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Annual Report 1979-80

BENCHMARK SOILS PROJECT
Department of Agronomy and Soil Science
College of Tropical Agriculture and Human Resources
University of Hawaii at Manoa

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Annual Report
Benchmark Soils Project/Hawaii

(with experimental sites in
Cameroon, Hawaii, Indonesia, and the Philippines)

Crop Production and Land Capabilities of a
Network of Tropical Soil Families

Contract No. AID/ta-C-1108

FISCAL YEAR OCTOBER 1, 1979 - SEPTEMBER 30, 1980

James A. Silva
Principal Investigator
Benchmark Soils Project
Department of Agronomy and Soil Science
College of Tropical Agriculture and Human Resources
3190 Maile Way
Honolulu, Hawaii 96822

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# Summary Sheet

*Project Title and Contract Number:*
Crop Production and Land Capabilities of a Network of Tropical Soil Families (The Benchmark Soils Project)
AID/ta-C-1108

*Principal Investigator and Contractor:*
James A. Silva, University of Hawaii

*Contractor's Address:*
Department of Agronomy and Soil Science, College of Tropical Agriculture and Human Resources, University of Hawaii
3190 Maile Way, Honolulu, Hawaii 96822

*Contract Period (as amended):*
May 31, 1974 - May 30, 1983

| | |
|---|---|
| *Total AID Funding to Date:* | $5,064,755 |
| *Total Expenditures and Encumbrances through Previous Fiscal Year:* | 2,805,619 |
| *Total Expenditures and Encumbrances for Current Fiscal Year:* | 1,266,568 |
| *Estimated Expenditures for Next Fiscal Year:* | 1,287,560 |

# Narrative Summary of Accomplishments and Utilization

The following items are highlights of progress achieved by the Benchmark Soils Project in fiscal 1979-80. These matters are discussed more fully in the sections Accomplishments to Date, Dissemination and Utilization of Research Results, and LDC Training and Involvement and Feedback. Supporting data are shown in the appendixes.

* With the hiring of a Project Leader and planting and harvesting of uniformity trials in Cameroon, the network of Benchmark soil families has been completed.
* Experimental fieldwork conducted included 38 transfer experiments, 5 variety experiments, and 22 management experiments in all four countries.
* Monitoring of weather continued at all sites, and data were released for analysis by several consultants.
* Input into the soil data bank continued; data were released to Project Leaders and cooperating agencies for analysis, as well as to Project personnel for interpretation.
* Further confidence in the transferability of agrotechnology was provided. The fourth statistical test on the Hydric Dystrandepts was completed and is released in this Annual Report. Data from 27 Hydric Dystrandept sites are included. A first test on the Tropeptic Eutrustox is expected in 1981 from the Puerto Rico Project, which is closing field operations in December 1980. A first test of the Typic Paleudults was begun in fiscal 1979-80 using data from 10 sites. The preliminary results show distinct interaction differences between the Hydric Dystrandepts and the Typic Paleudults.
* Additional work on the P methodology indicates differences in ranges of soil P (modified Truog method) required for each soil family.
* Maize variety X304C continues to be rated as the likely best-adapted variety tested for the Tropeptic Eutrustox and Typic Paleudult soil families.
* Graduate student research results were made available. Harris, Manrique, and Escaño are preparing abstracts and poster sessions for the American Society of Agronomy meetings in December 1980 in Detroit. The P placement and sources study (Harris) illustrates different requirements and responses between soil families. A seasonal cropping pattern was developed for the Tropeptic Eutrustox to take advantage of crop requirements and to match them to climatic conditions (Manrique). Two approaches to determining nutrient requirements for crops were compared (Escaño).
* Participants at a panel consultation in Rome recommended a joint strategy for land evaluation and agrotechnology transfer in the tropics and subtropics, with the Benchmark Soils Project recommended to assume the leadership in coordinating and implementing the network (INBSAT: International Network of Benchmark Soils for Agrotechnology Transfer).
* University of Hawaii researchers suggested collaboration using a multidisciplinary research approach since the HITAHR workshop presentations demonstrated there is already evidence that agroenvironmental niches, as identified by Soil Taxonomy, stratify soil management requirements, as well as disease, insect and weed hazards, crop adaptation, and other inputs.

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* Continuing work was done in establishment of the network of cooperating countries and agencies. In FY 1979-80, Jerry McIntosh was on sabbatic leave at the University of Hawaii from IRRI/CRIA in Indonesia. He provided valuable advice and guidance in the establishment of cropping systems research as part of the BSP program of management experiments. This illustrates a commitment/agreement for collaborative work between IRRI/CRIA and BSP.
* As previously agreed upon, cooperative NifTAL/BSP experiments were installed in FY 79-80 on Benchmark sites in the Philippines, Indonesia, and Hawaii.
* Plans continued for the February 1981 International Conference on Soils with Variable Charge, for which the Benchmark Project was previously invited to hold a 1-day symposium on the Benchmark Soils approach to agrotechnology transfer as well as to present displays and exhibits.
* During a sabbatic leave at the University of Wageningen, the Netherlands, H."Ike" Ikawa used Benchmark data in a land-evaluation study with J. Bennema, Head of the Tropical Soil Science Section; the data were shown to support Soil Taxonomy and the research findings of the Project. Linkages among scientists in the west were established as Ikawa spoke and lectured in the classroom and at the International Soil Science Society Working Group on Soil Fertility in West Germany.
* Participation by Project personnel in various meetings, conferences, and symposia continued to promote awareness and utilization of Project concepts. In addition, articles and publications, as well as slide shows and displays and exhibits, assisted in disseminating research results and Project concepts. Published by the Project in FY 1979-80 were Technical Report 2 and Technical Report 5. Quarterly publication of the Benchmark Soils News continued; the mailing list was updated, and a new computer program was designed to allow retrieval of the initial data base for many uses. The original mailing list of 895 people was purged of "old" names and names of 200 more people who asked to be placed on the list were added. The mailing list for the BSP News now totals 899 people; there are 469 organizations represented. The breakdown is 251 people in the United States and 592 in foreign countries. We now reach people in 85 countries. These numbers do not include AID mission directors and 319 people on the "old" list who have not responded to our update request. A monthly employee newsletter was begun, and a survey of employees for their interest and need is planned for early 1981.
* An article for Advances in Agronomy, Vol. 33, was invited by Nyle C. Brady, IRRI, editor of the journal; the article was prepared, submitted, and accepted for publication in late 1980. Publication is expected in early 1981.
* One additional graduate student was accepted by the Project and by the University: M. Soekardi from SRI in Indonesia.
* Crisanto Escaño is completing his doctoral dissertation and is expected to graduate from the UH with a Ph.D in Soil Science in December 1980; he will return to the host country agency, PCARR, as agreed.
* Training workshops continued; a follow-up workshop on agrotechnology transfer was held in the Philippines from July 14 to 18, 1980. The participants at the 1979 workshop in the Philippines prepared reports and presented them at this second workshop. A two-part workshop on Soil Taxonomy and agrotechnology transfer was held in Indonesia from June 23 to July 11, 1980.

# General Background

In May 1974 a contract was signed between the U.S. Agency for International Development (AID) and the University of Hawaii (UH) to initiate a project entitled "Crop Production and Land Capabilities of a Network of Tropical Soil Families." A companion contract (AID/Contract No. ta-C-1158) was signed with the University of Puerto Rico in December 1975. The Projects are more briefly and popularly known as the Benchmark Soils Project (BSP). The purpose of the Project is to test an innovative approach to agrotechnology transfer designed to assist LDCs (less developed countries) in appropriately utilizing their land resources for increased and better quality food production by bypassing three major constraints: scarcity of qualified research personnel; insufficient capital; and, above all, time needed to close the widening gap between agroproduction and food requirements. The traditional approach to agricultural research is extremely time-consuming, and farmers urgently need the basic information conducive to higher outputs; they cannot wait for local research to regenerate information that is already available to them via transfer.

The concept in question is "Can agrotechnology be transferred from one tropical region to another tropical region on the basis of Soil Taxonomy at the soil family level of classification?" The concept, if proven correct, will have far greater effect on food production and its tempo than may seem possible at first glance. Its effect may well be profound. First, millions of dollars worth of research information produced by thousands of man-year efforts will be available for immediate tapping. Second, costs of site-specific trials all over the world--which reach millions will be alleviated. Third, the overall process will be the formation of a worldwide network of expertise and a Soil and Crop Data Bank(s) to expedite and provide the needed information and communication for development. Fourth, the concept of agrotechnology transfer will be all-encompassing; it will include transfer of information on soil management practices and all that goes with it--information on crops and cropping systems, water management practices, erosion control measures, suitability to new crops, and economics of crop production.

# Project Objectives

The thrust of the Benchmark Soils Project is the acceleration and reduction of cost of agricultural planning and development in the less developed countries (LDCs) through the process of agrotechnology transfer. This relates to AID's objective of expanding the information available on the management of tropical soils to increase food production in the tropics. The objectives are:

1. To determine scientifically the transferability of agroproduction technology among tropical and subtropical countries.
2. To assist tropical countries in assessing the potential of upland areas for intensive cropping and intensive soil management.
3. To demonstrate the value of soil and land classification in formulating agricultural development plans in selected areas.

There are five major activities through which these objectives are being met:

1. Establish and complete the network of soils.
2. Establish, install, complete, and analyze transfer experiments.
3. Establish, install, complete, and analyze crop (variety) and soil management experiments.
4. Analyze information for soil interpretation and land evaluation.
5. Disseminate principles, concepts, and results.

# Continued Relevance of Objectives

The contractural objectives of the Project continue to be relevant since accelerated agricultural development to increase food production to meet the growing demand is as urgent as ever. The research conducted to date does not indicate the need for modification of Project objectives at this time.

# Accomplishments to Date

The milestone events are illustrated in Appendix 1.

## Establishment of a Network of Benchmark Soil Families

The soil family was selected in 1974 as the basis for the transfer of agrotechnology because it stratifies the soils of the world into relatively narrow agro-environments, integrating the environmental (climatic) information that is important to plant growth with the physical and chemical characteristics that affect soil response to management. The three soil families that were selected to test the hypothesis of agrotechnology transfer are:

- thixotropic, isothermic Hydric Dystrandepts
- clayey, kaolinitic, isohyperthermic Tropeptic Eutrustox (this is the link between the Hawaii and Puerto Rico projects)
- clayey, kaolinitic, isohyperthermic Typic Paleudults

Establishing the network of soils in four countries and six locations in the tropics required, for each cooperating country, a combination of negotiation, soil survey and classification, and training. Agreements were negotiated with the cooperating country government agencies for use of the site and joint participation in the Project. For each cooperating country, a project leader was trained in Hawaii in the agronomic techniques to be followed and then assigned to head the country project on location. Table 1 shows the milestones achieved to date on the network; Table 2 shows the purpose and expected results of the types of experiments.

The eight sites on the Hydric Dystrandepts are fully operational; continuing agreements with the cooperating agencies PCARR (Philippine Council for Agriculture and Resources Research) in the Philippines and SRI (Soil Research Institute) in Indonesia, as well as with the Kohala Corporation and Davies Hamakua Sugar Company in Hawaii, are renewed periodically. As reported last year, the PLP site on the Hydric Dystrandepts in Indonesia was terminated when the PLP Experiment Station expanded its building program for extension service training.

The two sites on the Tropeptic Eutrustox in Hawaii also continue to be fully operational. Lease agreements with Molokai Ranch, Inc., on the Island of Molokai and Gentry Pacific on the Island of Oahu are renewed each year.

Table 1. Soil family network of experimental sites

| Location | Site | Reference abbreviation | Experimental site type | Milestone[a] achieved |
|---|---|---|---|---|
| Soil Family A: thixotropic, isothermic Hydric Dystrandepts | | | | |
| Hawaii | Niulii, Iole, North Kohala, Hawaii | IOLE | Primary | 5 |
| | Kukaiau, Honokaa, Hawaii | KUK | Secondary | 5 |
| | Niulii, Halawa, North Kohala, Hawaii | HAL | Secondary | 5 |
| Philippines | Philippine Union College, Panicuason, Naga City | PUC | Primary | 5 |
| | Palestina, Pili, Camarines Sur | PAL | Secondary | 5 |
| | Burabod, Calabanga, Camarines Sur | BUR | Secondary | 5 |
| Indonesia | ITKA, Cisarua, Java | ITKA | Primary | 5 |
| | Segunung, Cipanas, Java | LPH | Secondary | 5 |
| | PLP, Lembay, Java | PLP | Secondary | 6 |
| Soil Family B: clayey, kaolinitic, isohyperthermic Tropeptic Eutrustox | | | | |
| Puerto Rico | Ramal, Isabela | ISA | Primary | 5 |
| | Cerro, Isabela | ISA-2 | Secondary | 5 |
| | Calero, Isabela | ISA-3 | Secondary | 5 |
| Brazil | Paraná, Jaiba | PAR | Primary | 5 |
| | Bahía, Jaiba | BAH | Secondary | 5 |
| | Ceará, Jaiba | CEA | Secondary | 5 |
| Hawaii | Maunaloa, Molokai | MOL | Primary | 5 |
| | Waipio, Oahu | WAI | Secondary | 5 |
| Soil Family C: clayey, kaolinitic, isohyperthermic Typic Paleudults | | | | |
| Philippines | Davao, Mindanao | DAV | Primary | 5 |
| | Sorsogon, Luzon | SOR | Secondary | 5 |
| Indonesia | Lampung, South Sumatra | NAK | Primary | 5 |
| | Lampung, South Sumatra | BUK | Secondary | 5 |
| | Lampung, South Sumatra | BPMD | Secondary | 5 |
| Cameroon | Barombi-Kang | CAM | Primary | 5 |
| | Southwest Province | CAN | Secondary | 4 |

[a]Milestone: 1=soil survey initiated; 2=soil survey completed; 3=agreements signed; 4=site prepared and staffed; 5=experiments underway; 6=experiments completed.

Table 2. Experiments in the Benchmark Soils Project's three soil family networks

| Type | Purpose | Expected results |
|---|---|---|
| Transfer experiments | To test hypothesis of transferability of agrotechnology | Similar yield response on similar soil families |
| Variety experiments | To identify most responsive and best-adapted varieties for transfer experiments. | Selection of best-adapted varieties |
| Management experiments | To test and develop soil management practices for a particular soil family | Management practices recommended for a region and a soil family |

The five sites on Typic Paleudults in Indonesia and the Philippines are operational; agreements covering activities at these sites are included as part of the overall agreement with both PCARR and SRI. Two sites at Barombi Kang, Cameroon, have increased the network of Typic Paleudults to seven sites. A memorandum of understanding with DGRST (General Delegation for Scientific and Technical Research), formerly ONAREST, is the basic document covering a cooperative effort among IRA (Institute de la Recherche Agronomique), FAO, USAID/Yaounde, and the Project.

The two sites at Barombi Kang and at Sorsogon (Philippines) are the final three experimental sites to be established under the present contract. The latter was planted with a transfer experiment this past year. One hectare at Barombi Kang's primary site was planted with maize to determine the uniformity of the proposed area for the initial transfer experiment, to be planted in November 1980. The secondary site has been partially cleared of trees and undergrowth. Completion of site establishemnt is expected during the 1981 dry season under the supervision of Project Specialist, Donald A. Berger. Berger was hired during the past fiscal year and assumed his position in Cameroon in July.

Figure 1 shows the network of cooperating countries on the three soil families of the Benchmark Soils Project. Agencies in cooperating countries contribute to Project expenses, thus they actively support and participate in Project planning and development. Statements of the financial contribution of PCARR, SRI, DGRST, and the University of Hawaii are in the section Statement of Expenditures and Obligations.

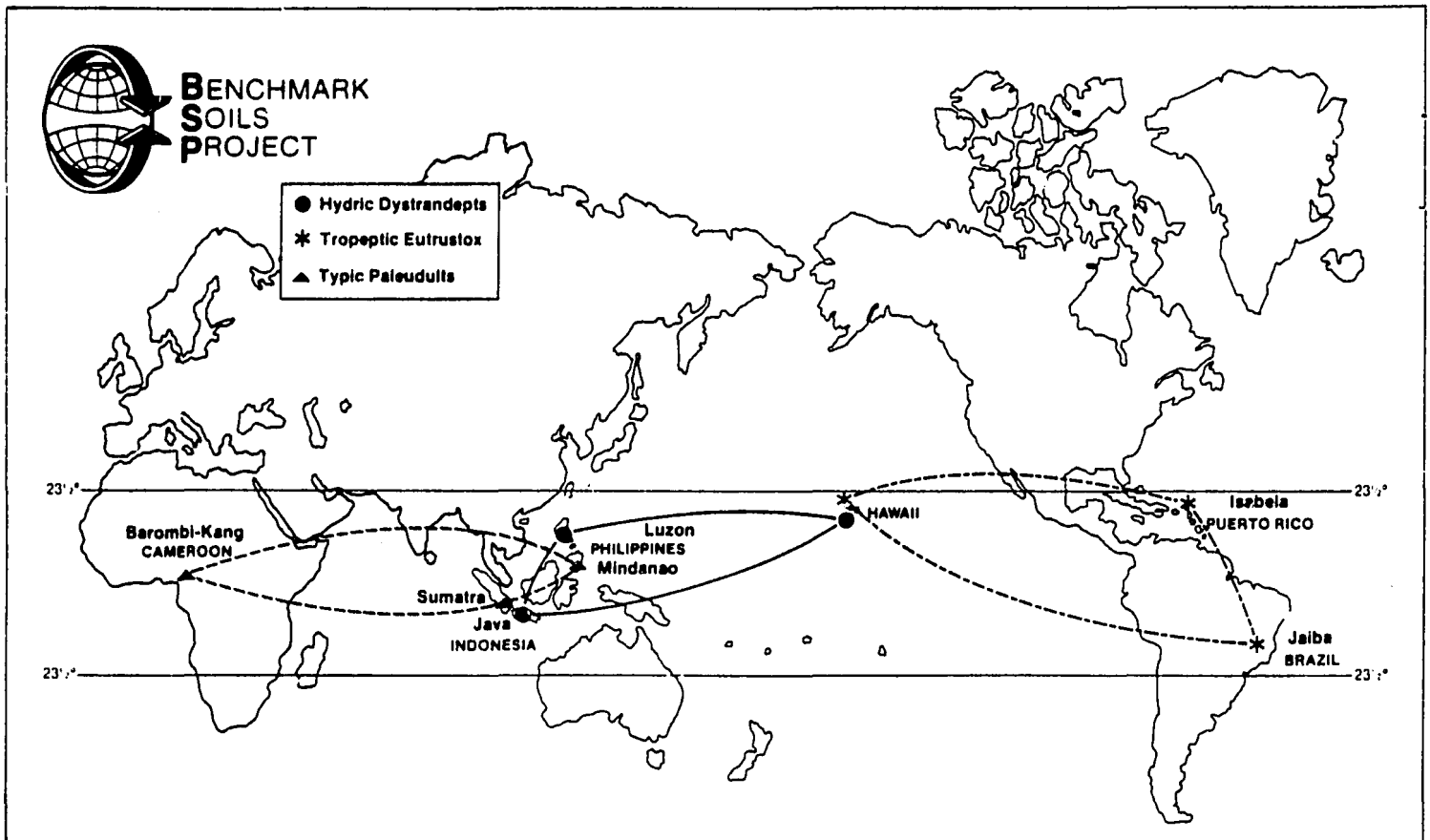


*Fig. 1. The three soil family networks in the Benchmark Soils Project.*

## Conducting Experimental Fieldwork

The total number of experiments completed in FY 79-80 was 69 and is shown by soil family and type of experiment in Table 3. Primary emphasis continues to be placed in the management of transfer experiments at all sites. Varieties common to all transfer experiments in Hawaii, Indonesia, and the Philippines were planted in variety experiments at the primary sites. A review of these experiments is presented in a later section. Of the 22 management experiments, 13 were designed as part of the graduate programsof three graduate students as indicated in abstracts listed in Appendix 2. The remaining experiments were designed to evaluate plant population and residual effects of phosphorus.

Table 3. Experiments completed, October 1979 - September 1980

| Soil/Location | Experiments | | |
|---|---|---|---|
| | Transfer | Variety | Management |
| Hydric Dystrandepts | | | |
| Hawaii | 4 | 0 | 1 |
| Indonesia | 4 | 1 | 5 |
| Philippines | 14 | 1 | 6 |
| Subtotal | 22 | 2 | 12 |
| Tropeptic Eutrustox | | | |
| Hawaii | 3 | 0 | 4 |
| Subtotal | 3 | 0 | 4 |
| Typic Paleudults | | | |
| Cameroon | 0 | 0 | 0 |
| Indonesia | 12 | 2 | 5 |
| Philippines | 1 | 2 | 2 |
| Subtotal | 13 | 4 | 7 |
| TOTAL | 38 | 5 | 22 = 65 |

*Transfer experiments*

Data to test the hypothesis of agrotechnology transfer continue to be generated with the completion of 38 out of 39 transfer experiments planted. Although the rainy season weather did create some havoc, all of the wet season experiments were completed. The data for all transfer experiments in the three-family network are reported in Appendix 3. There are three categories of transfer experiments:

a. newly opened blocks, computer coded as 10
b. residual blocks requiring no additional P, computer coded as 11, 12, and so on
c. previously used blocks requiring reapplication of P to reestablish the coded P differential, computer coded as 20, 30, and so on.

Soil test values obtained with a modified Truog extraction procedure were used to determine whether a block will be placed in either of the latter two categories. The criteria used to establish the levels of P fertilizer application in accordance with the coded P levels is discussed more fully in the next section.

Inclusion of each of the transfer experiments in the test of transferability was determined by the response of the maize test crop to the coded P and N levels and by the coefficient of variation (C.V.). If the C.V. is excessively high (> 20), the data set is rejected. Previous experiments with high C.V. and/or poor response to P can generally be attributed to extreme weather effects, pest damage, and high native P level. To reduce the effect of the latter, several blocks throughout the network were cropped to reduce the level of P and improve crop response to P in future experiments. For this reason, the total number of transfer experiments is down from the last reporting period.

The section on Devlopment and Evaluation of a Soil Family Transfer Model describes the status of the test of the transfer hypothesis using data generated to date.

*Variety experiments*

Field experiments with maize varieties used in the transfer experiments of this three-soil family network continue to be planted on the primary sites of each soil family per country. As reported earlier, the variety experiments of the Project are conducted simultaneously with the transfer experiments in order to (1) identify a "well-adapted" variety for a given agroenvironment and (2) allow comparison of performance of a particular variety in the transfer experiments within a soil family network. Data for all variety experiments are reported in Appendix 4.

The report that follows is taken in part from the research effort of Mr. Djoko Santoso (see Appendix 2), graduate student from Indonesia.

Maize varieties were evaluated from 19 variety experiments conducted on three soil family networks over a period from the dry season 1976 through the wet season 1980. Varieties of maize performed differently at different locations, and certain varieties were found to be well adapted to a specific region. Table 4 summarizes the adaptation of certain maize varieties relative to the adaptation of a standard variety for a specific country. The standard variety in each country is that variety recommended for use in the transfer experiments because of its being recognized as well adapted to local environmental conditions in the region of our experimental site

Table 4. Adaptation of maize varieties relative to the standard variety at sites in three soil families

| | | Adaptation relative to the standard variety | | |
|---|---|---|---|---|
| | Standard variety | Less well adapted | Equally adapted | Better adapted |
| Hydric Dystrandepts | | | | |
| Hawaii | H610 | H788 (1)[a] | H688 (1) | X4816 (1) |
| | | | X304B (1) | X4817 (1) |
| | | | | X304C (2) |
| Indonesia | H6 | UPCA-1 (2) | | |
| | | H610 (3) | | |
| | | Bima (1) | | |
| | | Bastar Kuning (1) | Bastar Kuning (1) | |
| | | Harapan (1) | Harapan (3) | |
| | | | | Wonosobo (1) |
| Philippines | UPCA-1 | H610 (2) | H610 (1) | |
| | | H788 (1) | H6 (1) | |
| | | DMR Comp.1 (1) | | |
| Tropeptic Eutrustox | | | | |
| Hawaii | H610 | | H688 (1) | X304C (1) |
| Typic Paleudults | | | | |
| Indonesia | H6 | Kodok (1) | Tiniguib (1) | |
| Philippines | UPCA-1 | | Tiniguib (1) | X304C (1) |

[a]Figures in parentheses are number of comparisons of the variety.

There were three standard varieties used in the Hydric Dystrandept network. They are H610 in Hawaii, H6 in Indonesia, and UPCA-1 in the Philippines. Several other varieties were identified as being as well or better adapted than the standard variety in the Hydric Dystrandept sites in Hawaii and Indonesia. In Hawaii, X4816,[1] X4817,[1] and X304C[1] were better adapted than H610,[2] while H688[2] and X304B[1] were rated as well adapted as H610. In Indonesia, Wonosobo[3] was rated better adapted, and Bastar Kuning[3] and Harapan[3] were as well adapted as the standard variety H6,[3] which is an Indonesian variety. Results in the Philippines were not consistent, so that possibly only variety H6 may be considered as equally adapted as UPCA-1.[4] The number of comparisons of a particular variety is indicated in assessment of the adaptability of a particular variety.

From these results, it appears that X304C should be considered for the transfer experiments on all three soil families. The use of a single variety will minimize the effect of genetic variability in the comparison of yield response of different sites. It should be pointed out, however, that variety X304C does not have any inherent resistance to downy mildew, which is a serious disease in the warm, moist environment of the Typic Paleudults. All maize seeds for the variety experiments are treated with Ridomil[tm] to reduce the incidence of downy mildew. This chemical treatment has enhanced the survival of a number of varieties that normally may not be grown in these areas.

*Management experiments*

The Project carried out 22 management experiments in FY 79-80. This report highlights the experiments conducted by D. J. Harris on a Hydric Dystrandept in the Philippines and a Typic Paleudult in Indonesia, through a joint agreement between BSP and IFDC (International Fertilizer Development Center, Muscle Shoals, Alabama). The remaining management experiments are listed in Table 5. Harris, Research Associate, BSP/Hawaii, is currently writing his dissertation covering this research, which is scheduled for completion in May 1981.

Large areas of currently cultivated or potentially arable land in the nonarid upland regions of the tropics are occupied by soils for which P deficiency is the factor most limiting crop production. Therefore. finding economical methods for

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[1]Variety from Pioneer Hi-Bred International. Des Moines, Iowa.

[2]Variety from University of Hawaii.

[3]Variety from Indonesia.

[4]Variety from the Philippines.

Table 5. Management experiments, 1979-80.

| Soil | Crop | Number of experiments | Type of experiment |
|---|---|---|---|
| *Hydric Dystrandepts* | | | |
| Indonesia | Maize | 1 | Plant population x P x N (D79, ITKA) |
| | Maize | 2 | Residual P x K (D79, LPHS; D79, ITKA) |
| | Soybean | 1 | Residual P (D79, LPHS) |
| | Potato | 1 | Residual P (W80, ITKA) |
| | Subtotal | 5 | |
| Philippines | Maize | 4 | P-placement and sources (W&D80) |
| | Maize | 1 | Residual effects indigenous P (guano) (D79, PUC) |
| | Rice | 1 | Use of indigenous P (guano) (W79, PUC) |
| | Subtotal | 6 | |
| *Tropeptic Eutrustox* | | | |
| Hawaii | Potatoes | 2 | Cropping system or residual P |
| | Soybean | 1 | Cropping system or residual P |
| | Maize | 1 | Cropping system or residual P |
| | Subtotal | 4 | |
| *Typic Paleudults* | | | |
| Indonesia | Sorghum | 1 | Native P response (continuous, NAK) |
| | Maize | 2 | P-placement (W&D80, NAK) |
| | Maize | 2 | P-sources (W&D80, NAK) |
| | Subtotal | 5 | |
| Philippines | Maize | 1 | Residual P, sorghum (D80, DAV) |
| | Maize | 1 | NifTAL legume inoculation test (W80, DAV) |
| | Subtotal | 2 | |
| | TOTAL | 22 | |

overcoming P deficiency is integral to increasing productivity. There are two possible strategies for improving the economic attractiveness of P fertilization:

Using phosphate rock, for direct application, as an alternative to acidulated phosphates, particularly where indigenous rock sources occur;

Using restricted placement of soluble phosphate fertilizers to maximize the return from low rates of applied P where financial constraints limit fertilizer use by farmers.

To evaluate these strategies on selected sites of the Benchmark experimental network, a collaborative research project between the University of Hawaii/Benchmark Soils Project and the International Fertilizer Development Center (IFDC) was initiated in early 1979. During the experimental phase of this project, nearly 20 field experiments were conducted with maize on three Benchmark sites.

Field experiments on P sources were conducted on a Hydric Dystrandept in Luzon, the Philippines, and a Typic Paleudult in Sumatra, Indonesia, using a split-plot design with P rate as the main plots and sources as the subplots. Maize was the main test crop. These field experiments compared crop response to one highly reactive (North Carolina, NCf) and one moderately reactive (Central Florida, CFf) phosphate rock. These two sources were in finely ground form.

Since the dusty nature of finely ground phosphate rocks hinders transport and handling, IFDC has developed the minigranulation process. Minigranular North Carolina rock (NCm) was also included in this study to determine if minigranulation reduces agronomic effectiveness. Because partial acidulation of phosphate rocks of low reactivity has been shown to increase effectiveness, partially acidulated Central Florida rock in a minigranular form (CFpam) was also tested.

The results of the P-source field experiments on the Hydric Dystrandept show a striking difference in effectiveness of sources ranging from singlesuperphosphate and Nc phosphate rock to the moderately reactive CF rock. Partial acidulation increased the effectiveness of the CF rock in the first season, but not in the second. Minigranulation did not reduce the effectiveness of the NC rock, thus confirming the agronomic viability of the minigranulation process.

On the Typic Paleudult, no statistically significant differences were observed between the four phosphate rock materials and triplesuperphosphate (TSP) during three seasons. This indicates that the Typic Paleudult is well suited for direct application of phosphate rocks of moderate and possibly lower reactivity, whereas the Hydric Dystrandept requires phosphate rocks of high reactivity to obtain yields comparable to those of superphosphate.

In the placement experiments, the treatments compared ranged from placement by-the-seed, as the most restricted placement, to incorporated broadcast application, as the most extensive placement. Experiments were installed on a Hydric Dystrandept in Luzon, the Philippines, and a Typic Paleudult in Sumatra, Indonesia.

On the Hydric Dystrandept, which has a high P requirement by virtue of its minerology, the results observed in the first three crops confirm C. T. De Wit's[1] relationships--i.e., at suboptimum rates, restricted band placement gives higher yields than broadcast, whereas, at rates reaching a yield plateau, broadcast treatments give superior yields. These results suggest the importance of developing fertilizer application methods that maximize returns from small P applications on soils with high P fertilizer requirements.

On the Typic Paleudult, for the crops that received new applications of TSP, the most restricted placement (approximately 8 cm to the side of the new seed and 10 cm below the soil surface) was significantly inferior at low rates to the other placements, including broadcast.

For both the Typic Paleudult and the Hydric Dystrandept, the inferiority of the most restricted placement when the P is freshly applied suggests the importance of spatial availability in addition to chemical availability in determing plant response to placement.

## Weather Monitoring

The influence of weather on crop growth and development was the topic assigned to two ~~individuals~~ consultants, Dr. Philip Motooka and Mr. F. C. T. Guiking, ~~contracted as consultants~~.

Dr. Motooka's work consisted primarily of reviewing past and current work on the influence of weather on maize grown in the tropics as well as to assess the monitoring of uncontrolled weather variables for crop modeling. His work was initiated to aid in our interpretation of uncontrolled weather variables and its effect on maize in the transfer experiments. Similarly, Mr. Guiking was asked to evaluate the weather variables recorded by the Benchmark Soils Project in relation

[1] C. T. de Wit. 1953. A physical theory on placement of fertilizers. Verslagen van Landbouwkundige Onderzoekungen 59:4.

to potential crop yields. This evaluation is being written in terms of weather and phenological development of maize in a crop model design.

The cooperative association with Dr. Allen Jones, a crop physiologist formerly at the HSPA (Hawaiian Sugar Planters' Association) and currently with the Grassland Soil and Water Research Laboratory in Temple, Texas, was expanded to include the use of weather and maize yield data from several sites in his crop model work. This association involves no transfer of funds as payment to Jones. Coordination and integration of results generated by the three above-mentioned researchers will add to the information base for technology transfer.

The Project was fortunate to have also had an opportunity to interact with Dr. Ray Jackson of the U.S. Water Conservation Laboratroy, USDA, in Phoenix, Arizona. Jackson spent approximately 19 days in Hawaii collaborating with both Benchmark and HSPA on detecting moisture and nutritional stress in maize grown in transfer experiments as a function of plant temperature. These measurements were made nondestructively with an infrared radiometer. A report of his activity was printed in the Benchmark Soils News (Vol. 4, No. 3).

Project scientists will continue to study the influence of the uncontrolled weather variables on crop development and yield in association with the statistical test of agrotechnology transfer. Appendix 5 reports the weather data collected at all sites in FY 79-80.

## Development and Evaluation of a Soil Family Transfer Model

The premise of the Benchmark Soils Project is that agrotechnology can be transferred from one site to another, within a stratified agroenvironment, based on the information contained in the soil family classification of Soil Taxonomy.

Although the desirability, and at times the implicit assumption, of transferring information on agricultural production requirements and recommended practices for specific crops in specific areas is widely recognized, to date there has been no means of "scientifically" assessing, for the purposes of prediction, whether the practices that are recommended for one set of sites will actually work at another site. Up to now, the time-consuming process of repetitive experimentation has been required as a test before actual implementation of specific practices.

To demonstrate scientific assessment of the transfer hypothesis, through a quantitative evaluation, the experimental designers of the Benchmark Soils Project

chose to question how use of a technology (an innovation, which presumes a change in technique or tools) would affect crop response.

This narrow definition of agrotechnology will let us predict the response to a change in technology before that technology is applied. This is statistical extrapolation: the inferring of an unknown from something that is known. The basic premise of our transfer model, then, is the prediction of how much increase in yield response can be expected from an application of a technology in a location where the technology has not been applied as determined by yield response in other locations of the same soil family. Thus, agrotechnology transfer is defined here as the extrapolation of a response-input relationship, estimated from known experimental situations to other similar conditions. This relationship has to be identified and estimated, and, before being used in practice, its worth needs to be evaluated quantitatively with experimental data.

For what technologies has this been tried? With what success?

*Summary of steps required for analysis*

Previous reports have developed the basic criterion used in assessing "goodness" of transfer predictions, which can be summarized as follows. Yields at new or "nonexperimental" sites have to be measured and compared with the yields predicted from the transfer model estimated from experimental sites. More specifically, it seems reasonable to judge the transfer process satisfactory if the predictions based on the experimental sites are close to predictions based on the observed yields at selected nonexperimental sites. Since plots have to be established at the new site, all the sites, old and new, are actually "experimental" sites. With a total of $k$ experimental sites, then, we would set up a systematic series of calculations for evaluating the transfer conjecture with each site in turn assuming the role of a "nonexperimental" site. The sequence of steps for a quantitative transfer evaluation includes:

1. Calculation of a within-site prediction equation for each of the $k$ sites based only on the yield data for that site. Various alternatives, including exponentials and polynomials, have been used historically to relate yield to controlled-input variables. The differences between the within-site predicted yields and the observed yields are called within-site ordinary residuals.

2. Identification of the general nature of the transfer model. The simplest model would include the same components as the within-site prediction equation of the first step. More complex transfer models incorporate uncontrolled-input variable information.
3. Estimation of the selected transfer model for each set of ($\underline{k}$ - 1) sites.
4. Prediction of yields for each plot at one site using the transfer model estimated from the other ($\underline{k}$ - 1) sites. The differences between the transfer predicted yields and the observed yields are called <u>transfer residuals</u>.
5. Comparison of the transfer residuals with the ordinary residuals for each site. If the two residuals are the same magnitude, we have evidence of successful transfer for the technology.

With several sites, an appealing specific criterion is the ratio of the transfer residual sum of squares to the within-site ordinary residual sum of squares where both sums are pooled over the several sites. The resulting summary statistic is called the prediction or transfer statistic.

*Transfer analysis using 27 Hydric Dystrandept sites*

The transfer methodology has been applied and preliminary evaluations reported in previous reports. These previous analyses reflected well for transfer even though each involved a small number of sites. With more data now available, especially with the Hydric Dystrandepts, a more comprehensive transfer analysis and evaluation was completed.

Effort during the past year has emphasized the following:

1. Transfer of the applied phosphorus (P) response separately from the applied nitrogen (N) response because:
   a. P is the single most important controlled variable in BSP transfer technology considerations;
   b. With no strong interaction between P and N within the range of the treatment design, each factor can be analyzed separately utilizing the extra "replication" of the other factor;

c. One-factor analyses and graphics are easier to understand and communicate.

2. Incorporation of both P-responding and -nonresponding sites in one transfer analysis and evaluation.

The transfer of site average yields is of general interest but requires relatively complex functions of several uncontrolled variables. In addition, individual site means are not part of the consideration for determining the economic optimal level of phosphorus application. Consequently, in this first comprehensive transfer evaluation of the Hydric Dystrandepts, emphasis centers on the P-response portion of the relationship between yield and applied phosphorus.

The simplest transfer model (Model 1) for P response is the sum of two independent parts--namely, the P linear and the P quadratic responses. The first relates to net or average P response over the range of applied phosphorus, while the latter reflects the degree of curvature in the P-response curve. With the differences between the within-site ordinary residual sum of squares and the Model 1 transfer sum of squares for each of 27 Hydric Dystrandept sites shown in Table 6, it is not surprising that the value of the transfer statistic, the ratio of transfer residuals to within-site ordinary residuals, is associated with a very small probability level of occurring on chance alone. Therefore, the transfer model has to be modified.

The within-site P-response curves vary systematically from site to site. For understanding these interactions between P response and site, at least one uncontrolled factor which interacts with P response needs to be identified and measured. Preplant soil phosphorus is one likely environmental variable that (1) can be measured at each site, (2) can be an indicator of differences among environments due to natural variability and past management practices, and (3) can be related to P response. The particular measure used was a modified Truog soil test (0.02N $H_2SO_4$ + 0.3% $(NH_4)_2SO_4$). Examination of plots between both P linear (Figure 2) and P quadratic (Figure 3) responses and modified Truog values reveals the nature of the interactions between the controlled applied P levels and the uncontrolled site variable. Modeling these relationships as part of an augmented transfer model (Model 2), the transfer sums of squares in Table 6 are found. Now, the probability level associated with the transfer statistic value of 1.062 is much more likely to occur on chance alone, roughly one in four. This indicates that the predicted responses do not differ from the actual responses obtained in an experiment conducted at the site.

Table 6. Within-site and transfer statistics for 27 Hydric Dystrandept sites of the Benchmark Soils Project

| Site | Within-site Ordinary Residual Sum of Squares ($x10^3$) | Transfer Residual Sum of Squares ($x10^3$) | | Average Absolute Differences between Transfer Predictions and Within-site Predictions | |
|---|---|---|---|---|---|
| | | Model 1 | Model 2 | Model 1 | Model 2 |
| | | | | ----------(kg/ha)---------- | |
| IOLE-E-10 | 7,049 | 7,915 | 8,263 | 109 | 134 |
| HAL-B-21 | 17,062 | 20,435 | 17,695 | 214 | 95 |
| HAL-B-22 | 13,264 | 16,579 | 13,830 | 221 | 90 |
| HAL-D-12 | 20,226 | 21,317 | 21,066 | 128 | 109 |
| PUC-K-10 | 5,869 | 17,728 | 8,492 | 406 | 189 |
| PUC-R-10 | 13,052 | 45,432 | 14,641 | 696 | 153 |
| PUC-S-10 | 10,325 | 59,157 | 13,521 | 853 | 219 |
| PAL-E-10 | 6,590 | 74,161 | 7,003 | 1009 | 79 |
| PAL-F-10 | 8,379 | 30,249 | 9,692 | 574 | 136 |
| BUR-B-10 | 25,055 | 50,172 | 30,069 | 598 | 275 |
| BUR-D-10 | 12,677 | 20,523 | 13,947 | 343 | 136 |
| PLP-G-10 | 29,893 | 33,072 | 32,324 | 214 | 191 |
| LPH-A-16 | 16,240 | 20,004 | 17,047 | 236 | 110 |
| LPH-D-20 | 7,947 | 8,924 | 8,108 | 120 | 48 |
| LPH-E-10 | 17,880 | 17,950 | 17,964 | 32 | 35 |
| LPH-E-12 | 19,563 | 20,555 | 20,114 | 116 | 87 |
| LPH-G-10 | 25,800 | 30,685 | 27,185 | 232 | 122 |
| LPH-G-11 | 41,424 | 47,119 | 42,522 | 253 | 111 |
| ITKA-C-10 | 16,384 | 20,416 | 17,718 | 211 | 120 |
| ITKA-C-11 | 32,090 | 34,542 | 32,809 | 166 | 86 |
| ITKA-C-12 | 21,605 | 28,105 | 21,914 | 268 | 58 |
| ITKA-D-10 | 19,867 | 31,670 | 22,155 | 355 | 156 |
| ITKA-D-11 | 53,490 | 59,881 | 53,695 | 267 | 47 |
| ITKA-E-10 | 18,445 | 21,518 | 19,165 | 185 | 88 |
| ITKA-E-11 | 26,330 | 36,351 | 27,428 | 335 | 107 |
| ITKA-K-12 | 24,638 | 28,071 | 24,640 | 227 | 5 |
| ITKA-K-13 | 9,607 | 15,665 | 10,001 | 301 | 74 |
| Total | 520,751 | 818,195 | 553,009 | | |
| P Statistic | | 1.57 | 1.06 | | |
| Average | | | | 321 | 113 |
| Range | | | | 32-1009 | 5-275 |

*Confidence of the transfer model*

The summary transfer statistic provides strong evidence for the ability to transfer P response within the Hydric Dystrandept soil family. Figure 4 and Table 6 graphically and numerically summarize the transfer evaluation by showing the closeness of predicted values, estimated from the two transfer models with the within-site predictions. The curves in the figures are the predicted P responses for the range of applied phosphorus used in the experiment, and the four figures are representative of the 27 sites. In general, the dashed prediction curve, estimated from the transfer model with modified Truog information, is sufficiently close to the prediction curve obtained from site-specific experimentation so that we could use the transfer prediction in practice even if an experiment had not been available for that site. The average of the absolute values of differences between the dashed prediction curves of each transfer model and the solid within-site predictions are given in the last two columns of Table 6. On the average, the differences of both transfer models are sufficiently small to be of practical importance, but the smaller range of values in the last column would be a deciding factor for predicting with Transfer Model 2.

We would have confidence in using the augmented transfer model for predicting P response and the corresponding phosphorus application rate to obtain the optimal P response for a new Hydric Dystrandept site without doing a site-specific experiment. The only information necessary from a new site in the same family would be the modified Truog measure of soil phosphorus. This provides information about past management which by design is not indicated by the soil family designation and therefore effectively refines the initial stratification of the agroenvironment provided by the soil family.

A technical report developing the transfer concepts, data-analysis methodology, computational procedures, and details using a specific example is being prepared and will be published in 1981.

*Typic Paleudult transfer test begun*

A preliminary transfer analysis has been completed for the Typic Paleudult soil family. Ten sites (three from NAK and three from BPMD in Indonesia and three from BUK and one from SOR in the Philippines) were utilized. Based on the limited number of sites, the results appear to reflect well for transfer of phosphorus response within the Typic Paleudult family, although more definitive statements can only be made after more data become available. The relationship

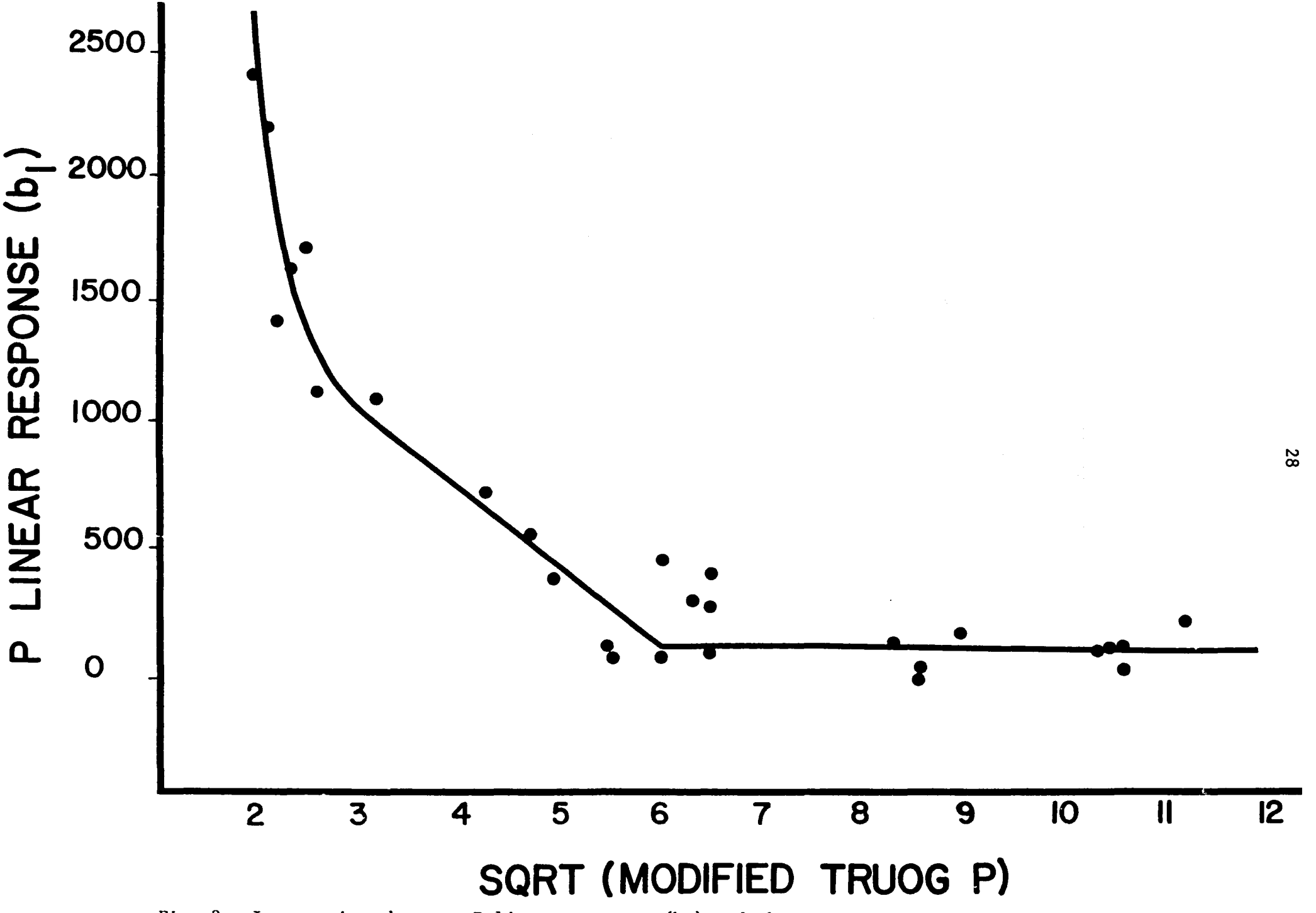



Fig. 2. Interactions between P linear response ($b_1$) and the uncontrolled site variable (modified Truog P).

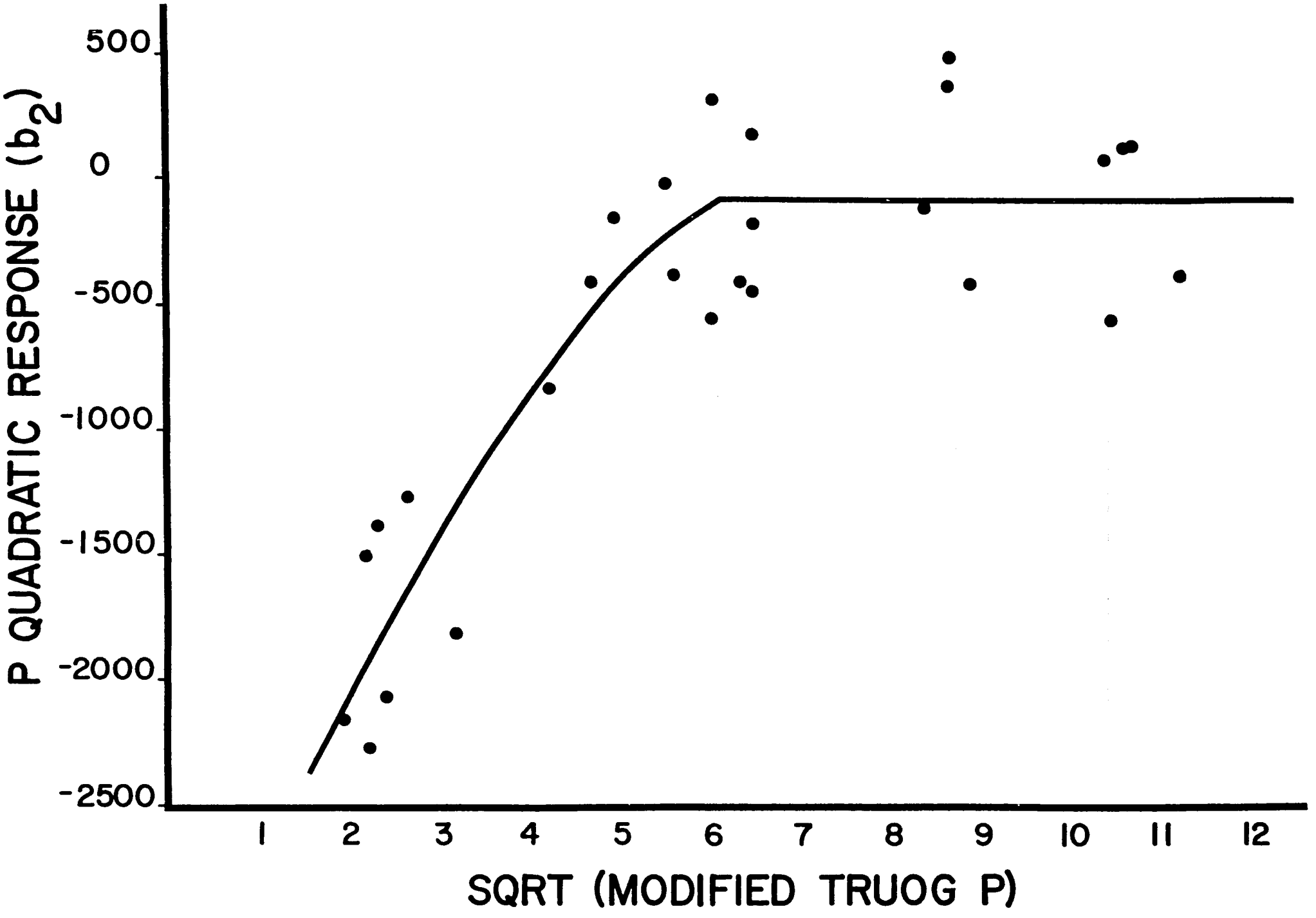



Fig. 3. Interactions between P quadratic response ($b_2$) and the uncontrolled site variable (modified Truog P)

MTP = modified Truog P
(soil-available P, in ppm,
in control plot--no fertilizer added)

△ Actual mean yield response (g) for each P level

—— Individual site model

--- Transfer model 1

----- Transfer model 2

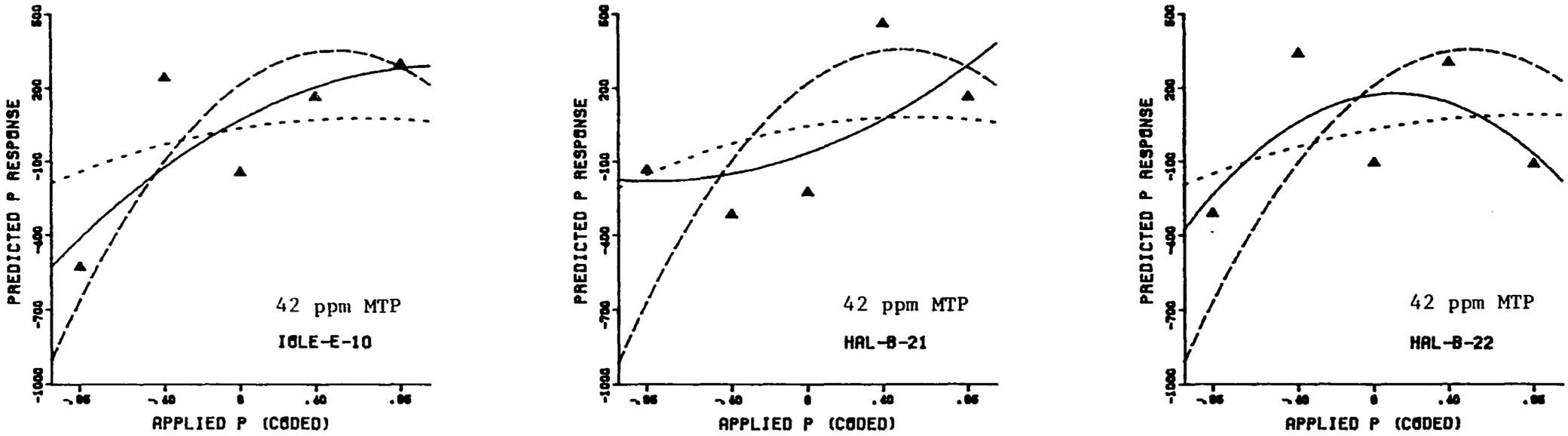
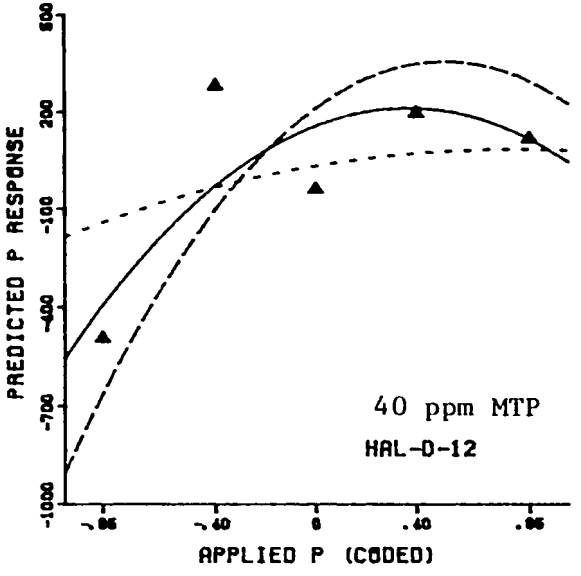
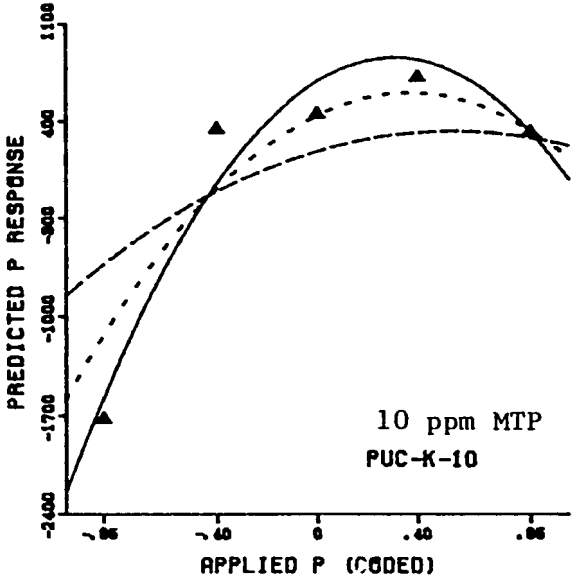
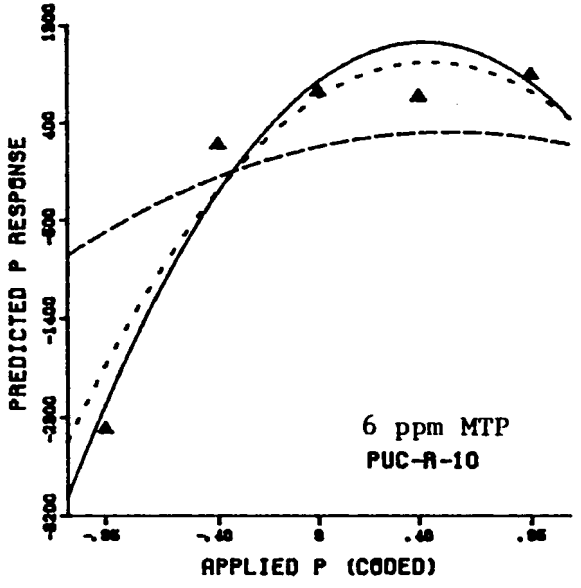
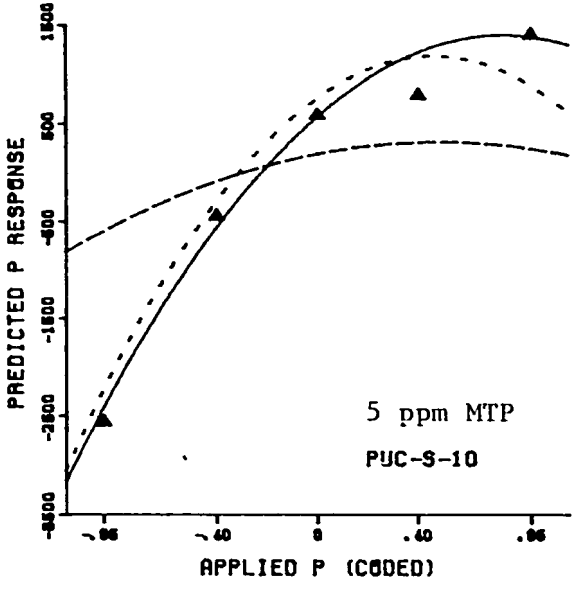


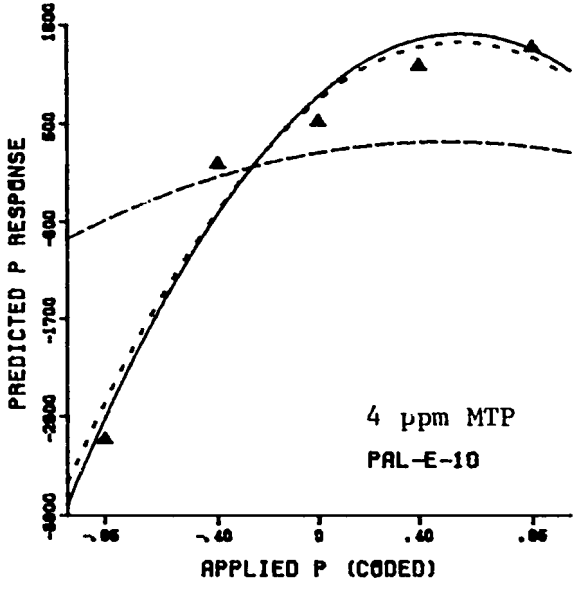

Fig. 4. The actual maize yield response obtained for the range of applied P in 27 experiments on the Hydric Dystrandept sites is compared with predicted yield responses expressed as deviations from the mean of the experiment in kg/ha. The predicted response curve based on transfer model 2 (with a measure of soil P) is generally closer to the response curve predicted with the individual site model than is the curve predicted with transfer model 1 (no measure of soil P). Note that the vertical scale (predicted P response) varies on the different graphs due to the variation in range of response at the different sites. This tends to exaggerate differences in some sites such as ITKA which, because of the high levels of soil P, did not respond to P applications.

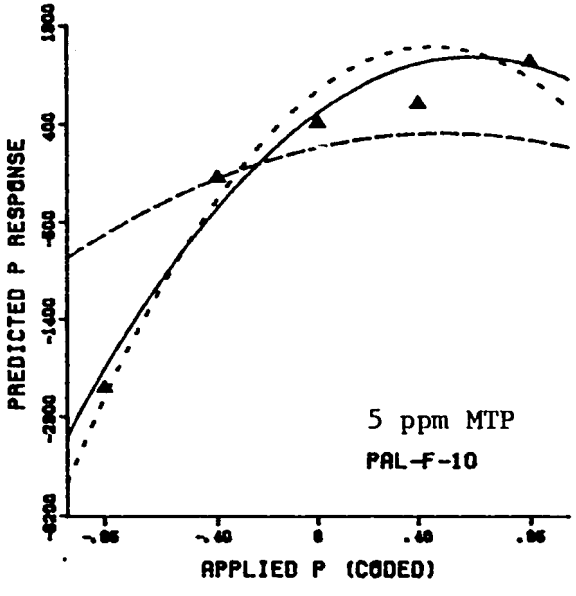

PREDICTED P RESPONSE
APPLIED P (CODED)
40 ppm MTP
HAL-D-12

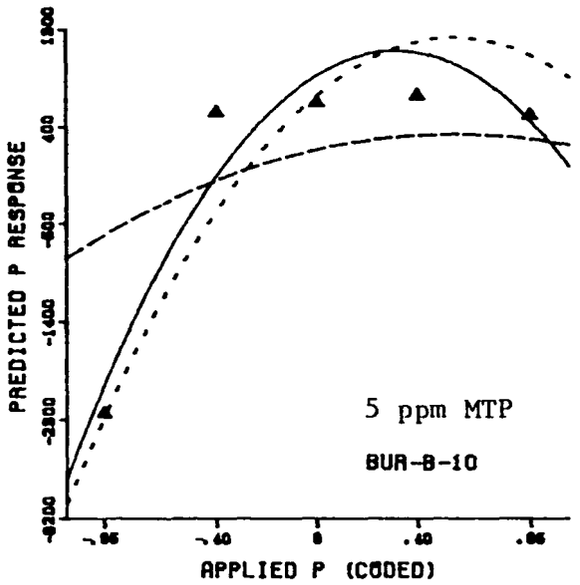

PREDICTED P RESPONSE
APPLIED P (CODED)
10 ppm MTP
PUC-K-10

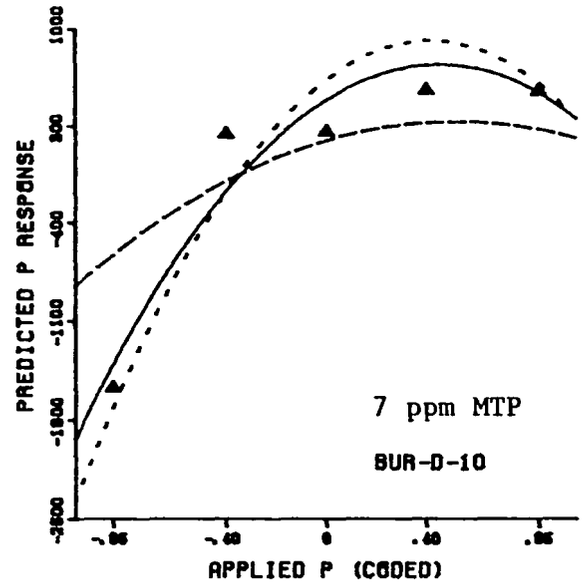

PREDICTED P RESPONSE
APPLIED P (CODED)
6 ppm MTP
PUC-A-10

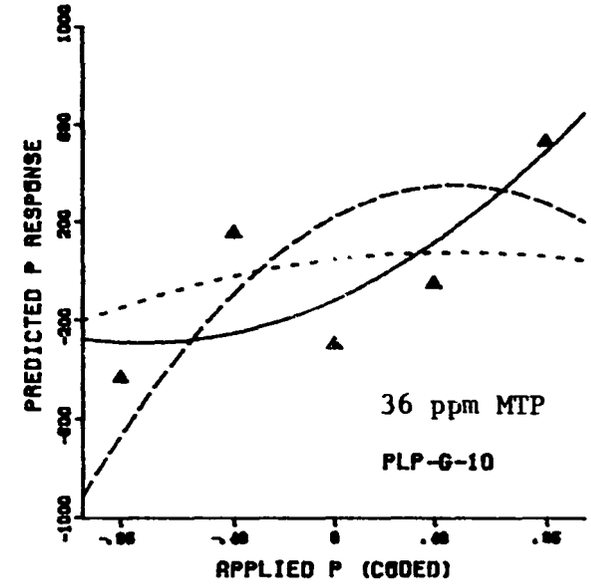

PREDICTED P RESPONSE
APPLIED P (CODED)
5 ppm MTP
PUC-S-10

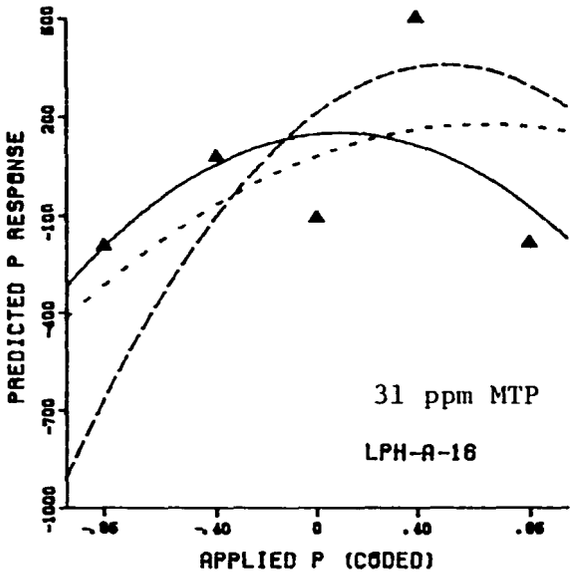

PREDICTED P RESPONSE
APPLIED P (CODED)
4 ppm MTP
PAL-E-10

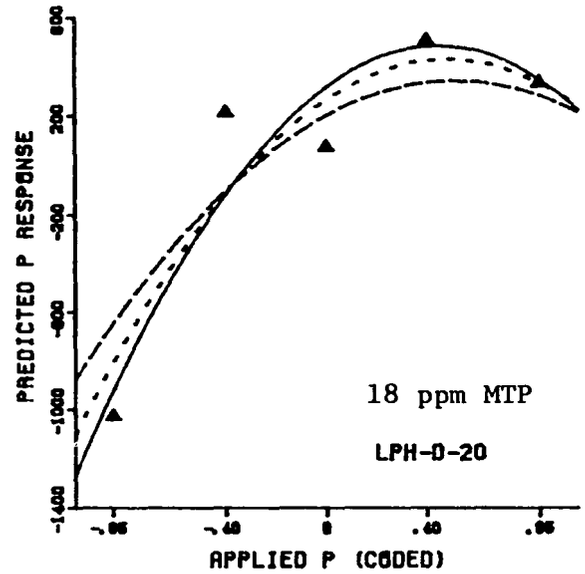

PREDICTED P RESPONSE
APPLIED P (CODED)
5 ppm MTP
PAL-F-10

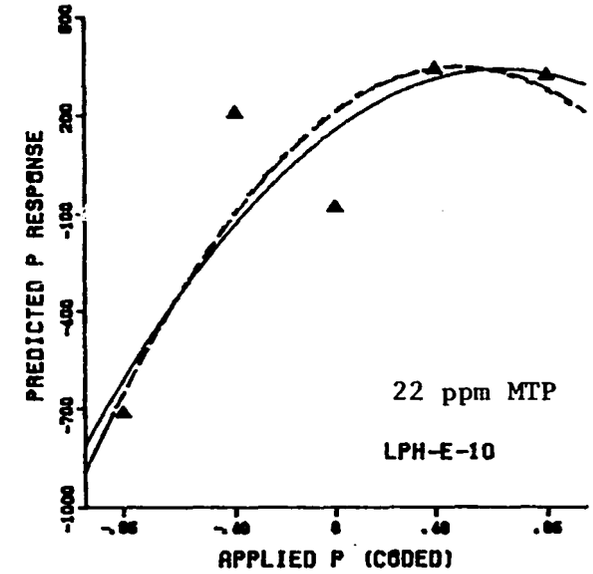

PREDICTED P RESPONSE
APPLIED P (CODED)
5 ppm MTP
BUR-B-10

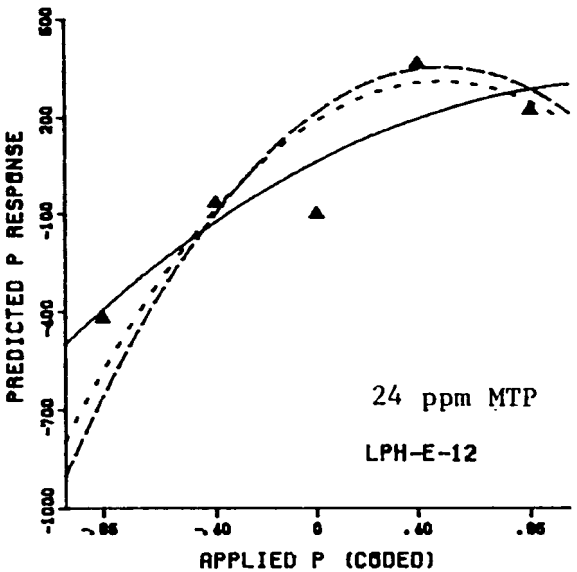

PREDICTED P RESPONSE
APPLIED P (CODED)
7 ppm MTP
BUR-D-10

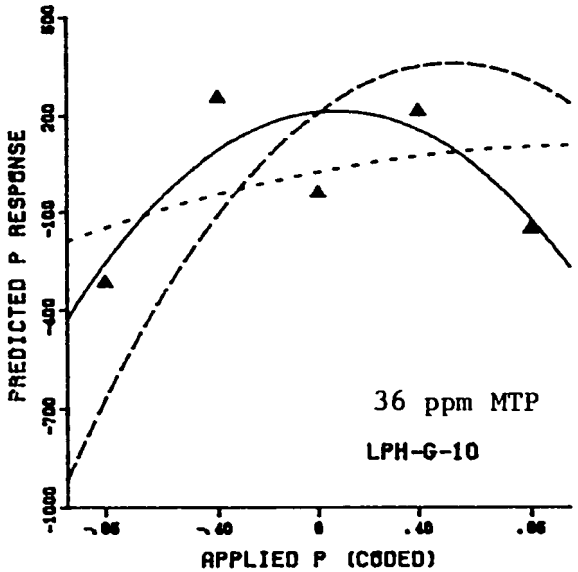

PREDICTED P RESPONSE
APPLIED P (CODED)
36 ppm MTP
PLP-G-10

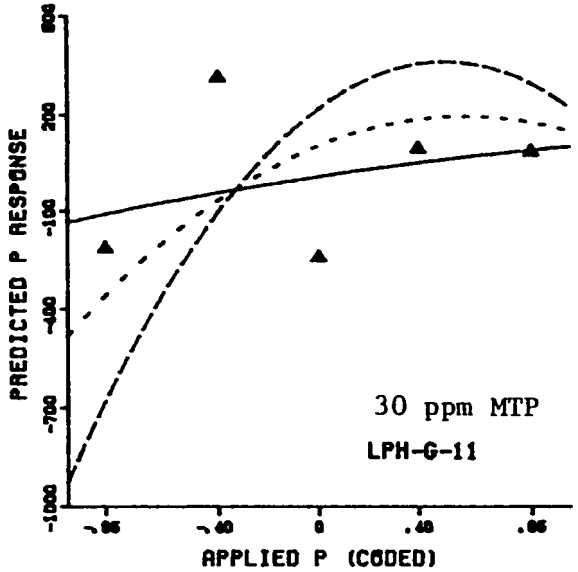

PREDICTED P RESPONSE
APPLIED P (CODED)
31 ppm MTP
LPH-A-16


PREDICTED P RESPONSE
APPLIED P (CODED)
18 ppm MTP
LPH-D-20

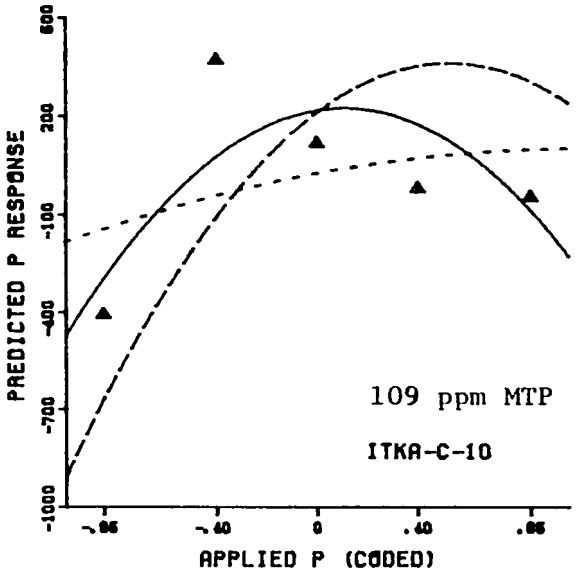

PREDICTED P RESPONSE
APPLIED P (CODED)
22 ppm MTP
LPH-E-10

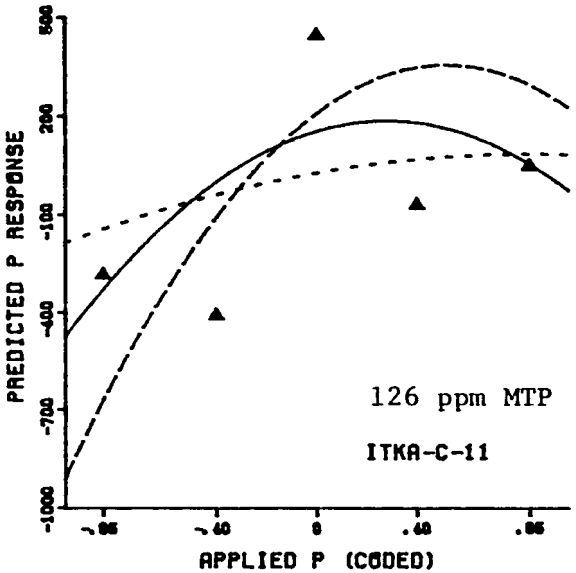

PREDICTED P RESPONSE
500
200
-100
-400
-700
-1000
-.85
-.40
0
.40
.85
APPLIED P (CODED)
24 ppm MTP
LPH-E-12

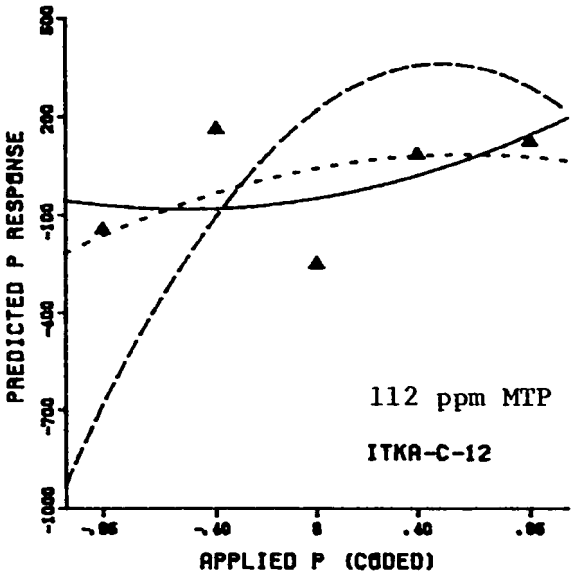

PREDICTED P RESPONSE
500
200
-100
-400
-700
-1000
-.85
-.40
0
.40
.85
APPLIED P (CODED)
36 ppm MTP
LPH-G-10

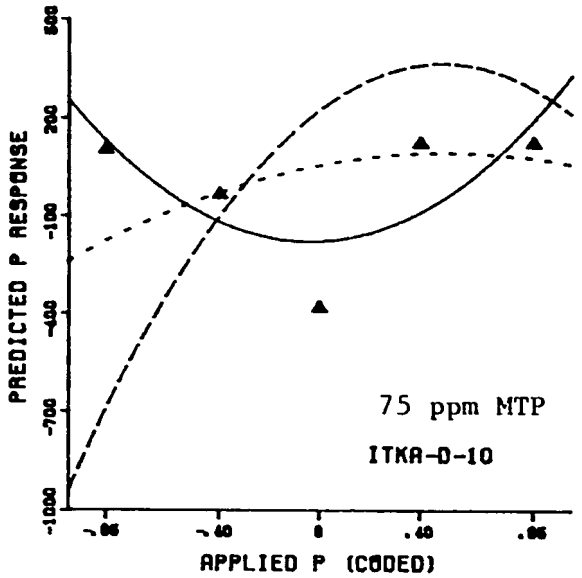

PREDICTED P RESPONSE
500
200
-100
-400
-700
-1000
-.85
-.40
0
.40
.85
APPLIED P (CODED)
30 ppm MTP
LPH-G-11

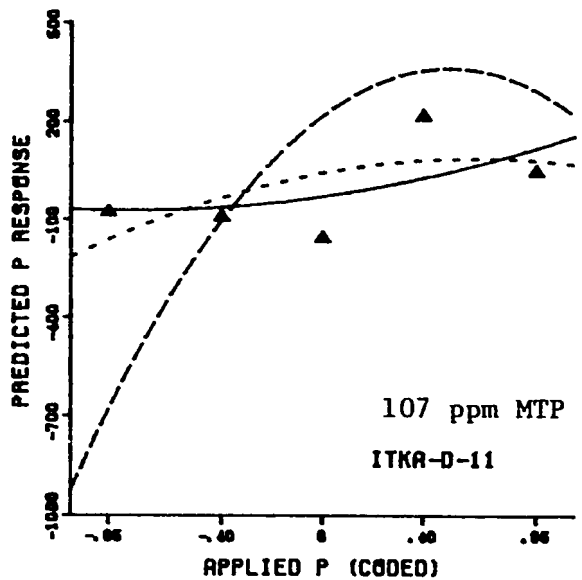


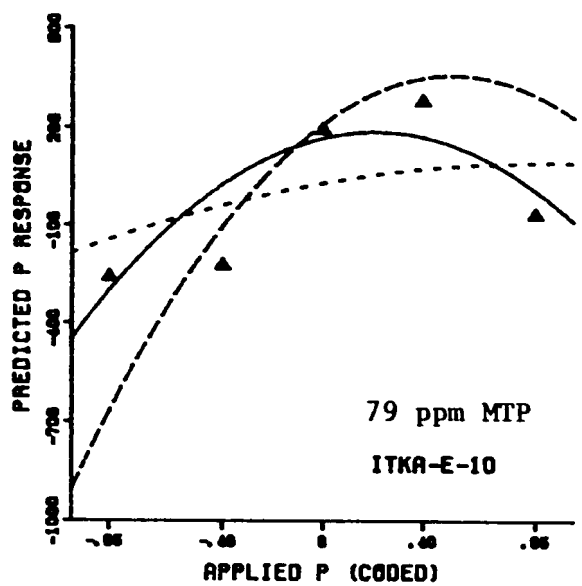

PREDICTED P RESPONSE
500
200
-100
-400
-700
-1000
-.85
-.40
0
.40
.85
APPLIED P (CODED)
109 ppm MTP
ITKA-C-10

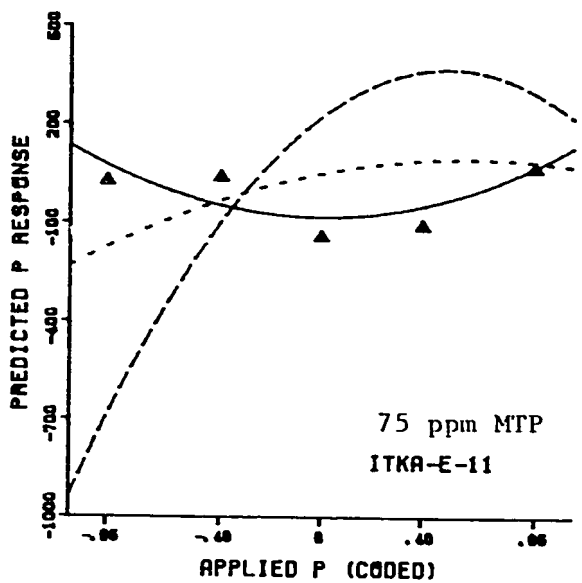

PREDICTED P RESPONSE
500
200
-100
-400
-700
-1000
-.85
-.40
0
.40
.85
APPLIED P (CODED)
126 ppm MTP
ITKA-C-11

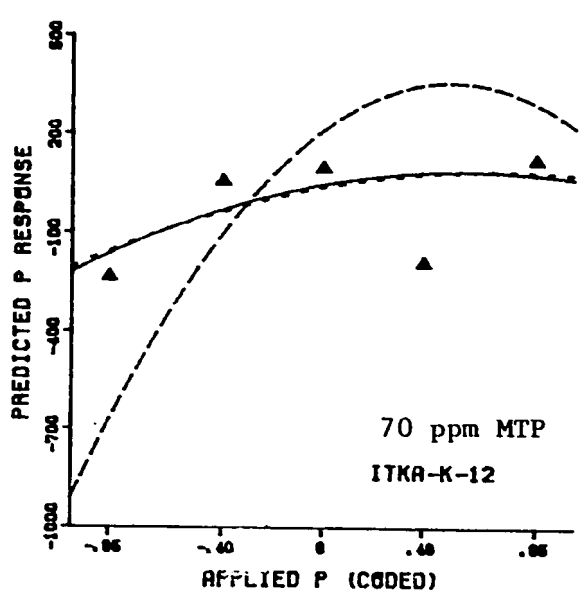

PREDICTED P RESPONSE
500
200
-100
-400
-700
-1000
-.85
-.40
0
.40
.85
APPLIED P (CODED)
112 ppm MTP
ITKA-C-12

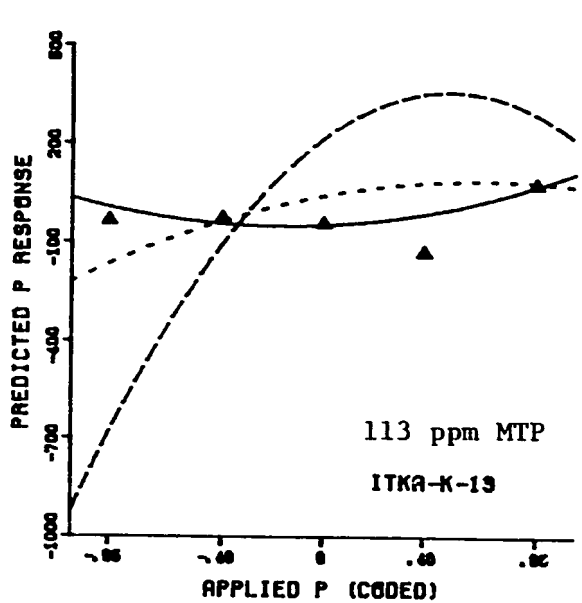

PREDICTED P RESPONSE
APPLIED P (CODED)
75 ppm MTP
ITKA-D-10


PREDICTED P RESPONSE
APPLIED P (CODED)
107 ppm MTP
ITKA-D-11


PREDICTED P RESPONSE
APPLIED P (CODED)
79 ppm MTP
ITKA-E-10


PREDICTED P RESPONSE
APPLIED P (CODED)
75 ppm MTP
ITKA-E-11


PREDICTED P RESPONSE
APPLIED P (CODED)
70 ppm MTP
ITKA-K-12


PREDICTED P RESPONSE
APPLIED P (CODED)
113 ppm MTP
ITKA-K-13

between P linear response and the modified Truog measure of soil phosphorus shows a pattern similar to that of the Hydric Dystrandept family. However, specific differences have been observed in the nature of the interaction between the controlled levels of applied P and the uncontrolled site variables. Their comparisons will be further investigated during the next fiscal year.

## Demonstration of Soil Taxonomic Considerations

In an earlier report (Progress Report 2, 1979), the effect of land qualities and management inputs on crop performance was described subjectively on the basis of experience embodied in the nomenclature of Soil Taxonomy. To demonstrate the utility of soil taxonomic considerations for planning and development effectively, Project personnel were involved in several activities related to this purpose.

*IRRI/CRIA collaboration on cropping systems research*

Firstly, Dr. Jerry L. McIntosh, cropping systems agronomist of the cooperative IRRI/CRIA program in Indonesia, is currently on a year's study leave with the Benchmark Soils Project. He represents a firm commitment between IRRI/CRIA and the University of Hawaii to collaborate on designing cropping systems for agroenvironments identified by Soil Taxonomy. It is anticipated that the impact of BSP principles and concepts in conjunction with a cropping systmes approach will be greater and more meaningful to most countries. The collaborative work with McIntosh and IRRI/CRIA is the first direct involvement of BSP with an international research center in the design and conduct of agronomic activities to further test the transferability of agroproduction technology based on soil taxonomic considerations. In principle, the design of a cropping systems program involves the matching of crop requirements to agroenvironments.

A synopsis of the joint activities is presented in the Benchmark Soils News (Vol. 4 No. 3, 1980)

*Multidisciplinary research integrated into management experiments*

Secondly, a multidisciplinary approach to agrotechnology transfer was discussed at a University of Hawaii workshop. Noel P. Kefford, interim dean of the College of Tropical Agriculture and Human Resources, introduced the workshop by saying:

> ... we should be able to reap the benefits of involving a broader spectrum of participating scientists, and the workshop should provide a starting point to expand our thinking in terms of applicability of each of our research programs and to integrate them with other disciplines.

The 3-day workshop involved 24 UH research scientists from the fields of agricultural and resource economics, plant pathology, microbiology, entomology, horticulture, botany, agricultural biochemistry, agronomy and soil science, geography, food and nutritional sciences, communication, and resource systems. Papers presented indicated that there is already evidence that agroenvironmental niches stratify not only soil-management requirements, but also disease, insect and weed hazards, crop adaptation, quality and nutritional value of farm products, symbiotic relationships between plants and microorganisms, allelopathy, land erosion, animal performance, and a host of other factors we have yet to identify.

As a consequence of this workshop, several researchers agreed to meet with project staff to discuss areas of cooperation. It is likely that a cropping systems approach to our management experiments will allow integration of technical expertise among HITAHR scientists with the Benchmark Soils Project at no additional cost to the project.

*Seasonal cropping research matches crops and climates*

And, thirdly, a cropping system capable of taking full advantage of seasonal variations in a tropical soil family was developed and is currently being conducted on the clayey, kaolinitic, isohyperthermic Tropeptic Eutrustox under the guidance of Luis Manrique, Research Associate, BSP. A summary of his report follows.

A summer planting of maize followed by a crop of soybean and a final winter planting of Irish potato appears to be one cropping sequence that makes efficient use of land area and solar energy. This cropping sequence takes advantage of the warm periods with high solar radiation, which fall between spring and autumn, to grow maize and soybeans and uses the winter months to meet cooler soil temperature requirements for potato production.

By matching crops not only to a particular soil family but also to seasons within a family, crop production can be dramatically increased without increasing land area. The principle of transferability among regions with the same soil characteristics suggests that the results obtained in Hawaii will likely apply to other areas in the tropics that have the same land characteristics.

## Other Accomplishments

*Modified Truog method used to determine P levels*

Beginning with transfer experiments planted in January 1978, the Project has continued to use the modified Truog method (0.02N $H_2SO_4$ + 0.3% $(NH_4)_2SO_4$) to determine the soil phosphorus status of all experimental blocks. Prior to that date, the soil P levels and the corresponding fertilizer P application rates were established with the P-sorption method. However, early results of yield response of maize to P treatments indicated that our application rates were high primarily due to the high level of P in solution given as the requirement for maize, and, in addition, there was difficulty in determining low levels of P in solution with consistent precision.

With the modified Truog method, it was determined from field observations that there was little or no yield response to added P if the soil phosphorus levels exceeded 25 ppm in the Hydric Dystrandepts. The 25 ppm level is being used as the upper limit in the treatment design (i.e., +1.00 coded level) in all three soil families. As additional data are generated on the three families, the sufficiency level for optimum yield will be tested and adjusted accordingly.

Although the sufficiency level of 25 ppm is used in calculating P treatments for all three soils, the amount of P added to reach 25 ppm differs for each soil family. On the Hydric Dystrandept sites that responded well to P, application of 150-220 μg P/g soil was required to reach the sufficiency level of 25 ppm soil-available P. On the other hand, in the Typic Paleudults, 50-76 μg P/g soil was required on the plots that showed very high P response. In the Tropeptic Eutrustox, the range appears to be similar to that of the Typic Paleudults, although further verification is still needed to confirm this trend.

Results of new experiments to date indicate that the response of maize grain yield to coded treatment levels is adequate for statistical analysis in testing the hypothesis of transferability. A report on these early results to predict P requirements for maize using the modified Truog method is being prepared as BSP Technical Report 9, Predicting P Requirements of Maize in Three Tropical Soil Families.

*Strategy recommended for land evaluation and agrotechnology transfer in the tropics and subtropics*

In an effort to pave the way for effective utilization of the principles and concepts of the Benchmark Soils Project, a Panel Consultation on the strategies for land evaluation and agrotechnology transfer was held on March 10-12, 1980,

Table 7. Participants at the Panel Consultation in Rome, March 10-12, 1980

P.L. Arens, Technical Officer, FAO-Rome

F.H. Beinroth, Principal Investigator, BSP-Puerto Rico, USA

A.F. de Castro, Chief, Servico Nacional de Levantamento e Conservacao de Solos, Empresa Brasileira de Pesquisa Agropecuária, Brazil

R. Dudal, Director, Land and Water Development Division, FAO-Rome

R. Fauck, Soil Scientist, Office de la Recherche Scientifique et Technique d'Outre-Mer, France

K.W. Flach, Assistant Administrator for Soil Survey, Soil Conservation Service, FAO-Rome

G.M. Higgins, Technical Officer, FAO-Rome

L.T. Kadry, Technical Officer, FAO-Rome

H. Luken, Soil Scientist, Federal Institute for Geosciences and Natural Resources, Federal Republic of Germany

H. Mattana Saturnino, President, Empresa de Pesquisa Agropecuária de Minas Gerais, Brazil

A. Osman, Director, Soil Science Division, Arab Center for the Studies of Arid Zones and Dry Lands, Syria

A.J. Pécrot, Senior Officer, FAO-Rome

M.F. Purnell, Technical Officer, FAO-Rome

I. Rosenthal, Agricultural Officer, U.S. Agency for International Development, Rome, Italy

J.A. Silva, Principal Investigator, BSP-Hawaii, USA

W.G. Sombroek, Director, International Soil Museum, The Netherlands, and Secretary-General, International Society of Soil Science

N. Stahlbrand, Technical Officer, FAO-Rome

C. Sys, Professor, Geological Institute, University of Ghent, Belgium

R. Tavernier, Professor and Director, Geological Institute, University of Ghent, Belgium

G. Uehara, Soil Scientist, BSP-Hawaii, USA

A.R. Van Wambeke, Professor, Cornell University, USA

in Rome, Italy. The meeting was sponsored by the Benchmark Soils Project, hosted by FAO of the United Nations, and held at FAO headquarters.

The intent of the consultation was to develop a strategy for land evaluation research and soil-based transfer of agroproduction technolgy in the tropics and subtropics at an international level. At the end of the 3-day meeting, the results of the discussion were summarized in a set of recommendations that reflect growing international acceptance of the BSP concept and willingness to coordinate and implement agrotechnology transfer on a worldwide scale.

The Panel Consultation recommended that an International Network of Benchmark Sites for Agrotechnology Transfers (INBSAT) be established for the tropics and subtropics. The main objective of this Network would be to elucidate the fundamental relationships between land characteristics and crop requirements with the intent to facilitate the exchange of agrotechnological production methodologies.

The Panel called for an international network of standardized field experiments to establish cause-and-effect relationships between land characteristics and crop performance in the tropics and subtropics. These relationships will be stored for retrieval and interpretation and will be the basis for formulating a land evaluation system for agrotechnology transfer. The need for a multidisciplinary effort was emphasized, with inputs from plant physiologists, agronomists, socioeconomists, agrobiologists, land managers, and others required.

The Panel further recommended that the Benchmark Soils Project assume the leadership in organizing the Network and initiating the actions necessary to implement the program. The project would be developed in close cooperation with FAO, various universities, and international research centers. It is expected that cooperating experiment stations would fold activities needed for the project into their ongoing experimental work. This would include necessary activities in soil mapping of sites and setting up meteorological instrumentation.

The guidelines and recommendations of the participating panel members have since been published as a Benchmark Soils Project Leaflet (1980). The list of participants is in Table 7.

*Ikawa sabbatic stressed land evaluation for land use planning*

Dr. H. Ikawa, Soil Scientist with the Benchmark Soils Project, returned from a year's sabbatical leave in the Netherlands. The Project provided support in terms of travel and expenses during the leave. His summary report of activities and accomplishments follows.

A sabbatical leave was taken during September 1, 1979 to February 29, 1980 from the University of Hawaii at the Agricultural University, Wageningen, The Netherlands. The purpose was to gain proficiency in the area of land evaluation for land use planning and to study some of the soils of the Netherlands in relation to soil interpretation and land use.

During the leave, there was an opportunity to study the principles and basic concepts of land evaluation with those who have contributed much in this area of specialization. In particular, much of the study was made under the direction of Professor Dr. Ir. J. Bennema, Head of the Tropical Soil Science section in the Department of Soil Science and Geology, Agriculture University, Wageningen, The Netherlands. Using the data of Benchmark Soils Project, the concepts of land evaluation were applied to determine the suitability of the different experimental sites in the network.

The study showed that when minimum temperature and irradiance were used to examine the maize yields, the best-suited sites were those with minimum temperatures of 19.5 to 22$^{o}$C and an irradiance of over 362 g cal/day. Predicted grain yields ranged from 8500 to over 10,500 kg/ha. Although other factors must be considered, preliminary analysis indicated that sites in Indonesia and Philippines classified as clayey, kaolinitic, isohyperthermic Typic Paleudults have a high potential for maize production. The clayey, kaolinitic, isohyperthermic Tropeptic Eutrustox of Hawaii and Puerto Rico are rated much higher than those of Brazil, while the thixotropic, isothermic Hydric Dystrandepts of the Philippines have a higher potential than those of Hawaii and Indonesia. A low minimum temperature accounted for much of the low potential. A manuscript by H. Ikawa and J. Bennema is in preparation.

Land evaluation was also studied by attending a course in this subject matter offered by Dr. Ir. J. S. Veenenbos and Dr. J. C. Dijkerman of the M.Sc. Course on Soil Science and Water Management. In addition to the subject of land evaluation, useful techniques in teaching land evaluation were obtained. There were also opportunities to study some of the soils under different kinds of management and land use during two field trips.

Two additional field trips were made with the staff members of the International Soil Museum, located near the University, to study additional soils in Central and Eastern Netherlands and to learn the method of collecting soil monoliths. Soil monoliths are especially useful for teaching purposes when several kinds of soil profiles are studied in the classroom or laboratory.

Several visits were made to the nearby Soil Survey Institute in Wageningen to discuss soil survey interpretation, soil data bank, and land evaluation with

specialists in these disciplines. These contacts afforded opportunities for further exchange of research information.

As a visiting colleague, I presented eight lectures and one seminar to a soils class of 40 to 50 students, mostly graduate students. The presentations covered soils of Hawaii and their management and use, as well as the subject matter of the Benchmark Soils Project. In addition, I gave three other presentations about the Project at the University of Amsterdam and the Utrecht University in the Netherlands and to the International Soil Science Society Working Group on Soil Fertility in West Germany. These lectures and presentations were used to inform others of our studies and research results in Hawaii and in the Benchmark Soils Project.

A week's visit in December 1979 to FAO, Rome, was used to attend a meeting of the "Expert Consultation on Land Evaluation Guidelines for Rainfed Agriculture." The FAO methodology of land evaluation (with large input from the Dutch) was emphasized by the participating specialists from Great Britain, Malaysia, the Netherlands, and the United States. If the exchange of information on land evaluation for land use planning is to be meaningful, there is a need to have a standardized system of land evaluation such as that proposed by the world organization FAO.

The immediate benefit of the sabbatical leave was to be able to lecture on the subject of land evaluation in workshops on agrotechnology transfer sponsored by the Benchmark Soils Project and other institutions in Indonesia and the Philippines in June and July 1980. In addition, during the fall semester of 1980, just concluded, in the Department of Agronomy and Soil Science Soils 304 class, the 110 students were exposed to the subject of land evaluation. They were made aware that the study of soil science led to land utilization through processes such as land evaluation.

# Dissemination and Utilization of Research Results

## Visitors

Visitors to Project sites in FY 79-80 are listed on the following pages.

| Name | Country | Purpose of Visit |
|---|---|---|
| *Cameroon* | | |
| H. Eswaran | U.S. | Visit BSP site and explore possibility of holding international soil classification meeting in Cameroon. |
| J. Ayuk-Takem | Cameroon | Inspect uniformity trial at Barombi Kang. |
| *Hawaii* | | |
| F. B. Cady<br>Cornell University | U.S. | Consultation on analysis of transfer data. |
| R.B. Stryker<br>Orchid Palace Hotel<br>Jakarta | U.S. | Meet with BSP staff prior to assuming post in Indonesia. |
| A. Hooper<br>Dept. of Genetics and Cell Biology<br>University of Minnesota, St. Paul, Minnesota | U.S. | Received information on BSP activities. |
| R. C. Barba<br>Institute of Plant Breeding, UP Los Banos College, Laguna | Philippines | Received information of BSP activities in Philippines. |
| J. L. McIntosh<br>B. J. McIntosh<br>CRIA/IRRI, Bogor | Indonesia | One year study leave with BSP. |

| Name | Country | Purpose of Visit |
|---|---|---|
| L. A. Nelson<br>Dept. of Statistics<br>N.C. State University,<br>Raleigh, N.C. | U.S. | Consultation on data processing of transfer experiment. |
| H. L. Thompson<br>ICRISAT, Hyderabad | India | Meet with C. Garver on publications. |
| Karean Zukeran<br>NifTAL | U.S. | Meet with administrative staff. |
| Jan L. Nanere<br>Bogor, Indonesia | Indonesia | Received information on BSP activities in Indonesia. |
| Osny Bacchi<br>IAA/Planalsocar,<br>Brazil | Brazil | Received information on BSP activities. |
| Peter Randall<br>CSIRO, Canbewa,<br>Australia | Australia | Received information on BSP activities. |
| Dave Schuelke<br>Lab for Research in<br>Scientific Comm.<br>325 Haecker Hall<br>University of Minne-<br>sota, St. Paul, Minn.<br>55108 | U.S. | EWC scholar; discussed communications strategy with BSP. |
| Bill Kerry<br>Paia, Maui, NifTAL | U.S. | Consult with BSP staff on cooperative work. |
| Vince Neall<br>Dept. of Soil Science<br>Massey University,<br>Palmerston North,<br>New Zealand | New Zealand | |
| William D. Bishop<br>IRDC, Muscle Shoals,<br>Alabama | U.S. | Meet with BSP staff on IFDC-UH work. |
| Aurelio A. Briones<br>UP at Los Banos | Philippines | Consultation with BSP staff on soils program at UPLB. |
| Ray Diamond<br>IFDC | U.S. | Meet with BSP staff and D. Harris on IFDC-UH contract. |
| L.L. Hammond<br>IFDC | U.S. | Meet with BSP staff. Plan inspection and review of IFDC-UH contract. |

| Name | Country | Purpose of Visit |
|---|---|---|
| M. Sudjadi<br>SRI Bogor | Indonesia | Participate in harvest and in Project Leader meeting |
| R. W. Arnold<br>SCS, Washington, D.C. | U.S. | Meet with BSP staff on strategy to assist PCARR in planning both soil survey and classification program and SMSS program. |
| L. D. Swindale<br>ICRISAT | U.S. | General meeting with BSP staff. |
| Dr. Keith N. Palmer<br>Timberline Camp,<br>Waipahu | U.S. | Information on BSP. |
| Dr. W. E. Eguagee<br>NIHORT,<br>P.M.B. 5432, Nigeria | Nigeria | Received information on BSP. |
| Tan Ying<br>101 South Geseping Rd.<br>Taipei, Taiwan | Taiwan | Received information on BSP. |
| G. N. Alcasid, Jr.<br>Bureau of Soils,<br>Manila | Philippines | Meet with BSP staff on proposed soils institute in Philippines. |

*Indonesia*

| | | |
|---|---|---|
| Ir. Subagio<br>SRI staff | Indonesia | The participants were guided through our secondary site, LPH Segunung, where they were briefed on the BSP concepts, hypothesis, goals, and achievements, weather monitor instruments, crop management, and soil profile examination in the pit. |
| Dr. Amir Kassem<br>Agro-ecology consultant<br>Mr. J. Brunt<br>Associate Expert, Agronomy<br>Mr. Frank Dent<br>Head of FAO | Indonesia | Visited the LPH Segunung site. Kassen and Brunt showed interest in agro-climatic data collections and daily weather monitor data. |
| Mr. Larry Marshall<br>US/AID, Mission Office | U.S. | Marshall interested in economic aspects. Visited Typic Paleudult sites. |
| Dr. James A. Silva<br>Principal Investigator<br>Dr. Robert Davis<br>Project Coordinator<br>Asia, NifTAL | U.S.<br><br>U.S. | Visited Paleudult sites. Guests pleased with the clean cultivation and the performance of our maize crops. Also praised were the establishment and the management of the site under trying conditions. |

| Name | Country | Purpose of Visit |
|---|---|---|
| Dr. Ron Stryker<br>Food Extension Program | Indonesia | Visited BSP site at LPH, Segunung. |
| Mr. Michael Korin<br>Project Officer, US/AID Mission, Jakarta | Indonesia | |
| Riyadi and Nasrul | India | |
| Mr. M. Rahman<br>Director, Dept. of Soil Survey, Bangladesh | Bangladesh | Visited the primary site, NAK, Typic Paleudults. |
| Dr. J. A. Silva<br>Dr. G. Uehara<br>Dr. H. Ikawa<br>Dr. B. Cagauan, Jr.<br>Dr. J. L. McIntosh<br>Dr. W. H. Hudnall | U.S. | Visited the primary site, NAK, Typic Paleudults. Demonstration of drip irrigation and weather instruments were shown.<br>Participated in workshops on Soil Taxonomy and Agrotechnology Transfer. |
| Dr. Raymundo<br>Project Leader, Philippines | Philippines | |
| Dr. Elwood Black<br>Associate Professor, Univ. of Wisconsin | U.S. | Visited the Typic Paleudult sites. |
| Dr. Santhad Rojanasoothan<br>Assistant Professor, Kasetsart University, Bangkok | Thailand | Visited Hydric Dystrandept and Typic Paleudult sites. |
| Mr. Alan Hurdus<br>Agronomic Advisor Research, US/AID Mission, Jakarta | U.S./ Indonesia | Visited Typic Paleudult sites |
| Dr. Ray Isabell<br>CSIRO, Australia consultant AID, East Kalimantan | Australia | Visited the BSP Office, Bogor at different times. Information on BSP concepts, hypothesis, goals, soil taxonomical classification system, our findings furnished. |
| Dr. Rainer Hoffmann<br>Pedologist Transmigration Area Development, Indonesia | U.S. | |
| Jerome F. Harrington<br>President, IRI Research Institute, Inc., Rockefeller Plaza, USA | U.S. | Visited BSP site at LPHS. |
| Roy S. Rasad<br>Financial Manager/Agriculture Specialist, UNDP/IBRD | Indonesia | Visited BSP Site in Lampung, Sumatra. |
| Soepojo Rahardjo<br>Agricultural/Social Systems Specialist, UNDP/IBRD | Indonesia | |

| Name | Country | Purpose of Visit |
|---|---|---|
| Dr. Juno<br>Agronomist, UNDP/IBRD<br>Jambi Project, Indonesia | Indonesia | |
| Dr. Alex Simon<br>Associate Professor<br>Univ. of Wisconsin, USA | U.S. | Visited BSP site in LPHS. |
| Mr. Wiranto Soehendro<br>Senior Agriculture Assistant<br>of the World Bank | Indonesia | Attended the entire agrotechnology transfer workshop and participated in the workshop discussions. |
| Ritchie Cowan<br>IRRI liaison scientist<br>Ed Oyer<br>International Agricultural<br>Development Service (IADS) | Indonesia | Attended some of the agrotechnology transfer worshop sessions. |
| Dr. Ernesto Lucas<br>AID Agricuture Economist | Indonesia | Gave one of the opening remarks in the Agrotechnology Transfer workshop on behalf of AID. |
| Dr. Bernardino Cagauan, Jr. | U.S. | Workshop planning coordinator. |
| Mr. David J. Harris<br>BSP/Hawaii | U.S. | Supervised work on IFDC-BSP experiment in NAK, Sumatra. |
| *Philippines* | | |
| Dr. James A. Silva<br>Principal Investigator,<br>BSP<br>Mr. Crisostomo B. Alcalde<br>PCARR BSP Project Leader<br>Dr. Robert J. Davis<br>NifTAL | U.S.<br><br><br>R.P.<br><br>U.S. | Semi-annual visit of the project and explore participation in the network of legume inoculation studies at Naga and Davao. Also visited Sorsogon. |
| Joe R. Gingrich<br>Cliff Monroe<br>International Crop<br>Protection Center/National<br>Crop protection Center,<br>UPLB. | U.S. | Visit project and check on the plans of Edgar de la Torre on herbicide trials at Naga. |
| PCARR Inventory Team<br>Anselmo Cuarto<br>Hector Sacarmento<br>Jose Mercado<br>Rizalina Salamat<br>Clarito Villa | R.P. | Checked and evaluated status of the International Pick Up at Naga. |
| Gordon Y. Tsuji<br>Project Manager, BSP | U.S. | Semi-annual visit to Naga and Sorsogon. |

| Name | Country | Purpose of Visit |
|---|---|---|
| Mr. Epifanio Ciron<br>Staff PUC Naga View Campus | R.P. | Reminded project as to the renewal of the contract. |
| Engrs. Eduardo V. Manalili<br>Rodelio R. de Guzman<br>RSDC Makati | R.P. | Visited the drip irrigation system used by the project. |
| PCARR Evaluation Team on Soils and Water Research<br>Dr. Amado R. Maglinao<br>Mr. Rodolfo C. Undan<br>Miss Teodula M. Metra | R.P. | Evaluation of BSP and other PCARR-financed research activities on soils and water. |
| Mr. Weny Paez<br>Mr. Epifanio Ciron<br>PUC staff members | R.P. | Visited project site at Naga. |
| Mr. Aaron M Salazar<br>New Director, PUC,<br>Naga View Campus | R.P. | Inspection of PUC site |
| Mr. Marvic Celeja Jr.<br>Naga City Assessor's Office | R.P. | Inspection and assessment of properties at PUC. |
| Dr. Larry Hammond<br>IFDC | U.S. | Inspection of IFDC-financed experiment on P-sources conducted in cooperation with BSP in Naga and Sorsogon. |
| Mr. David J. Harris<br>Graduate Research Assistant<br>BSP, University of Hawaii | U.S. | Supervise work in his experiments and plan out modification for succeeding experiments at Naga. Accompanied Dr. Hammond to Sorsogon. |
| Dr. Alfonso Roda<br>President Philippine Union College | R.P. | Silang Cavite with other PUC officials visited the site. |
| Dr. Bernie G. Cagauan Jr.<br>Tranining Coordinator BSP | U.S. | Inspected sites at Naga, Sorsogon and Davao on behalf on PI. |
| Students of Sorsogon<br>National Agricultural School<br>under Mr. Bueno Mendez | R.P. | Visit research experimental area at Sorsogon as part of their field trip. |
| Dr. Bonifacio Felizardo<br>UPLB | R.P. | Visited Davao site with Rex Talupe. |
| Mr. Benjamin Cariaga<br>OIC Bureau of Soils Region XI | R.P. | Visited BSP project site. |

| Name | Country | Purpose of Visit |
|---|---|---|
| Messrs. Arturo Dayot and Alfonso Crucena<br>Bureau of Soils | R.P. | Visited BSP project site. |
| Agriculturists from the Bureau of Agricultural Extension | R.P. | Davao del Sur with farmer leaders and guided by BPI personnel. Visited the site at BPI, Davao. |
| PCARR Soil and Water Research Review Team<br>Mr. Reynaldo Palis<br>Mr. Rodolfo Ilao<br>Miss Teodula Metra | R.P. | Evaluated UH-PCARR BSP in Davao. |
| Dr. Richard Arnold<br>Soil Conservation Service<br>USDA Washington | U.S. | Visited BSP Davao site. |
| Mr. Romulo Flores<br>Twin Rivers Tagum | R.P. | Visited the BPI site and inquired probable visit by Bernie Cagauan. |
| Josie de Jesus<br>BSP Naga | R.P. | Supervised the turnover of responsibilities of clerk-typist at Davao headquarters. |
| Leny Guerrero<br>Cotabato City | R.P. | Visited BPI site and inquired as to available job opportunities. |
| Mrs. Nelia T. Gonzales<br>Assistant Minister, Agriculture | R.P. | Conducted inspection of Ministry Research Station. |
| Dr. and Mrs. Peairs Wilson<br>Kansas State University accompanied by BPI, Davao personnel | U.S. | |

## Publications, Papers, and Displays

Publication and distribution of Project concepts and results continues to be an effective aspect of the process of dissemination and utilization of Project-generated information.

In Fiscal 1979-80, the following technical reports were printed:

| | Title | Pages | Press run |
|---|---|---|---|
| Tech. Rep. 2 | Laboratory Data and Descriptions of Soils of the Benchmark Soils Project: Vol. 2--Puerto Rico Project (F. H. Beinroth) | 8 | 1000 cc |
| Tech. Rep. 5 | Classification of the Soil Series of Hawaii in four Systems: A Guide to Correlating Tropical Soils (F. H. Beinroth, H. Ikawa, and G. Uehara) | 54 | 2000 cc |

In addition, a leaflet was printed after the BSP/FAO panel consultation in Rome:

| | | | |
|---|---|---|---|
| Leaflet 3 | Strategy for Land Evaluation and Agrotechnology Transfer in the Tropics and Subtropics. | 2 | 200 cc |

A Working Proceedings of the HITAHR Workshop on Agrotechnology Transfer was compiled for use by the participants in the August meeting. This set of papers has been reviewed by University of Hawaii College of Tropical Agriculture and Human Resources faculty members and has been accepted for publication in FY 1980-81 as a CTAHR Research Extensions series entitled A Multidisciplinary Approach to Agrotechnology Transfer. G. Uehara is the editor.

Currently in press for publication in FY 1980-81 are the following:

| | |
|---|---|
| Tech. Rep. 3 | Report on P Methodology (Lai, Chu, Cagauan, Silva) |
| Tech. Rep. 4 | Soils of the Hawaii Agricultural Experiment Station (Ikawa) |
| Tech. Rep. 6 | Quantitative Evaluation of Agrotechnology Transfer with an Application to Phosphorus Response on Hydric Dystrandepts (Cady, Chan, Garver, Wood) |
| Tech. Rep. 7 | A Multidisciplinary Approach to Agrotechnology Transfer (Uehara) |
| Tech. Rep. 8 | Proceedings of the Benchmark Symposium at the International Conference on Soils with Variable Charge |

The Benchmark Soils News continues to be published quarterly. The newsletter has expanded from 6 pages to 8 pages each issue: Vol. 4(4) (December 1980) will be 12 pages long. This is due to expanded reporting of research results.

The article previously invited for Advances in Agronomy, edited by Nyle C. Brady, was completed and submitted for publication in December 1980 in Vol. 33.

F. H. Beinroth, G. Uehara, J. A. Silva, R. W. Arnold, and F. B. Cady. 1980. Agrotechnology transfer in the tropics based on Soil Taxonomy. Advances in Agronomy 33. pp. 303-339.

Statistical consultant Foster B. Cady wrote a paper with C. L. Wood entitled "Intersite Transfer of Estimated Response Surfaces" for the journal Biometrics, Vol. 37(1): pp. 1-11.

Papers were presented at various conferences. The list follows:

| Presenter | Conference | Title of Paper |
|---|---|---|
| H. Ikawa | Univ. of Utrecht | The Benchmark Soils Project of Hawaii and Puerto Rico. |
| H. Ikawa | FAO, Rome, Expert Consultation on Land Evaluation Guidelines for Rainfed Agriculture | The Benchmark Soils Project of Hawaii and Puerto Rico |
| H. Ikawa | ISSS Working Group on Soil Fertility, Dulmen, W. Germany | Documentation and Reporting of the Experimental data of the Benchmark Soils Project |
| | | The Benchmark Soils Project of Hawaii and Puerto Rico |
| M. Raymundo | Philippine Union College | Slide show overview of the Benchmark Soils Project |
| M. Raymundo | Ministry of Agriculture, Davao, Reg. XII | " |
| M. Raymundo | Univ. Philippines, Los Banos College of Agriculture | " |
| R. G. Manuelpillai | Workshop on Research and Development | Seminar on Agricultural Research and Supporting Consultants |
| J. A. Silva | FAO, Rome, Panel Consultation on the Strategies for Land Evaluation and Agro-Technology Transfer | Slide presentation on the Benchmark Soils Project--overview and results. |

Plans and preparations continued for Project participation at the New Zealand International Conference on Soils with Variable Charge in February 1981. The Project has been invited to hold a 1-day symposium at the conference and to prepare a room of displays and exhibits. In addition, abstracts for poster sessions have been submitted by H. Ikawa and Modesto Recel and by F. B. Cady and C. L. Wood. Publicity items on the Benchmark Soils Project were prepared at the request of the conference organizers and sent to New Zealand.

Abstracts for poster session presentations have been submitted by D. Harris, L. Manrique, and C. Escano to the American Society of Agronomy meetings in December 1980. Plans for these posters have begun.

A monthly newsletter, the BSP Communique, was begun as a means of internal employee communication, since the network of Project personnel encompasses widely separated geographic locations. Feedback from field and laboratory employees indicates this medium enhances feelings of loyalty to and unity with Project operations.

Data-reporting sheets for transfer experiments were finalized and printed for all-site use. These are being compiled with the procedures for transfer experiments in a technical report as guidelines for interested countries.

The following list details requests for publications received by mail and answered:

| | | |
|---|---|---|
| Prog. Rep. | 1 | -- 32 |
| | 2 | -- 81 |
| Tech. Rep. | 1 | -- 62 |
| | 2 | -- 73 |
| | 5 | -- 47 |
| Book | | --105 |
| Leaflets 1, 2 | | -- 21 |
| Other | | -- 5 |

Publications were also distributed to visitors at headquarters and various BSP sites. A summary of a publications inventory in May 1980 is in Table 8.

Mailing List

The mailing list for the News was updated and reprogramed on-line with the IBM computer at the University of Hawaii to enhance the capability for retrieval. Update cards were mailed to the 895 people on the "old" keypunched computer cards; a total of 507 replies were received as of October 1980. Additional requests to be placed on the mailing list were also received; at this time, the mailing list for the News numbers over 900. Additional copies are distributed personally by Project Leaders at the various sites. Total print run for the News is 1500 copies.

Appendix 6 provides a frequency tally of agencies and countries receiving the News.

Table 8. Publications inventory, Benchmark Soils Project, May 1, 1980

| | No. left 4/7/80 | No. printed (date) | Remarks |
|---|---|---|---|
| book (Swindale) | 600 ca. | 2000 (10/78) | |
| Progress Rep. 1 | 36 | 1500 (8/78) | out of print |
| Progress Rep. 2 | 815 | 1500 (8/79) | |
| DP 26 | 44 | 1000 (2/75) | out of print |
| DP 50 | 63 | 1500 (1,1/77) | |
| Tech. Rep. 1 (Misc. Pub. 165) | 350 | 2000 (1/79) | 912 in PIO* |
| Tech. Rep. 2 (Misc. Pub.. 166) | 232 | 2000 (2/80) | 1050 in PIO |
| Tech. Rep. 5 | 500 ca. | 1000 (2/80) | |
| Leaflet 1 | | | |
| English | 746 | 5000 (8/78) | |
| French | 273 | 1000 " | |
| Spanish | 736 | 2000 " | |
| Leaflet 2 | | | |
| English | 1162 | 5000 ( /78) | |
| Spanish | 618 | 2000 ( /78) | |
| News | | | |
| 1(1) March 1977 | 51 | 900 | out of print |
| (2) June | 1 | 900 | " |
| (3) Sept. | 5 | 900 | " |
| (4) Dec. | 49 | 900 | " |
| 2(1) 1st quart. 78 | 38 | 1500 | " |
| (2) 2nd | 37 | 1200 | " |
| (3) 3rd | 85 | 1200 | |
| (4) 4th | 1 | 1500 | " |
| 3(1) 1st quart. 79 | 106 | 1500 | |
| (2) 2nd | 64 | 1500 | |
| (3-4) 3rd-4th | 111 | 1500 | |
| 4(1) 1st quart. 80 | | 1500 | |

*PIO = Publications and Information Office,
College of Tropical Agriculture and Human Resources, UH.

# LDC Training

Since recommendations for a training component of the Project were made in 1976 and reinforced in 1979 by the AID review teams, training programs have been planned and implemented. The major programs or activities are training workshops in Soil Taxonomy and Agrotechnology Transfer and graduate training for selected individuals recommended by the host-country cooperating agency in Cameroon, Indonesia, and the Philippines.

## Workshops on Soil Taxonomy and Agrotechnology Transfer

In order to catalyze in-country action programs that are based on Project concepts, training workshops were conducted in the Philippines and Indonesia during the months of June and July 1980. These workshops were conducted in consultation with the local AID missions and the cooperating agencies of each country. The Soil Research Institute (SRI) in Indonesia and the Philippine Council for Agriculture and Resources Research (PCARR) and the Bureau of Soils within the Philippines made the necessary arrangements and selected participants. Appendix 7 gives the outlines of the workshops; Appendix 8 gives the list of speakers and participants.

### *Indonesia workshops*

Twenty-five participants from the Soil Research Institute, Agricultural Extension Service, Directorate of Planning, Pajajaran University, Andalas University, and Central Research Institute of Agriculture (CRIA) attended both the workshops on Soil Taxonomy and Agrotechnology Transfer. The first 2 weeks were devoted to Soil Taxonomy. Drs. H. Ikawa, Wayne Hudnall and Martin Raymundo taught the course. Ikawa and Raymundo are BSP personnel while Hudnall is a consultant hired by the project. Additional lectures were given by local professionals. Mr. Darryl Gallup, retired Soil Conservation Service (SCS) scientist, now working with FAO at SRI, gave an afternoon's lecture on the "Relationship of Soil Taxonomy and the FAO Legenc." Dr. Roel Oldeman, agricultural climatologist, working with CRIA, gave a lecture on "Agroclimatic Classification of Rice-growing Areas in Indonesia." Dr. U. Syafei discussed the "Contribution of Geomorphology to Soil Mapping."

Everyone made much effort to learn to use the Soil Taxonomy, and after a few days of class, there was active participation by most of the group in the classroom. Three quizzes and a final examination were administered to monitor the group's progress in learning. The course grades ranged from 65 to 92 for the 25 participants, with a mean score of 81.5 percent and a median score of 82.

At the conclusion of the workshop, the participants were able to use soil descriptions and laboratory data to identify the different diagnostic soil horizons and to classify the soils to the soil family category of Soil Taxonomy. These participants should be able to use the taxonomic names, such as the soil family, for their work (soil survey, research, extension, planning, etc.) and for technology transfer.

The participants made a field trip to Lampung, Sumatra, at the end of the second week to visit field experiments for agrotechnology transfer--these included the BSP sites in Nakau, SRI's own Benchmark experiments on corn and legumes, and the newly established cropping systems experiments of IRRI-CRIA for the transmigration communities.

The third week was devoted to the Agrotechnology Transfer workshop, which was held at SRI's conference hall. Papers were presented in the morning and the afternoons were devoted to workshop exercises. As originally planned, 13 papers were presented during the workshop. Four case studies were prepared for the exercises in consultation with local experts. The case studies were local examples and were selected (1) to give the participants some perspectives on the important issues in agricultural development through the transfer of agrotechnology and (2) to guide the participants in relating the principles and concepts learned about agrotechnology transfer based on agroenvironmental factors. The participants were divided into three groups, and each group presented the results of its analysis on the case studies.

The discussions during the workshop sessions were conducted both in English and Indonesian. Papers were also in English except one which was delivered in Bahasa Indonesia.

*Philippine workshop*

Twenty-four participants attended the agrotechnology transfer workshop. Ten of the participants completed the training workshop on Soil Taxonomy conducted by BSP in June-July of 1979. The rest of the particpants were mostly regional agricultural planners of the National Economic Development Authority (NEDA); program specialists of PCARR; agriculture planners of the National Irrigation

Administration, Bureau of Plant Industry and Bureau of Lands; and senior soil technologists with the Bureau of Soils.

The workshop was formally started on July 14. Dr. Aida Librero, PCARR Director, Socio-Economics Division, gave the welcome address in lieu of Dr. J. D. Drilon, PCARR Director-General, who was sick on that day. Dr. James A. Silva, BSP Principal Investigator, gave the keynote address.

Paper presentations were divided into three sessions:

Session I - Establishment of the Foundation of Agrotechnology Transfer. Moderator: A. A. Briones

Session II - Analysis of Experiences on Agrotechnology Transfer in the Philippines. Moderator: B. G. Cagauan, Jr.

Session III - Rationalization of Land Use and Policy Directions for Agrotechnology Transfer. Moderator: Amado Maglinao

Under session I, Jim Silva presented the paper on agrotechnology transfer. Ike Ikawa gave a paper on "Soil Classification for Agrotechnology Transfer: Principles and Concepts." Martin Raymundo gave a slide show on the Benchmark Soils Project. Most papers presented were relevant to agrotechnology transfer, and the manuscripts were distributed during the seminar.

The participants summarized the key principles and concepts learned after every session and were given the opportunity to present their summaries.

The workshop sessions started on July 16. The participants were divided into three commodity groups: rice, plantation crops, and upland diversified crops. Both soils specialists and agricultural planners were uniformly distributed in each group for maximum interaction between these 2 groups of professionals. The commodity grouping was considered necessary since the workshop tasks were oriented towards these commodities.

The first phase of the workshop activity was the differentiation of experiment stations in relation to the above commodities. The Soil Taxonomy participants gave a 15-minute presentation of their findings on the soil survey and classification of various experiment stations in the Philippines. With this background the participants proceeded to identify the <u>objectives</u> of an experiment for a given commodity in relation to the area surveyed; made recommendations on the <u>locations</u> in relation to <u>soil</u> and <u>agroenvironment</u>: identified <u>socioeconomic considerations</u> in relation to the experiment station for the given commodity: outlined what <u>government support</u> and

institutional involvement may be necessary; defined success indicators of the experiment stations; and identified potential problems in relation to the recommendations made.

The second phase of the workshop dwelled on the development of soil-based action-research project proposals for the various commodities. These proposals summarized the aims of the workshop, which were to:

1. Develop a framework for soil-based agrotechnology transfer;
2. Organize and integrate existing information on soil-based agrotechnology and integrate thereto new research findings;
3. Operationalize the soil-based agrotechnology transfer framework to evolve land use projects and other related agro-based development programs;
4. Identify research requirements for soil-based agrotechnology transfer and development planning.

These research proposals are in line with PCARR's priorities and attempts were made by the participants to write them in PCARR's format.

The workshop culminated with a field trip planned and arranged by Martin E. Raymundo, BSP project leader. Ike Ikawa also joined the participants. The trip traversed the western section of Laguna Province, the southern towns of Rizal Province and the northeastern section of Cavite Province. Soils and their associations and land use patterns were shown along the way. The group made a stop at the International Institute for Rural Reconstruction and toured the IIRR facilities and self-sufficiency projects.

*Future Training Programs*

A training workshop in Cameroon is being planned for implementation in late 1981 or middle of 1982 in coordination with FAO and the Soil Management Support Services (SMSS) project (PASA No. AG/DSB-1129-5-79) of the Soil Conservation Service of USDA. Mr. Bert van Barneveld, formerly FAO Soil Resources Project Manager at the Ekona Research Station for Perennial Crops and currently working with Brawijaya University, Malang, Indonesia, as a soils expert, has been very instrumental in making arrangements to establish the Benchmark Soils Project in Cameroon. He has indicated his willingness and availability to cooperate with training activities to be conducted in Cameroon.

## Graduate Training

Six graduate students from the Philippines and Indonesia supported by the Project are pursuing their M.S. or Ph.D. degrees at the University of Hawaii. These students are employed by the cooperating government agencies in each country. Upon completion of their degrees, these students have a written contract with their employers to go back to their respective agencies as an assurance that the country benefits from their training. Brief thesis statements of each student are compiled in Appendix 2; their programs and fields of study are listed in Table 9.

Two other graduate students who are not from the cooperating countries are partly supported by the Project to work on some aspects of Project objectives. Both are pursuing Ph.D. work at the University of Hawaii.

Two students from Cameroon have been identified and have submitted applications to the University of Hawaii for enrollment in the spring 1981 term under BSP sponsorship (see Table 9). Both plan to work on their M.S. degrees in agronomy and soil science.

Table 9. Graduate students under BSP sponsorship at the University of Hawaii

| | Program | Field of study/thesis topic |
|---|---|---|
| Cameroon | | |
| Charles Adamu | M.S. | Soil Classification |
| John Awemo | M.S. | Soil Fertility/Agronomy |
| Indonesia | | |
| Djoko Santoso | M.S. | Soil Fertility/Adaptation of Maize Varieties to Three Tropical Soil Families and Their Response to N and P Fertilization |
| I P. Widjaja-Adhi | Ph.D. | Soil Fertility/Prediction of Maize Response to P Application under Different Levels of Soil P in Typic Paleudults and Tropeptic Eutrustox |
| M. Soekardi | M.S./Ph.D. | Soil Classification/Land Evaluation for Agricultural Use |
| Philippines | | |
| Crisanto R. Escaño | Ph.D. | Soil Management/Comparative Evaluation of the Different Diagnostic Techniques for Determining the Nutrient Requirements of Maize Grown on Hydric Dystrandepts |
| Modesto Recel | M.S. | Soil Classification/Reclassification of Andepts of the State of Hawaii in the Proposed Order Andisols |
| Beatriz P. del Rosario | Ph.D. | Soil Management/Nutritional Diagnosis in Maize Grown in Three Tropical Soil Families |
| Hawaii | | |
| David Harris | Ph.D. | Soil Fertility/Phosphorus Placement and Sources for Maize on Three Soil Families |
| Luis Manrique | Ph.D. | Soil Management/Effects of Potato Research on Tropical Food Production: Matching Crops and Soils |

# LDC Involvement and Feedback

By design, the Benchmark Soils Project operates successfully only with the involvement and cooperation of host-country governments and their respective agencies and institutes. Except for the design of the transfer experiments, all other activities are conducted jointly with mutually beneficial results to both parties. The discussion of results and accomplishments described in previous sections on field experiments and training are also appropriate for this section.

As stated earlier, commitment to user needs and in-country utilization continues to be essential to the Benchmark Soils Project concept as is the basic experimental field research; thus, LDC involvement and LDC training are not seen as secondary aspects of the Project but as part of the primary focus.

To implement this commitment in part, the Project, in cooperation with host-country agencies and local AID missions, has established advisory committees to (1) serve as a panel for an open discussion of Project concepts, progress, status, and goals and (2) provide guidance for the effective dissemination of Project information. The chairs of these committees are D. Muljadi of SRI, Indonesia, and Dr. Amado Maglinao of PCARR, the Philippines. It is anticipated that a similar committee will be established in Cameroon in FY 80-81.

# Statement of Expenditures and Obligations

The following are the line item expenditures and encumbrances incurred by the Project from October 1, 1979 to September 30, 1980.

| Line Item | Expenditures/Encumbrances |
|---|---|
| Salaries and Wages | 402,722 |
| Fringe Benefits | 40,700 |
| Consultants | 19,968 |
| Equipment, Supplies and Services | 278,143 |
| Vehicles | 17,952 |
| Freight | 47,976 |
| Travel and Subsistence | 129,757 |
| Publications | 10,568 |
| Indirect Costs | 184,334 |
| Advances to Philippines, Indonesia and Cameroon | 134,449 |

Expenditures and encumbrances for FY 1979-80 were within the projected budget forecast reported last year. However, rising airfare, both locally and internationally, and fuel costs in our host countries are concerns to be reconciled in future budgeting plans. For example, interisland airfare from Honolulu to Hilo (Island of Hawaii, where the three Hydric Dystrandepts sites are located) has increased from $60 to more than $100 in the last 2 years. In an effort to maintain Project commitments where travel is required, the Project has continued to utilize budget and excursion fares when applicable to combat fare increases.

Fuel costs in both the Philippines and Cameroon have increased to more than $3.00 per gallon. The use of U.S.-made pick-up trucks with larger and less fuel-efficient engines are uneconomical as these costs reach exhorbitant levels. Project operations would be hampered due to insufficient funds provided in our budgeting. To meet these anticipated needs, line item changes may be made to contract management during FY 1980-81.

The Project has continued to receive the support of host government cooperating agencies. Much of this support is in the form of salaries of personnel assigned

to assist in implementation of local Project operations. A total dollar amount of approximately $75,000 was contributed in FY 1979-80 by PCARR, the Philippines, SRI, Indonesia, and DGRST, Cameroon. In addition, the University of Hawaii provided an amount equivalent to one FTE (full-time equivalent) position, approximately $60,000.

# Work Plan and Budget Forecast

The Project will continue to carry out the work plan toward the three objectives as presented in Appendix 1 as milestone events. Management and coordination of operations and activities in Hawaii, Cameroon, Indonesia, and the Philippines will remain under the guidance of the Project management team based in Honolulu. Operationally, Project funds continue to be managed through the business office of the College of Tropical Agriculture and Human Resources for most Hawaii operations, while the Research Corporation of the University of Hawaii (RCUH) is used for overseas activities.

Anticipated Accomplishments by September 1981

- Complete establishment of secondary site at Barombi Kang, Cameroon (Typic Paleudult).
- Continue to conduct transfer experiments with maize on the three soil families.
- Continue to conduct variety experiments on the three soil families, which evaluate the top varieties within each soil family network.
- Conduct a series of cropping systems experiments with maize and other crops on the three soil families in conjunction with our management experiments.
- Participate in International Conference on Soils with Variable Charge in February 1981 to be held at Palmerston North, New Zealand.
- Participate in the Fourth International Soil Classification Meeting in Rwanda in June 1981.
- Implement plans for a Soil Taxonomy and Agrotechnology Transfer workshop in Cameroon.
- Complete the fourth approximation of the test of transferability for the Hydric Dystrandepts network.
- Conduct first approximation of the test of transferability for the Tropeptic Eutrustox in collaboration with Puerto Rico (contract no. AID/ta-C-1158).
- Conduct first approximation of the test of transferability for the Typic Paleudults network.
- Select two graduate students from Cameroon.
- Continue publication of Benchmark Soils News, quarterly newsletter.
- Continue to publish technical and progress reports.

- Continue to publish technical and progress reports.
- Continue to expand the mailing list for the Benchmark Soils News.
- Continue to develop and expand the framework and data file for the Benchmark Data Bank.
- Graduate second and third Benchmark-sponsored students.
- Continue to develop and maintain linkages with international, national, and local agencies and institutions.

Budget Forecast

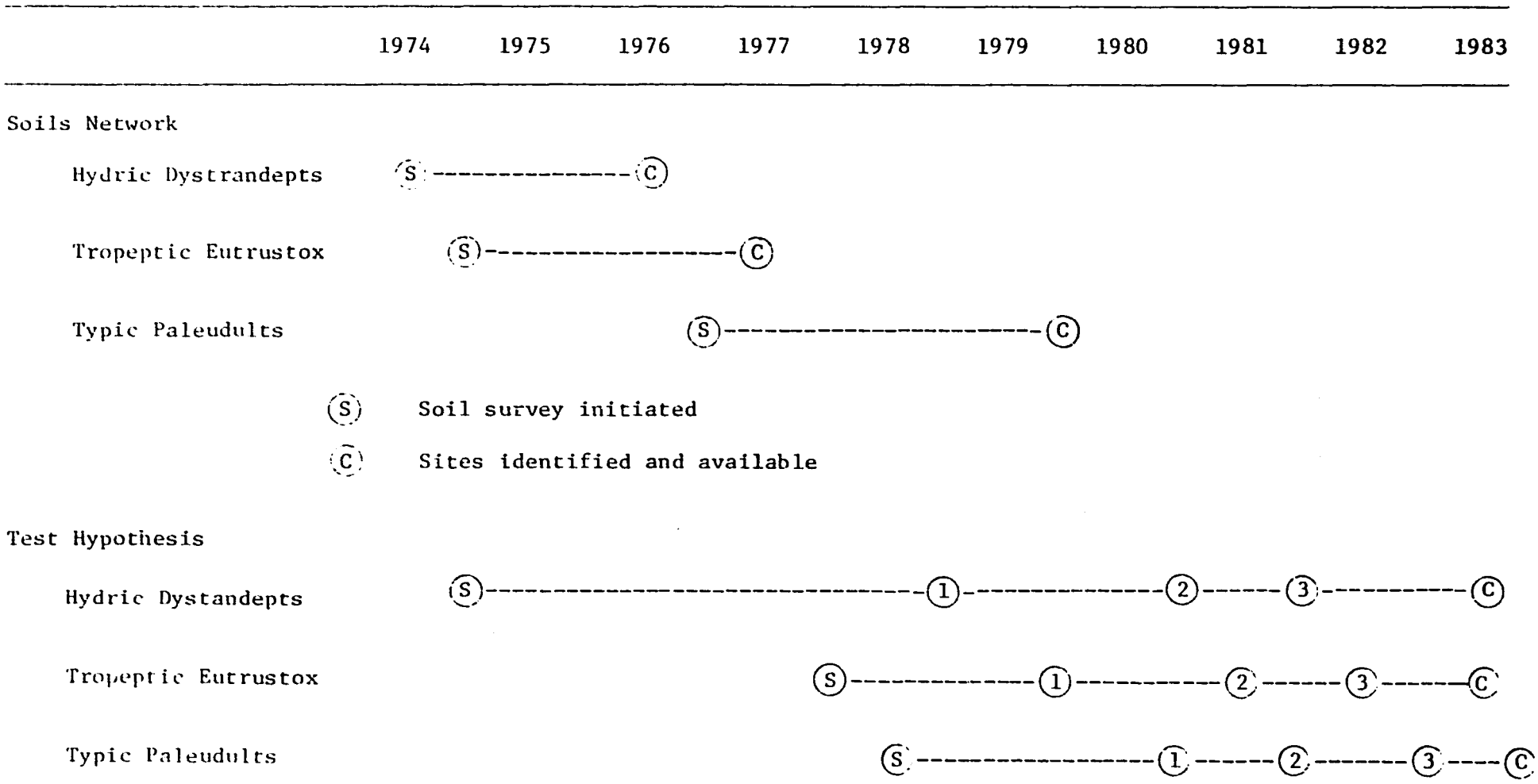
| Line item | 1980-81 |
|---|---|
| Salaries | $476,020 |
| Fringe benefits | 138,890 |
| Consultants | 28,600 |
| Equipment, Supplies, and Services | 207,075 |
| Vehicles | - 0 - |
| Freight | 38,650 |
| Travel | 124,965 |
| Publications | 50,050 |
| Indirect costs | 233,310 |

## Appendix 1

### Milestone Events

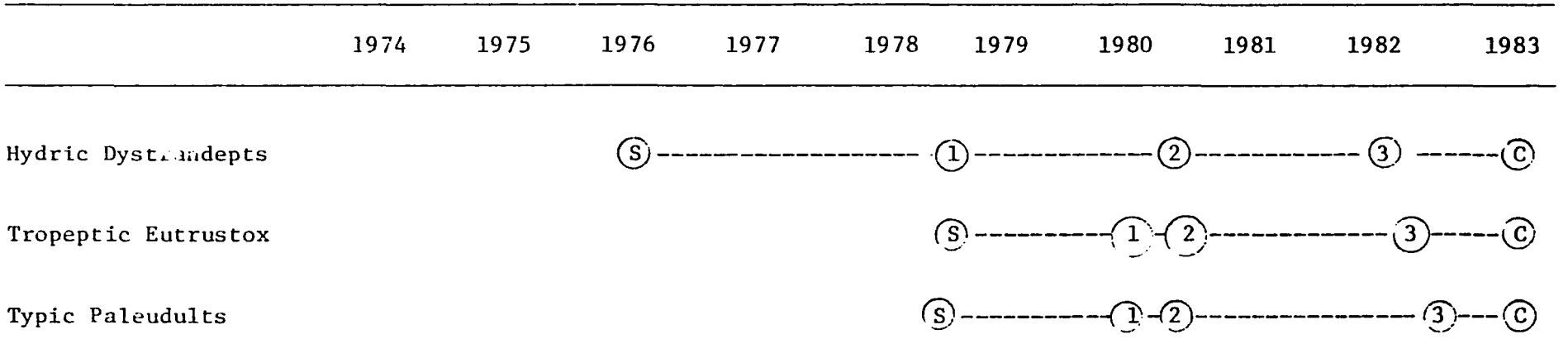
Objective 1:

To determine scientifically the transferability of agroproduction technology among tropical and subtropical countries.



Objective 2:

To assist tropical and subtropical countries in assessing the potential of upland areas for intensive cropping and soil management.




S Experiments designed

1 Recommendations formulated

2 Recommendations reviewed - cropping systems implemented

3 Recommendations formulated for evaluation

C Test completed

Objective 3:

To demonstrate the value of soil and land classification in formulating agricultural development plans in selective areas.

| | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 |
|---|---|---|---|---|---|---|---|---|---|---|
| Data Bank | | (S)-(1)------ | (2)---------- | | (3)----- | (4)---------- | | (5)------ | (6)----- | (C) |

(S) Data bank conceptualized

(1) Soil data bank concept presented at ICRISAT

(2) BSP soils data entered into bank

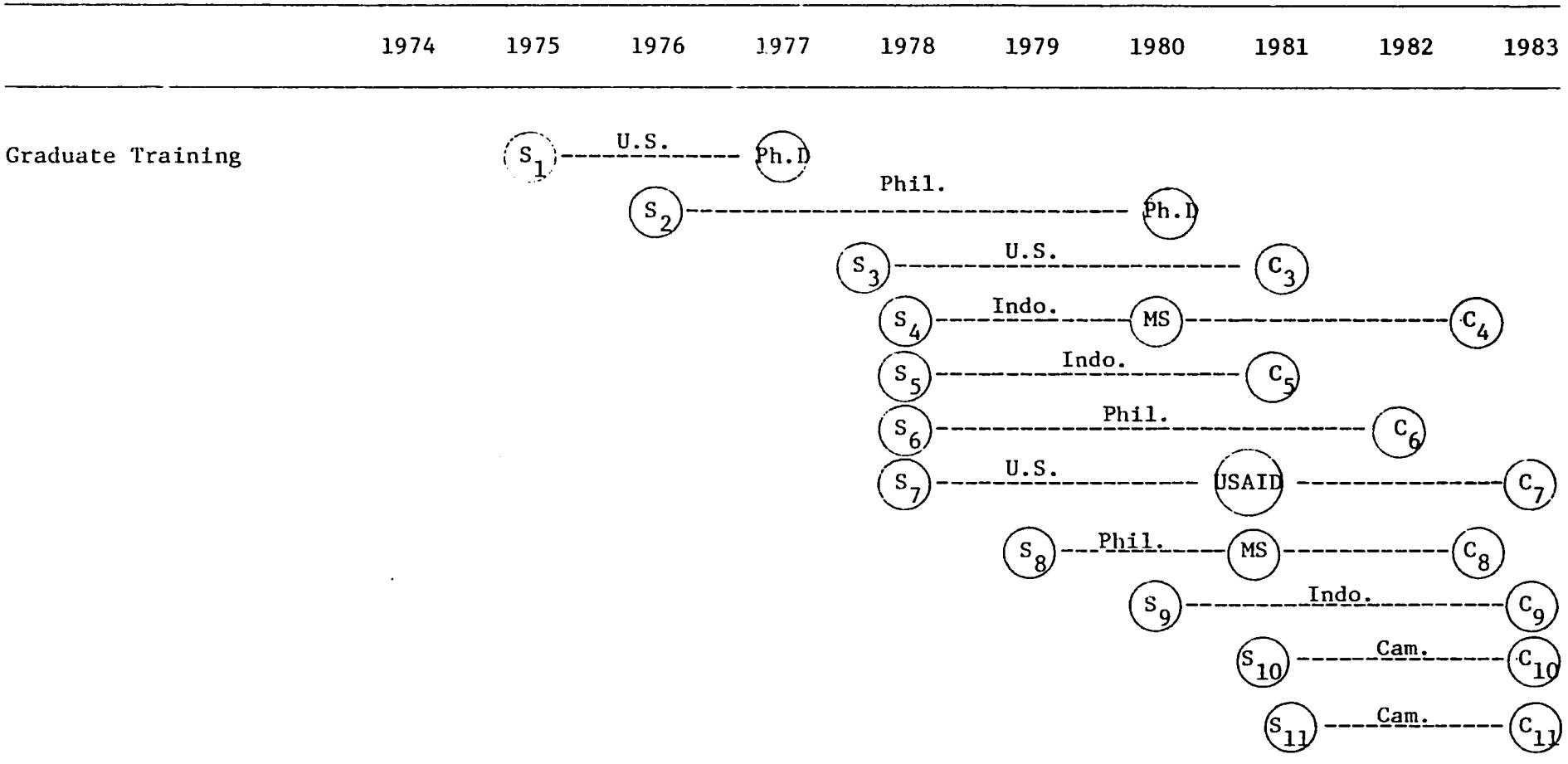
(3) Framework for improved data bank system developed

(4) BSP soil, crop, and climate data file developed

(5) Model framework for interpretation data bank developed

(6) Interpretation data bank functional

(C) Data bank operational


1974
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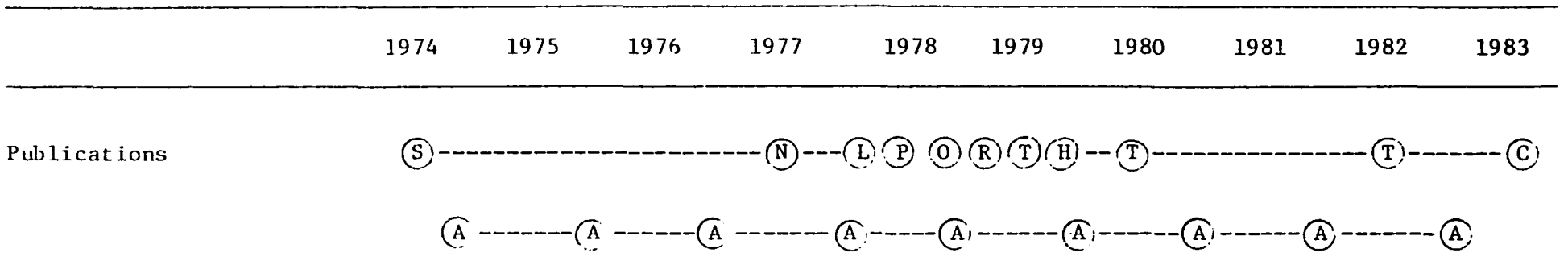
Graduate studies completed




(S) Project Initiated

(N) Benchmark Soils Project News - initiated

(A) Annual Reports

(P) Progress Report series - initiated

(R) Technical Report series - initiated

(L) Leaflets on project information - initiated

(H) Handbook - initiated

(O) Others: Books, reports, audiovisuals

(T) Training Materials

(C) Final Report

# Appendix 2

## Proposals and Abstracts of Graduate Students Associated with BSP

Beatriz P. del Rosario/Ph.D. candidate
Senior Program Specialist
Philippine Council for Agriculture and Resources Research

### Nutritional Diagnosis of Maize Grown in a Network of Three Tropical Soil Families

The Benchmark Soils Project has been conducting field experiments to test the hypothesis of transferring agroproduction technology for planning agricultural development via interpretation of information organized and condensed in Soil Taxonomy. This information includes land qualities which are important to maize production. One of these land qualities is nutrient availability, and plant analysis is one of the methods used to assess nutrient availability. The general principle involved is that nutrient concentration within plants integrates the influence of all factors on crop performance and hence analyses of these nutrients can be used to assess the nutrient requirement of that plant.

Nutritional problems can be examined from two different viewpoints: (1) by conventional methods or using the critical level, or critical concentration, that is associated with maximum yield, and (2) the DRIS approach which considers ratios associated with maximum yield. There are constraints associated with the use of the conventional critical level approach as a diagnostic tool for determining the nutrient requirements of crops, such as the climate, soil, variety, and plant part sampled. These constraints, however, are supposedly overcome by the DRIS approach (Diagnosis and Recommendation Integrated System) developed by Beaufils in the 1950s. The success of the DRIS approach for various crops are reported in the literature.

The DRIS approach was used by Escaño (1980) on the Hydric Dystrandepts in Hawaii. The DRIS approach was demonstrated to be better than the conventional critical level approach for diagnosing the nitrogen requirement of maize. Preliminary analysis of Philippine data on the same soil family of Hydric Dystrandepts gave higher diagnostic accuracy for determining the nitrogen and phosphorus

requirements of maize compared to those values obtained using the conventional approach. Further tests on the validity of the DRIS approach to maize on other locations of the same soil family and of other soil families in the Benchmark Soils network are necessary. More specifically, this study will try to establish norms for each of the soil families and compare these norms among the three.

Information and data generated on nutrient availability as a land quality will be added to a soil information or data bank system. As indicated last year, the computer data files on soil properties and crop performance can be analyzed to provide an interpretive file for planners or agricultural scientists involved in agricultural development.

Crisanto R. Escaño/Ph.D. candidate
Senior Program Specialist
Philippine Council for Agriculture and Resources Research

## Comparative Evaluation of Some Diagnostic Techniques for Determining the Nutrient Requirement of Maize Grown in Hydric Dystrandepts

The use of leaf tissue analysis to determine the nutritional needs of a given crop is based on the assumption that, within certain limits, there is a positive correlation among doses of nutrient supplied, leaf content of this element, and yield. Most systems of maize tissue analysis utilize the "critical level" approach, defining the critical level as the concentration of nutrients below which yields will be reduced when other cultural and environmental factors are not limiting.

The DRIS (Diagnosis and Recommendation Integrated System) approach uses nutrient ratios and normalizes indices, thereby producing more accurate diagnoses of nutritional deficiencies and imbalances than conventional systems of soil and tissue analysis. E. R. Beaufils developed the concept in the 1950s and asserts that DRIS overcomes the effects of climate, soil, crop variety, and selected tissue sampled, all of which complicate interpretations of critical nutrient concentration.

Using experimental data generated on the thixotropic, isothermic family of Hydric Dystrandepts, two fundamentally different approaches--the conventional critical level approach and the DRIS approach--were compared in assessing the

nutrient requirements of maize. Results of 15 fertilizer experiments (eight N x P and seven $CaCO_3$ x P) were used in the evaluation.

The DRIS diagnostic approach was found to be more accurate in assessing maize need for N than the conventional critical level approach. At the established critical values (0.30% N and 0.5 DRIS N index), the DRIS diagnostic approach gave about 8 percent more accuracy than the conventional critical level approach. However, for P and Ca, no marked difference was observed when using either approach.

David J. Harris/Ph.D. candidate
Graduate Research Assistant (M.S. degree)
Department of Agronomy, Purdue University

## Evaluation of Phosphorus Fertilizer Materials and Placement Effects on a Network of Benchmark Soils of the Tropic

### A. The Agronomic Effectiveness of Finely-Ground, Minigranular, and Partially-Acidulated Phosphate Rocks Relative to Superphosphate on Three Benchmark Soils of the Tropics

Field experiments comparing directly applied phosphate rock sources with superphosphates were conducted on three soils: a Tropeptic Eutrustox, Oahu; a Hydric Dystrandept, Luzon; and a Typic Paleudult, Sumatra. Phosphate rock sources used were North Carolina, finely-ground (NCf); North Carolina, minigranular (NCm); Central Florida, finely-ground (CFf); and Central Florida, 20% partially-acidulated minigranular (CFpam). Yields of three successive crops grown on each soil were used to determine agronomic effectiveness. On the Eutrustox, differences were minimal due to high residual P. On the Hydric Dystrandept, in the first crop both NCf and NCm were as effective as single superphosphate (SSP). Both CFpam and CFf were less effective than other sources. By the second crop, the residual effect of SSP at the low rates was less than that of all other sources. CFf and CFpam gave similar yields and remained less effective than NC forms. On the Typic Paleudult, differences between rock sources and triple superphosphate (TSP) were small. The Typic Paleudult appears to be very well suited for direct application of phosphate

rock, since even a moderately reactive rock such as CF gives yields comparable to those of TSP.

B. Effect of P Placement on Maize Yield and P Uptake on a Hydric Dystrandept in the Philippines.

A field experiment in which single superphosphate at multiple rates was applied broadcast or in band widths of 1/2, 1/4, and 1/8 of the interrow space, or in a drill row, was conducted on a Hydric Dystrandept in Southeast Luzon, the Philippines. Yield results support C. T. deWit's placement theory. Maximum yield was obtained at the highest rate of 320 kg P/ha applied broadcast. At rates above 80 kg P/ha, yields from placement treatments were inferior to the broadcast application. Drill application was inferior to all other placements at all rates. At the low rates of 10 and 20 kg/ha, the 1/8-row width placement outyielded the broadcast treatments by 39% and 32%, respectively. These results suggest that farmers with limited capital for investment could maximize return from suboptimum phosphorus inputs by proper placement.

Alan R. Hurdus/Ph.D. candidate
Research Associate
BSP, University of Hawaii

Agrotechnology Transfer Based on the Stratification of the Agroecosystem by the Soil Family Category of the U.S. Soil Taxonomy: A Study of Three Benchmark Soil Families

Currently employed by USAID as an agronomy advisor in Indonesia.

Luis A. Manrique/Ph.D. candidate
Agronomist
International Potato Center

## Matching Crop Requirements to Land Characteristics in a Tropeptic Eutrustox of the Benchmark Soils Project

The objective of this work is to test the concept of matching crop requirements to land characteristics developed by the Benchmark Soils Project. A cropping pattern growing corn, soybean, and Irish potato has been developed for a clayey, kaolinitic, isohyperthermic Tropeptic Eutrustox soil family in Hawaii. Each crop requires a land preparation period of 3-5 months. Corn was grown between mid-April to August 1979; a grain yield of 10,000 kg/ha was obtained. This was followed by a soybean crop which was grown between September until mid-December 1979; the soybean yield was 3000 kg/ha. On December 20, 1979, Irish potato was planted; after 100 days the average potato tuber yield was 34,000 kg/ha. This cropping pattern was designed to take advantage of the warm, sunny period between April and November to grow corn and soybean. Potato, which requires cool soil temperatures for tuber initiation and enlargement, was grown in the winter months. By matching crop requirements to seasonal climatic variation, it was possible to increase yield performance.

Modesto R. Recel/M.S. candidate
Supervising Soil Technologist
Bureau of Soils, the Philippines

## Reclassification of Andepts of the State of Hawaii in the Proposed Order Andisols

Six selected Hawaiian soils belonging to the suborder Andepts were studied for reclassification into the new soil order Andisols as proposed by Guy Smith. Included is the Hydric Dystrandepts, which was the first soil selected in establishing a soil family network among Hawaii, Indonesia, and the Philippines under the auspices of the Benchmark Soils Project.

The present study will consider some of the limitations in the classification of Andepts by Soil Taxonomy of Hawaiian Andepts to the new order Andisols. Early results indicate that the thixotropic, isothermic Hydric Dystrandepts would be reclassified as hydrous, isothermic Typic Haplotropands.

Djoko Santoso/M.S. candidate
Coordinator, Soil Management Team
Soil Research Institute, Indonesia

## Adaptation of Maize Varieties to Three Tropical Soil Families and Their Response to N and P Fertilization

Through proper use of Soil Taxonomy and general knowledge of maize production in the tropics, yields of maize at different sites of the same soil family can be predicted with fairly good precision. This theory has been postulated by the Benchmark Soils Project based on the assumption that soils classified in the same soil family have similar physical and chemical properties important to plant growth. Hence, these soils should have nearly the same management requirements, a common response to cultural practices, and a similar potential for crop production.

It is widely known, however, that crop performance varies from site to site and even on the same site in different seasons. Variability in the performance of crops grown on the same soil family in different locations indicates that a better understanding of the genotypic characteristics of crop varieties is essential to the transfer of agroproduction.

The objectives of this study are to evaluate the adaptation of maize varieties to different soil families in the tropics and to differentiate their responsiveness to N and P fertilization.

Results from 19 variety experiments of the Benchmark Soils Project conducted on three soil families in three countries were used in this study. The varieties of primary interest are H6, X304C, H610, and UPCA var. 1.

M. Soekardi/M.S. candidate
Head, Subdivision of Land Classification
Soil Research Institute, Indonesia

## Soil Interpretation for Agricultural and Nonagricultural Uses of Three Benchmark Soil Families

Many users of soil maps in different fields want more general and applicable information rather than what is presently available from the soil mapping units. Interpretation of data from soil survey for use in various fields of study and interest is possible once the need is identified. This will accelerate the transfer of technology to the users and reduce costs and time to develop a technology that has already been developed elsewhere.

Three Benchmark soil families in six tropical countries are being used to test the hypothesis of transferability of agricultural production technology based on soil classification. The interpretation of information embodied in the soil family nomenclature for agricultural and nonagricultural uses will be the area of concern of this study. The results should provide information and alternatives to land use planning for agricultural development.

I Putu Gedjer Widjaja-Adhi/Ph.D. candidate
Head, Soil Testing Subdivision, Lembaga Penelitian Tanah
Soil Research Institute, Indonesia

## Prediction of Maize Response to P Application under Different Levels of Soil P on Typic Paleudults and Tropepetic Eutrustox

The response of a crop to application of P is smaller in soils with initially higher P levels. Soils with different native P levels will consequently give a different yield response equation. A common response equation should be developed by including soil variables selected from those soil factors which affect yield. One such variable is the initial or native "available" soil P.

Different soil tests give different values of "available" soil P. Therefore, appropriate soil test methods should be selected. Important aspects which should be

considered are: (1) the P-availability factors and the soil properties that govern these availability factors of the soil family, (2) the chemical characteristics of the extractant, and (3) the calibration of a soil test method with crop response on a particular soil family.

Sites differ in their level of soil P, which can affect the yield response to P. Therefore, incorporation of an appropriate soil variable to account for this variation in soil P is needed to allow more accurate yield prediction among sites within a family.

The objectives of the present study are:

1. To select and calibrate the appropriate soil test for a soil family;
2. To evaluate the availability and behavior of soil-labile P;
3. To incorporate soil test values into the yield-prediction equation for maize grown under different levels of soil P.

Table 1. Hydric Dystrandepts transfer experiments on maize, yield data (kg/ha), means of 3 or 4 reps, harvested Oct. 79-Sept. 80

| | | *Hawaii* | | | | *Indonesia* | | | |
|---|---|---|---|---|---|---|---|---|---|
| TREATMENT | | LOCATION/SITE: | | | | LOCATION/SITE: | | | |
| | | TOLEF11 | KUKA22 | KUKC12 | HALB22 | ITKAE11 | ITKAK13 | LPHA16 | LPHG11 |
| P | N | D 79 | W 80 | D 79 | D 79 | D 79 | D 79 | D 79 | D 79 |
| +.85 | +.85 | 7176 | 4909 | 9262 | 8629 | 7266 | 8427 | 7782 | 8281 |
| +.85 | 0 | 7439 | 4796 | 8934 | 6863 | 6564 | 8721 | 6565 | 7387 |
| +.85 | -.85 | 5079 | 3263 | 7249 | 2992 | 6191 | 7723 | 5909 | 5254 |
| +.40 | +.40 | 6957 | 4642 | 9213 | 7815 | 6772 | 8185 | 7978 | 7637 |
| +.40 | -.40 | 6638 | 4319 | 8221 | 5339 | 6233 | 7981 | 6894 | 6328 |
| 0 | +.85 | 7209 | 4511 | 9230 | 8298 | 7201 | 8476 | 7113 | 7359 |
| 0 | 0 | 6875 | 4393 | 9448 | 7027 | 6706 | 8305 | 7109 | 7298 |
| 0 | -.85 | 4389 | 3298 | 8411 | 3172 | 5481 | 7734 | 6260 | 5286 |
| -.40 | +.40 | 7081 | 4704 | 8824 | 7455 | 6730 | 8450 | 7767 | 7399 |
| -.40 | -.40 | 7157 | 4061 | 8137 | 5766 | 6557 | 7922 | 6263 | 7006 |
| -.85 | +.85 | 7956 | 4228 | 8462 | 8373 | 6979 | 8236 | 7821 | 7227 |
| -.85 | 0 | 7828 | 4183 | 8419 | 7099 | 6797 | 8817 | 6710 | 6620 |
| -.85 | -.85 | 4794 | 3508 | 7170 | 2401 | 6115 | 7482 | 5694 | 6184 |
| COMPLETE CONTROL | | 2909 | 1597 | 3245 | 778 | 3961 | ***** | ***** | 4475 |
| PARTIAL CONTROL | | 6494 | 1870 | 4404 | 1004 | 4544 | 6015 | 4841 | 4591 |
| 0 | NO N | ***** | ***** | ***** | ***** | 4621 | 4571 | 3896 | 3477 |
| NO P | 0 | ***** | ***** | ***** | ***** | 7071 | ***** | ***** | 6459 |
| 0 | 0 NO MICRO | ***** | ***** | ***** | ***** | 4759 | ***** | ***** | 6008 |
| MEAN YIELD FOR P TREATMENT | | 6660 | 4217 | 8541 | 6248 | 6584 | 8189 | 6913 | 6866 |
| MEAN YIELD FOR CONTROL | | 3202 | 1734 | 3824 | 891 | 4252 | 6015 | 4841 | 4533 |
| P TREATMENT OVER PARTIAL CONTROL - % | | 91 | 125 | 94 | 522 | 45 | 36 | 43 | 50 |

--continued

Table 1. Continued

*Philippines*

| TREATMENT | | LOCATION/SITE: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PUEA15 | PUCR20 | PUCR11 | PUCS10 | PUCS11 | PALC14 | PALE11 | PALF10 | PALF11 | PALG10 |
| P | N | D 80 | D 80 | W 79 | W 79 | D 80 | W 79 | D 80 | W 79 | D 80 | D 80 |
| 1.85 | 1.85 | 3841 | 6159 | 865 | 5047 | 6103 | 1771 | 3116 | 3714 | 3934 | 6878 |
| 1.85 | 0 | 3113 | 3994 | 1456 | 4941 | 6530 | 1936 | 2851 | 3562 | 4195 | 7036 |
| 1.85 | -.85 | 3237 | 3990 | 487 | 4209 | 4466 | 973 | 2628 | 4164 | 3610 | 5664 |
| 1.40 | 1.40 | 2268 | 5460 | 892 | 3916 | 5378 | 1077 | 2402 | 3494 | 3497 | 6429 |
| 1.40 | -.40 | 2088 | 3515 | 752 | 4322 | 4855 | 1073 | 2277 | 3379 | 3314 | 6196 |
| 0 | 1.85 | 2117 | 5087 | 1036 | 4266 | 4234 | 844 | 1542 | 3222 | 2543 | 6798 |
| 0 | 0 | 3042 | 3707 | 1196 | 3640 | 4123 | 1184 | 1454 | 3703 | 2481 | 6125 |
| 0 | -.85 | 2611 | 2821 | 648 | 3842 | 3555 | 576 | 1992 | 2857 | 2946 | 5837 |
| -.40 | 1.40 | 1780 | 3739 | 488 | 2823 | 2451 | 995 | 774 | 3024 | 1184 | 5825 |
| -.40 | -.40 | 1020 | 3764 | 778 | 2949 | 2632 | 707 | 1224 | 2487 | 1514 | 5628 |
| -.85 | 1.85 | 170 | 3711 | 0 | 933 | 583 | 692 | 424 | 795 | 647 | 3377 |
| -.85 | 0 | 225 | 3127 | 207 | 574 | 442 | 728 | 529 | 902 | 696 | 2794 |
| -.85 | -.85 | 430 | 2779 | 135 | 810 | 539 | 349 | 570 | 745 | 606 | 3102 |
| COMPLETE CONTROL | | 0 | ***** | 0 | 0 | 41 | 0 | 261 | 163 | 294 | 890 |
| PARTIAL CONTROL | | 0 | 0 | ***** | ***** | ***** | 323 | ***** | ***** | ***** | 1151 |
| 0 | NO N | ***** | 3134 | 506 | 2510 | 2819 | ***** | 2241 | 2864 | 2676 | 4279 |
| NO P | 0 | ***** | 98 | 0 | 77 | 437 | ***** | 50 | 108 | 266 | ***** |
| 0 | 0 NO MICRO | ***** | ***** | ***** | ***** | ***** | ***** | ***** | ***** | ***** | ***** |
| MEAN YIELD FOR P TREATMENT | | 1996 | 3989 | 688 | 3252 | 3530 | 993 | 1676 | 2773 | 2397 | 5514 |
| MEAN YIELD FOR CONTROL | | 0 | 0 | 0 | 0 | 41 | 161 | 261 | 163 | 294 | 1021 |
| P TREATMENT OVER PARTIAL CONTROL, % | | ***** | ***** | ***** | ***** | ***** | 208 | ***** | ***** | ***** | 379 |

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Table 1. Continued

*Philippines*

| TREATMENT | | LOCATION/SITE: | | | |
|---|---|---|---|---|---|
| | | BURA14 | BURD11 | BURE10 | BURE11 |
| P | N | D 80 | W 79 | W 79 | D 80 |
| +.85 | +.85 | 1168 | 392 | 1317 | 3384 |
| +.85 | 0 | 485 | 382 | 2357 | 3783 |
| +.85 | -.85 | 1359 | 649 | 1765 | 3907 |
| +.40 | +.40 | 605 | 329 | 1678 | 2506 |
| +.40 | -.40 | 1030 | 559 | 1899 | 3661 |
| 0 | +.85 | 234 | 400 | 1752 | 2307 |
| 0 | 0 | 510 | 657 | 1861 | 2008 |
| 0 | -.85 | 106 | 646 | 1560 | 2667 |
| -.40 | +.40 | 173 | 324 | 1653 | 1562 |
| -.40 | -.40 | 318 | 276 | 1459 | 1721 |
| -.85 | +.85 | 70 | 48 | 525 | 620 |
| -.85 | 0 | 0 | 60 | 446 | 347 |
| -.85 | -.85 | 117 | 62 | 555 | 601 |
| COMPLETE CONTROL | | 0 | 0 | 166 | 358 |
| PARTIAL CONTROL | | 237 | ***** | ***** | ***** |
| 0 | NO N | ***** | 620 | 1672 | 2556 |
| NO P | 0 | ***** | 0 | 123 | 447 |
| 0 | 0 NO MICRO | ***** | ***** | ***** | ***** |
| MEAN YIELD FOR P TREATMENT | | 475 | 368 | 1448 | 2237 |
| MEAN YIELD FOR CONTROL | | 119 | 0 | 166 | 358 |
| P TREATMENT OVER PARTIAL CONTROL, % | | 100 | ***** | ***** | ***** |

Table 2. Tropeptic Eutrustox transfer experiments on maize, yield data (kg/ha), means of 3 or 4 reps, harvested Oct. 79-Sept. 80

*Hawaii*

| TREATMENT | | LOCATION/SITE: | | |
|---|---|---|---|---|
| | | MOLA11 | WAIA11 | WAID10 |
| P | N | W 80 | W 80 | D 79 |
| +.85 | +.85 | 5711 | 8494 | 9992 |
| +.85 | 0 | 5628 | 8254 | 8149 |
| +.85 | -.85 | 3535 | 5973 | 6661 |
| +.40 | +.40 | 5313 | 8446 | 8750 |
| +.40 | -.40 | 5130 | 7058 | 7982 |
| 0 | +.85 | 5835 | 8641 | 9236 |
| 0 | 0 | 5445 | 7589 | 8412 |
| 0 | -.85 | 3580 | 5932 | 5848 |
| -.40 | +.40 | 5564 | 8252 | 7869 |
| -.40 | -.40 | 4811 | 6830 | 7344 |
| -.85 | +.85 | 5095 | 8702 | 8535 |
| -.85 | 0 | 4959 | 6984 | 7957 |
| -.85 | -.85 | 3783 | 5647 | 6569 |
| COMPLETE CONTROL | | 1917 | ***** | 5797 |
| PARTIAL CONTROL | | 2408 | 3690 | 5694 |
| 0 | NO N | ***** | 4020 | 5701 |
| NO P | 0 | ***** | 7283 | ***** |
| 0 | 0 NO MICRO | ***** | ***** | ***** |
| MEAN YIELD FOR P TREATMENT | | 4953 | 7446 | 7946 |
| MEAN YIELD FOR CONTROL | | 2162 | 3690 | 5745 |
| P TREATMENT OVER PARTIAL CONTROL, % | | 106 | 102 | 40 |

Table 3. Typic Paleudults transfer experiments on maize, yield data (kg/ha), means of 3 or 4 reps, harvested Oct. 79-Sept. 80

*Indonesia*

| TREATMENT | | LOCATION/SITE: | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | NAKA20 | NAKD11 | NAKJ10 | NAKJ11 | BPMDA20 | BPMDC11 | BPMDD10 | BPMDD20 | BUKA11 |
| P | N | W 80 | W 80 | W 80 | D 80 | D 80 | W 80 | W 80 | D 80 | W 80 |
| +.85 | +.85 | 4765 | 5821 | 7002 | 4387 | 6227 | 6404 | 6334 | 5679 | 7500 |
| +.85 | 0 | 4905 | 5719 | 6362 | 4530 | 6229 | 6407 | 5986 | 6214 | 6849 |
| +.85 | -.85 | 3944 | 4261 | 5837 | 4144 | 5250 | 4936 | 3668 | 4022 | 5959 |
| +.40 | +.40 | 5465 | 5617 | 6720 | 3849 | 5871 | 5810 | 5877 | 5912 | 7427 |
| +.40 | -.40 | 4491 | 5279 | 6425 | 4141 | 6738 | 5856 | 4588 | 5191 | 6568 |
| 0 | +.85 | 4964 | 5780 | 6553 | 3273 | 6652 | 4973 | 5559 | 5724 | 6404 |
| 0 | 0 | 4921 | 5448 | 6519 | 3813 | 6059 | 4842 | 5381 | 5629 | 6822 |
| 0 | -.85 | 4289 | 4260 | 5088 | 3441 | 4726 | 4559 | 3677 | 4280 | 6092 |
| -.40 | +.40 | 4663 | 3913 | 5527 | 2165 | 5694 | 3507 | 3941 | 5431 | 5078 |
| -.40 | -.40 | 4621 | 4187 | 5116 | 2606 | 5269 | 3425 | 4155 | 4057 | 5244 |
| -.85 | +.85 | 2867 | 1577 | 2981 | 181 | 4444 | 1051 | 1706 | 3453 | 3726 |
| -.85 | 0 | 3162 | 671 | 3594 | 920 | 4453 | 491 | 2450 | 3688 | 3588 |
| -.85 | -.85 | 2283 | 1696 | 2958 | 1066 | 3553 | 1041 | 1566 | 3396 | 3820 |
| COMPLETE CONTROL | | 115 | 1447 | 2274 | 994 | 244 | 677 | 300 | 164 | 3056 |
| PARTIAL CONTROL | | 519 | 1137 | 1594 | 354 | 474 | 476 | 334 | 0 | 3368 |
| 0 | NO N | 3455 | 5271 | 4868 | 2453 | 3626 | 4518 | 3099 | 1929 | 6612 |
| NO P | 0 | 157 | 645 | 2203 | 1957 | 581 | 112 | 594 | 0 | 3277 |
| 0 | 0 NO MICRO | 4156 | 4367 | 5991 | 3148 | 1749 | 1753 | 3721 | 3063 | 6506 |
| MEAN YIELD FOR P TREATMENT | | 4223 | 4171 | 5437 | 2963 | 5474 | 4100 | 4222 | 4821 | 5775 |
| MEAN YIELD FOR CONTROL | | 317 | 1292 | 1934 | 674 | 359 | 577 | 317 | 82 | 3212 |
| P TREATMENT OVER PARTIAL CONTROL, % | | 715 | 267 | 241 | 738 | 1055 | 761 | 1163 | ***** | 71 |

--continued

Table 3. Continued

| TREATMENT | | *Indonesia* LOCATION/SITE: | | | *Philippines* LOCATION/SITE: |
|---|---|---|---|---|---|
| | | BUKA20 | BUKC10 | BUKD10 | DAVI10 |
| P | N | D 80 | W 80 | D 80 | D 80 |
| +.85 | +.85 | 5897 | 7210 | 7339 | 4704 |
| +.85 | 0 | 6406 | 6690 | 7632 | 4684 |
| +.85 | -.85 | 5977 | 6961 | 6903 | 4788 |
| +.40 | +.40 | 6039 | 6851 | 6892 | 4373 |
| +.40 | -.40 | 6397 | 6969 | 6355 | 4226 |
| 0 | +.85 | 5202 | 6917 | 7156 | 4028 |
| 0 | 0 | 5762 | 6328 | 7042 | 4665 |
| 0 | -.85 | 5601 | 6571 | 6682 | 4096 |
| -.40 | +.40 | 4718 | 6424 | 6726 | 4089 |
| -.40 | -.40 | 4935 | 6582 | 6296 | 4636 |
| -.85 | +.85 | 3879 | 4072 | 3718 | 4743 |
| -.85 | 0 | 3279 | 5130 | 4719 | 4929 |
| -.85 | -.85 | 3345 | 4693 | 4233 | 4694 |
| COMPLETE CONTROL | | 2444 | 2613 | 2411 | 4399 |
| PARTIAL CONTROL | | 3238 | 3100 | 2857 | 4000 |
| 0 | NO N | 5515 | 6137 | 6289 | 4191 |
| NO P | 0 | 2884 | 3179 | 3548 | ***** |
| 0 | 0 NO MICRO | 4870 | 7021 | 4781 | ***** |
| MEAN YIELD FOR P TREATMENT | | 5187 | 6261 | 6284 | 4512 |
| MEAN YIELD FOR CONTROL | | 2841 | 2857 | 2634 | 4200 |
| P TREATMENT OVER PARTIAL CONTROL, % | | 60 | 102 | 120 | 13 |

TABLE 1. HYDRIC DYSTRANDEPTS VARIETY EXPERIMENTS ON MAIZE, YIELD DATA (KG/HA), MEANS OF 3 OR E REPS, OCT. 79-SEPT. 80

| CODED TREATMENT P | N | | VARIETY | | | | | |
|---|---|---|---|---|---|---|---|---|
| INDONESIA/ITKA-F | | D 79 | H610 | UPCA-1 | X304C | HARAPAN | H6 | WONOSOBO |
| -0.85 | -0.85 | | 5759 | 5040 | 6383 | 5540 | 6302 | 5908 |
| -0.85 | 0.40 | | 5814 | 5388 | 7818 | 6690 | 6192 | 7085 |
| 0.40 | -0.85 | | 4826 | 4945 | 7374 | 5873 | 5857 | 5449 |
| 0.40 | 0.40 | | 6920 | 6560 | 7165 | 7132 | 6813 | 8681 |
| | | | 5830 | 5483 | 7185 | 6309 | 6291 | 6781 |
| PHILIPPINES/PUC-L | | D 80 | H610 | UPCA-1 | X304C | H6 | NK-T66 | |
| -0.85 | -0.85 | | 1679 | 2780 | 2513 | 2460 | 2526 | |
| -0.85 | 0 | | 2300 | 2383 | 2315 | 2802 | 2951 | |
| 0 | -0.85 | | 5331 | 4559 | 5475 | 5279 | 4960 | |
| 0 | 0 | | 6816 | 5750 | 6782 | 5871 | 6133 | |
| | | | 4032 | 3868 | 4271 | 4103 | 4142 | |

TABLE 2. TYPIC PALEUDULTS VARIETY EXPERIMENTS ON MAIZE, YIELD DATA (KG/HA), MEANS OF 3 OR 4 REPS, OCT. 79-SEPT. 80

| CODED TREATMENT P | CODED TREATMENT N | | VARIETY | | | | | |
|---|---|---|---|---|---|---|---|---|
| INDONESIA/NAK-D | | W 80 | UPCA-1 | TINIGUIB | H6 | DMR-5 | WONOSOBO | KODOK |
| -0.85 | -0.85 | | 3091 | 3102 | 2562 | 2946 | 2893 | 2071 |
| -0.85 | 0 | | 2923 | 2526 | 2584 | 2818 | 3015 | 1359 |
| 0 | -0.85 | | 3911 | 4724 | 4249 | 5133 | 4798 | 3877 |
| 0 | 0 | | 6370 | 5313 | 6364 | 5973 | 6105 | 5339 |
| | | | 4074 | 3916 | 3940 | 4217 | 4203 | 3161 |
| INDONESIA/NAK-E | | D 80 | H610 | X304C | TINIGUIB | H6 | KODOK | ARJUNA |
| -0.85 | -0.85 | | 3180 | 3573 | 2909 | 3233 | 2283 | 3603 |
| -0.85 | 0 | | 2955 | 3486 | 2626 | 3356 | 2866 | 3370 |
| 0 | -0.85 | | 3629 | 4400 | 3218 | 3265 | 3014 | 3589 |
| 0 | 0 | | 3714 | 4148 | 2963 | 2975 | 2600 | 2936 |
| | | | 3370 | 3902 | 2929 | 3207 | 2691 | 3374 |
| PHILIPPINES/DAV-B | | D 80 | H610 | UPCA-1 | X304C | TINIGUIB | H6 | |
| -0.85 | -0.85 | | 2724 | 2777 | 3720 | 3178 | 2469 | |
| -0.85 | 0 | | 5005 | 4699 | 5451 | 4663 | 4368 | |
| 0 | -0.85 | | 2645 | 2372 | 3234 | 2603 | 1963 | |
| 0 | 0 | | 4383 | 4710 | 5777 | 4558 | 4653 | |
| | | | 3689 | 3640 | 4546 | 3751 | 3363 | |
| PHILIPPINES/DAV-G | | W 79 | DMR-1 | UPCA-1 | X304C | TINIGUIB | NK-T66 | |
| -0.85 | -0.85 | | 2905 | 2219 | 3624 | 2507 | 1808 | |
| -0.85 | 0 | | 3921 | 3927 | 6686 | 3817 | 2259 | |
| 0 | -0.85 | | 3107 | 2549 | 4343 | 3069 | 1939 | |
| 0 | 0 | | 3617 | 3987 | 6111 | 3456 | 2415 | |
| | | | 3388 | 3170 | 5191 | 3212 | 2105 | |

Appendix 5

Weather Data

thixotropic, isothermic Hydric Dystrandepts

MONTHLY AVERAGE FOR 1979-80

| MONTH | TEMPERATURE (DEGREE C) MAX. | TEMPERATURE (DEGREE C) MIN. | RELATIVE HUMIDITY (%) MAX. | RELATIVE HUMIDITY (%) MIN. | WIND RUN (KM/HR) | CUMULATIVE RAINFALL (MM) | SOLAR RADIATION (G CAL/DAY) |
|---|---|---|---|---|---|---|---|
| *Hawaii* | | | | | | | |
| KUKAIAU | | | | | | | |
| OCT | 28.80 | 20.78 | 93.43 | 62.60 | 8.50 | 65.40 | 349.99 |
| NOV | 26.47 | 19.06 | 93.01 | 67.26 | 7.50 | 969.60 | 264.38 |
| DEC | 26.54 | 18.31 | 92.34 | 62.00 | 7.54 | 281.40 | 286.54 |
| JAN | 26.22 | 17.60 | 88.38 | 55.06 | 7.26 | 114.00 | 327.58 |
| FEB | 26.44 | 18.47 | 89.40 | 58.61 | 7.32 | 194.00 | 344.83 |
| MAR | 23.39 | 18.19 | 93.59 | 72.46 | 12.85 | 1319.60 | 266.71 |
| APR | 24.08 | 17.90 | 93.15 | 73.20 | 10.71 | 863.40 | 338.13 |
| MAY | 26.94 | 19.36 | 91.85 | 65.04 | 10.62 | 124.60 | 466.87 |
| JUN | 26.94 | 19.66 | 91.56 | 63.06 | 11.82 | 81.50 | 503.59 |
| JUL | 27.36 | 20.10 | 93.08 | 63.34 | 10.15 | 63.10 | 474.55 |
| AUG | 27.76 | 19.75 | 92.57 | 60.14 | 8.39 | 39.80 | 473.52 |
| SEP | 27.37 | 20.20 | 92.00 | 66.41 | 7.97 | 178.30 | 410.83 |
| YEARLY AVERAGE | 26.53 | 19.08 | 91.93 | 63.82 | 11.51 | | 437.90 |
| TOTAL | | | | | | 4294.70 | |
| IOLE | | | | | | | |
| OCT | 26.40 | 18.13 | 93.67 | 61.85 | 11.04 | 115.30 | 373.15 |
| NOV | 23.42 | 16.21 | 91.90 | 69.27 | 11.43 | 478.80 | 309.46 |
| DEC | 24.28 | 16.39 | 91.82 | 57.84 | 11.23 | 221.20 | 325.85 |
| JAN | 24.09 | 15.18 | 89.77 | 52.72 | 12.60 | 345.80 | 296.71 |
| FEB | 24.34 | 15.78 | 90.71 | 57.75 | 11.70 | 186.20 | 360.70 |
| MAR | 21.14 | 16.22 | 92.13 | 74.75 | 19.39 | 958.60 | 298.20 |
| APR | 23.07 | 16.81 | 92.99 | 77.07 | 17.75 | 556.20 | 347.74 |
| MAY | 24.84 | 17.50 | 93.14 | 66.68 | 14.13 | 275.60 | 405.53 |
| JUN | 24.93 | 18.07 | 91.95 | 62.01 | 14.89 | 162.80 | 406.01 |
| JUL | 25.58 | 18.32 | 94.46 | 67.10 | 14.57 | 171.40 | 426.94 |
| AUG | 27.73 | 18.03 | 93.51 | 64.28 | 12.54 | 113.80 | 495.67 |
| SEP | 26.63 | 18.33 | 92.57 | 64.17 | 11.61 | 160.20 | 445.90 |
| YEARLY AVERAGE | 24.62 | 17.00 | 92.35 | 64.63 | 9.28 | | 373.22 |
| TOTAL | | | | | | 3745.90 | |

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MONTHLY AVERAGE FOR 1979-80

| MONTH | TEMPERATURE (DEGREE C) MAX. | TEMPERATURE (DEGREE C) MIN. | RELATIVE HUMIDITY (%) MAX. | RELATIVE HUMIDITY (%) MIN. | WIND RUN (KM/HR) | CUMULATIVE RAINFALL (MM) | SOLAR RADIATION (G CAL/DAY) |
|---|---|---|---|---|---|---|---|
| *Hawaii* | | | | | | | |
| HALAWA | | | | | | | |
| OCT | 26.82 | 18.34 | 93.35 | 65.46 | 8.75 | 87.00 | 364.25 |
| NOV | 24.14 | 16.64 | 94.10 | 70.71 | 8.99 | 371.00 | 262.06 |
| DEC | 24.46 | 16.26 | 93.31 | 61.59 | 9.18 | 132.00 | 335.98 |
| JAN | 24.44 | 14.57 | 92.85 | 56.64 | 9.35 | 206.00 | 325.90 |
| FEB | 24.72 | 15.78 | 94.43 | 63.55 | 11.55 | 128.00 | 361.78 |
| MAR | 20.83 | 16.01 | 94.50 | 77.14 | 15.35 | 939.00 | 293.40 |
| APR | 22.60 | 15.34 | 94.07 | 74.32 | 12.96 | 441.50 | 349.44 |
| MAY | 24.41 | 16.92 | 90.51 | 66.70 | 11.32 | 216.00 | 442.37 |
| JUN | 25.09 | 18.00 | 89.00 | 64.28 | 12.43 | 180.00 | 430.20 |
| JUL | 25.92 | 18.32 | 89.64 | 64.35 | 12.10 | 112.00 | 501.94 |
| AUG | 26.13 | 17.59 | 89.03 | 65.29 | 10.14 | 142.00 | 551.02 |
| SEP | 26.13 | 17.75 | 89.17 | 64.81 | 8.28 | 63.00 | 460.97 |
| YEARLY AVERAGE | 24.64 | 16.80 | 91.99 | 66.21 | 8.77 | | 386.76 |
| TOTAL | | | | | | 3017.50 | |
| *Indonesia* | | | | | | | |
| ITKA | | | | | | | |
| OCT | 26.76 | 14.79 | 98.02 | 42.90 | 5.74 | 72.80 | 428.35 |
| NOV | 26.37 | 15.94 | 99.79 | 58.06 | 4.93 | 253.80 | 277.30 |
| DEC | 25.05 | 15.21 | 99.79 | 60.22 | 4.82 | 321.90 | 320.21 |
| JAN | 22.85 | 16.31 | 99.79 | 72.08 | 9.82 | 213.10 | 370.39 |
| FEB | 24.60 | 15.80 | 99.79 | 56.84 | 6.85 | 89.50 | 463.32 |
| MAR | 25.71 | 14.57 | 99.00 | 51.14 | 6.00 | 184.00 | 402.12 |
| APR | 26.21 | 15.64 | 99.79 | 59.07 | 5.17 | 202.50 | 320.40 |
| MAY | 27.00 | 15.04 | 99.79 | 50.27 | 5.28 | 39.60 | 355.68 |
| JUN | 26.56 | 14.50 | 99.79 | 49.04 | 5.70 | 41.80 | 342.00 |
| JUL | 26.53 | 15.03 | 99.79 | 47.92 | 5.53 | 59.40 | 342.19 |
| AUG | 26.09 | 14.42 | 98.26 | 39.91 | 6.14 | 80.80 | 394.01 |
| SEP | 26.72 | 15.66 | 96.96 | 47.96 | 5.19 | 120.00 | 320.71 |
| YEARLY AVERAGE | 25.90 | 15.25 | 99.28 | 53.06 | 4.44 | | 360.48 |
| TOTAL | | | | | | 1679.20 | |

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MONTHLY AVERAGE FOR 1979-80

| MONTH | TEMPERATURE (DEGREE C) MAX. | TEMPERATURE (DEGREE C) MIN. | RELATIVE HUMIDITY (%) MAX. | RELATIVE HUMIDITY (%) MIN. | WIND RUN (KM/HR) | CUMULATIVE RAINFALL (MM) | SOLAR RADIATION (G CAL/DAY) |
|---|---|---|---|---|---|---|---|
| *Indonesia* | | | | | | | |
| LPHS | | | | | | | |
| OCT | 28.12 | 15.22 | 98.78 | 43.93 | 3.19 | 177.80 | 417.24 |
| NOV | 26.88 | 16.28 | 99.63 | 65.16 | 3.08 | 502.50 | 330.07 |
| DEC | 26.16 | 16.08 | 98.00 | 71.88 | 3.26 | 474.60 | 304.99 |
| JAN | 24.97 | 17.42 | 99.17 | 82.17 | 3.58 | 373.90 | 236.42 |
| FEB | 27.19 | 17.17 | 99.79 | 71.78 | 3.75 | 209.30 | 311.26 |
| MAR | 28.32 | 16.25 | 99.79 | 61.96 | 3.34 | 552.00 | 346.58 |
| APR | 28.39 | 17.07 | 99.79 | 68.26 | 3.65 | 420.20 | 356.06 |
| MAY | 28.65 | 17.03 | 99.79 | 59.59 | 3.65 | 215.40 | 372.74 |
| JUN | 28.32 | 15.63 | 99.79 | 60.25 | 3.46 | 67.70 | 335.69 |
| JUL | 28.22 | 15.64 | 99.79 | 57.28 | 3.24 | 107.90 | 337.39 |
| AUG | 27.86 | 15.42 | 99.79 | 54.20 | 3.35 | 167.40 | 379.68 |
| SEP | 30.17 | 17.68 | 99.79 | 59.96 | 3.64 | 208.60 | 372.86 |
| YEARLY AVERAGE | 27.80 | 16.40 | 99.52 | 62.97 | 8.79 | | 341.83 |
| TOTAL | | | | | | 3477.30 | |
| *Philippines* | | | | | | | |
| PUC | | | | | | | |
| OCT | 30.64 | 22.60 | 92.82 | 65.23 | 7.29 | 215.50 | 308.86 |
| NOV | 29.53 | 21.58 | 91.25 | 71.10 | 8.53 | 530.70 | 284.93 |
| DEC | 29.00 | 21.32 | 86.86 | 64.57 | 9.92 | 419.30 | 301.80 |
| JAN | 29.17 | 20.03 | 85.34 | 51.89 | 6.73 | 173.00 | 325.06 |
| FEB | 28.64 | 18.10 | 95.64 | 61.64 | 6.56 | 88.70 | 338.42 |
| MAR | 30.03 | 18.00 | 96.00 | 51.76 | 7.07 | 327.90 | 396.60 |
| APR | 33.20 | 19.35 | 96.50 | 45.21 | 5.32 | 2.70 | 443.09 |
| MAY | 32.97 | 21.75 | 94.37 | 51.53 | 6.73 | 347.50 | 412.25 |
| JUN | 31.50 | 21.97 | 95.91 | 71.30 | 3.87 | 230.70 | 319.85 |
| JUL | 31.26 | 22.79 | 92.64 | 70.77 | 8.19 | 346.00 | 314.50 |
| AUG | 31.42 | 21.35 | 94.12 | 67.95 | 5.53 | 343.50 | 330.79 |
| SEP | 30.07 | 22.21 | 89.63 | 78.25 | 6.03 | 233.00 | 283.70 |
| YEARLY AVERAGE | 30.61 | 20.88 | 92.59 | 61.92 | 8.15 | | 338.81 |
| TOTAL | | | | | | 3258.50 | |

continued

MONTHLY AVERAGE FOR 1979-80

| MONTH | TEMPERATURE (DEGREE C) MAX. | TEMPERATURE (DEGREE C) MIN. | RELATIVE HUMIDITY (%) MAX. | RELATIVE HUMIDITY (%) MIN. | WIND RUN (KM/HR) | CUMULATIVE RAINFALL (MM) | SOLAR RADIATION (G CAL/DAY) |
|---|---|---|---|---|---|---|---|
| *Philippines* | | | | | | | |
| PAL | | | | | | | |
| OCT | 30.90 | 21.47 | 95.39 | 55.43 | 6.25 | 226.60 | 299.90 |
| NOV | 29.76 | 20.56 | 96.95 | 63.59 | 6.51 | 627.30 | 282.86 |
| DEC | 28.57 | 19.67 | 95.46 | 59.78 | 8.35 | 433.90 | 302.50 |
| JAN | 30.32 | 19.09 | 96.89 | 52.42 | 5.39 | 162.90 | 350.40 |
| FEB | 30.30 | 18.64 | 99.60 | 52.28 | 6.04 | 92.90 | 355.34 |
| MAR | 32.37 | 18.63 | 99.41 | 44.09 | 6.07 | 341.80 | 407.86 |
| APR | 33.88 | 20.22 | 99.26 | 39.88 | 5.53 | 3.50 | 429.02 |
| MAY | 33.97 | 22.03 | 98.90 | 48.83 | 6.54 | 286.20 | 378.70 |
| JUN | 32.09 | 22.03 | 99.10 | 66.00 | 3.77 | 262.40 | 300.53 |
| JUL | 31.19 | 22.50 | 98.03 | 69.39 | 6.39 | 393.40 | 325.85 |
| AUG | 33.21 | 22.85 | 99.71 | 65.90 | 4.35 | 494.10 | 319.25 |
| SEP | 31.61 | 23.30 | 95.21 | 66.83 | 4.81 | 271.30 | 292.63 |
| YEARLY AVERAGE | 31.52 | 20.92 | 97.84 | 57.05 | 5.84 | | 337.24 |
| TOTAL | | | | | | 3596.30 | |
| PUR | | | | | | | |
| OCT | 28.63 | 22.25 | 93.75 | 61.13 | 11.75 | 358.00 | 264.77 |
| NOV | 27.01 | 21.34 | 92.48 | 63.90 | 12.10 | 864.10 | 262.46 |
| DEC | 25.71 | 20.32 | 92.25 | 65.00 | 16.21 | 465.30 | 264.67 |
| JAN | 27.14 | 20.03 | 91.53 | 53.47 | 12.17 | 378.80 | 319.68 |
| FEB | 27.54 | 19.65 | 92.72 | 48.65 | 11.08 | 157.90 | 337.63 |
| MAR | 29.57 | 20.32 | 97.89 | 49.85 | 9.77 | 538.00 | 374.57 |
| APR | 32.53 | 21.59 | 99.79 | 45.97 | 6.35 | 23.30 | 416.76 |
| MAY | 32.47 | 22.71 | 99.32 | 52.35 | 9.53 | 286.60 | 387.41 |
| JUN | 29.79 | 22.19 | 99.79 | 69.00 | 5.81 | 414.40 | 253.13 |
| JUL | 29.57 | 22.27 | 99.57 | 69.60 | 11.68 | 432.70 | 321.14 |
| AUG | 30.17 | 22.36 | 99.79 | 68.40 | 7.96 | 380.20 | 326.40 |
| SEP | 28.31 | 22.51 | 99.79 | 74.28 | 10.44 | 327.90 | 233.57 |
| YEARLY AVERAGE | 29.04 | 21.46 | 96.59 | 60.25 | 14.28 | | 313.34 |
| TOTAL | | | | | | 4627.20 | |

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clayey, kaolinitic, isohyperthermic Tropeptic Eutrustox

MONTHLY AVERAGE FOR 1979-80

| MONTH | TEMPERATURE (DEGREE C) MAX. | TEMPERATURE (DEGREE C) MIN. | RELATIVE HUMIDITY (%) MAX. | RELATIVE HUMIDITY (%) MIN. | WIND RUN (KM/HR) | CUMULATIVE RAINFALL (MM) | SOLAR RADIATION (G CAL/DAY) |
|---|---|---|---|---|---|---|---|
| *Hawaii* | | | | | | | |
| MOLOKAI | | | | | | | |
| OCT | 29.71 | 21.01 | 79.97 | 67.67 | 17.46 | 34.70 | 447.43 |
| NOV | 27.56 | 19.50 | 80.64 | 71.16 | 22.09 | 32.90 | 394.10 |
| DEC | 25.78 | 17.91 | 85.03 | 59.21 | 16.64 | 144.00 | 332.18 |
| JAN | 23.57 | 17.32 | 86.12 | 66.03 | 16.82 | 492.60 | 358.32 |
| FEB | 24.44 | 15.89 | 87.61 | 65.40 | 13.58 | 92.20 | 421.46 |
| MAR | 24.58 | 17.71 | 87.79 | 78.14 | 28.82 | 67.50 | 522.12 |
| APR | 24.97 | 18.37 | 95.42 | 79.50 | 24.93 | 73.80 | 565.97 |
| MAY | 27.63 | 19.46 | 97.00 | 79.14 | 17.96 | 128.30 | 488.38 |
| JUN | 27.30 | 19.75 | 99.66 | 60.60 | 22.95 | 60.70 | 604.58 |
| JUL | 28.46 | 20.46 | 99.79 | 67.29 | 22.65 | 42.40 | 583.25 |
| AUG | 28.92 | 20.40 | 99.67 | 67.39 | 20.49 | 59.30 | 590.78 |
| SEP | 29.53 | 20.57 | 99.72 | 66.00 | 18.04 | 49.90 | 507.46 |
| YEARLY AVERAGE | 26.86 | 19.03 | 90.86 | 67.67 | 3.61 | | 479.09 |
| TOTAL | | | | | | 1278.30 | |
| WAIPIO | | | | | | | |
| OCT | 31.39 | 23.85 | 92.42 | 53.30 | 8.34 | 57.40 | 365.62 |
| NOV | 28.28 | 21.36 | 92.96 | 53.67 | 9.08 | 59.30 | 357.84 |
| DEC | 26.22 | 19.62 | 93.89 | 52.72 | 8.17 | 49.90 | 295.61 |
| JAN | 24.39 | 18.62 | 91.51 | 54.29 | 10.06 | 316.20 | 283.75 |
| FEB | 25.68 | 18.34 | 90.96 | 49.75 | 8.25 | 75.50 | 371.47 |
| MAR | 25.06 | 21.70 | 91.85 | 62.80 | 11.26 | 99.70 | 405.91 |
| APR | 26.84 | 21.73 | 91.54 | 60.70 | 10.06 | 79.60 | 452.66 |
| MAY | 27.39 | 21.10 | 87.73 | 57.39 | 8.60 | 54.10 | 534.67 |
| JUN | 27.66 | 21.34 | 90.87 | 58.81 | 8.30 | 96.30 | 472.44 |
| JUL | 28.38 | 21.96 | 91.41 | 60.28 | 7.39 | 85.90 | 509.33 |
| AUG | 28.76 | 21.94 | 92.50 | 52.82 | 7.62 | 40.40 | 505.56 |
| SEP | 26.52 | 19.86 | 82.50 | 47.64 | 7.40 | 64.60 | 423.77 |
| YEARLY AVERAGE | 27.20 | 20.96 | 90.84 | 55.48 | 3.26 | | 413.16 |
| TOTAL | | | | | | 1078.90 | |

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**clayey, kaolinitic, isohyperthermic Typic Paleudults**

MONTHLY AVERAGE FOR 19[illegible]-80

| MONTH | TEMPERATURE (DEGREE C) MAX. | MIN. | RELATIVE HUMIDITY (%) MAX. | MIN. | WIND RUN (KM/HR) | CUMULATIVE RAINFALL (MM) | SOLAR RADIATION (G CAL/DAY |
|---|---|---|---|---|---|---|---|
| *Cameroon* | | | | | | | |
| OCT | ***** | ***** | ***** | ***** | ***** | ****** | ****** |
| NOV | ***** | ***** | ***** | ***** | ***** | ****** | ****** |
| DEC | ***** | ***** | ***** | ***** | ***** | ****** | ****** |
| JAN | ***** | ***** | ***** | ***** | ***** | ****** | ****** |
| FEB | ***** | ***** | ***** | ***** | ***** | ****** | ****** |
| MAR | ***** | ***** | ***** | ***** | ***** | ****** | ****** |
| APR | ***** | ***** | ***** | ***** | ***** | ****** | ****** |
| MAY | 33.68 | 23.67 | 99.79 | 62.79 | 1.75 | 435.10 | 385.32 |
| JUN | 33.72 | 22.96 | 99.79 | 67.07 | 2.35 | 246.40 | 350.62 |
| JUL | 31.01 | 23.46 | 99.79 | 75.81 | 2.51 | 216.00 | 257.23 |
| AUG | 31.19 | 23.13 | 99.79 | 74.60 | 2.25 | 613.20 | 243.26 |
| SEP | 33.32 | 22.14 | 98.35 | 54.25 | 2.21 | 327.20 | 328.34 |
| YEARLY AVERAGE | 32.63 | 23.07 | 99.47 | 66.42 | 10.44 | | 312.35 |
| TOTAL | | | | | | 1837.90 | |
| *Indonesia* | | | | | | | |
| NAGHU | | | | | | | |
| OCT | 35.06 | 19.73 | 95.69 | 20.90 | 4.35 | 120.40 | 468.24 |
| NOV | 34.10 | 20.10 | 93.26 | 29.00 | 2.84 | 179.80 | 414.10 |
| DEC | 31.42 | 20.66 | 88.34 | 42.39 | 4.24 | 415.80 | 381.24 |
| JAN | 31.17 | 22.46 | 91.19 | 28.00 | 4.58 | 503.80 | 406.10 |
| FEB | 32.58 | 21.34 | 97.00 | 38.64 | 4.78 | 418.00 | 396.10 |
| MAR | 35.41 | 21.21 | 97.38 | 26.84 | 3.34 | 206.00 | 440.38 |
| APR | 34.80 | 21.96 | 98.41 | 32.27 | 3.46 | 190.20 | 429.48 |
| MAY | 35.15 | 21.44 | 99.28 | 32.06 | 3.46 | 50.00 | 400.97 |
| JUN | 35.08 | 22.01 | 99.79 | 33.35 | 3.46 | 77.40 | 377.71 |
| JUL | 35.18 | 21.05 | 99.79 | 30.56 | 3.08 | 249.30 | 381.98 |
| AUG | 33.37 | 20.11 | 95.47 | 29.19 | 3.71 | 78.30 | 408.89 |
| SEP | 34.50 | 20.78 | 96.76 | 26.20 | 3.46 | 191.50 | 422.45 |
| YEARLY AVERAGE | 33.98 | 21.17 | 96.50 | 31.26 | 7.05 | | 410.76 |
| TOTAL | | | | | | 2680.50 | |

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MONTHLY AVERAGE FOR 1979-80

| MONTH | TEMPERATURE (DEGREE C) MAX. | TEMPERATURE (DEGREE C) MIN. | RELATIVE HUMIDITY (%) MAX. | RELATIVE HUMIDITY (%) MIN. | WIND RUN (KM/HR) | CUMULATIVE RAINFALL (MM) | SOLAR RADIATION (G CAL/DAY) |
|---|---|---|---|---|---|---|---|
| *Indonesia* | | | | | | | |
| BPMD | | | | | | | |
| OCT | 35.85 | 20.69 | 99.79 | 24.85 | 2.44 | 120.60 | 426.38 |
| NOV | 35.35 | 21.17 | 97.66 | 33.76 | 1.71 | 167.90 | 405.72 |
| DEC | 31.35 | 21.76 | 99.00 | 58.66 | 1.76 | 512.10 | 397.82 |
| JAN | 34.67 | 23.35 | 99.00 | 52.73 | 2.21 | 311.70 | 372.10 |
| FEB | 35.03 | 23.27 | 99.79 | 48.54 | 2.45 | 225.10 | 426.98 |
| MAR | 39.10 | 22.87 | 99.79 | 36.54 | 1.92 | 244.00 | 449.64 |
| APR | 37.42 | 23.06 | 99.79 | 44.34 | 1.69 | 218.10 | 418.30 |
| MAY | 35.32 | 21.38 | 99.79 | 49.12 | 1.59 | 115.70 | 372.19 |
| JUN | 35.70 | 21.25 | 99.69 | 47.16 | 1.89 | 136.40 | 369.05 |
| JUL | 34.97 | 20.71 | 99.67 | 42.21 | 1.66 | 221.00 | 367.68 |
| AUG | 35.13 | 20.34 | 99.67 | 46.73 | 2.21 | 142.30 | 370.22 |
| SEP | 34.11 | 20.42 | 99.63 | 40.37 | 2.05 | 240.80 | 393.34 |
| YEARLY AVERAGE | 35.60 | 21.75 | 99.50 | 43.33 | 6.20 | | 397.37 |
| TOTAL | | | | | | 2655.70 | |
| BUKIT | | | | | | | |
| OCT | 35.25 | 22.50 | 79.32 | 24.82 | 4.72 | 110.00 | 466.63 |
| NOV | 35.14 | 22.54 | 83.06 | 31.96 | 4.57 | 93.30 | 529.49 |
| DEC | 32.14 | 22.21 | 83.47 | 49.77 | 4.47 | 350.60 | ****** |
| JAN | 31.60 | 23.00 | 86.67 | 56.82 | 3.74 | 462.20 | 357.31 |
| FEB | 33.00 | 22.89 | 86.92 | 45.03 | 3.76 | 276.40 | 393.86 |
| MAR | 34.92 | 22.23 | 87.10 | 36.70 | 4.00 | 344.10 | ****** |
| APR | 34.72 | 23.13 | 88.13 | 41.47 | 4.24 | 392.60 | ****** |
| MAY | 35.56 | 23.53 | 88.06 | 36.54 | 4.56 | 156.00 | ****** |
| JUN | 35.21 | 22.46 | 87.78 | 37.54 | 4.15 | 112.50 | ****** |
| JUL | 34.62 | 22.27 | 88.10 | 35.47 | 3.78 | 292.00 | 442.46 |
| AUG | 34.28 | 21.43 | 88.62 | 29.92 | 4.24 | 182.60 | 383.54 |
| SEP | 34.35 | 22.82 | 89.42 | 33.89 | 4.59 | 260.60 | 362.16 |
| YEARLY AVERAGE | 34.20 | 22.60 | 86.39 | 38.46 | 6.56 | | [illegible] |
| TOTAL | | | | | | 3032.90 | |

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MONTHLY AVERAGE FOR 1979-80

| MONTH | TEMPERATURE (DEGREE C) MAX. | TEMPERATURE (DEGREE C) MIN. | RELATIVE HUMIDITY (%) MAX. | RELATIVE HUMIDITY (%) MIN. | WIND RUN (KM/HR) | CUMULATIVE RAINFALL (MM) | SOLAR RADIATION (G CAL/DAY) |
|---|---|---|---|---|---|---|---|
| *Philippines* | | | | | | | |
| DAVAO | | | | | | | |
| OCT | 35.89 | 24.42 | 96.06 | 52.76 | 4.82 | 179.50 | 374.74 |
| NOV | 35.66 | 23.29 | 97.77 | 51.85 | 5.78 | 74.50 | 431.95 |
| DEC | 33.56 | 23.96 | 97.57 | 54.67 | 6.96 | 176.00 | 379.25 |
| JAN | 34.27 | 24.25 | 96.32 | 57.12 | 5.25 | 166.70 | 366.77 |
| FEB | 34.13 | 23.46 | 98.50 | 52.50 | 5.77 | 96.90 | 385.85 |
| MAR | 36.60 | 23.67 | 96.21 | 35.63 | 6.42 | 59.50 | 506.54 |
| APR | 36.42 | 21.85 | 90.42 | 40.85 | 5.75 | 137.80 | 451.90 |
| MAY | 35.88 | 23.44 | 93.32 | 42.54 | 5.75 | 78.00 | 476.40 |
| JUN | 33.41 | 21.67 | 94.29 | 56.60 | 3.92 | 605.40 | 410.90 |
| JUL | 32.85 | 21.40 | 93.10 | 52.71 | 4.51 | 335.20 | 424.87 |
| AUG | 34.22 | 23.09 | 92.72 | 52.29 | 4.13 | 223.30 | 408.94 |
| SEP | 34.60 | 23.10 | 92.85 | 52.00 | 3.96 | 124.80 | 428.74 |
| YEARLY AVERAGE | 34.70 | 23.19 | 95.13 | 50.80 | 5.43 | | 420.58 |
| TOTAL | | | | | | 2257.60 | |
| SOR | | | | | | | |
| OCT | ***** | ***** | ***** | ***** | ***** | ****** | ****** |
| NOV | ***** | ***** | ***** | ***** | ***** | ****** | ****** |
| DEC | ***** | ***** | ***** | ***** | ***** | ****** | ****** |
| JAN | 28.92 | 23.12 | 97.09 | 62.18 | 10.92 | 107.40 | 321.24 |
| FEB | 29.00 | 21.92 | 99.79 | 64.64 | 9.81 | 190.40 | 355.10 |
| MAR | 31.50 | 21.59 | 99.79 | 48.29 | 9.04 | 202.20 | 478.46 |
| APR | 32.81 | 22.14 | 99.79 | 54.06 | 8.75 | 39.40 | 484.99 |
| MAY | 33.77 | 23.17 | 99.66 | 52.21 | 7.95 | 25.80 | 454.13 |
| JUN | 31.73 | 23.52 | 99.75 | 78.96 | 6.88 | 397.50 | 323.76 |
| JUL | 32.47 | 23.70 | 92.39 | 60.50 | 7.17 | 245.70 | 400.08 |
| AUG | 33.46 | 23.14 | 91.28 | 53.67 | 4.58 | 402.60 | 384.31 |
| SEP | 32.03 | 23.32 | 89.26 | 60.39 | 5.72 | 467.30 | 329.35 |
| YEARLY AVERAGE | 31.72 | 22.85 | 96.35 | 58.88 | 5.66 | | 391.34 |
| TOTAL | | | | | | 2078.30 | |

# Appendix 6

## BSP Mailing List

### By Agency

| ORG | FREQUENCY | ORG | FREQUENCY |
|---|---|---|---|
| NO AGENCY CITED | 19 | CENIAP/FONAIAP/M | 1 |
| ACSAD | 1 | CENTRAL ARID ZON | 1 |
| AFOA | 1 | CENTRAL LIB. FOR | 1 |
| AGLS/FAO | 1 | CENTRAL LUZON ST | 4 |
| AGRIC. DEVEL. CT | 2 | CENTRO DE EDAFOL | 1 |
| AGRIC. ECOL. LAN | 1 | CHANDRAVIHAR SOC | 1 |
| AGRIC. EXP. STA. | 1 | CHIANG MAI UNIV. | 2 |
| AGRIC. RES. CORP | 1 | CHINESE ACADEMY | 1 |
| AGRIC. RES. INST | 4 | CIAF | 1 |
| AGRICULTURAL UNI | 2 | CIAT (INT. CENTE | 3 |
| AGRIMA PROJECT | 1 | CIMMYT (INT.CTR. | 4 |
| AGROTECHNIQUE S. | 1 | CIP (INT. POTATO | 3 |
| AHRD--LITBANG | 1 | CLOUTIER, WILKIE | 2 |
| ALBERT R. MANN L | 1 | CNIECA | 1 |
| ALBERTA RES. COU | 1 | COLORADO STATE U | 6 |
| ALCORN STATE UNI | 1 | COMMART (PHILS.) | 1 |
| ALL INDIA COORD. | 1 | COMMONWEALTH AGR | 1 |
| AMER. ASSO. ADVA | 1 | COMMONWEALTH DEV | 2 |
| AMER. SOC. AGRON | 1 | COOK COLLEGE, RU | 1 |
| AMER. UNIV. BEIR | 2 | COOP. CRIA-IRRI | 2 |
| AMERICAN EMBASSY | 1 | CORNELL UNIV. | 6 |
| AMERICAN SOC. OF | 2 | CREATIVE ASSOCIA | 1 |
| AMFAC NURSERIES, | 2 | CRI | 1 |
| ANNUAL CROPS PRO | 1 | CRIA (CENTRAL RE | 11 |
| APECS LTD. (AGRI | 1 | CRIES, USDA | 1 |
| ASPEN INST. FOR | 1 | CRIS/USDA | 1 |
| ASSISTANCE TO LA | 1 | CROPS AND SOILS | 1 |
| ATENEO DE DAVAO | 1 | CROPS RES. INST. | 1 |
| AVRDC (ASIAN VEG | 3 | CSIRO | 5 |
| BANGLADESH AGRIC | 1 | CSIRO CUNNINGHAM | 1 |
| BAPPENAS | 1 | CUERPO DE PAZ | 2 |
| BELGIAN EMBASSY | 1 | DAMIEN UNIV. | 1 |
| BELTSVILLE AGRIC | 1 | DAVAO EXP. STA. | 1 |
| BICOL RIVER BAST | 1 | DAVAO FRUITS COR | 2 |
| BICOLANDIA SUGAR | 1 | DAVERENE ENTERPR | 1 |
| BIMAS | 1 | DAVIES HAMAKUA S | 1 |
| BINA PRODUKSI | 1 | DCS-ESAL | 2 |
| BIOTROP-SEAMEO R | 1 | DEKALB AG. RES. | 1 |
| BIS/STRC/DAU | 1 | DEL MONTE CORP. | 1 |
| BLACKWELL MANAGE | 1 | DEPT. AGRIC. | 14 |
| BOGOR AGRIC. UNI | 2 | DEPT. AGRIC. & F | 1 |
| BPLP | 1 | DEPT. DEVEL. | 1 |
| BPPB | 1 | DEPT. LAND DEVEL | 1 |
| BPRI (BANGLADESH | 1 | DEPT. OF PUBLIC | 1 |
| BUREAU OF AGRIC. | 1 | DINAS PERTANIAN | 2 |
| BUREAU OF PLANT | 7 | DIRECCION RECUR | 1 |
| BUREAU OF SOILS | 15 | DIRECT. GENERAL/ | 1 |
| BUREAU OF SOILS/ | 1 | DIV. SOIL SCI. A | 1 |
| BUREAU RESOUR. A | 1 | DIV. WATER & LAN | 1 |
| CABANG LEMBAGA P | 1 | DOKUCHAEV SOIL I | 1 |
| CALIFORNIA POLYT | 2 | DON MARIANO MARC | 1 |
| CALIFORNIA STATE | 1 | DSB/US/AID | 1 |
| CARD (CTR. AGRIC | 1 | DSE FOOD & AGRIC | 1 |
| CATIE (CENTRO AG | 1 | DSIR | 2 |
| CENIAP | 1 | EAST-WEST CENTER | 3 |

| ORG | FREQUENCY |
|---|---|
| ECONOMIE RURALE | 1 |
| EDINBURGH UNIV. | 1 |
| EHIME UNIV. | 1 |
| EID-PARRY (INDIA | 1 |
| EKONA AGRON. CTR | 1 |
| EL CENTRO PARA E | 1 |
| EMBRAPA | 2 |
| EMBRAPA CPATU | 2 |
| EMBRAPA-SNLCS | 2 |
| EMBRAPA/CPAC | 1 |
| ENSA | 2 |
| EPAMIG (EMP. PES | 2 |
| ESCUELA AGRICOLA | 1 |
| ESCUELA NACIONAL | 1 |
| ESTACAO AGRONOMI | 1 |
| EXTENSION SERVIC | 1 |
| FACULTY OF AGRIC | 1 |
| FAO | 1 |
| FAO (FOOD AGR. O | 6 |
| FAO LIVESTOCK PR | 1 |
| FAO SOIL SURVEY | 1 |
| FAO--C/O UNDP | 1 |
| FAO/AGPC | 1 |
| FAO/NER//5/009 | 1 |
| FAO SRI (SOIL RE | 1 |
| FAO UNDP IN BANG | 1 |
| FAO FPU #AGOA/E | 1 |
| FEDERAL DEPT. AG | 4 |
| FEDERAL MINISTRY | 1 |
| FLORIDA A & M UN | 1 |
| FONAIAP | 1 |
| FLOD CROPS PRODU | 1 |
| FLR. AGRIC. SERV | 1 |
| FOUND.FOR PEOPLE | 1 |
| FREDERIKSEN, KAM | 1 |
| FUNDACAO UNIV. O | 1 |
| GADJAH MADA UNIV | 2 |
| GENTRY PACIFIC. | 1 |
| GEODERMA | 1 |
| GEOLOGISCH INST. | 2 |
| GHANA ORG. VOL. | 1 |
| GSL-IRRI PROJ. | 1 |
| HAWAII STATE DEP | 3 |
| HAWAII STATE UIV | 1 |
| HAWAII STATE LEG | 1 |
| HEBREW UNIV. | 1 |
| HIGHLANDS RES. U | 2 |
| HIKIDLA COOPERAT | 1 |
| HOKKAIDO UNIV. | 2 |
| HOLDEN'S FOUNDAT | 1 |
| HORT. RES. INST. | 1 |
| HORTICULTURE | 1 |
| HSPA CHAUALIAP S | 3 |
| IABC (INT. ASSO. | 1 |
| IADS (INT. AGRIC | 5 |
| IAFI (INDIAN AGR | 3 |
| ICAR (INDIAN COU | 3 |
| ICARDA (INT.CTR. | 1 |

| ORG | FREQUENCY |
|---|---|
| ICRISAT (INT. CR | 5 |
| ICTA | 1 |
| IDIAP (INST.INVE | 3 |
| IFDC (INT. FERT. | 8 |
| IICA (INST.INTER | 2 |
| IICA/OEA (INST. | 1 |
| IITA (INT. INST. | 8 |
| IITA-ZAIREAN PRO | 1 |
| ILCA (INT. LIVES | 1 |
| ILCA-CIPEA (INT. | 1 |
| ILRAD (INT. LAB. | 2 |
| INDUSTRIAL CROPS | 1 |
| INERA-YANGAMBI | 1 |
| INIAP (INST.NACI | 4 |
| INKA | 1 |
| INRA (INST. NICA | 1 |
| INST. AGRIC. & F | 1 |
| INST. AGRON. S. | 1 |
| INST. AGRONOMICO | 1 |
| INST. COLOMBIANO | 1 |
| INST. DES SCI. A | 1 |
| INST. MEXICANO D | 1 |
| INST. OF AGRIC. | 2 |
| INST. OF CULTURA | 1 |
| INST. OF SOIL & | 1 |
| INST. PACIFIC IS | 1 |
| INST. PERTANIAN | 1 |
| INST. SENEGALAIS | 1 |
| INSTITUTO AGRONO | 1 |
| INSTITUTO DE EDA | 1 |
| INT. COUNCIL FOR | 1 |
| INT. INST. LAND | 2 |
| INT. MINERALS & | 3 |
| INT. SOIL MUSEUM | 2 |
| INT. VOLUNTARY S | 1 |
| INTA-MIDA | 1 |
| INTEGRATED CEREA | 1 |
| IOWA STATE UNIV. | 5 |
| IPB, FACULTY OF | 1 |
| IRAT (INST. RECH | 2 |
| IRRI (INT. RICE | 12 |
| ISABELA STATE UN | 2 |
| ITC (INT. INST. | 2 |
| ITKA (INST. THEO | 1 |
| IWATE AGRIC. EXP | 1 |
| JOURNAL OF SOIL | 1 |
| KABUKIRAN ENTERP | 1 |
| KADO (REGIONAL A | 1 |
| KANSAS STATE UNI | 3 |
| KASETSART UNIV. | 1 |
| KAWANDA RES. STA | 1 |
| KENYA AGRIC. RES | 1 |
| KENYA SOIL SURVE | 1 |
| KOHALA CORPORATI | 1 |
| KOKOKAHI CROPCP | 1 |
| KU LEUVAN | 1 |
| KUAPULAN GUTHRIE | 1 |
| KYOTO UNIV. | 1 |

| ORG | FREQUENCY | ORG | FREQUENCY |
|---|---|---|---|
| KYUSHU UNIV. | 1 | NITRAGIN CO., IN | 1 |
| LAND DEVEL. DEPT | 4 | NORTH CAROLINA S | 8 |
| LAND RESOURCE RE | 1 | NRC (NATIONAL RE | 1 |
| LAND RESOURCES D | 3 | NTIS | 1 |
| LAND RESOURCES S | 1 | NUFFIC/UNIBRAW | 1 |
| LAND SYSTEMS INT | 1 | OFF. DEVEL. INFO | 1 |
| LAND USE DIVISIO | 1 | OFF. RURAL DEVEL | 2 |
| LEMBAGA PUSAT PE | 3 | OFF. SAASVELD FO | 1 |
| LINCOLN COLLEGE | 2 | OFICINA PARA EL | 1 |
| LIPI (LEMBAGA RI | 2 | OHIO STATE UNIV. | 2 |
| LOKAHI PACIFIC | 1 | OKLAHOMA STATE U | 1 |
| LOS ANGELES PUBL | 1 | OREGON STATE UNI | 2 |
| LOUISIANA STATE | 1 | ORSTOM | 5 |
| LP. HORTICULTURE | 1 | P.T. PUPUK SRIWI | 1 |
| LP.3 MAROS | 1 | PADJADJARAN UNIV | 1 |
| LP.3 SUKAMANDI | 1 | PARKS AND RECREA | 1 |
| LPTI (LEMBAGA PE | 1 | PCA (PHILIPPINE | 2 |
| LUIS JIMENEZ SEG | 1 | PCARR (PHILIPPIN | 9 |
| MACDONALD COLLEG | 1 | PDD-NIA, EDSA | 1 |
| MAEJO INST. AGRI | 1 | PELADANG KIMIA S | 2 |
| MALAYSIAN AGRIC. | 2 | PENN STATE UNIV. | 4 |
| MAROS RES. INST. | 1 | PHILIPPINE PACKI | 2 |
| MASSEY UNIV. | 1 | PHILIPPINE TOBAC | 4 |
| MAX AGR. SDN BHD | 1 | PHILIPPINE UNION | 1 |
| MEIJI UNIV. | 1 | PHOSPHATE COOP. | 1 |
| METRO-MANILA | 1 | PIONEER HI-BRED | 3 |
| MICHIGAN STATE U | 7 | PLANTATION SERV. | 1 |
| MILINGIMBI | 1 | PLANTERS PRODUCT | 2 |
| MINISTERIO DE AG | 2 | POTASH & PHOSPHA | 1 |
| MINISTRY AGRIC. | 6 | PPQ/APHIS/USDA | 1 |
| MINISTRY FOOD, A | 1 | PRAIRIE VIEW A&M | 1 |
| MINISTRY OF AGRI | 18 | PRIME MINISTER'S | 1 |
| MINISTRY OF DEVE | 1 | PROGRAMA CIENCIA | 1 |
| MINISTRY OF ECON | 1 | PROGRAMA ERIS | 1 |
| MINISTRY OF FOOD | 2 | PROGRAMA REGIONA | 1 |
| MINISTRY OF NATU | 1 | PROJECTO DE DESA | 1 |
| MINISTRY WORKS & | 1 | PROYEK PENYULUHA | 1 |
| MISSISSIPPI STAT | 2 | PT. PERTANI | 1 |
| MITSUBISHI INT'L | 1 | PUNJAB AGRIC. UN | 2 |
| MONTANA STATE UN | 1 | PURDUE UNIV. | 4 |
| MOSCOW UNIV. | 1 | PUSAT PENGEMBANG | 2 |
| N.Y. STATE ENERG | 1 | RES. CORP., UNIV | 5 |
| NASULGC | 1 | RES. INST. FOR T | 1 |
| NATIONAL AGRIC. | 3 | RES. INST. SOIL | 2 |
| NATIONAL BUR.SOI | 2 | ROTHAMSTED EXP. | 3 |
| NATIONAL CHUNG H | 1 | ROYAL TROPICAL I | 1 |
| NATIONAL COLLEGE | 1 | RUA BENEDITE MOT | 1 |
| NATIONAL CTR. FO | 1 | RUBBER RES. CTR. | 1 |
| NATIONAL FERTILI | 1 | RUBBER RES. INST | 4 |
| NATIONAL HORT. R | 1 | SAM HOUSTON STAT | 1 |
| NATIONAL IRRIG. | 2 | SAN MIGUEL CORP. | 1 |
| NATIONAL REMOTE | 1 | SATUAN PENGENDAL | 1 |
| NATIONAL UNIV. S | 1 | SCHOOL OF AGRIC. | 1 |
| NATL. BUR. SOIL | 3 | SCIENCE & TECH. | 1 |
| NATL. FOOD CROPS | 1 | SEPRA Y CIA. LTD | 1 |
| NATURAL RESOURCE | 1 | SEPSA (SEC. EJEC | 1 |
| NBSS & LUP. REGI | 1 | SHAIKH DEEN & KH | 1 |
| NEW ZEALAND SOIL | 1 | SNLC SOLOS | 1 |

| ORG | FREQUENCY |
|---|---|
| SOC. ECUATOR. DE | 1 |
| SOIL & LAND USE | 1 |
| SOIL BUREAU | 2 |
| SOIL CONSERV. SE | 11 |
| SOIL CONSERV. SO | 1 |
| SOIL SCIENCE SOC | 2 |
| SOIL SURVEY & LA | 1 |
| SOIL SURVEY ADMI | 1 |
| SOUTH DAKOTA STA | 1 |
| SOUTH PACIFIC CO | 1 |
| SOUTH. HIGHLANDS | 1 |
| SOUTH-EAST CONSO | 1 |
| SOUTHERN FOREST | 1 |
| SOUTHERN ILLINOI | 2 |
| SPI (SOIL RES. I | 10 |
| SRIWIJAYA UNIV. | 1 |
| ST. ANDREW'S AGR | 1 |
| STANDARD (PHIL.) | 1 |
| STATE UNIV. GHEN | 4 |
| SUDAN AGRIC. RES | 1 |
| TAIWAN FERTILIZE | 2 |
| TAMS ENGINEERS A | 1 |
| TANGANYIKA PYRET | 1 |
| TECH. UNIV. MUEN | 1 |
| TENNESSEE VALLEY | 2 |
| TEXAS A & M UNIV | 3 |
| TEXAS TECH. UNIV | 1 |
| THE MAUI CO. | 1 |
| THE ROCKEFELLER | 1 |
| THE ROYAL AGRIC. | 1 |
| THE WORLD BANK | 3 |
| TROPICAL AGRIC. | 1 |
| TWIN RIVERS RES. | 4 |
| U.S. DEPT. INTER | 1 |
| UNDP (UNITED NAT | 2 |
| UNDP/IRRD | 2 |
| UNELLEZ (UNIV. N | 1 |
| UNESCO | 1 |
| UNIV. ABERDEEN | 1 |
| UNIV. AGRARIA | 1 |
| UNIV. AMSTERDAM | 2 |
| UNIV. ARIZONA | 2 |
| UNIV. BRITISH CO | 2 |
| UNIV. CALIFORNIA | 3 |
| UNIV. CENTRO DOC | 1 |
| UNIV. CHILE | 2 |
| UNIV. COSTA RICA | 1 |
| UNIV. DAR ES SAL | 1 |
| UNIV. DELAWARE | 1 |
| UNIV. DSCHANG | 1 |
| UNIV. EAST ANGLI | 1 |
| UNIV. FED. DE VI | 1 |
| UNIV. FED. RURAL | 1 |
| UNIV. FLORIDA | 1 |
| UNIV. FORT HARE | 1 |
| UNIV. GEORGIA | 2 |

| ORG | FREQUENCY |
|---|---|
| UNIV. GUAM | 1 |
| UNIV. GUELPH | 1 |
| UNIV. HAMBURG | 2 |
| UNIV. HAWAII | 15 |
| UNIV. HAWAII/CTA | 40 |
| UNIV. HAWAII/HIL | 1 |
| UNIV. HOHENHEIM | 1 |
| UNIV. IDAHO | 1 |
| UNIV. IFE | 1 |
| UNIV. ILLINOIS | 4 |
| UNIV. KANSAS | 1 |
| UNIV. KENTUCKY | 3 |
| UNIV. LOS BANOS | 1 |
| UNIV. LOUVAIN | 1 |
| UNIV. MARYLAND | 1 |
| UNIV. MARYLAND, | 1 |
| UNIV. MASSACHUSE | 3 |
| UNIV. MINNESOTA | 4 |
| UNIV. MISSOURI | 5 |
| UNIV. NACIONAL | 1 |
| UNIV. NACIONAL A | 2 |
| UNIV. NAIROBI | 1 |
| UNIV. NEBRASKA | 1 |
| UNIV. NEW SOUTH | 1 |
| UNIV. NORTH CARO | 1 |
| UNIV. NORTH SUMA | 1 |
| UNIV. OXFORD | 2 |
| UNIV. PAPUA NEW | 1 |
| UNIV. PED. Y TEC | 1 |
| UNIV. PHILIPPINE | 7 |
| UNIV. PUERTO RIC | 2 |
| UNIV. READING | 1 |
| UNIV. SIERRA LEO | 1 |
| UNIV. SOUTH PACI | 5 |
| UNIV. SOUTHERN M | 1 |
| UNIV. SULAIMANIY | 2 |
| UNIV. SUSSEX | 2 |
| UNIV. SYDNEY | 1 |
| UNIV. SYIAHKUALA | 1 |
| UNIV. TENNESSEE | 1 |
| UNIV. TOKYO | 1 |
| UNIV. UDAYANA | 1 |
| UNIV. UTRECHT | 1 |
| UNIV. WAGENINGEN | 1 |
| UNIV. WAIKATO | 1 |
| UNIV. WEST INDIE | 1 |
| UNIV. WISCONSIN | 1 |
| USAID | 1 |
| USAID (AGENCY FO | 1 |
| USAID REP./BURMA | 1 |
| USAID--AFRICAN B | 1 |
| USAID/AGR. RDX 4 | 1 |
| USAID/BARBADOS | 1 |
| USAID/LISBON | 1 |
| USAID/USDA | 1 |
| USDA | 1 |

| ORG | FREQUENCY |
|---|---|
| USDA FOREST SERV | 1 |
| USDA-ARS | 1 |
| USDA-FAS-CCAD | 1 |
| USDA-SEA | 1 |
| USDA/OFF. GOV. & | 1 |
| USDA/SEA/AR | 1 |
| USDA, ECON. & ST | 1 |
| UTAH STATE UNIV. | 2 |
| VICTORIAS MILLIN | 1 |
| VIRGINIA POLYTEC | 1 |
| VISAYAS STATE CO | 6 |
| WAGENINGEN AGRIC | 1 |
| WALTER LUM ASSOC | 1 |
| WASHINGTON INT. | 1 |
| WASHINGTON STATE | 3 |
| WEST TEXAS STATE | 1 |
| WOMEN & FOOD COM | 1 |

Total: 899 names in 469 organizations; 19 people did not name an organization.

Note: These numbers do not include AID mission directors and 319 people on the "old" list who have not responded to our update request.

## By Country

| COUNTRY | FREQUENCY |
|---|---|
| DOMESTIC | 307 |
| ARGENTINA | 1 |
| AUSTRALIA | 14 |
| BANGLADESH | 6 |
| BELGIUM | 9 |
| BELIZE | 1 |
| BOLIVIA | 3 |
| BRAZIL | 20 |
| BURMA | 3 |
| CAMEROON | 7 |
| CANADA | 8 |
| CENTRAL AFRICAN EMPIRE | 1 |
| CHILE | 2 |
| COLOMBIA | 7 |
| COOK ISLANDS | 1 |
| COSTA RICA | 10 |
| CZECHOSLAVAKIA | 1 |
| DOMINICAN REPUBLIC | 3 |
| ECUADOR | 6 |
| EGYPT | 2 |
| EL SALVADOR | 1 |
| ENGLAND | 10 |
| ETHIOPIA | 3 |
| FIJI | 2 |
| FRANCE | 5 |
| GHANA | 5 |
| GUATEMALA | 3 |
| GUYANA | 2 |
| HAITI | 3 |
| HONDURAS | 3 |
| HUNGARY | 1 |
| INDIA | 28 |
| INDONESIA | 91 |
| IRAQ | 2 |
| ISRAEL | 1 |
| ITALY | 8 |
| IVORY COAST | 1 |
| JAMAICA | 1 |
| JAPAN | 9 |
| KENYA | 7 |
| KOREA | 2 |
| LEBANON | 2 |
| MALAWI | 2 |
| MALAYSIA | 19 |
| MEXICO | 5 |
| MOROCCO | 1 |
| NEPAL | 6 |
| NETHERLANDS | 14 |
| NEW CALEDONIA | 2 |
| NEW ZEALAND | 20 |
| NICARAGUA | 5 |
| NIGER | 1 |
| NIGERIA | 16 |
| PAKISTAN | 3 |
| PANAMA | 4 |

| COUNTRY | FREQUENCY |
|---|---|
| PAPUA NEW GUINEA | 2 |
| PEOPLE'S REP. OF CHINA | 2 |
| PERU | 6 |
| PHILIPPINES | 104 |
| PORTUGAL | 2 |
| REP. OF SOUTH AFRICA | 3 |
| REPUBLIC OF CHINA (TAIWAN) | 6 |
| RWANDA | 2 |
| SCOTLAND | 2 |
| SENEGAL | 1 |
| SIERRA LEONE | 3 |
| SINGAPORE | 1 |
| SOMALIA | 1 |
| SPAIN | 1 |
| SRI LANKA | 5 |
| SUDAN | 4 |
| SURINAME | 2 |
| SWEDEN | 1 |
| SYRIA | 1 |
| TAHITI | 2 |
| TANZANIA | 6 |
| THAILAND | 15 |
| TRINIDAD | 1 |
| UGANDA | 1 |
| UNITED KINGDOM | 6 |
| USSR | 2 |
| VENEZUELA | 7 |
| WEST GERMANY | 5 |
| WESTERN SAMOA | 3 |
| ZAIRE | 2 |

Total: 307 domestic; 592 foreign--84 countries (20 developed, 64 developing). Note: These numbers do not include AID mission directors and 319 people on the "old" list who have not responded to our update request.

Appendix 7

Outline of Workshops on Soil Taxonomy and Agrotechnology Transfer

I. Indonesia

A. Outline of Two-Week Soil Taxonomy Workshop

| | | | |
|---|---|---|---|
| Week 1 | Sun. | a.m. | Participants arrive and register. |
| | | p.m. | -do- |
| | Mon. | a.m. | Opening ceremony. |
| | | p.m. | Purpose of soil classification.<br>Introduction to Soil Taxonomy.<br>Weathering and soil formation. |
| | Tue. | a.m. | Physiography and geology of country. |
| | | p.m. | Agroclimatic data of country. |
| | Wed. | a.m. | Horizon designation and symbols.<br>Diagnostic epipedons. |
| | | p.m. | Diagnostic epipedons and subsurface horizons. |
| | Thu. | a.m. | Diagnostic subsurface horizons and other soil features.<br>Soil moisture regime. |
| | | p.m. | Soil moisture regime (continued).<br>Soil temperature regime. |
| | Fri. | a.m. | Quiz<br>Categories of Soil Taxonomy and system of nomenclature.<br>Discussion of orders including key to orders. |
| | | p.m. | Key to the other categories. |
| | Sat. | a.m. | Field trip--identification of diagnostic horizons and classification of selected soils in the field. |
| | | p.m. | -do- |
| Week 2 | Sun. | | Review |
| | Mon. | a.m. | Family differentiae--particle size class. |
| | | p.m. | Family differentiae--mineralogy. |
| | Tue. | a.m. | Detailed exercises in soil classification. |
| | | p.m. | -do- |
| | Wed. | a.m. | Use of Soil Taxonomy in soil survey programs--in designing and naming of mapping units. |
| | | p.m. | Use of Soil Taxonomy in soil survey programs--in development of interpretations. |
| | Thu. | a.m. | Soil Taxonomy, the Benchmark Soils Project, and agrotechnology transfer. |
| | | p.m. | -do- |
| | Fri. | a.m. | Final examination<br>Procedure for testing and updating Soil Taxonomy.<br>Relationship of FAO soil units and Soil Taxonomy. |
| | | p.m. | Closing ceremony. |

B. Workshop On Soil Taxonomy And Agrotechnology Transfer For Agricultural Development, Cipayung, June 23 to July 11, 1980

## Program For Work Sessions and Field Trip

Workshop on Soil Taxonomy

MONDAY, JUNE 23 1980

| | | |
|---|---|---|
| 0800 - 1000 | Opening Ceremony | - SC / OC<br>- Co Principal Investigator BSP (Dr. H. Ikawa)<br>- Head of AARD (Mr. M. Sadikin S.) |
| 1000 - 1030 | Break | Dr. W.H. Hudnall, H. Ikawa |
| 1030 - 1230 | Purpose of soil classification | - " - |
| 1230 - 1330 | Lunch | |
| 1330 - 1500 | Introduction to Soil Taxonomy | - " - |
| 1500 - 1530 | Break | |
| 1530 - 1700 | Introduction to Soil Taxonomy | - " - |

TUESDAY, JUNE 24 1980

| | | |
|---|---|---|
| 0800 - 1000 | Diagnostic horizons | - " - |
| 1000 - 1030 | Break | |
| 1030 - 1230 | Diagnostic horizons | - " - |
| 1230 - 1330 | Lunch | |
| 1330 - 1500 | Agroclimatic classification of rice growing areas in Indonesia | Dr. L.R. Oldeman |
| 1500 - 1530 | Break | |
| 1530 - 1700 | Agro climatic classification of rice growing areas in Indonesia | - " - |

WEDNESDAY, JUNE 25 1980

| | | |
|---|---|---|
| 0800 - 1000 | Physiography and geology of Indonesia | Dr. Chambers / Dr. U. Syafei |
| 1000 - 1030 | Break | |
| 1030 - 1230 | Diagnostic horizons | Dr. W.H. Hudnall, H. Ikawa |
| 1230 - 1330 | Lunch | |
| 1330 - 1500 | Diagnostic horizons | - " - |
| 1500 - 1530 | Break | |
| 1530 - 1700 | Diagnostic horizons | - " - |

THURSDAY, JUNE 26 1980

| | | |
|---|---|---|
| 0800 - 1000 | Soil moisture regime | Dr. W.H. Hudnall, H. Ikawa |
| 1000 - 1030 | Break | |
| 1030 - 1230 | Soil moisture regime | - " - |
| 1230 - 1330 | Lunch | |
| 1330 - 1500 | Soil temperature regime | - " - |
| 1500 - 1530 | Break | |
| 1530 - 1700 | Soil temperature regime | - " - |

FRIDAY, JUNE 27 1980

| | | |
|---|---|---|
| 0800 - 1000 | Quiz | Dr. W.H. Hudnall, H. Ikawa |
| 1030 - 1230 | Break | |
| 1230 - 1330 | Lunch | |
| 1330 - 1500 | Categories of Soil Taxonomy | - " - |
| 1500 - 1530 | Break | |
| 1530 - 1700 | Categories of Soil Taxonomy | - " - |

SATURDAY, JUNE 28 1980

| | | |
|---|---|---|
| 0800 - | Field trip | Dr. W.H. Hudnall, H. Ikawa<br>Ismangun |

MONDAY, JUNE 30 1980

| | | |
|---|---|---|
| 0800 - 1000 | Key to orders | Dr. W.H. Hudnall, H. Ikawa |
| 1000 - 1030 | Break | |
| 1030 - 1230 | Key to suborders | - " - |
| 1230 - 1330 | Lunch | |
| 1330 - 1500 | Key to the great groups | - " - |
| 1500 - 1530 | Break | |
| 1530 - 1700 | Key to the great groups | - " - |

TUESDAY, JULY 1 1980

| | | |
|---|---|---|
| 0800 - 1000 | Key to the Subgroups | Dr. W.H. Hudnall, H. Ikawa |
| 1000 - 1030 | Break | |
| 1030 - 1230 | Key to the Subgroups | - " - |
| 1230 - 1330 | Lunch | |
| 1330 - 1500 | Family differential particle size classes and control section | - " - |
| 1500 - 1530 | Break | |
| 1530 - 1700 | Family differential particle size classes and control section | - " - |

WEDNESDAY, JULY 2 1980

| | | |
|---|---|---|
| 0800 - 1000 | Phases of the soil family | Dr. W.H. Hudnall, H. Ikawa |
| 1000 - 1030 | Break | |
| 1030 - 1230 | Phases of the soil family | - " - |
| 1230 - 1330 | Lunch | |
| 1330 - 1500 | Relationship of Soil Taxonomy and FAO legend | - " - |
| 1500 - 1530 | Break | |
| 1530 - 1700 | Relationship of Soil Taxonomy and FAO legend | - " - |

THUR[illegible]Y 3 1980

| | | |
|---|---|---|
| 0800 - [illegible] | Examination | Dr. W.H. Hudnall, H. Ikawa |
| 1000 - 1030 | Break | |
| 1030 - 1230 | Soil classification exercises using Soil Taxonomy | - "- |
| 1230 - 1330 | Lunch | |
| 1330 - 1500 | Soil classification exercises using Soil Taxonomy | - " - |
| 1500 - 1530 | Break | |
| 1530 - 1700 | Soil classification exercises using Soil Taxonomy | - " - |

FRIDAY to SUNDAY, JULY 4-6 1980

Field trip to Lampung — Dr. J.A. Silva, Dr. W.H. Hudnall, H. Ikawa, Ismangun

Object - Sites:
1. Tanjung Iman
2. Nakau
3. Kelapa Tujuh
4. Bukit Kemuning
5. Pekalongan

Workshop On Agrotechnology

MONDAY, JULY 7 1980

| | | |
|---|---|---|
| 0800 - 1000 | Soil classification for agro-technology transfer: Principles and concepts | Dr. G. Uehara |
| 1000 - 1030 | Break | |
| 1030 - 1230 | Soil inventory and mapping program in Indonesia | Dr. D. Muljadi |
| 1230 - 1330 | Lunch | |
| 1330 - 1500 | Group work sessions | |
| 1500 - 1530 | Break | |
| 1530 - 1700 | Group work sessions | |

TUESDAY, JULY 8 1980

| | | |
|---|---|---|
| 0800 - 1000 | Soil interpretation for agro-technology transfer: Principles and concepts | Dr. G. Uehara |
| 1000 - 1030 | Break | |
| 1030 - 1230 | Cropping system and soil classification for Agrotech-nology development and transfer | Dr. J.A. Silva, Dr. McIntosh |
| 1230 - 1330 | Lunch | |
| 1330 - 1500 | Group work sessions | |
| 1500 - 1530 | Break | |
| 1530 - 1700 | Group work sessions | |

WEDNESDAY, JULY 9 1980

| | | |
|---|---|---|
| 0800 - 0900 | An overview of the rationale policies and supports of agro-technology transfer in Indonesia | Ir Sardjono Reksodimuljo |
| 0900 - 1000 | Optimizing the use of available resources and information as the basis for agrotechnology | Drs. Iman Nazeni MSc. |
| 1000 - 1030 | Break | |
| 1030 - 1230 | Government policies and legislative reforms: Their role in agrotech-nology transfer | Dr. A.T. Birowo |
| 1230 - 1330 | Lunch | |
| 1330 - 1500 | Group discussions | |
| 1500 - 1530 | Break | |
| 1530 - 1700 | Group discussions | |

THURSDAY, JULY 10 1980

| | | |
|---|---|---|
| 0800 - 1000 | 1. Critical factors and issues of agrotechnology transfer in Indonesia | Dr. S. Baharsyah |
| | 2. Vertical transfer of agrotech-nology: The case of the BIMAS program | Ir Dudung Abdulmadjid |
| 1000 - 1030 | Break | |
| 1030 - 1230 | 1. The case of the estate crops: A corporate approach to agro-technology transfer | Dr. Rachmat Sugiarpradja |
| | 2. Agrotechnology transfer in the transmigration areas: Require-ment and possibilities for re-search and development | M. Soepraptohardjo |
| 1230 - 1330 | Lunch | |
| 1330 - 1500 | Group discussions | |

| | | |
|---|---|---|
| 1500 - 1530 | Break | |
| 1530 - 1700 | Group discussions | |

FRIDAY, JULY 11 1980

| | | |
|---|---|---|
| 0800 - 1000 | Groups presentation of recommendations | |
| 1000 - 1030 | Break | |
| 1030 - 1230 | 1. Principles and concepts of land evaluation for landuse planning | Dr. H. Ikawa |
| | 2. Summary of the workshop | Dr. G. Uehara |
| 1230 - 1330 | Lunch | |
| 1330 - 1500 | 1. Closing address | Dr. D. Muljadi |
| | 2. Awarding of certificates | |

Appendix 8

List of Speakers and Participants in the
Soil Taxonomy/Agrotechnology Transfer Workshop

Soil Taxonomy

1. Wayne H. Hudnall - Louisiana State University, Baton Rouge, Louisiana
2. H. Ikawa - University of Hawaii
3. M. E. Raymundo - BSP, Philippines
4. Darryl Gallup - FAP, Soil Research Institute
5. Y. Syafei - Institute Pertanian Bogor (IPB)
6. Roel Oldeman - CRIA

Agrotechnology Transfer

| | Speaker(s) | Topic |
|---|---|---|
| 1. | G. Uehara<br>University of Hawaii | Agrotechnology Transfer<br>Soil interpretation for agrotechnology transfer: principles and concepts |
| 2. | D. Muljadi<br>Soil Research Institute | Soil inventory and mapping program in Indonesia |
| 3. | J. A. Silva<br>University of Hawaii | Matching crop requirements to soil properties and climate |
| 4. | Jerry McIntosh<br>IRRI/CRIA | Cropping system and soil classification for agrotechnology development and transfer |
| 5. | Sardjono Reksodimuljo | An overview of the rationale, policies and support of Agrotechnology Transfer in Indonesia |
| 6. | Iman Nazeni | Optimizing the use of available resources and information as the basis for agrotechnology transfer |
| 7. | A. T. Birowo and J. Budianto<br>(the junior author made the presentation) | Government policies and the legislative reforms: The role of government in the transfer of agrotechnology |
| 8. | S. Baharsjah and Andin Taryoto | Critical factors and issues of agrotechnology transfer in Indonesia |
| 9. | Dudung Abdul Adjid | Vertical transfer of Agrotechnology: The case of Bimas program |
| 10. | Rachmat Subiapradja and Hastjarjo Sumardjan<br>(presented by the junior author) | The case of the estate crops: A corporate approach to agrotechnology transfer |
| 11. | M. Spepraptohardjo<br>Soil Research Institute | Agrotechnology transfer in the transmigration areas: Requirement and possibilities for research and development |
| 12. | H. Ikawa<br>University of Hawaii | Principles and concepts of land evaluation for land use planning |

List of Participants

Abdullah Abas Id.
Soil Research Institute
Soil and Water Conservation Division
Jalan Ir. H. Juanda 98
Bogor, Indonesia

U. Affandi
Soil Research Institute
Pedology Division
Jalan Ir. H. Juanda 98
Bogor, Indonesia

Sjaiful Bachri
Soil Research Institute
Land Capability Division
Jalan Ir. H. Juanda 98
Bogor, Indonesia

Basuni Hw.
Soil Research Institute
Pedology Division
Jalan Ir. H. Juanda 98
Bogor, Indonesia

Achmad Firman
Soil Research Institute
Soil Fertility Division
Jalan Ir. H. Juanda 98
Bogor, Indonesia

Hikmatullah
Soil Research Institute
Pedology Division
Jalan Ir. H. Juanda 98
Bogor, Indonesia

Ismaelnur Dt. R. Imbang
Faculty of Agriculture
Andalas University
Airtawar
Padang, Indonesia

S. Manullang
Directorate of Food Crops Development
Jalan Ragunan, Pasar
Minggu
Jakarta, Indonesia

A. Rasyid Marzuki
Central Research Institute for Agriculture
Jalan Merkeda 99
Bogor, Indonesia

Midjojo
Dinas Pertanian Rakyat
(Agricultural Extension Service)
Jalan Slamet Riyade 336
Solo, Indonesia

Kusumo Nugroho
Soil Research Institute
Soil Survey and Mapping Subdivision
Jalan Ir. H. Juanda 98
Bogor, Indonesia

Saifuddin Sarief
Department of Soil Science
Faculty of Agriculture
University of Padjadjaran
Jalan Bukit Dago
Bandung, Indonesia

Lukman Hakim Sibuea
Soil Research Institute
Soil Fertility Division
Jalan Ir. H. Juanda 98
Bogor, Indonesia

Agus Sofyan
Soil Research Institute
Soil Fertility Division
Jalan Ir. H. Juanda 98
Bogor, Indonesia

Sudirman
Soil Research Institute
Jalan Ir. H. Juanda 98
Bogor, Indonesia

Sugijono
Soil Research Institute
Soil Fertility Division
Jalan Ir. H. Juanda 98
Bogor, Indonesia

Soleh Sukmana
Soil Research Institute
Jalan Ir. H. Juanda 98
Bogor, Indonesia

R. B. Sunjoto
Soil Research Institute
Soil Survey and Mapping Subdivision
Jalan Ir. H. Juanda 98
Bogor, Indonesia

Suprijadi
Directorate of Planning
Directorate Jeuderal of Food Crops
Salemba Raya 16
Jakarta Pusat, Indonesia

V. Suwandi
Soil Research Institute
Pedology Division
Jalan Ir. H. Juanda 98
Bogor, Indonesia

Son Suwasono
Pusat Pengembangan Pertanian
Kotak Pos 4, Lawang
Jawatimur, Indonesia

Hafni Syakban
Dinas Pertanian Rakyat
Prop. Sulawesi Selatan
Jalan Dg. Pasewang 20
Ujung Pandang, Indonesia

Aspiran Syateri
Jalan Panjang 65
Telukbetung
Lampung, Indonesia

Jarzal Tandjin
Soil Research Institute
Pedology Division
Jalan Ir. H. Juanda 98
Bogor, Indonesia

Observers

1. Wiranto Soehendro
   Senior Agriculture Assistant
   World Bank - RSI
   Arthaloka Building, 8th floor
   Jln. Jend. Sudirman 2
   Jakarta

2. Didik Masrun
   Staff of Research and Development Division
   P.T. Pupuk Sriwidjaja (PUSRI)
   Jalan Taman Anggrek
   Kemanggisan jaya
   Jakarta

3. Ronald B. Stryker
   Agronomist - National Food Crops Extension Project
   Jl. AUP (Compleks SP Bimas)
   Kotak Pos 21/Pasar Minggu
   Jakarta Selatan, Indonesia

4. E. B. Oyer
   Program Director
   International Agricultural Development Service (IADS)
   Jalan Salak 18
   Bogor, Indonesia

5. Alan R. Hurdus
   Project Officer
   United States Agency for International Development (USAID)
   American Embassy
   Jakarta Pusat, Indonesia

6. Ernesto Lucas
   Agricultural Economist
   United States Agency for International Development (USAID)
   American Embassy
   Jakarta Pusat, Indonesia

7. R. George Manuelpillai
   Project Leader
   Benchmark Soils Project
   Soil Research Institute
   Jalan Ir. H. Juanda 98
   Bogor, Indonesia

8. M. Sudjadi
   Chief, Soil Fertility Division and
   Project Coordinator, Benchmark Soils Project
   Soils Research Institute
   Jalan Ir. H. Juanda 98
   Bogor, Indonesia

9. J. Ritchie Cowan
   IRRI Liaison Scientist
   Cooperative CRIA/IRRI Program
   Bogor, Indonesia

## II. Philippines

### A. Workshop on Agrotechnology Transfer
July 14-19, 1980
Los Banos, Philippines

#### Session I

Establishment of the Foundation
of Agrotechnology Transfer

Moderator: A. A. Briones, Department of Soil Science, UPLB

| | | |
|---|---|---|
| 1. | Godofredo Alcasid, Jr.<br>Director, Bureau of Soils | State of the art on soil information for agrotechnology transfer planning in the Philippines |
| 2. | Goro Uehara (presented by Jim Silva)<br>Professor of Soil Science, Univ. of Hawaii | Agrotechnology Transfer<br>Soil classification for Agrotechnology Transfer: Principles and concepts |
| 3. | Martin E. Raymundo<br>Philippines Project Leader, Benchmark Soils Project | The Benchmark Soils Project<br>(A slide show) |
| 4. | James A. Silva<br>Professor of Soil Science and Principal Investigator, Benchmark Soils Project, Univ. of Hawaii | Matching crop requirements to soil properties and climate |
| 5. | Percy Sajise<br>UPLB Hydro-Ecology Program | Physico - Environmental factors and issues on soil-based agrotechnology transfer |
| 6. | Florentino Librero<br>Executive Director<br>Philippine Training Center for Rural Development<br>College, Laguna | Area differentiation for integrated agrotechnology transference |

#### Session II

Analysis of Experiences on
Agrotechnology Transfer in the Philippines

Moderator: B. G. Cagauan, Jr., Benchmark Soils Project
University of Hawaii

| | | |
|---|---|---|
| 7. | Aida R. Librero<br>Director, Socio-economics Division, PCARR | Socio-economic factors and issues in agrotechnology transfer |
| 8. | -do- | Politico-institutional involvement in soil-based agrotechnology transfer |

| | | |
|---|---|---|
| 9. | Jorge D. Davide<br>Manager, Extension Services<br>Planters' Products | Approaches to agrotechnology transfer: Corporate vs. individual farmers |
| 10. | Carlos D. Isles<br>National Irrigation Administration | Irrigation infrastructure as an issue in agrotechnology transfer |

Session III

Rationalization of land use and
policy directions for agrotechnology transfer

Moderator: Amado Maglinai, PCARR

| | | |
|---|---|---|
| 11. | H. Ikawa<br>Associate Professor of<br>Soil Science, Univ. of Hawaii | Land evaluation and land use planning for agrotechnology transfer: Principles and concepts |
| 12. | Romeo C. Bruce<br>Professor, Center for Applied<br>Geodesy and Photogrammetry<br>Univ. of the Philippines | A system of utilizing soil-based information for land use planning and agrotechnology transfer |
| 13. | Eduardo Corpus<br>Assistant Minister<br>National Economic Development<br>Authority | Government policies and legislative reforms: Their role in agrotechnology transfer. (Note: Speaker was present but did not read relevant paper.) |
| 14. | Serafin Talisayon<br>President's Center for<br>Special Studies | Dimensions and indicators of success for soil-based agrotechnology transference program/projects. |

B. List of Participants

Florentino Batin
Sr. Soil Technologist
Bureau of Soils, Region No. 1
San Fernando, La Union
Philippines

Ernesto Cabilitasan
Bureau of Lands
Insurance Life Bldg.
Plaza Cervantes, Binondo, Manila

Rafael Caintic
Agriculture Planner
National Economic Development Authority
Region VIII
Tacloban City

Guillermo Celis
Agriculture Planner
National Economic Development Authority
Region XI
Davao City

Domiciano M. Comendador
Senior Soil Technologist
& Soil Survey Coordinator
Bureau of Soils, Region VIII
Cebu City

Isidro Digal
Agriculture Planner
National Irrigation Administration
Epifanio de los Santos
Quezon City

Quirino R. Domingo
Supervising Soil Technologist
Bureau of Soils, Region XII
Cotabato City

Lorenzo Frianeza
Chief, Planning and Management Section
Bureau of Plant Industry
San Andres, Manila

Cecilia O. Honrado
Program Specialist
Socio-Economics Research Division
PCARR, Los Banos, Laguna

Rodolfo Ilao
Program Specialist
Farm Resources and Systems Research Division
PCARR, Los Banos, Laguna

Rodolfo Labarinto
Agriculture Planner
National Economic Development Authority
Region I
San Fernando, La Union

Arleen D. Labarcon
Science Research Assistant
Agronomy & Soils Division
Philippine Coconut Authority
P.O. Box 295
Davao City

Gilberto F. Layese
Agriculture Planner
National Economic Development Authority
Region V
Legaspi City

David Medrano
Agriculture Planner
National Economic Development Authority
Region III
Tuguegarao, Cagayan

Edna Nadal
Agriculture Planner
National Economic Development Authority
Region VII

Truman C. Palmejar
Senior Soil Technologist
Soil Survey Section
Bureau of Soils, Region VI
Iloilo City

Nicolas Beda Priela, Jr.
Agriculture Planner
Bicol River Basin Development Project
San Jose, Pili, Camarines Sur

Ireneo B. Ramat
Senior Soil Technologist
Acting Chief, Soil Fertility
Investigation Section
Bureau of Soils, Sunvesco Building
Taft Avenue, Manila

Gilbert C. Sigua
Instructor, Dept. of Soil Science
Central Luzon State University
Munoz, Neuva Ecija

Flordeliz Tiamzon
Program Specialist
Crops Research Division
PCARR, Los Banos, Laguna

Noel M. Tomenio
Senior Soil Technologist
Soil Survey Section
Bureau of Soils, Region VIII
Tacloban City

Alexander Valenciano
Agriculture Planner
National Economic Development Authority
Region VI
Iloilo City

Oswaldo E. Ventura
Senior Soils Technologist
Bureau of Soils, Region V
Naga City

Observers:

Crisostomo Alcalde
Supervising Soils Technologist
Bureau of Soils
Sunvesco Bldg., Taft Avenue, Manila

Alfonso Crucena
Supervising Soil Technologist
Bureau of Soils
Sunvesco Bldg., Taft Avenue, Manila

Arturo Dayot
Supervising Soils Technologist
Bureau of Soils
Sunvesco Bldg., Taft Avenue, Manila

Alejandro Micosa
Supervising Soils Technologist
Bureau of Soils
Sunvesco Bldg., Taft Avenue, Manila

# Appendix 9

## Project Personnel

*Cameroon*

| | |
|---|---|
| Project Specialist | Donald A. Berger |
| Project Manager/FAO | G. W. van Barneveld |
| Project Counterpart | John N. Awemo |
| FAO Associate Expert | Bruno Delvaux |
| Agricultural Assistant | Paul Mbonde |
| Driver | Mwang Ndowmbe |

*Hawaii*

| | |
|---|---|
| Principal Investigator | James A. Silva |
| Soil Scientist | Goro Uehara (808) - 945 - 8902 |
| Associate Soil Scientist | Haruyoshi "Ike" Ikawa |
| Project Manager | Gordon Y. Tsuji (808) - 945 - 6604 |
| Hawaii Agronomist | Patrick C. Ching |
| Training Coordinator | Bernardino G. Cagauan, Jr. |
| Editor/Publications Specialist | Cynthia L. Garver |
| Data Analyst/Computer Specialist | Clement P. Y. Chan |
| Administrative Aide | Jill D. Kosaki |
| Secretary/Administrative Assistant | Annette E. Chang |
| Laboratory Technicians | Ada E. Chu |
| | Dwight T. Tanoue |
| Research Associate | Luis A. Manrique |
| Agricultural Research Technician, HITAHR | Richard M. Uehara |
| Agricultural Technicians: | |
| Hawaii | William K. Y. Wong |
| | James Couttie |
| | Lawrence Pasco |
| Molokai | Thomas R. Hill |
| | Rudy Dela Cruz |
| Oahu | Marc T. Meisner |
| | Benito Ordillo |
| Graduate Assistants: | Crisanto R. Escano |
| | David J. Harris |
| | Alan R. Hurdus |
| | I Putu Gedjer Widjaja-Adhi |
| | Beatriz P. del Rosario |
| | Modesto R. Recel |
| | Djoko Santoso |
| | M. Soekardi |
| Student Assistants/Temporary Hire: | |
| Assistant Editor | Barbara FitzSimmons |
| Graphics | Victoria S. L. Lee |
| Computer Services: | Maggie Ho |
| | Darcy Kouchi |
| | Margaret Ma |
| | Phyllis Matsuura |
| | Linda Ushijima |
| Clerical Services: | Joel Asuncion |
| | Laurie Hunt |
| | Iris Kakugawa |
| | Susan Nations |
| | Monica Pelletier |
| | Susan Tamura |
| | Jan Watanabe |
| | Karin Wong |

| | |
|---|---|
| Laboratory Services: | Pat Arakaki |
| | Jo Ann Goya |
| | Raye Koyanagi |
| | Bryan Sakka |
| | Lisa Schattenburg |
| | Keane Suzuki |
| | Carl Yamaoka |
| Agricultural Services: | Richard Horiuchi |
| | Don Ikeda |
| | Robert Traxler |
| | Scott Yamauchi |
| Technical Services: | Frederick C. T. Guiking |
| Consultants: | Foster B. Cady |
| | Wayne H. Hudnall |
| | Philip S. Motooka |

*Indonesia*

| | |
|---|---|
| Project Leader | R. George Manuelpillai |
| Project Coordinators | Ir. Supartini |
| | M. Sudjadi |
| Agricultural Assistant/Farm Managers: | |
| Java | Ir. Tini Surtiningsih |
| | Ir. Sogijono |
| Sumatra | Ir. Soleh |
| Secretary/Typist | Julia Ishaq |
| Administrative Assistant | Nursuwahyanti Soleh |
| | Tatang Djuanda |
| Research Aides: | |
| Java | Lulus Sunaryo |
| | Udin Hasanuddin |
| | Anda Suhandra |
| | Arman A. R. |
| Sumatra | Imam Purwanto |
| | Achmad Hasanuddin |
| | Agus Tarman |
| | Tri Haryanto |
| | Burlian |
| Drivers, Benchmark Vehicles: | |
| Java | Sulaeman |
| Sumatra | Windu |

*Philippines*

| | |
|---|---|
| Project Leader | Martin E. Raymundo |
| Co-Project Leader | Crisotomo B. Alcalde |
| Director, Farm Resources and System Research Division, PCARR | Amado R. Maglinao |
| Field Operations Coordinator | Perfecto "Pec" R. Vincente |
| Administrative/Fiscal Assistant | Penafrancia "Anchie" P. Pago |
| Secretarial Staff: | |
| Naga | Josefa "Josie" de Jesus |
| Davao | Lolita "Lita" A. de Juan/E. R. Fernandez |
| Research Assistants | |
| Naga | Maria Dolores Ativo Gibe |
| | Edgardo de la Torre |
| Davao | Clara A. Jacob |
| Research Aides: | |
| Naga | Jaime "Jim" N. Gibe |
| | Rogelio "Roy" C. Arco |
| Davao | Rosendo "Sendong" T. Edquila |
| Sorsogon | Nelson J. Arimado |