columns. A code for planting cycle is given to separate soil samples taken at various times from the same plot since in some sites the same plots will be used in successive years for the transfer experiment. The stage sampled is also indicated as explained for the tissue data card. The depth of sample is described by the upper and lower depth of sampling so that samples other than surface samples may be accommodated with this format. Decimals are indicated on the format and should be punched on the cards.

The usefulness of these formats will become evident with use and they may be changed, if it is felt beneficial.

CODE SHEET FOR BENCHMARK SOILS PROJECT YIELD

Data Card

Column Number	Code
1 - 2	Country Hawaii (1-49) 1 = Hawaii 2 = Philippines 3 = Indonesia Puerto Rico (50-99) 50 = Puerto Rico 51 = Brazil
3 - 4	Family 1 = Thixotropic, isothermic Hydric Dystrandepts 2 = Clayey, kaolinitic, isohyperthermic Tropeptic Eutrustox 3 = Clayey, kaolinitic, isohyperthermic Tropeptic Haplustox

Column Number	Code
5 - 6	Series Family 1 1 = Kukaiau 2 = Niulii Family 2 1 = Coto 2 = Lahaina Taxajunct (tentative)
7	Site 1 = Primary 2 = Secondary #1 3 = Secondary #2
8 - 9	Block in Site 1 = A 2 = B 3 = C etc.
10	Crop 1 = Maize 2 = Soybeans
11 - 12	Variety Maize 1 = H610 2 = Pioneer 306B 3 = DMR Comp #1 4 = Bastar Kuning 5 = UPCA-1 Soybean 1 = Kahala 2 = Jupiter 3 = TK5 4 = Orba 5 = Hardee
13	Season 1 = Wet Season 2 = Dry Season

Column Number	
28 - 29	**Treatment** 1 = A 2 = B 3 = C 4 = D 5 = E 6 = F 7 = G 8 = H 9 = J 10 = K 11 = L 12 = M 13 = N 14 = O 15 = P
30 - 32 33 - 35	**Coded P and $CaCO_3$ Levels** + .85 + .40 0 - .40 - .85 - Partial Control - Complete Control Decimal not punched (Actual soil values coded for partial and complete control treatments for the experiment)
75-78	**Pest, Insect, Disease and Other Animal Pest Rating** 1 = No damage 2 = Slight damage 3 = Moderate damage 4 = Moderately severe damage 5 = Severe damage
79 - 80	**Card Identification** 1 = Daily basic weather card 2 = Daily supplementary weather card 3 = Weekly basic weather card 4 = Weekly supplementary weather card 5 = Yield data card 6 = Plant analysis card 7 = Soil data card

IBM FORTRAN Coding Form GX28-7327-6 U/M 050** Printed in U.S.A.

PROGRAM: Soybean Yield Data Card - Transfer Experiment

PROGRAMMER: Benchmark Soils Project

Country	Family	Series	Site	Block in Site	Agronomic Crop	Variety	Season	Month Planted	Day Planted	Week Planted	Year Planted	Month Harvested	Day Harvested	Rep No.	Plot No.	Treatment No.	Coded Treatments: P Levels	Coded Treatments: $CaCO_3$ Levels	Actual Treatments: P in Solution (ppm)	Actual Treatments: P Applied (kg/ha)	Actual Treatments: $CaCO_3$ Applied (kg/ha)	Grain Yield (kg/ha)	Weight of 100 Seeds (g)	Plant Height at Harvest (cm)	Days to 50% Flowering	Days to Physiological Maturity	% of Harvested Plants Lodged	Pest Rating for Crop (overall)	Insect Rating for Crop	Disease Rating for Crop	Rating of other Animal Pests	Card Identification

IBM FORTRAN Coding Form GX28-7327-6 U/M 050** Printed in U.S.A.

PROGRAM: Maize Yield Data Card - Transfer Experiment

PROGRAMMER: Benchmark Soils Project

Country	Family	Series	Site	Block in Site	Agronomic Crop	Variety	Season	Month Planted	Day Planted	Week Planted	Year Planted	Month Harvested	Day Harvested	Rep. No.	Plot No.	Treatment No.	Coded Treatments: P Levels	Coded Treatments: $CaCO_3$ Levels	Actual Treatments: P in Solution (ppm)	Actual Treatments: P Applied (kg/ha)	Actual Treatments: $CaCO_3$ Applied (kg/ha)	Grain Yield (kg/ha)	Stover Yield (kg/ha)	Average Filled Ear Length (cm)	Weight of 100 Kernels (g)	Plant Height at 30 days (cm)	Plant Height after Tasseling (cm)	Days to 50% Tasseling	Days to Physiological Maturity	% of Harvested Plants Lodged	Pest Rating for Crop (overall)	Insect Rating for Crop	Disease Rating for Crop	Rating of other Animal Pests	Card Identification

IBM

FORTRAN Coding Form

GX28-7327-6 U/M 050**
Printed in U.S.A.

PROGRAM	Plant Analysis Card	PUNCHING INSTRUCTIONS	GRAPHIC		PAGE OF
PROGRAMMER	Benchmark Soils Project	DATE	PUNCH		CARD ELECTRO NUMBER*

FORTRAN STATEMENT

Card Identification	Country	Family	Series	Site	Block in Site	Agronomic Crop	Variety	Season	Month Planted	Day Planted	Week Planted	Year Planted	Month Sampled	Day Sampled	Rep. No.	Plot No.	Treatment No.	Stage Sampled	Plant Part Sampled	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	S (%)	Al (ppm)	Mn (ppm)	Fe (ppm)	Cu (ppm)	Zn (ppm)	H_2O (%)

Codes are the same as for the Yield Data Card with the following additions:

Stage Sampled

1 = at 50% Tasseling or Flowering
2 = at Harvest
3 = Prior to Tasseling or Flowering
4 = Prior to Planting (Soil Sampling)

Plant Part Sampled

Maize

1 = Ear Leaf
2 = Recently Matured Leaf
3 = Stover
4 = Grain

Soybeans

1 = Recently Matured Leaf
2 = Grain

*A standard card form, IBM electro 888157, is available for punching statements from this form

**Number of forms per pad may vary slightly

IBM

FORTRAN Coding Form

GX28-7327-6 U/M 050**
Printed in U.S.A.

Soil Data Card

Benchmark Soils Project

Country	Family	Series	Site	Block in Site	Agronomic Crop	Variety	Season	Month Planted	Day Planted	Week Planted	Year Planted	Month Sampled	Planting Cycle	Rep. No.	Plot No.	Treatment No.	Stage Sampled	Depth of Sample: Upper Depth of Sample (cm)	Depth of Sample: Lower Depth of Sample (cm)	FORTRAN STATEMENT: P in Solution without Added P (ppm)	P sorbed at P Treatment (µg/g)	me/100 g.: Exch. Ca	Exch. Mg	Exch. Na	Exch. K	Extr. Al	Cation Exchange Capacity	pH (H_2O)	pH (KCl)	Card Identification

Codes are the same as for the Yield Data Card with the following additions:

Planting Cycle

1 = 1st planting in the plots

2 = 2nd planting in the plots

3 = 3rd planting in the plots

etc.

Stage Sampled

1 = at 50% tasseling or flowering

2 = at Harvest

3 = Prior to tasseling or flowering

4 = Prior to planting

**Number of forms per pad may vary slightly

IBM FORTRAN Coding Form GX28-7327-6 U/M 050** Printed in U.S.A.

PROGRAM: Climatic/Site Variables Data Card

PROGRAMMER: Benchmark Soils Project

FORTRAN STATEMENT

Country	Family	Series	Site	Month	Day	Week	Year	Air Temperature	Relative Humidity	Rainfall	Soil Temperature (1)	Soil Temperature (2)	Soil Temperature (3)	Soil Temperature (4)	Solar Radiation	Wind Speed 0600	1200	1800	2400	Wind Direction 0600	1200	1800	2400	Card Identification

Soil Temperature:

(1) 5 cm depth

(2) 10 cm

(3) 20 cm

(4) 50 cm

*A standard card form (IBM # GX20-8137) is also available for punching statements in the 1130.

**Number of forms per pad may vary slightly

Appendix XI

GUIDELINES FOR MANAGEMENT EXPERIMENTS

L. D. Swindale

Purpose of Management Experiments (from May 1974 Workshop)

Management experiments on maize will be installed at the primary site in each country. The objectives of these experiments will be (1) to provide information to governments on ways to increase production by improved availability and utilization of resources; and (2) to provide basic information to farmers with limited resources to indicate how they can increase their yields. Management variables to be investigated, each at two levels (with and without) will probably be: irrigation, lime, weed control, insect and disease control, N, P, and K. Details of the management experiments and other research to be conducted will be worked out with each participating country.

Purpose of the Soil Survey Interpretation/Land Classification Objectives of the BSP

To demonstrate to the cooperating countries and in principle how to:

1. Transfer soil management information within and among countries
2. Provide planning agencies with more useable soils data
3. Improve soil survey interpretation/land classification work of national soils institutions and stimulate research into this field
4. Establish better coordination of agricultural research through the classification of soils of the agricultural research stations

Relationship Between Transfer and Management Experiments and Soil Survey Interpretation

A. Defining Levels of Management

Soil survey interpretation is always made in relation to one or more levels of management.

The ones commonly used are:

Level 1. The combinations of management practices used most commonly by successful farmers for the soil under study.

Level 2. A combination of superior management practices followed by farmers who obtain yields of crops well above the average. This group may be 5 percent of farmers in some areas and as much as 30 percent in others.

Level 3. The optimum combinations of management practices that can be defined for full application of the current state of knowledge and techniques for crop production.

Level 1 will be determined from national surveys on the benchmark soil families used in the Project. Professional staff of the national soils institutes will need to be assisted in learning how to collect and organize data for this purpose.

Level 3 will be determined primarily by the transfer experiments. A limited number of management experiments may be needed to ensure that optimum levels have been achieved.

Level 2, which lies between levels 1 and 3, will be determined by the management experiments. They will explore in particular those inputs and practices most costly and most difficult to achieve in any country. They may explore to some extent the substitution of recycled biological materials for expensive manufactured inputs or high energy using management practices.

B. Soil Selection for National Maize Development or Utilization

One use of the benchmark soil concept is to assist government in the development and implementation of national commodity utilization plans. As an example in participating countries where a national (or regional) maize utilization plan is being undertaken or considered, management experiments can be undertaken to determine the relationships between soil characteristics and commodity yield and the subsequent development of national or regional soil suitability ratings for maize.

Note: The above guidelines were adopted by the group with no modifications.

Appendix XII

A PROPOSED MANAGEMENT EXPERIMENT FOR HAWAII

J. A. Silva

Some experience has been gained since the workshop and the group in Hawaii has questioned the usefulness of the original management experiment in that the effects of some of these variables can be approximated from information in other areas or soil samples and that the information obtained would be of relatively limited use, i.e., to the local farmers and governments only. Also it was apparent from the transfer experiments conducted to date that very large amounts of P fertilizer are required for optimum yield on the Hydric Dystrandepts, in particular, and to a lesser extent on the Tropeptic Eutrustox. In addition, it was clearly evident that P was the major limiting factor in these soils. Therefore, there is a need to develop information on ways to decrease the amounts of P required for economically optimum yields and for maximum utilization of limited amounts of P fertilizer applied to these soils by farmers with limited resources. This information should increase utilization of the knowledge gained in the transfer experiments, not only in the country in which the experiment is conducted, but in other countries with similar soils since basic information on the use of P fertilizer would be obtained.

One of the techniques frequently recommended to increase utilization of applied P is to place it in a band rather than broadcast it and mix it with the total soil volume. This is reported to reduce the amount of P sorbed in relatively unavailable form by the soil and thus increase the amount of applied P available to plants. Although this sounds simple, there are some points that are not altogether clear. One of these is: how does the effect of banding P vary with amount of P applied? Theory suggests the family of curves shown in figure 1 which describes the yield response to applied P with different band widths. It is apparent from this that although banding increases utilization of a small amount of applied P, it actually decreases utilization of higher amounts of applied P. Therefore, there is a need to determine if this theory applies to the soils used in these experiments and also, what combinations of band width and applied P give optimum yields.

An experiment to investigate the relationship between band width and applied P should have various combinations of band widths and rates of applied P. Since the row spacing used in the transfer experiments of Maize is 75 cm the suggested band widths are 15, 30, 45 and 75 cm, with 75 cm being the broadcast placement. The rates of P are patterned after those in the transfer experiment, i.e., -.85, optimum, +.85 as well as zero for comparison.

The amount of P applied will be that required to give the appropriate concentration of P in the soil solution or determined from P sorption curves. Thus for Maize, the optimum level of P in solution is .05 ppm, therefore, the -.85 level would be .01 ppm and the +.85 level would be .09 ppm. The amount of P applied to a particular band width will be that required to raise the P concentration in the particular volume of soil to the appropriate level. Therefore, the volume of soil to be fertilized with P in the 15 cm width would be 15 cm x 15 cm x 6 m for 1 row 6 meters long, while for the 45 cm width the volume would be 45 cm x 15 cm x 6 m. In order to compare the response to the optimum level of P in a particular band width with the response to broadcast

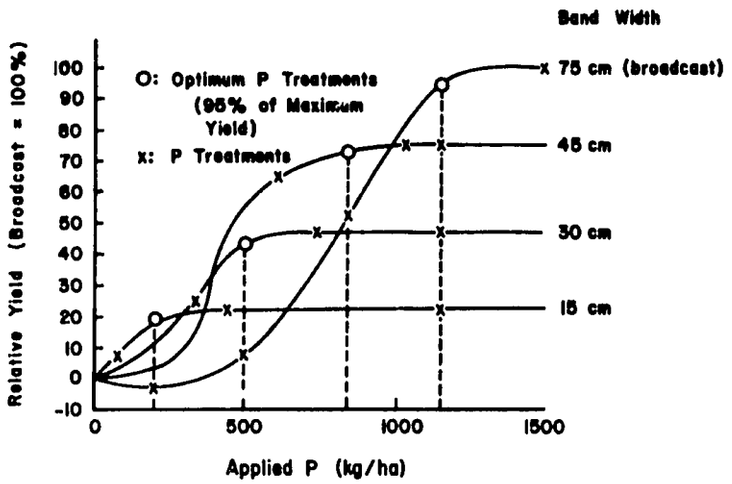


Fig. 1 Theoretical yield response to applied at different amounts in several band widths.

placement, the same amount of P that was applied in the particular band width to attain the optimum P concentration, must be applied broadcast. This is indicated by treatments on the broadcast curve which are at the optimum rate of applied P for the various band treatments in Figure 1. Similarly, in order to compare the response to the optimum amount of P applied broadcast with the same amount applied banded, the set of treatments extending down from the optimum P rate of the broadcast curve are required. This results in a total of 18 treatment combinations, including zero P. These are presented in the table below.

Table 1. Treatment Combinations for Band Width x Applied P Management Experiment.

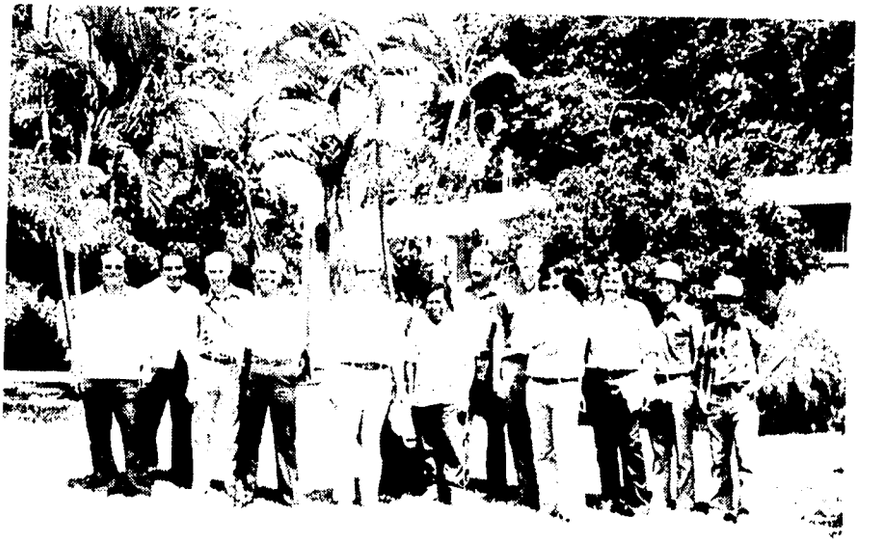
Band Width	zero P	-.85	Opt. 15	Opt. 30	Opt. 45 cm.	Opt.	+.85	Opt. 75 cm.
15		x				x	x	x
30		x				x	x	x
45		x				x	x	x
75	x		x	x	x	x	x	

Establishment of the bands would have to be done with a slightly modified rototiller, i.e., one having only 1 blade or possibly 2 blades. The band should be established after the blanket application has been applied and rototilled in. The required amount of P fertilizer should be applied in the desired width on the surface and then carefully rototilled in with the modified rototiller to a depth of 15 cm. The maize seed should then be planted in the center of the band. The experiment can be installed in a randomized complete block design with three replicates as in the transfer experiments. All other fertilizer variables should be held constant at adequate rates and general mangement practices should be those followed in the transfer experiments.

It would not be necessary to plant more than one variety of maize as suggested in the original management experiments because in the new variety tests a P x lime differential will be established to screen varieties for their responsiveness to P and lime.

PARTICIPANTS

Raul Abrams	Department of Agronomia Mayaguez, Puerto Rico
Jose Badillo	Isabela Substation - RUM Isabela, Puerto Rico
Friedrich H. Beinroth	Agronomy Department - CAAM University of Puerto Rico Mayaguez, Puerto Rico
Aurelio A. Briones	Soil Science Department University of Philippines at Los Banos College, Laguna, Philippines
Foster B. Cady	Biometrics Unit Cornell University Ithaca, New York
Bernardino G. Cagauan, Jr.	Zenith Apartment 12-E Misericordia Street Naga City, Philippines
Luis Calduch	Isabela Substation - RUM Isabela, Puerto Rico
Tejpal S. Gill	AID/TAB/AGR Washington, D.C.



Alan R. Hurdus	Department of Agronomy and Soil Science University of Hawaii Honolulu, Hawaii
Juan A. Vega Lopez	Agronomy Department - RUM University of Puerto Rico Mayaguez, Puerto Rico
Louis Mejia-Matte	College of Agricultural Science University of Puerto Rico Mayaguez, Puerto Rico
Larry A. Nelson	Department of Statistics North Carolina State University Raleigh, North Carolina
Luis Carlos Sarmiento	Agronomy Department - RUM University of Puerto Rico Mayaguez, Puerto Rico
Chris E. Seubert	EPAMIG Janauba, Minas Gerais Brazil
James A. Silva	Department of Agronomy and Soil Science University of Hawaii Honolulu, Hawaii
Gene L. Spain	Agronomy Department - RUM University of Puerto Rico Mayaguez, Puerto Rico

Leslie D. Swindale

Department of Agronomy and Soil Science
University of Hawaii
Honolulu, Hawaii

Gordon Y. Tsuji

Department of Agronomy and Soil Science
University of Hawaii
Honolulu, Hawaii

I Putu Gedjer Widjaja-Adhi

Soil Research Institute
Bogor, Indonesia