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Annual Report

1 October 1984 to 30 September 1985

SOIL MANAGEMENT SUPPORT SERVICES

AGENCY FOR INTERNATIONAL DEVELOPMENT
SMSS
SOIL CONSERVATION SERVICE

TO REQUEST ASSISTANCE

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ANNUAL REPORT

1 October 1984 to 30 September 1985

SOIL MANAGEMENT SUPPORT SERVICES

Hari Eswaran
Program Leader

Soil Management Support Services (SMSS) is a program of the Agency for International Development (AID), implemented by the Soil Conservation Service (SCS) of the U.S. Department of Agriculture (USDA) with logistical support from the Office of International Cooperation and Development (OICD) of USDA. SMSS provides technical assistance to developing countries in soil surveys, soil classification, and the use and management of soils.

PROLOGUE

I recently met with Dr. Tej Gill of the U.S. Agency for International Development, who set up the Soil Management Support Services (SMSS) program that the [Soil Conservation Service] SCS administers.

I am in favor of using SCS people to increase the awareness and understanding of soil and water resources throughout the world in the years ahead. I am proud that the national cooperative soil survey has the SMSS leadership housed in the SCS.

I'm very proud of all of our international assistance. SCS now has more than a dozen full-time positions in developing nations. I'd like to see us increase that number, and I hope you and your staffs will consider an international assignment as the chance arises. During an average year, SCS sends as many as 150 people on assignments to more than 40 countries. In 1985, 4 [South Technical Center] STC's, 2 [North Technical Center] NTC directors, and 9 [National Headquarter] NHQ division directors, along with those mentioned above were involved in foreign travel.

The only real long-term answer to many of the problems being faced by developing nations is for them to develop a sustainable agriculture through which they can feed themselves. And they do that through natural resource protection and improvement. That's where we come in. We can help them get started.

We benefit, too, because our people can learn from the experience and improve their technical knowledge and professional capabilities. They can apply that new understanding to problems here at home. We'll be emphasizing cooperative agreements with other nations to promote these mutual benefits.

We'll be emphasizing chances for foreign visitors to observe our conservation programs here, too.

Overseas and here at home we have a number of opportunities to add to the technology of conservation--what SCSA calls the "science and art of good land use."

Excerpt from a speech by
William Scaling, Chief, SCS
23 September 1985
delivered at
French Lick, Indiana

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Dr. Ralph J. McCracken Deputy Chief,
(Retired) Soil Conservation Service

FOREWORD

This has been an eventful, exciting and productive year for Soil Management Support Services (SMSS). Its activities have included a wide range of sponsored events, publications, and support of and cooperation with a number of other important agricultural development programs. The past year has seen increased usage and understanding of Soil Taxonomy (which has now become a worldwide soil classification system) as a vehicle for technology transfer, and as a guide for soil management. This year there has also been significant improvement of Soil Taxonomy by contributions of the SMSS International Committees.

As a legendary American baseball pitcher and folk hero noted for his witty and wise sayings, Satchel Paige (now retired) once said, "Never look back, something may be gaining on you." Looking back over a year's accomplishments, however, does provide incentive and encouragement to work even harder in the upcoming year, and also helps plan the emphasis and efforts for the next year. So we will disregard Paige's advice, and we will look back with pride at SMSS accomplishments last year, with its cooperators, and in the developing country national research programs with which it works. And then, based on experiences and successes thus far, let us look ahead to areas which need further emphasis and attention.

The past year has been indeed a busy one for SMSS: workshops, seminars and training courses in widely scattered parts of the tropical and subtropical world on the structure of soil taxonomy and the applications of this soil classification system to real-world problems of food, fiber, and fuelwood production; major contributions to the improvement of Soil Taxonomy by International Committees, including contributions from several Less Developed Country (LDC) national programs; issuance of flow charts and field guides, slide sets, and technical and nontechnical publications on Soil Taxonomy and its uses; and the provision of technical assistance to several LDC's. These and other activities too numerous to mention have been the action agenda for SMSS this past year. We are especially pleased to note that many LDC's are progressing from a learning and training mode to stages of applying Soil Taxonomy for solutions of their problems, and they are making scientific, technical recommendations for improvement of Soil Taxonomy based on their experiences and research.

SMSS has also contributed significantly in the past year to the support and development of other soil-related programs for the LDC's. This included strong support of and cooperation with its sister programs, IBSNAT and TropSoils, which are also funded by AID; and support for and participation in the planning and conduct of workshops on soil constraints to increased productivity by the International Board for Soil Research and Management (IBSRAM).

From the solid base of results thus far and the progress being made with Soil Taxonomy by the developing countries, SMSS looks ahead to its next phases of activities, including the further development of Soil Taxonomy as a vehicle for technology transfer and its use for applications to soil conservation, fertility, and management.

My brief involvement with SMSS has been very rewarding and I have been proud to be a part of this small effort to assist others, less fortunate than ourselves, to seek self-sufficiency in food and fiber production. I believe SMSS can and must continue to play an important role in technical assistance to developing countries, and I hope that the program can be strengthened to sustain the impact it is already having.

Dr. Ralph J. McCracken
Deputy Chief, SCS (Retired)

ACKNOWLEDGMENT

The success of Soil Management Support Services (SMSS) Program is due to the collaboration and cooperation of countless individuals. With the miniscule staff that the project has, it is obvious that the outputs achieved are due to the hard work and perseverance of others. Although it is difficult to distinguish any individual or group, perhaps the people who have worked most for SMSS in recent years are the staff of the International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT) with headquarters on the University of Hawaii campus, and the Research Corperation of the University of Hawaii (RCUH). Under a reimbursable agreement to provide management support for the SMSS Project, RCUH has performed superbly.

The project gladly welcomes back Greg Garbinsky of Office of International Cooperation and Development (OICD), who replaces Robert Wack. The project also lost Ralph McCracken, Deputy Chief of the Soil Conservation Service (SCS) who provided valuable guidance throughout the past three years. William Scaling was appointed Chief of SCS, in August, and Richard Deusterhaus as Deputy Chief. Both have indicated their commitment to international assistance and their initial support promises an active and productive future for the project.

Project Monitor Raymond Meyer (S&T/AGR/RNR) continues to provide SMSS with support services and guidance, and specifically, to strengthen our linkages with other projects.

We continue to be indebted to SCS, particularly the National Soil Survey Laboratory at Lincoln, Nebraska.

Universities and individuals have continued to participate in our activities. And, last but not least, are the worldwide individuals and institutions, and through their comments, suggestions, and support the Soil Management Support Services is a meaningful program.

SUMMARY

Statistics

Title:	Soil Management Support Services (SMSS)
Contractor:	Office of International Cooperation and Development (OICD), USDA Gregory Garbinsky
Implemented by:	Soil Conservation Service (SCS), USDA
Principal Investigator:	Richard Arnold
Program Leader:	Hari Eswaran
Soil Chemist:	John Kimble
Soil Scientist:	Terry Cook John Witty
Project Monitor:	Raymond Meyer (S&T/AGR/RNR)
Duration:	Phase I. 1 October 1979 to 30 September 1982 Phase II. 1 October 1982 to 30 September 1987
Reporting Period:	1 October 1982 to 30 September 1985

AID Funding:		
	Phase I.	$2,127,000
	Phase II.	$5,250,000
	Total	$7,377,000
	Until FY 1985	$3,445,000

Descriptive Background

Introduction

With considerable advanced planning and a confidence that SMSS will survive the rumored of budget cuts, this FY 1985 has been one of the busiest years in the short, 6-year life span of the project. SMSS ended its FY 1984 with the IXth International Training Forum held 3-14 September in Guam for the Pacific region, and began the new fiscal year with a mid-term Project Review. SMSS celebrated its fifth anniversary with the special number publication of Soil Taxonomy News (STN #9), and the publication of the SMSS Progress Report which summarized five years of work. In a message STN #9 on the occasion of the fifth anniversary, Peter C. Meyers, chief of the Soil Conservation Service (SCS) wrote:

> In its first years, the Soil Management Support Services has made great strides in helping developing countries, a tribute to those involved in SMSS and to the fine cooperation between the Agency for International Development and the U.S. Department of Agriculture....Congratulations on a very active and productive first five years. With your track record, the next three years should be even more rewarding.

These sentiments were echoed in a report by the Review Panel and that provided renewed vigor and the impetus for achieving our objectives.

SMSS's mandate is to assist those institutions in less developed countries that ask for technical advice on how they can achieve the best uses of land; all our activities are designed for this purpose. This Annual Report summarizes the activities for FY 1985. For upcoming FY 1987, we must also be already thinking about the long-term future of progress and plans enabling others to assist us in our future directions. This report also summarizes the SMSS activities to complete date of the project.

Technical Assistance

During this fiscal year, SMSS responded to requests from 16 countries which involved about 406 person-days of temporary duty assignments (TDYs) and 41 persons (See Table 1). The total project requests is from 50 countries, with about 2539 person-days of TDYs and 199 persons. The number of technical assistance requests is small because they originated from the developing countries themselves, and were mot generated by SMSS which has the capacity to handle more requests. Many USAID Missions are still not aware of the services available and creating this awareness continues to be an important activity.

The SMSS Progress Report published in 1984 has aided this component of the project considerably. The countries and the kinds of technical assistance provided in FY 1985 are summarized below:

Country Requesting TDY		Temporary Duty Assignments	Person-days
Belgium		1	2
Botswana		1	7
Brazil		2	35
Burundi		3	18
Indonesia		5	70
Jamaica		2	24
Japan		4	46
Pakistan		2	7
Peru		3	28
Philippines		4	44
Rwanda		3	21
South Korea		1	4
Thailand		2	20
Tunisia		2	18
Western Samoa		2	26
Zambia		4	42
Totals	16	41	406

Linkages

SMSS activities are useful and cost-effective, and is achieved through collaboration with institutions or programs. FY 1985 marked the launching of the new organization the International Board for Soil Research and Management (IBSRAM). Both AID and SCS stressed the importance of IBSRAM to international agricultural development, and both have urged SMSS to nurture this young organization and to assist it within the means of SMSS. SMSS staff were actively involved in the design and organization of three inaugural IBSRAM workshops held at Hyderabad, India (workshop on Vertisols), Peru/Brazil (workshop on acid soils), and Indonesia (workshops on land clearing).

SMSS continued to collaborate with the International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT), a sister AID project implemented by the University of Hawaii with assistance from the University of Puerto Rico.

This symbiotic relationship has now led to the joint publication of the newsletter, Agrotechnology Transfer. SMSS has also established links with another AID Project implemented by United States Department of Agriculture (USDA) Agriculture Research Service (ARS), the Technology of Soil Moisture Management (TSMM) Project. The AID Science and Technology Bureau (AID/S&T), the Forest Support Program, and SMSS staffs recently met to discuss areas of common concern and to develop plans for collaboration.

Collaborating with the Universities of Hawaii and Puerto Rico continuously strengths the SMSS program and improves the quality of its services. The University of Hawaii continues to assist in the general management of the project and handle many of its publications. A reimbursable agreement with Cornell University provides for other publication services, and also for special studies on soil moisture regimes. The University of Puerto Rico continues to handle International Soil Classification Workshops, and North Carolina State University recently has agreed to provide software for classifying soils.

The institutions in foreign countries have also collaborated immensely with SMSS. The University of Ghent in Belgium provided the staff to teach the training courses in French. The Food and Fertilizer Technology Centre for Asia and the Pacific Region utilized SMSS assistance in their workshops. Linkages with international agricultural research centers such as the International Crops Research Institute for Semi-Arid Tropics (ICRISAT) and the International Rice Research Institute (IRRI) have been strengthened. In FY 1985, SMSS also developed linkages with other centers such as the International Council for Research in Agroforestry (ICRAF) in Kenya and also the International Centre for Integrated Mountain Development (ICIMOD) in Nepal.

SMSS activities, particularly its training courses, have attracted international interest and more donors that are willing to sponsor or share costs. SMSS is developing linkages with donor organizations including the Belgian Administration for Development Cooperation (ABOS/AGCD), the Norwegian Technical Assistance (NORAD), the German Technical Assistance (DSI), the Commonwealth Foundation, the Australian Centre for International Agricultural Research (ACIAR), the Kellogg Foundation and the Office de Recherche Scientifique et Technique Outre-Mer (ORSTOM) in France.

Technology Transfer

An important continuing effort of SMSS is the emphasis on the development, the refinement, and the utilization of the USDA Agricultural Handbook No. 436 Soil Taxonomy, a system of soil classification developed by the SCS. The purpose is to make the soil taxonomy system more effective as a technical language, thus increasing the accuracy of soil identification and facilitating the process of agrotechnology transfer.

International Committees

Over the last 6 years, 8 international committees were created, and each was chaired by a leading world specialist. The eight committees are now at different stages of their assigned tasks.

* The International Committee on Low Activity Clay (ICOMLAC) submitted their report, and it is being internationally tested. ICOMLAC's thirteen Circular Letters and other selected papers have been published as SMSS Technical Monograph No. 8.
* The International Committee on Soil Moisture Regimes (ICOMMORT) also submitted a report. The ICOMMORT chairman developed a data base of the soil moisture regimes of the intertropical countries (SMSS Technical Monographs Nos. 2, 3, and 9) to supplement the work of the committee.
* The International Committee on Vertisols (ICOMERT) also completed its task and will be submitting the report for testing. A symposium is planned in conjunction with the annual meeting of the American Society of Agronomy held in Chicago in December 1985 at Chicago.
* The International Committee on Oxisols (ICOMOX) will submit their report in January 1986 and that will be tested at the Eighth International Soil Classification Workshop in Brazil during March 1986.
* The International Committee on Andisols (ICOMAND) is expected to submit its report at the end of 1986.
* The International Committee on Soils with Aquic Soil Moisture Regimes (ICOMAQ), the International Committee on Aridisols (ICOMID), and the International Committee on Spodosols (ICOMOD) will submit their reports in 1987.

International soil classification workshops are organized to support the work of these committees. No workshops were held in FY 1985, however, preparations have been initiated for the 1986 Oxisol Workshop in Brazil, and the 1987 Andisol-Aquic Moisture Regime Workshop in Japan.

Computerization of Soil Taxonomy

The entire Soil Taxonomy reference book is now computerized and consequently, changes can be easily made. The changes which resulted in the second edition of Keys to Soil Taxonomy were made in this manner.

In collaboration with North Carolina State University, SMSS has also developed software using expert systems for computer-assisted classification of soils.

Training Forums

Three training forums were organized during this fiscal year.

Number	Locations	Regions Served	Participants
Xth	Rwanda/Burundi	Central Africa	45
XIth	Zambia	South Africa	65
XIIa	Tunisia	North Africa	35

Plans have been developed for future SMSS training forums.

International Workshops/Symposia

SMSS organized the following workshops for IBSRAM:

Subjects	Places	Dates
Vertisols	India	February 1985
Acid Soils	Peru/Brazil	April 1985
Land Clearing	Indonesia	August 1985

In November 1984, SMSS collaborated with IRRI to organize a Workshop on Physical Aspects of Management of Rice Soils. SMSS has now initiated a new series of workshops on soil management and the first two, on acid sulfate soils and on peat land soils, will be conducted in 1986.

Publications

The following publications were completed in FY 1985:

- Proceedings of the 4th International Soil Classification Workshop, Rwanda
- Proceedings of the IVth International Forum, Thailand
- Proceedings of the VIth International Forum, Costa Rica
- Proceedings of the VIIth International Forum, Philippines
- Proceedings of the VIIIth International Forum, Jordan
- Soil Taxonomy News Nos. 9, 10
- Agrotechnology Transfer No. 1.
- Japanese translation of Keys to Soil Taxonomy

- Keys to Soil Taxonomy, 2nd edition
- Soil Moisture Regimes of Asia

Training Packages

A slide set on the "Guidelines for Using Soil Taxonomy to Name Soil Map Units" has been produced. The accompanying text which currently is in English will be translated into Spanish and French.

Utilization and Impact

Because SMSS is a worldwide program, it cannot have the same kind of impact as a country-specific project. Nevertheless, six years of SMSS activities is evidence of its utilization, and the project output is continuously increasing. The project outputs are listed later.

SMSS cost-sharing activities are perhaps a good indicator of SMSS utilization and impact. In FY 1985, more than $350,000 were contributed to SMSS activities by other donors or institutions. This sum does not include the salaries and personal services of the countless people who contributed to the activities.

The training and workshop components are also bearing fruit with various countries developing their own in-service courses from SMSS training packages. The Arab Center for Studies of Arid Zone and Dry Lands (ACSAD) is an example of a regional institution which has obtained $175,000 to conduct a training course on Soil Taxonomy in Arabic. Translating SMSS publications into national languages indicates their usefulness. The experience SMSS has in organizing workshops is the reason it was selected to assist the newly formed International Board for Soil Research and Management in their series of inaugural workshops.

SMSS continues to service USAID Bureaus and Missions and institutions in LDCs, and the technical assistance component is maintaining its momentum. The Soil Conservation Service of USDA, which provides most of the technical assistance (TA) personnel has acknowledged the impact this program has on their staff. Although there are areas where SCS can provide assistance, the TA program is mutually beneficial as it broadens the experience of soil scientists.

Because all or most agrotechnologies are soil based, SMSS is becoming the central focal point for S&T's cluster of soil related projects. The linkages established with IBSNAT, the Technology of Soil Moisture Management (TSMM) and other projects are mutually beneficial and make each project more relevant and meaningful.

In conclusion, there is ample evidence to indicate that SMSS activities are useful, necessary, appreciated, and followed up.

INTRODUCTION

Fiscal year (FY) 1985 marks the sixth year of Soil Management Support Services operation. From preceding years, SMSS has compounded its experience and refined its programs to an efficient and cost-effective project designed to deliver quality products and address some of the major constraints of crop production in developing countries. Agriculture provides income and employment for many people in the developing world. In Africa, over two-thirds of the population is dependent on agriculture and yet the performance of African agriculture has been less than satisfactory. In developing countries, the agricultural sector continues to be the poorest, and with dismally low soil productivity.

SMSS is a cog in the wheel of cumulative efforts of the Agency for International Development (AID) to assist countries in seeking self-sufficiency in food and fiber production. The constraints, however, to increasing food production or improving crop performance are many, and a project like SMSS has little impact on this global problem. The causes of poor soil performance include: agroecological conditions; weak institutions; lack or absence of infrastructures· constrained economic policies; critical shortage of research facilities, researchers, and extension staff; and few farmer-tested high yielding technologies. These incidences are universally common constraints, and many technical assistance programs opt for short-term success largely for the immediate impact and recognition despite their awareness of the long-term nature of the problem. The recent, well-publicized plight of the Sahelian countries is perhaps the best example of this.

Major constraints of stable food production in many parts of the world is the lack of soil and climate knowledge, United States agricultural research has shown that a surpluses of food can result with good soil management. The irony of international technical assistance is that, with the exception of a few, are generally reluctant to develop projects on soil resource inventories, but rather have agronomic and soil fertility kinds of programs, though which are important, is limited without a knowledge of the geography of the soils. In lesser developed countries (LDCs), production-oriented agricultural research conducted through bilateral programs have limited value because the results seldom reach the farmers. While traveling throughout LDCs, one can see relics of such programs, with the beneficiaries being only the "experts" who conducted

the experiments to produce glossy reports, and thus, gather the experience of international agriculture to assure credibility as international consultants.

There is an urgent need to make a constraint analysis in each recipient country and the work of SMSS in more than sixty countries of the world has shown there is a way to design technical assistance programs to remove constraints. Particularly in Africa, one immediate step is to develop soil resource inventories and simultaneously test appropriate soil management technologies. This soil resource and management program should be accompanied by each countries serious effort for institutional development enhancement of research capabilities for scientists as well as institutions.

The SMSS activities are streamlined toward these objectives. SMSS cannot use the limited project funds to develop a soil resource inventory of the country; SMSS can and is used to create an awareness, assist the scientists, disseminate information, and provide short-term technical assistance when requested.

It has been an extremely active and productive 1985 fiscal year. The SMSS Project, operating above its capacity will continue to work to become one of the more cost-effective programs of the Agency for International Development. This Annual Report will show that much can be achieved through sheer hard work and dedication. Soil Management Support Services is establishing itself not only as a project but as an institution.

TECHNICAL ASSISTANCE

Summary of TDYs

During FY 1985, SMSS was involved with technical assistance to 16 countries requiring 406 person-days of work. Since its inception, SMSS has served 50 countries with about 2539 person-days involving 199 persons. As previously stated, the countries themselves requested most of these missions. Soil scientists traveling for SMSS soil sampling purposes, however, are becoming increasingly involved in technical assistance and also with on-site training.

The general areas of technical assistance include:

a) Reviewing ongoing projects (Indonesia);

b) Technical back-stopping of ongoing projects (Jamaica, Peru);

c) Providing technical information and assisting national institutions with program development (Thailand);

d) Providing consultant services to national institutions (Taiwan); and

e) Providing consultant services to AID/Washington (Fragile Lands Initiative)

Indonesia

Mission: 2-23 August 1985; 18 days.

Purpose: The objectives were: 1) To review and comment on the amendments of the Applied Agriculture Research Program for the mission; 2) to review field and organizational arrangements of the Centre for Soil Research, Government of Indonesia (GOI); and 3) to lecture on aspects of soil survey as requested.

Cooperating Agencies: USAID/Jakarta; Centre for Soil Research, Government of Indonesia (GOI); TropSoils Project.

Consultant: Richard W. Arnold, Director, Soil Survey Division, USDA/SCS, Washington, D.C.

Accomplishments: Plans for the visit and lectures on landscape mapping and legend design were completed the first week. A review of the TropSoils and CSR work in Sitiung and surrounding areas indicated the commitment of the participants and also pointed out the need for additional interaction and exchange of information for increased effectiveness. Soil classification, interpretations, and research results were discussed at each of the research sites visited. All soils were low activity with high aluminum saturation, and are mainly Oxisols, Ultisols, and Inceptisol equivalents.

Field trips in the Bogor vicinity concentrated on land use, soil classification, map unit design, mapping procedures, and the development of

soil data bases. Soils near Bandung are Andepts and Tropudalfs; and north of Bogor are Tropudults, Paleudults, and some Oxisols. Paddy areas are of special concern in soil classification.

A visit was made to the University Gajah Mada analytical laboratories for soils and chemistry. They are excellent. Soil uses and problems were reviewed. A visit was made to the Uplands Cropping Systems Project near Salatiga where dry season cropping patterns and erosion control, including landslides, are being investigated. The interaction of soil scientists with the other specialists was explored with the agencies involved.

Additional recommendations specific to the project and agency needs were made to the respective leaders.

Mission:	13 October to 3 November 1984; 15 days.
Purpose:	To develop strategy for improving the efficiency and effectiveness of the Indonesian soil survey program.
Cooperating Agencies:	USAID, Indonesia Ministry of Agriculture, and Centre for Soil Research (CSR).
Consultants:	Kenneth C. Hinkley, Assistant Director; William U. Reybold, National Leader for Soil Geography, Soil Survey Division, USDA/SCS, Washington, D.C.; Thomas W. Priest, State Soil Scientist, USDA/SCS, Denver, Colorado.
Accomplishments:	Soil surveys in Indonesia have a greater significance than in most countries of the world. Soil survey information is used to determine soil capability in transmigrated areas. The difference between abject poverty and a decent livelihood in the lives of thousands of farmers and their families are directly affected by the soil survey data from areas selected for settlement. The Centre for Soil Research staff and budget appears small compared to the significance and magnitude of the work.

The report provides recommendations for improving the efficiency and effectiveness of Indonesia's soil survey program in an effort to maximize budget and staff. It builds upon an excellent existing program served by a highly qualified staff.

The report is the result of an evaluation conducted by a team of USDA soil scientists as requested by SMSS and funded through the AID.

Soil resource data is basic to capable land use and management. There is a need for reliable soil survey information for transmigration areas, as well as for improving existing agricultural areas. Soil survey information is strongly needed to facilitate agrotechnology transfer from the research

stations to the local farmer. Soil information is also valuable for land management, erosion control, fertilizer recommendations, crop suitability, and long range agricultural planning and improvement.

The Indonesian soil survey is organized into units that include administrative, laboratory, cartographic, photo-interpretation, and field survey divisions. The basic organization structure is adequate to continue the survey program in its present form, or to serve as the basic core of an expanded national program.

Activities and Recommendations

1) Reconnaissance Soil Surveys (scale 1:250,000)

- Design surveys to provide highly accurate information, while spending a greater amount of time in areas with the highest potential for agriculture.
- Reduce field time spent in areas having little or no potential for agriculture.
- Increase efforts to identify and relate the soils to the landscapes.
- Discontinue grid pattern recording of observations.
- Discontinue interpreting only for single crops, and make general interpretations.
- Assign low priority to reconnaissance soil surveys made outside of transmigration project areas.
- Develop guidelines consistent with map reconnaissance surveys so they can be correlated and ultimately provide information for a national data base.

2) Detailed Soil Surveys (scale 1:25,000)

- Because of the urgent need for information, detailed mapping should receive the highest priority for use of CSR resources.
- Research centers, field trial areas, and demonstration plots should receive the highest mapping priority.
- Standards and guidelines should be developed for detailed mapping with soil landscape methods. Discontinue detailed maps made by recording grid pattern observations.
- Wherever possible remove the vegetation prior to making detailed soil maps.
- Increase the efforts to make detailed soil maps.
- Describe map units in a way that provides useful information in addition to those for agriculture.
- Publish maps at the same scale as they are mapped in the field.
- Correlate all detailed mapping.

3) Photographic Interpretation

- Involve field personnel in the photographic interpretation process.
- Continue efforts to obtain good photographic coverage during cloud-free periods.
- Test the use of infrared photography for field work.

4) Soil Correlation

- Develop correlation expertise.
- Establish a correlation position at CSR.
- Classify and correlate all soils according to Soil Taxonomy.
- Establish and correlate a soil series as time and manpower permits.

5) Training

- Seek U.S. soil scientists assistance for training on soil correlation procedures and soil landscape mapping procedures.
- Develop a comprehensive training program that provides all levels of instruction.
- Provide photo-interpretation training to all field personnel making soil surveys.

6) Program Operations and Management

- Develop standards and procedures, manuals, handbooks and guidelines for mapping, correlation, and publication.
- Continue capabilities for completing detailed soil surveys.
- Adjust the time span for completing a soil survey area.
- Evaluate the usefulness of soil maps with the users.

7) Soil Survey Data Base

- Eight computer data bases have been identified for establishment.
- Establish a position for computer program specialist in CSR.
- Establish a national cooperative soil survey for Indonesia that involves all providers or users of the information.

Jamaica

Mission: 15-26 October 1984; 12 days.

Purpose: To review operations of the soil laboratory and the soil survey operations.

Cooperating Agencies: USAID/Jamaica, Rural Physical Planning Division (RPPD), Jamaican Ministry of Agriculture, and Soil Survey Unit (SSU).

Consultants: George Holmgren, Research Soil Scientist, NSSL-USDA/SCS, Lincoln, Nebraska; and Steve R. Base, Soil Correlator, NTC-USDA/SCS, Lincoln, Nebraska.

Accomplishments: Jamaica is currently in the process of updating an older soil survey by using Soil Taxonomy and the United States soil survey methods and procedures. Time was spent

reviewing the Jamaican soil survey program and providing some training to the Soil Survey Unit.

A method for summarizing field notes was presented to: 1) select the type location for a series and/or a typical pedon for the series in the soil survey area; 2) determine the range in characteristics; 3) determine map unit composition; and 4) determine the type of map unit.

The days were spent in the classroom with all the soil scientists. A variety of topics were discussed including Soil Taxonomy, the field notes, soil survey procedures, the soil correlation process, map units and taxonomic units, and the development of a national soil series file. Two days were spent in the field observing some of the soils in the Claredon Parish. On this trip, a detailed description was made of one pedon.

The St. Catherine Coastal Plain Report was reviewed and comments were prepared for this report. On the last day, a summary session was held with the people stationed in Kingston and recommendations were made to Robert DeKruyff.

Laboratory procedures were studied in detail and the procedures used in Soil Taxonomy were recommended. The laboratory was judged to be well run and a valuable resource for Jamaican agriculture.

Thailand

Mission: 11-19 November 1984; 8 days.

Purpose: To participate in the "International Workshop on Soil Erosion and Its Countermeasures" held in Chiangmai.

Cooperating Agencies: USAID, USDA/SCS, Kasetsart University, Food and Fertilizer Technology Center (FFTC), Chiangmai University, Soil and Water Conservation Society of Thailand, Department of Land Development, and Royal Forestry Department.

Consultant: Charles Onstad, North Central Soil Conservation Research Laboratory, Minnesota.

Accomplishments: The total workshop attendance was 127 persons including 87 Thais from 19 different government agencies, and 40 foreign participants from 14 different countries. Of the five Americans that attended, two reside in Thailand--one from the Peace Corps and the other from FAO. The workshop format included two days of formal paper presentations, and a one and a half day field trip into the Chiangmai area which was followed by a 1-day discussion workshop on "Problems and Constraints of Soil Conservation in Developing Countries." The weekend following the conference was reserved for another field trip to the underdeveloped resettlement area on the southeast coast near Rayong. Two papers were presented

during the workshop. The first was titled "Current Research Topics in Soil Erosion Processes," and the second, "Problems and Constraints of Soil Conservation in the USA." The first paper will be published in the conference proceedings, and remarks from the second paper, with related statements from country representives will be incorporated into a proceedings paper to be written by an editor of the Food and Fertilizer Technology Center in Taipei. On the last day, C. Onstad chaired and summarized the discussion of one of the small work groups.

Workshop organizers focused on the similar socioeconomic constraints that exist among countries at various stages of development. Indeed, the farmers' problems of accepting conservation policy are uniform regardless of location. Most of the participants were technically trained, however, and most papers were technical. Upon reflecting on the technical papers as a whole, additional gains need to be made technically as well as socioeconomically before effective conservation programs can be achieved in the southeast Asian community.

Of the thirty papers presented, about twenty papers dealt with solutions for specific erosion problems. In the hierarchy of "assessment, prediction, and control," assessment was obvious, and control was achieved through a "trial and error" procedure; prediction was entirely skipped. This is not surprising since there is an obvious scarcity of erosion and soils data, as well as the knowledge or experience for utilizing the information.

Throughout the workshop, no data was presented on the effects of climate and soils on erosion. Although some references were made to techniques for management control and for topography, the lack of definitive data was still obvious. Throughout the course of the workshop, the concept of "soil loss tolerance" was not mentioned and the consultant thought the problem was only lack of data. At two stops on the field trips, however, he saw natural runoff plots containing various management practices. One of the locations even had a flow measuring station at the outlet of a watershed. Representatives of both locations presented their papers without mentioning the runoff plots. From this, one can only conclude that insufficient data were obtained and/or that help is needed to interpret the data. A combination of the two is suspected.

This conference and field trip experiences, together with personal contacts made, reinforces the necessity a basic workshop on erosion and erosion control for researchers in this region. Such a workshop should provide details

concerning the types of methods for obtaining basic information to control soil erosion such as climatological, soils, management, and topographic data. Techniques for collecting data from runoff plots and watersheds should be included, and a major effort must be made to show the researchers how to analyze and interpret the data after it has been obtained. This most important phase identifies additional research gaps and the results are documented as publications or research reports. This is a difficult task that requires guidance and "follow-up" for the inexperienced erosion researcher to achieve the best results.

This discussion leads to the concept of a regionally uniform network of erosion experiments which has been previously discussed previously with USAID. There is a definite need.

Mission: 11-22 November 1984; 12 days.

Purpose: To attend the "International Workshop on Soil Erosion and Its Countermeasures" at Chiangmai and to assess information and training needs for the Mae Cheam Watershed Development Project.

Consultant: Henry C. Wyman, State Information Officer, USDA Soil Conservation Service, Davis, California.

Accomplishments: The workshop provided attendees from 15 countries with information on soil erosion control programs in the United States over the last 50 years. Participants exchanged information on adoption of conservation practice techniques. The assistance provided to the watershed development project included: 1) evaluating media programs; 2) recommending techniques and equipment; 3) training employees in public information skills; and 4) developing informational materials.

The SCS and USDA consultants were benefited by their increased understanding of soil conservation programs and practices and public information methods used in other countries.

Philippines

Mission: 6 January to 1 February 1985; 27 days.

Purpose: To sample soils for using at the 14th International Forum on Soil Taxonomy and Agrotechnology Transfer (scheduled for February 1986) and some additional pedons representing IBSNAT wheat project sites.

Cooperating Agencies: Philippines Bureau of Soils, Philippine Council for Agriculture and Resources Research and Development (PCARRD), USDA/SCS Soil Management Support Services (SMSS), National Soil Survey Laboratory USDA/SCS, and USAID/Philippines.

Consultant: Ronald D. Yeck, Research Soil Scientist, National Soil Survey Laboratory, USDA/SCS, Lincoln, Nebraska.

Accomplishments: During the first week, four pedons representing the IBSNAT sites were sampled at the Provinces of Nueva Ecija, Nueva Vizcaya, and Isabela. The remaining time was spent to sampling an additional seventeen pedons to be used in the upcoming forum. The seventeen pedons were from the Provinces of Iloilo, Negros Occidental, Cebu, Leyte, and Samar located in the Visayas region. In addition to providing soil pedons for IBSNAT and the upcoming forum, the field and laboratory data will add to the extensive and important Philippine soils data base.

New Zealand

Mission: 14 January to 6 February 1985; 24 days.

Purpose: To work with personnel at New Zealand Soil Bureau to develop a computer data base to support the work of ICOMAND.

Cooperating Agencies: DSIR - New Zealand Soil Bureau.

Consultant: John M. Kimble, Soil Chemist, USDA/SCS SMSS.

Accomplishments: A system for transmitting NSSL data to the New Zealand Soil Bureau was established along with a computer program to work with the data. Data from many other countries were reviewed, however. Because of differences in laboratory procedures, very little of this data will be added to the data base.

Peru

Mission: 23 March to 7 April 1985; 16 days.

Purpose: The objectives were (1) to provide technical assistance to S&T-LAC (Latin America and Caribbean) Fragile Lands Working Group of AID/Washington for assessing the crop production constraints of Fragile Lands--steep lands of the Sierra and High Selva and humid lowland areas of the Selva region--in Peru, and (2) to develop a package containing technological alternatives for alleviating land constraints in Fragile Lands.

Cooperating Agencies: USAID/PERU; S&T/AGR/RNR, USAID; Office of International Cooperation and Development (OICD).

Consultant: Luis A. Manrique, Soil Scientist, IBSNAT Project, Department of Agronomy and Soil Science, University of Hawaii.

Accomplishment: A Fragile Lands Rapid Assessment Team was dispatched by the joint S&T/LAC Fragile Lands Working Group of USAID/PERU. As a result, a 36-page report was prepared to be integrated in the paper for the Development Strategies for Fragile Lands (DESFIL) Project. The consultant wrote the technical portions of this report concerning: the assessment of existing problems constraining crop production of Fragile Lands in Peru, and the summary of available technology or research needed to alleviate constraints of Fragile Lands. Special reference was made to the use of basic information contained in soil surveys based on Soil Taxonomy to assess fragility of lands under existing agricultural technology. It was emphasized that if soil surveys based on Soil Taxonomy are available, the task of identifying and delimiting lands considered as potentially "fragile" can be readily achieved. Soil Taxonomy is a hierarchical system that comprises soil information in such an organized way that basic data on fragile lands can be extracted at any step of the taxonomic ladder.

Mission: 25-31 May 1985, 7 days.

Purpose: To provide administrative analysis and to recommend oversight for developing the Peruvian National Soil and Water Conservation System.

Cooperating Agencies: Government of Peru (GOP), Ministry of Agriculture, Division of Soils and Water, USAID/PERU cooperating with USDA/SCS.

Consultant: Jeffrey Vonk, USDA/SCS/OICD/PASA.

Accomplishments: The Peruvian National Soil and Water Conservation effort earnestly began with arrival of USDA/PASA Jerry Arledge in January 1982. The project was originally planned to be a demonstration type project in the Cajamarca Region of Peru. Arledge and counterparts significantly changed the thrust and scope of the project to provide a very active, more technical, and widespread soil and water conservation effort in the "sierra" region of the country. The project to date has surpassed all expectations with respect to the field effort and training of local farmers in nine regions of Peru. It is now at the point where the administrative details of the national system need to be worked out and legally established both within GOP-Ministry of Agriculture and administratively from a practical management standpoint. This has become critical for two reasons:

1) USAID is entering final year of funding for initial project; and
2) The impending establishment of a newly elected Government of Peru.

The following schedule was recommended and adhered to.

A) A logical, timely schedule for legal establishment of the national system was developed by project staff at the end of July 1985.

B) A comprehensive administrative and management plan for the new system is being developed, and should be accomplished by February 1986.

C) The Government of Peru's budget system needed to become firmer for 1986 and this was accomplished by August 1985, assuring continuity of the soil and water system program.

To effectively accomplish desired results for the GOP National System, a detailed analysis of current Ministry of Agriculture programs and agencies needs to be made. This will allow for a smooth, efficient integration of the new national system into the ministry upon its official legalization. This will also provide for the most effective organizational and administrative arrangement for the program within the Government of Peru.

The consultant had a good opportunity to view the soil and water program as it is presently functioning, both in terms of a general and specifically overview, the in-field training process that has been so successful. Consultant discussed the soil and water program with AID/Peru staff at all levels including with the deputy director of the mission. The consultant also had an opportunity to discuss the program with regional and national level Pervian officials. These discussions and field trips provided the consultant with a better understanding of the program as it is now functioning, the current direction of the program, and the areas where further work and direction is needed (as previously discussed). Since the consultant has also been appointed as resident advisor to the program (USDA/OICD/SCS/PASA), this trip was particularly important and valuable, giving the advisor a better understanding and appreciation of the program so that he can better prepare while in the United States, to perform the required job assignment upon arriving in Peru.

Western Samoa

Mission: 10-30 July 1985; 21 days.

Purpose: To locate, describe, and sample soils for laboratory characterization in preparation for an International Training Forum on Soil Taxonomy and Agrotechnology Transfer scheduled during July 1986 in Apia, Western Samoa.

Cooperating Agencies: University of the South Pacific (USP); Institute for Research, Extension, and Training in Agriculture (IRETA); USAID in Suva, Fiji; and USDA/SCS.

Consultant: Terry D. Cook, Soil Management Specialist, USDA/SCS/SMSS, Washington D.C.

Accomplishments: Fourteen soils were described and sampled from the island of Upolu, Western Samoa. Samples were collected for both the SCS National Soil Survey laboratory (NSSL) at Lincoln, Nebraska and for the USP laboratories at Alafua or Suva campuses.

Although it appears that only one or two Orders and a few Great Groups may be represented, a wide variety of conditions were selected to represent the diversity and complexity of the soils and environment of the island. Rainfall patterns varied from 2300 mm to over 6000 mm. Vegetation included coconut and banana plantations, pastures, and dense tropical forests. Elevation ranged from approximately 50 m to 750 m. The soils sampled varied in depth from less than 50 cm to more than 200 cm and included soils formed in alluvial deposits, pyroclastic flows and deposits, basalt flows, and colluvial detritus.

Informational discussions and planning meetings were held with USP staff and Pro Vice Chancellor Denis F. Osbourne who is also Head of USP at Alafua campus, and with IRETA Director Leonard H. Fernando. Their interview was tape recorded by USP radio station personnel for distribution to other South Pacific islands radio stations. Information on SMSS activities and on the Western Samoa Training Forum (Figure 1) were provided during the taped interview.

Data from these 14 soils sampled should provide an important benchmark for the USP and additional work in the future (Figure 2). At least nine of the sites are located on or near the Alafua campus, experimental plots, research stations, and intensively managed areas that have detailed records of experimental trials or crop management records. This data, along with the lab characterization data, should provide a valuable and useful source for possible agrotechnology transfer to other South Pacific islands.

Figure 1. Soil Science students from the University of South Pacific obtain hands-on soil sampling training in Western Samoa.

Figure 2. Soil characterization and sampling in Western Samoa. Professor at University of South Pacific, M. Ashgar (seated on box) provides expert guidance.

Bolivia

Mission: 3-9 June 1985; 6 days.

Purpose: To review and evaluation of a project for the planned and controlled use of natural resources in the El Monte subwatershed, an affluent of the Guadalquivir River in southern Bolivia; and also to review the adequacy and methodologies used in gathering the basic available data.

Cooperating Agencies: Corporation for the Development of Tarija (CODETAR), Soil Management Support Services (SMSS).

Consultants: Oscar Perez, Agricultural Engineer; and Peter Waldo, Sedimentation Geologist.

Accomplishments: The city of Tarija is located downstream of the El Monte Creek on the floodplain of the Guadalquivir River. Severe gully and wind soil erosion, lack of vegetation, lack of surface water, and pollution of the sediment caused by frequent flooding in the El Monte subwatershed hinder orderly development of the Tarija Valley.

As far as we are concerned, there is no feasible economic solution to the severe erosion in the subwatershed. These are "badlands" characterized by 1) intricate and sharp erosional structure of weak rocks with only scanty native vegetation, and 2) steep, furrowed, fantastically formed hills, labyrinthine drainage, and dry watercourses.

This trip was an excellent opportunity to become acquainted with the proposed project and the assigned personnel. We were extremely impressed by the magnitude of the problem in dealing with this 50 km^2 subwatershed comprised entirely of badlands. We feel that by discussing with the local staff, the SCS methodology for basic data collection, erosion and sediment yield prediction, and erosion and sediment control technology their capabilities for planning future projects, where these methods are applicable, should improve.

If a cooperative technical exchange agreement is established between the United States and Bolivia, an interdiciplinary team similar to ours could be sent to Bolivia to provide the very necessary training in soil and water management and erosion control practices to the local staff. Of course, this would be contingent upon the selection by Bolivia of projects with viable capabilities.

Technical cooperation between our countries in such an activity should prove beneficial to both.

Brazil

Mission: 6 April to 5 May 1985; 30 days.

Purpose: To study and sample sites for the 1986 ICOMOX workshop that will finalize adjustments in Oxisols classification to enhance the agrotechnology transfer capabilities of the U.S. Soil Taxonomy.

Cooperating Agencies: USAID; Office of International Cooperation and Development (OICD); Empresa Brasileira de Pesquisas Agropecuaria (EMBRAPA), Servico Nacional de Levantamento e Conservacao de Solos (SNLCS); U.S. Department of Agriculture, Soil Conservation Service (USDA/SCS); Soil Management Support Services (SMSS).

Consultant: C. Steven Holzhey, Head, National Soil Survey Laboratory, Soil Conversation Service, Lincoln, Nebraska.

Accomplishments: A team of four EMBRAPA and one U.S. scientist, plus technicians and laborers, studied and sampled a series of 22 sites from the vicinity of Brasilia, toward the Atlantic Coast north of Sao Paulo. EMBRAPA provided vehicles, most of the manpower, site locations, and accommodations. The tour route encompassed some of Brazil's most successful agricultural areas, and workshop participants saw modern soil management applied to a variety of typical, highly weathered soils without fertilization yield very little. Some localities were still in the native "cerrado", while others were on slightly more youthful soils, and that provided a well-rounded experience showing land contrasts related to management, geologic history, and kinds of materials.

Samples were collected for the SNLCS laboratory in Rio de Janeiro, and for the National Soil Survey Laboratory in Lincoln, Nebraska. A few other collaborating facilities received samples for detailed mineralogical identifications and fertility analyses. Data from these sources will be complied into a guidebook for the workshop. The data, sites, and the Brazilian agricultural experience with soils will enable participants of the ICOMOX committee to finalize practical improvements in groupings these and similar soils. Those improved groupings will be incorporated into the USDA soil taxonomy classification system to improve predictive value of the system for agricultural technology transfer efforts.

TECHNOLOGY TRANSFER

Institutional Linkages

For a small project like SMSS, institutional linkages are vital to the execution of its activities. Over the past six years, many linkages have been established but only those with which the program had activities in FY 1985 are reported here (Figure 3).

IBSNAT Project

The SMSS Program continues to work with the International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT) project. There are several areas where project objectives overlap; and at other times a specific activity may be better handled by only one of the projects. SMSS and IBSNAT projects have agreed to produce a joint newsletter called Agrotechnology Transfer, the first number which was published in September 1985.

TSMM

Technology of Soil Moisture Management (TSMM) is a new project being developed by AID (S&T/AGR/RNR). It is not yet fully funded and SMSS is collaborating to initiate this project. The project work will be on dryland agriculture, an area in which collaboration will be mutually beneficial.

FSP

The Forest Support Program (FSP) of S&T is moving into the area of agroforestry. Soil management is one of the concerns in this area, SMSS has had discussions with FSP for collaboration.

IBSRAM

The International Board for Soil Research and Management (IBSRAM) is a new organization with headquarters in Bangkok. SMSS has been strongly involved in the development of this organization and has organized their three workshops. These are discussed later in the Annual Report.

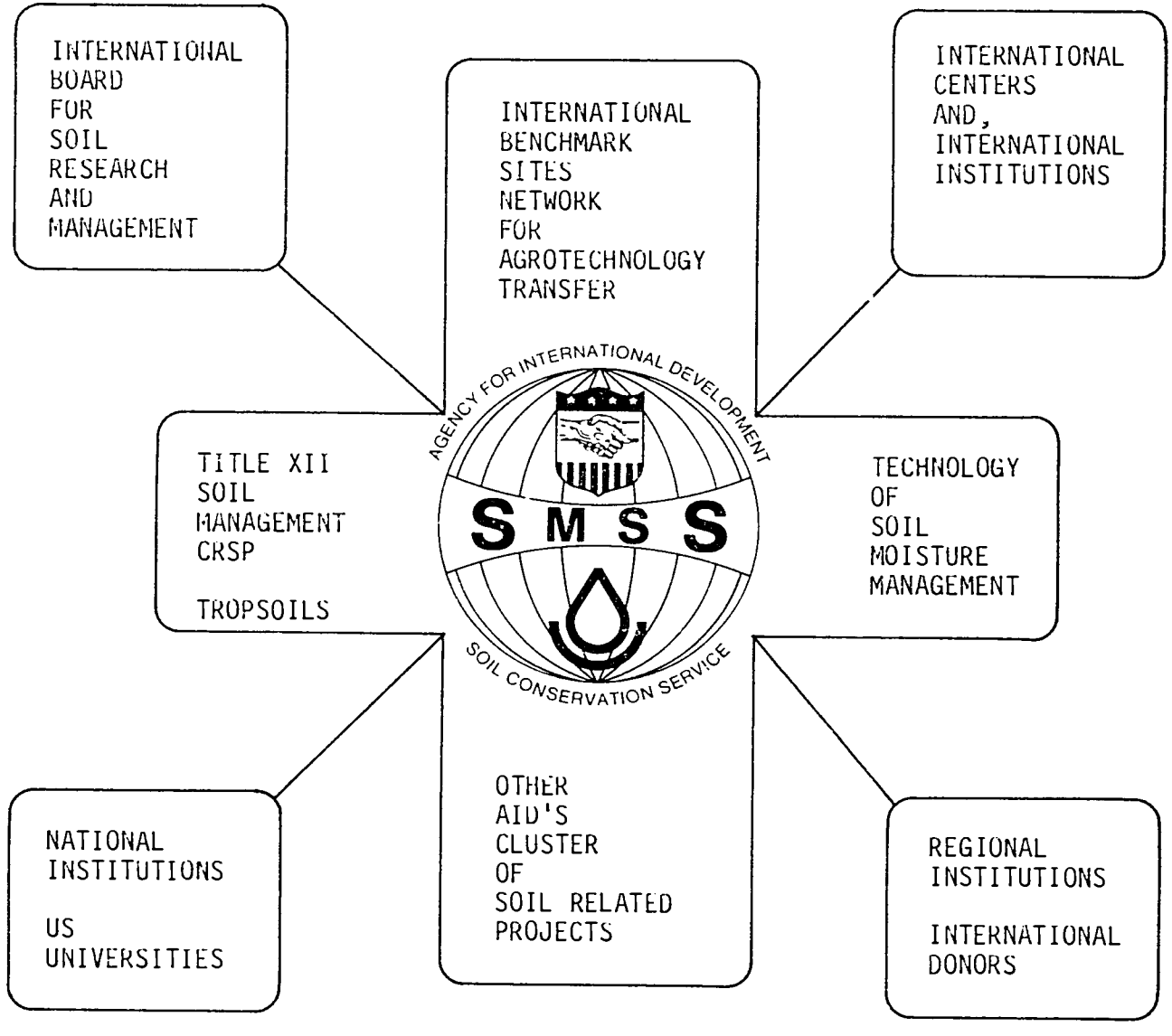

Figure 3. SMSS linkages with institutions.

FFTC/ASPAC

The Food and Fertilizer Technology Center for the Asia and Pacific Region (FFTC/ASPAC) in Taiwan has a Memorandum of Agreement with SMSS to collaborate in similar activities. FFTC organized a seminar in April 1985 with the assistance of SMSS. FFTC will also be funding a training course to be held in South Korea in 1987.

ACIAR

The Australia Centre for International Agricultural Research (ACIAR) has been a strong supporter of SMSS activities. They provided Australian resources persons to many SMSS forums. They also funded all of the IBSRAM workshops.

International Committees

The reports of the International Committees (ICOMS) are presented here. The International Committee on Low Activity Clays (ICOMLAC) has completed its assignment. The final report was distributed internationally for testing in August 1984. Responses have been received and changes to Soil Taxonomy are being made. The Circular Letters of the committee have now been compiled and published as SMSS Technical Monograph No. 8. SMSS takes this opportunity to thank and congratulate Frank Moormann of the State University of Utrecht for his leadership and guidance, and also for the very painstaking work involved. The committee was established in 1976 and worked a little less than a decade to complete its assignment.

International Committee on Oxisols (ICOMOX) FY 1985

Period reported: 1 October 1984 to 30 September 1985.

Reports Issued : Two Circular Letters--ICOMOX No. 14 dated January 1985 and ICOMOS No. 15 dated July 15.

The ICOMOX chairman participated in the XIth International Forum on Soil Taxonomy and Agrotechnology Transfer held in Zambia, providing him with a firsthand look at Oxisols and potential Oxisols in Southern Africa. The ICOMOX chairman also participated in the IBSRAM meeting held in Peru and Brazil giving him an opportunity to discuss the ICOMOX proposals with agronomists involved in acid humid tropical soil research. The selection of sampling sites in Brazil is for the May 1986 ICOMOX field trip.

FY 1985 has been a period of "sifting and winnowing" among the various proposals made by the ICOMOX members. This discussion period resulted in general management on several technical points in formulating the ICOMOX report. The major points are as follows:

1) Replace the suborder Orthox with Udox.
2) As a new suborder, Umox covers the well-drained Oxisols in perudic soil moisture regimes.
3) Replace the clayey family in Oxisols with fine and very fine families.
4) A general revision of mineralogical families in Oxisols to include: a) Ferruginous, those Oxisols with more than 40 percent total iron as Fe_2O_3 in the control section; b) Allic, those Oxisols with more than 2 meg/100 g of KCl extractable Al in the control section; c) Kaolinitic, any other Oxisols not meeting the criteria of

previously defined Oxisol families. (This proposed change allows kaolinitic to be used in Oxisols, comparable to the use of "mixed" in other orders; Kaolinitic is more desirable than mixed due to the limitations of low activity clay placed on Oxisols by the order definition.)

Further unresolved questions involve the desirability of including several color criteria at the subgroup level of the system. Committee members differed on this point and the responses to be received in the next few months will determine the course of the proposed key to be prepared before the May 1986 ICOMOX field trip.

FY 1986 will be critical for ICOMOX with the following scheduled activities:

1) In January 1986, Circular Letter No. 16 will be sent to all members. This letter will contain a complete key to the Oxisols as conceived to be the best compromise available from the committee suggestions. This key will serve as the basis for discussions during the Brazilian field trip.

2) During the Brazilian field trip in May 1986, the committee will observe and discuss not only the pedons selected for the trip, but also other aspects of the ICOMOX proposal.

3) Formulation of the final report containing the recommendations of ICOMOX to the National Cooperative Soil Survey staff for further testing is planned to follow directly after the March 1986 field trip.

4) Following the submission of the proposal and its circulation to committee members, ICOMOX will not actively pursue further discussions of Oxisol classification. Rather, it will remain available to respond to questions concerning its recommendations and perhaps serve to assemble any new data that are forwarded concerning characterization and placement of Oxisol pedons. Further ICOMOX activity is not planned except as directed by the SMSS Advisory Board.

Presently a computer-based system exists that keys all Oxisols, according to the ICOMOX proposals, to the series or pedon reference. This is an Apple-PC software. This will continue to be updated and converted to IBM-PC software. ICOMOX could continue to serve as a series (pedon) collection center in the correlation of Oxisols from around the world.

Impact of ICOMOX on Developing Countries

Because few Oxisols are known to exist in the United States, the Oxisols Order has not had the rigorous testing afforded most other kinds of soils. ICOMOX has provided a forum for soil scientists in developing tropical countries to express their wishes regarding the classification of such soils. This needs to be expanded to include more countries. This is difficult because

few of these countries have advanced to the same level of soil characterization as is available in developed countries. To bridge this development gap, it will be necessary to extend training and support services to these areas in the future. It is urged that SMSS and its parent organizations make provisions to continue and strengthen such support. Such activities not only enhance the technical excellence of Soil Taxonomy but also provide a forum for the strengthening of personnel and soil-related data bases within the developing countries. The formulation of an updated taxonomic format for Oxisols should not be looked upon as an end product of ICOMOX but rather the springboard from which to strengthen the entire infrastructure of soil related agronomic and land-use activities that stem from a quantitative evaluation of soil resources in developing countries.

International Committee on Aridisols (ICOMID)

Previous remarks, comments, and suggestions to improve the order of Aridisols showed that there is a need to reconsider the classification system at different levels starting from the Order, the Suborder, the Great Groups, the Subgroups, and even the Family level.

Aridisols

The Order

This Order is distinguished by the aridic (torric) soil moisture regime. The question to which we do not have a definite answer is: to what extent should Aridisols have a profile development? This will affect not only the soil properties but also the development of the diagnostic horizons themselves.

A specific diagnostic horizon characterizes one or another Order. This is the case of the Alfisols, Inceptisols, Oxisols, Spodosols, and so on. The soil moisture regime is considered at the Suborder level. Aridisols are the only Order where the aridic (torric) soil moisture regime is considered at the highest level of the system. Meanwhile, Aridisols are present under different soil temperature regimes (e.g., Pergelic in New Zealand, Cryic in Canada, and Frigid in the United States); many of these soils cannot be classified in the system.

The Suborder

The Suborder level emphasizes the presence of an argillic or a natric horizon in the Argids and considers the Calcic, the Gypsic, the Cambic, and the

Salic horizons only at the Great Group level in the Orthids Suborder. Suggestions were presented to consider the profile development at the Suborder level (e.g., Argids, Calcids, Gypsids, Salids, etc.).

The Great Groups

The information available on Great Groups is related mainly to Orthids. The Argids Suborder has been less discussed although its distribution seems to be much less limited especially the Duragids, the Nadurargids, and the Paleargids. The Haplargids Great Group itself has been criticized with regard to the properties of argillic horizon and the evidence of the cutans and the clay illuviation.

The Subgroups

Actually there are 55 Subgroups in the Argids, 20 of them in the Haplargids Great Group. The Orthids Suborder is subdivided into 51 Subgroups 20 of them in the Camborthids Great Group. The subdivision is based mainly on the soil moisture regimes and organic matter content of the A horizon that reflect the transition of these soils from the aridic (torric) soil moisture regime to other climatic conditions including the soil temperature regime (e.g., the Pergelic in New Zealand). Among the total 106 Subgroups, very few of them were discussed especially the accumulation of calcium and gypsum in the Calciorthids and the Gypsiorthids. Many soil scientists are not in favor of the introduction of a new group to one or another Great Group, but there is a common feeling that the whole of Aridisols Order should be reviewed. Unfortunately, most of the suggestions lack the necessary data on the location of the soil and its environmental conditions, and the typical profile description and its related analytical data.

ICOMID highly recommends all collaborators to include with their suggestions examples with information on the site and the description of the profile and the soil analysis.

Additional information on the importance and the agricultural impact as well as the mapability of the soil would be of great importance.

International Committee on Classification of Soil with Aquic Soil Moisture Regime (ICOMAQ)

In March 1985, J. Bouma succeeded F.R. Moorman as ICOMAQ's Chairman and since that time, two Circular Letters were prepared to define the scope of the work, the specific areas of interest to be covered, and the particular

expertise of the various members. The first two Circular Letters were sent to 40 scientists in 13 countries. Eighteen have answered positively so far with a commitment to make positive contributions.

Points of attention for ICOMAQ include: 1) derivation of criteria for defining surface-water gleys; 2) classification of water regimes in paddy soils; and 3) quantification of acidification potential as a function of the water regime.

Improved field characterization of wet soils with aquic moisture regimes is necessary for practical uses of soils in many areas of the world. An estimated 8 million hectares of potential cropland, mainly in developing countries is not being used because of excessive wet conditions that hamper plant growth. Drainage practices can result in increased soil productivity, but only when these practices are adjusted to specific site conditions as expressed by soil classification. For example, occurrence of seasonal ponding of water in surface horizons requires entirely different drainage procedures than the occurrence of continuous water-tables in valleys. A major task of ICOMAQ is to more specifically define wetness criteria in the field so as to allow reliable and reproducible field characterization by soil surveyors.

ICOMAQ has become very active under the new Chairman Johan Bouma. Frank Moormann requested to resign because of other work commitments and Bouma was selected the new chairman in November 1984. ICOMAQ Circular Letter Nos. 1 and 2 were published 12 March 1985 and 28 June 1985, respectively. Major points currently being investigated are:

1) Should aquic moisture regimes be associated with reducing conditions, or should we primarily focus on "wet" conditions, as defined in the new Soil Survey manual.

2) Considering data from West Germany and the United Kingdom, as provided, how do you interpret the difference between perched and real water tables? Which criteria being used in both systems would be suitable according to your experience?

3) At what level should the "paddy culture induced soil morphology" be expressed in the classification? Is the Subgroup level acceptable because of the major changes that occur, or should we descend to the Family level?

4) What is your opinion about use of wetness criteria in the current definition of the cambic horizon?

5) What information do you have in terms of methodology? (specifically: measuring hydraulic conductivity, water table levels, state of reduction of a soil material, etc.).

6) Summary questions, based on the above questions follows: What are the important attributes for aquic moisture regimes (e.g., depth of wetness, length of wetness period, etc.)? Why are they important and what are the determining soil properties? How can they be observed and measured in a practical, operational manner? The approach suggested by these summary questions are relevant, considering the fact that ICOMAQ is sponsored by the Soil Management Support Services. Aside from that, practical applications of soil survey data have been of interest to all of us for quite some time.

International Committee on Spodosols (ICOMOD)

ICOMOD has coded all the data published in its Circular Letter No. 1 (dated April 1984) plus additional data collected since publication. The coded data is being keyed into a computer for manipulation of data to test proposed changes in limits.

ICOMOD Circular Letter No. 2 was published in November 1984, and includes at least some of the computer test results.

International Workshops

All workshops organized in FY 1985 related to soil management. No soil classification workshops were organized during this year. This is partly the result of a SMSS Advisory Panel recommendation. International workshops are expensive to organize and the average cost is between $100,000 to $150,000. This does not include costs of preparation and of soil analyses, if any. There is a tremendous demand for these workshops particularly from LDC scientists who frequently do not have the opportunity to participate at international gatherings. Consequently, these workshops have become an integral part of SMSS activities. To achieve maximum utilization of funds, SMSS strives for cost-sharing in all these activities. We have been fortunate that several donors have contributed to the four workshops organized this year. Another feature of these workshops is that none were initiated by SMSS; in each case, SMSS was invited to collaborate.

The first workshop on "Physical Aspects of Soil Management in Rice-Based Cropping Systems" was a follow-up of a recommendation by the SMSS VIIth International Soil Classification Workshop held in the Philippines during April 1984. The follow-up workshop was organized by the International Rice Research Institute. A detailed report of this workshop is presented later.

The other three workshops were organized by SMSS for the newly created International Board for Soil Research and Management. Again, a range of donors provided the funding.

These soil management workshops are a prelude to others that are being planned by SMSS. SMSS strategy has been initially to focus on Soil Taxonomy and soil resource inventories, and by FY 1987 (end of SMSS Phase II), SMSS would have had about 7 years of work in this area. In Phase III, which is essentially the utilization phase of the project, the thrust will be on soil management. In preparation for this, SMSS will be initiating "International Soil Management Workshops" to address specific soil constraints or problem soils. Through these workshops we also hope to lay the basis for agrotechnology transfer.

Physical Aspects of Soil Management in Rice-based Cropping Systems Workshop

A workshop on the "Physical Aspects of Soil Management in Rice-based Cropping Systems" was held in the Philippines, 10-16 December 1984 to consider the soil physical properties limiting rice production. Particularly with the advent of high-yielding cultivars and improved fertilizer technology, soil constraints limiting the performance of rice are becoming increasingly apparent. Traditional management techniques are being re-examined. Such questions as "to puddle or not to puddle?" and "is a reducing environment necessary?" and "what is the optimal hydraulic conductivity?" are being raised. The system becomes still more complex when an irrigated rice crop is followed by a rainfed upland crop. What role do pans play in such situations, how can surface crusting or hardening be reduced, what is the optimal time for planting the second crop, and what type of machinery can be best utilized for both systems?

This workshop was organized by the International Rice Research Institute (IRRI) in collaboration with the Soil Management Support Services (SMSS), and with major funding provided by the Belgian organization Algemeen beschaft voor Ontwikkelingsamenwerking (ABOS). The workshop was also the occasion for the newly formed International Board for Soil Research and Management (IBSRAM) to discuss its proposed "Wetlands Network." The workshop was attended by more than eighty participants from about fifteen countries (Figure 4).

Rice is the most important food crop grown in the developing world. About 90 percent of the world production is from the wetlands of Asia. In Asia, production has kept pace with demand until now. By the end of this century, at least 30 percent more rice will be needed to keep pace with population demands. This increase, most likely, must come from the same rice growing areas of the world. Recently the improved varieties from intensive breeding programs and the increased use of fertilizers contributed to marked gains in rice yields. To realize further gains in rice performance and production in wetland soils, the dynamic effect of cultivation, submergence, and fallowing on the physical properties of these soils must be understood to implement proper management practices with respect to plant nutrition and growth. Knowledge of the kinds of soils and their distribution is equally important as knowledge of their physical aspects. For this reason, in March-April 1984 SMSS organized another

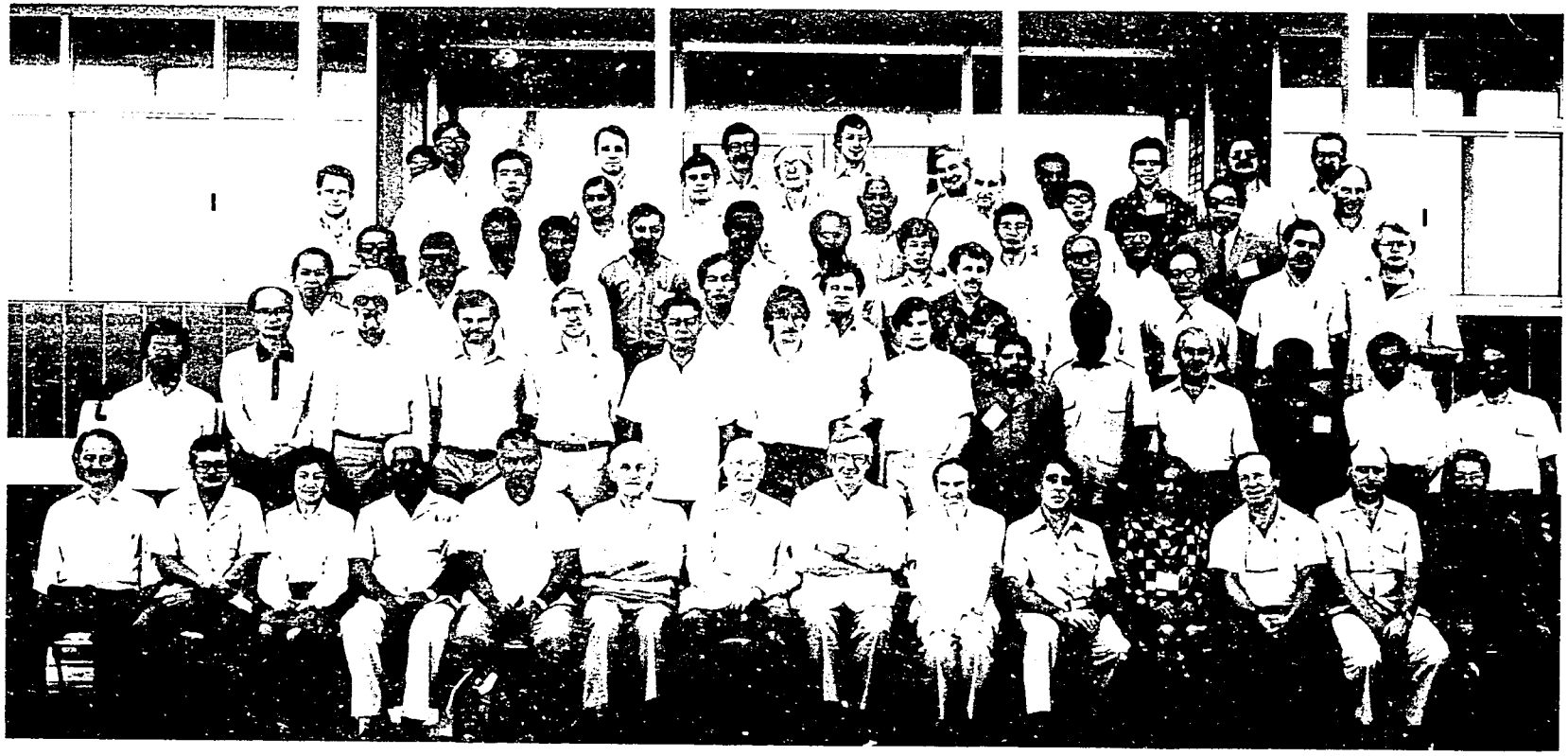

Figure 4. Participants at workshop on Physical Aspects of Soil Management in Rice-Based Cropping Systems (PASMIRCS) during 10-14 December 1984 at the International Rice Research Institute, Los Banos, Laguna, Philippines.

workshop in collaboration with IRRI and the Bureau of Soils of the Philippines on "Characterization, Classification and Utilization of Wetlands Soils."

The workshop identified gaps in our present knowledge and proposed areas for research. The Workshop Proceedings are expected within a year and may be obtained from IRRI.

The theme of the VIIth International Workshop on Soil Taxonomy and Agrotechnology Transfer was "Characterization, Classification, and Utilization of Wetland Soils." It was held in Los Banos, Philippines, from 26 March to 5 April 1984. The Workshop, organized by the Soil Management Support Services (SMSS) in collaboration with the International Rice Research Institute (IRRI) and the Bureau of Soils of the Philippines, was published in the Proceedings which may be purchased from IRRI (P.O. Box 933, Manila, Philippines). Soil scientists from developing countries may obtain one free copy by writing to Hari Eswaran of SMSS.

The recommendations adopted by the workshop are provided along with the reports of the four working groups, each which addressed a specific subject.

Recommendations

Noting that the wetland soils of Africa, Latin America, and South and Southeast Asia comprise some 550 million hectares, of which fewer than 150 million hectares are now used to grow rice and other crops, the workshop made the following recommendations that:

- Research be undertaken to characterize wetland soils (whether currently used for agriculture or not) in terms of hydrological, chemical, physical, morphological, mineralogical, and biological properties and processes in order to facilitate the extrapolation of results of soil and crop research to as large an area as may be economically utilized. (The specific recommendations of the four working groups which follow, give detailed guidance on the research needed to make this possible. The use of satellite imagery in support of the hydrological aspects of land characterization and classification was not discussed at the meeting but is recognized as an important adjunct to existing methods of wetlands assessment.)
- Donor agencies and implementing organizations such as SMSS, International Board for Soils Research and Management (IBSRAM), International Network on Soil Fertility and Fertilizer Evaluation for Rice (INSFFER), International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT), Food and Agriculture Organization (FAO), United Nations Development Program (UNDP), and the national agricultural research organizations be encouraged to support research, meetings, and workshops that provide opportunities for interaction among, and combined efforts of, soil and land classification groups, survey and land evaluation groups, and soil fertility and crop production scientists.

- The sponsoring organizations INSFFER, SMSS, and the Bureau of Soils, and the host institution IRRI be commended for the excellent organization, facilities, and support services provided at "Workshop on Characterization, Classification, and Utilization of Wetland Soils."

Working Group Reports

Group A. Characterization of wetland soils and needed research in relation to better utilization

The following characterizations should be accurately recorded if wetland soils are to be properly classified and utilized.

1. Morphology. Changes in the degree of wetness affect the morphology of wetland soils. Morphological descriptions therefore must either include a statement of conditions at the time of description with predicted states at seasonal extremes, or be made with the soil under extreme conditions. The description of morphology should include the following:

- a color distribution pattern of differences between interior and exterior of peds, or of the bulk soils if peds are not clearly expressed;
- a quantification of oxidized and reduced regions, made by using a grid, and a point counting;
- chemical characterizations of components determined by hydrochloric acid and lead acetate paper (carbonates and sulfides effervesce differently), color of residue after ignition (black = Fe-Mg silicates, white = organic matter, red = other Fe minerals), the presence of a-a'-dipyridil (or other reagents) for Fe^{+2} determination, and hydrogen peroxide test (manganese dioxide effervescence); and
- micromorphometric (optical and submicroscopic) characterization of microstructures and porosity (puddling effects, ease of regeneration).

2. Physical characteristics include the following:

- soil water content and potential;
- compressive strength, penetrability, shear strength, and aggregate stability determined at different soil moisture contents;
- porosity, bulk density, and swelling pressures at different moisture contents;
- pore size distribution determined from water retention (at least at 9.1 and 5.9 bar saturation before and after puddling), and using nonpolar liquids and mercury intrusion methods;
- water conductivity and oxygen diffusion are (ODR) determined at field capacity; and
- specific heat, heat capacity, and heat conductivity.

3. Electrochemical properties are:

- redox potential (Eh or pE) of the soil in defined conditions;
- redox buffer capacity;

- pH--wet (without and with hydrogen peroxide treatment) and dry (systematic studies will be necessary to interpret differences in wet and dry pH);
- pH buffer capacity (wet, with and without peroxide treatment);
- cation exchange capacity--wet and dry; again systematic studies are needed; and
- electric conductivity and composition of soil solution, including organic anions which affect the chemical oxygen demand.

4. Organic matter characterizations are the:

- quantity of oxidation or combustion present as determined by CO_2 evolution rather than consumption of O_2;
- carbon-nitrogen ratio;
- redox buffer capacity, and chemical oxygen demand;
- micromorphology (research is needed to characterize course organic matter under permanently wet and alternatively wet and dry conditions);
- soil microbial biomass;
- ash content of extracted organic matter; and
- interactions with heavy metals.

5. Mineral matter requirements are:

- iron and manganese minerals characterized using preferential extraction methods (oxalate, dithionite), micromorphology, before and after preferential extraction, and differential x-ray diffraction analysis;
- sulfide mineral characterization methods; and
- clay minerals and allophanes characterized by x-ray, infrared, and thermal methods.

The technique of sampling reduced soils requires special attention, since oxidation which occurs after sampling changes many of the features mentioned. (Methods dealing with the content of nutrient and toxic elements are addressed by Working Group D.)

Group B. Processes in wetland soils and needed research in relation to better utilization

While considering processes in wetland soils and the needed research in relation to its better utilization, the technical papers in sessions 1 and 2 noted the following constraints to agricultural production in rice-based cropping systems:

- soil moisture stress;
- excess soil water;
- nutrient availability, deficiencies, toxicities, imbalances, and losses;
- physical problems in puddling, and subsequent regeneration of soil structure upon desiccation for dryland crops; and

- development of pans and layers restrictive of root growth and water movement.

Group B addressed processes interrelated with soil properties and soil utilization. These processes result in properties which may in turn be characterized and used in soil classification. Furthermore, proper classification of soils is a prerequisite to information transfer on fertility responses and adequate application of cropping systems. Special attention should be given to future research on soils under field conditions.

The goals of this exercise were to determine those processes and resultant properties that are either directly or indirectly related to Soil Taxonomy and the utilization of wetland soils for food production.

The wetland soil processes related to soil properties have been structured as shown on Table 1.

The following high-priority research needs have been identified for wetland soil environments:

- verification of processes responsible for current soil moisture regimes and development of hydrological models for predicting the occurrence and duration of soil saturation and redox potentials under selected climatic, soil, and hydrologic conditions;
- determination of the processes resulting from puddling (destabilization of soil structure) including cohesive strength, bonding, hydraulic conductivity, apparent pore volume, and particle arrangement and its persistence as a function of texture, mineralogy, organic matter, and soil chemical properties;
- characterization of the processes responsible for shrink-swell phenomena (formation of cracks, slickenslides, and other structural voids), textural differentiation, moisture retention and desorption, and restrictive pans and surface crusts that are pertinent to water movement and root development (quantification of theses processes must be related to specific groundwater and surface water regimes, soil properties, and landform characteristics);
- development of land characterization and classification methods for biological activities in wetland soils (for example, suitability for azolla utilization or susceptibility to N losses by volatilization), and ecological limnology-type studies and on floodwater chemistry research studies;
- further studies to quantify organic matter production, decomposition, humification, and distribution in surface and subsurface horizons under different wetland environments to serve as properties used for Soil Taxonomy differentiation and to control nutrient availability to the crops and microbiological activity;
- determination of the intensity/capacity components under wetland field environments that control redox processes (pH changes; dissolution, distribution, adsorption, and desorption of soluble species; and mineral transformations); and

Table 1. Wetland soil processes and suggestions for necessary future research.

Water-dominated (mostly physical)	Chemical	Related to structural, morphological, and mechanical features	Biological
Periodicity, duration, and direction of water saturation	Redox process (intensity, capacity)	Puddling and regeneration of structure	Noncrop biomass production (aquatic weeds, algae, bacteria, zooplankton, etc.)
Ground water Permanently near surface Seasonal fluctuation	Migration, transformation, segregation of Fe, Mn, Al and other micronutrients and macronutrients	Formation of restrictive pans, surface crusts, and clods	Organic matter transformation
Surface water Flood water Perched water	Salinization, alkalinization, and carbonate accumulation (calcification)	Shrink-swell phenomenon in cracking clay soils, slickenslide development cracking hysteresis, gilgai formation	Decomposition and nutrient recycling
Dynamics o' water movement	pH changes, especially in acid sulfate soils	Micromorphological features under different lydromorphic conditions	Humus formation
Dynamics of gas exchange	Ferrolysis	Textural differentation	Food chains
Processes at water-soil interface zone in submerged soils	Chelation and complexation	Heat flow in nonsubmerged soils	Biological N fixation and immobilization
Heat flow in submerged soils			Rhizosphere effect: exudation, ion exchange gas exchange, root microbiology
			Nitrogen losses through volatilization and dentification processes

Needed Research

Formation, strength, and persistence (micromorphology and submicroscopy)--soil specific
Evaluation of puddling needs in terms of the physical, chemical, mineralogical, and organic composition of the soil--soil specific
Evaluation of the dynamics of nutrient and mobile elements--soil specific
Applicability of laboratory studies to field conditions
Regeneration of soil structure--soil specific characterizations, morphological, differences of aggregates
Toxicities and deficiencies--soil specific
Ripening

- determination of spatial variability of processes correlated with macromorphological and micromorphological features that can be used as morphological markers of contemporaneous wetlands pertinent to Soil Taxonomy and crop growth responses.

Tables 2 to 4 document the rationale used to formulate the final group report. They include examples of processes, effects on soil, relationship to Soil Taxonomy, relationship to utilization, and needed research.

Group C: Classification of wetland soils and needed research in relation to better utilization

The discussion began with the term "wetland soils." It was stated that wetland soils are not equivalent to "soils with an aquic moisture regime." Since most of the latter soils excluded the surface water gleys, and though this condition is of major importance for agricultural utilization, the definition of the aquic moisture regime was rewritten to include the surface water gleys (epiaquic, antraquic). It was agreed that:

- the soil water status and dynamics should be determined in "benchmark toposequences," with INSFFER sites as the initial locations, and research would include the use of auger-hole water measures, piezometers, tensiometers, and neutron probes, as well as additional measurements pertaining to rainfall (gauges, self-registering), evapotranspiration (pan method), irrigation water level, surface drainage, field measurement of relationship of reduction, with a detailed soil survey made at each site for compiling relevant geomorphological information;
- for the definition of epiaquic and anthraquic moisture regimes, a study of their relation to the environment is needed, with focus on geomorphology, flooding, vegetation, and hydraulic conductivity and climatic data;
- further studies to consider alternative criteria for use in the definition of the acquic moisture regime are:
    1) including surface water gley in the aquic soils moisture regime and the addition of epiaquic anthraquic taxa (limits/thickness of soil moisture control sections, etc.);
    2) methods of defining aquic regimes (boreholes versus piezometers, water transmission, water stagnation, reduction, etc.);
    3) methods of defining wet taxa on the basis of morphology;
        a) diagnostic horizons related to wetness (placic, "dasic," "quorizem," clacic, salic histic, suphidic materials, plinthite, albic horizon, bleached groundwater horizons etc.);

Table 2. Puddling.

Effects	Soil	Relation to		
		Soil Taxonomy	Utilization	
			Wetland	Dryland
Apparent pore volume	Surface-temporal	Mollic or umbric epipedon	Water management	Tilth
Soil strength			Nutrient management	Water availability
Particle arrangement		Translocation of particles to subsoil or accretion of sediments at surface	toxicities and deficiencies	Drainage
Color			Weeds	Moisture sorption-desorption
N forms and transformation		Differential sediment transport by "erosion"		
Redox and pH				
Other nutrient transformation: P, Fe, Mn				
Biological actions				
Water movement				
Shrink-swell				
Interaction of clay and organic matter				
Rooting volume				
Others				

Table 3. Water saturation, periodicity.

Duration	Effects: Electrochemical transformation	Effects: Chemical transformation	Effects: Biological transformation	Effects: Physical transformation
Long-depths directions	Redox pH	In situ nutrient mobilization and availability	Microflora and microfauna (native, biomass)	Color pattern Colloid accumulation
Short-directions	EC	Mineral transformation	Organic matter transformation (surface, subsoil)	Gaseous exchange Water movement
Alternate wetting and drying		Ferrolysis		Cracking pattern--shrink, swell
				Structure, strength
				Ripening
				Translocation: relative, absolute accumulation of element (Fe, Ca, etc
				Clay dispersion, translocation

Soil	Relation to: Soil Taxonomy	Relation to: Utilization (Wetland and dryland)	Needed research
Whole	Color patterns for aquic soils and intergrades	Cropping pattern Nutrient management	Differentiation of permanent, long-duration, short-duration, alternate wetting and drying
	Organic matter depth phenomena	Nutrient losses	Classification of water regime
	Diagnostic subsurface horizons	Toxicities and deficiencies	Microspatial pattern of biological redox
		Land preparation	Action relative to water regime, organic matter, biological action, pore distribution
			Electron donors, acceptors
			Ferrolysis--soil specific
			Ripening
			Monitoring and modeling of water regime, etc. (rice and weather program)
			Microphobic features
			Heat flow
			Humic forms and humus characteristics

Table 4. Processes at water-soil interface zone (interaction between floodwater and soil).

Effects			
Chemical	Physical	Biological	Needed research
Redox, redox pattern	Mixing	Activities of microfauna and macrofauna	Water chemistry (concentration and kinetics)
pH, CEC	Convection	Algae: diurnal fluctuation	Colloids in the floodwater
Flux of ions (sources: floodwater, fertilization, and translocation)	Heat flow	Bacteria	Siltation
	Seed environment	Nutrient transformation	Urease activity: nitrification - denitrification
			Nutrient cycles
			C input, turnover

b) horizon boundaries (in general, mainly based on color and texture, oxidation-reduction state, distribution, organic matter, structure, or difference in root density);

c) thickness of horizons or layers;

d) soil color relationships (matrix/intensity/distribution of gray colors and mottles/percentage in terms of quantitative limits, Fe or Mn content or both, root mottling as typical for paddy fields, coatings, etc.);

e) oxidation/reduction status (tested with a-a'-dipyridil, for example);

f) texture (clay distribution, etc.);

g) structure and consistency of relationships (difference in puddled soils, other terms for description);

h) traffic pans;

i) cracks;

j) organic matter relationships (example of lighter colored puddled topsoil higher in organic matter than darker underlying horizon; impact on oxidation-reduction status, etc.); and

k) concretions, nodules, and other features.

- and with regard to agricultural utilization, to differentiate among wet soils in seasonally dry areas, the items to be studied are:

1) periods when soil is moist (or wet) versus dry;

2) cracks (how long open, close when rewetted, and so on);

3) contrasting soil moisture regimes which could be expressed as "Ustic Tropaquepts";

4) the improved classification of wetland soils enabling necessary specifications with regard to utilization, such as:

a) water management [drainage (pro and con), irrigation (ponded mainly for rice), structural amelioration, including subsoiling, preservation of natural conditions];

b) trafficability;

c) structure regeneration (for dryland crops); and

d) chemical (fertility) relationships.

Group D: Fertility of wetland soils and land characterization in relation to soil classification

The group's mandate was to develop recommendations for a better characterization of the rice environment, and to relate environment to soil fertility and management practices. The group discussed issues concerning: 1) physical and chemical soil properties, 2) hydrological properties, 3) floodwater chemistry, 4) crop management aspects, and 5) soil testing practices that are now used for rice cultivation in several Asian countries.

On the basis of the papers presented, the field tour, and the discussions, Group D recommends that the following points be considered:

- The Fertility Capability Classification (FCC) system should be tested and applied to wetland rice soils as a means of grouping together soils with similar constraints.
- The FCC modifier for acid sulfate soils (c) needs further refinement to establish a better limit. An additional modifier for cation imbalance ratios (r) should be developed; additional modifiers for low topsoil organic N (q) and low native available topsoil P (p) should be investigated and incorporated into the system if reliable quantitative limits can be identified.
- Rice fertility and management field trials should classify the soil according to Soil Taxonomy at the family level. Emphasis should be given to mineralogical characterization in relation to fixation and release mechanisims. FCC should not be considered an alternative to Soil Taxonomy, but rather a technical system that facilitates the interpretation of Soil Taxonomy for agronomic purposes.
- A Hydrological Capability Classification (HCC) system should be developed similar to the FCC system to characterize in a systematic and quantitative manner extremely important factors such as: 1) water table depth during dry and wet seasons; 2) frequency, depth, speed, and duration of natural flooding; 3) quality of irrigation, flood, or groundwater; and 4) other relevant hydrological parameters. A working group should be established to develop the HCC. Hydrological constraints often override soil constraints in rice production. The development of this technical system, therefore is, considered urgent.
- Technical classification systems should be interpreted in terms of specific cropping systems, including rotations of puddled rice with other crops.
- An informal survey of soil testing methods for rice in Asia (Table 5) indicated that the Olsen-P method receives general acceptance. A critical level of about 10 ppm P is used in several countries. Total Kjeldahl N is widely used but critical levels are not clearly established. Various methods for K are used, but in many cases K is no problem at existing low yield levels. The strengthening of soil fertility evaluation services, including soil tests and correlations with yield responses, should be encouraged in rice-growing countries.
- Varietal differences in tolerance to soil problems should be quantified in terms of external (soil) or internal (tissue) critical levels. More research is needed on the physiological mechanisms involved in the Fe-toxicity syndrome, Al toxicity, and Zn and Cu deficiencies.
- Physical properties pose severe problems in wetland soils. Research is needed on structure regeneration after puddling in cropping systems with upland crops after rice. The use of raised beds after rice should receive more emphasis. Methods for collection and interpretation of data on physical parameters need improvement. It is hoped that the use of soil physical parameters will be clarified at the forthcoming IRRI conference on soil physical properties of wetland soils in December 1984.

Table 5. Some soil test methodologies and critical levels in various countries reported to Group D.

Country	N		P		K		Other remarks
	Method	Critical level	Method	Critical level	Method	Critical level	
Philippines	% OM	field trials 2 low 2-3 medium 3 high	Olsen	10 high 5-6 medium 4 low	K	75 ppm	Zn soil tests do not always correlate with yield response
India	% C	nr 1%	Olsen	some areas gr, other areas nr.		usually no K problem	Zn soil tests do not always correlate with yield responses
			Incubation + Olsen Bray II	gr nr			
Indonesia			Olsen	7-10	K	80	
Philippines (IRRI)			For azolla Olsen P.abs. capacity 1500 mg/100 g	25 gr			Zn soil tests do not always correlate with yield response
China			Olsen Bray (in soils pH 5)		avK		
Burma	% N		Truog		avK		Storrie index for general fertility status
Pakistan (rice-wheat)	% N	always deficient	Olsen calcareous saline, sodic soils	20	K calcareous saline, sodic soils	150	Sodicity: pH of sat. extract

Table 5. (continued)

Country	N		P		K		Other remarks
	Method	Critical level	Method	Critical level	Method	Critical level	
Malaysia	% N		Olsen		K		
Thailand	% N		Bray II		av K		Recommendations based on yield trials, in combination with soil tests
Vietnam	% N		Truog	10	total K	2%	K rarely a problem in deltaic areas
Nigeria	% N		Olsen Truog		No K problem in Niger		High pH-Zn deficiency
Cameroon	Only yield trials; no soil tests yet						
Australia							S deficiency of analysis of vegetative tissues and N-S ratios in grains.
Nepal	% N		Olsen		av K		

% N = total Kjeldahl N, % OM = Walkley and Black organic matter, avK = available K in NH_4OAc extract meq/100 g, K = K in soil extract ppm, nr = no relationship, gr = good relationship.

- For upland crops, some nutrient ratios with safe ranges exist. There is an urgent need to establish safe ranges of various ratios and their interactions with other nutrients for rice, and to translate the results into the proposed r modifier in the FCC. A working group to develop the r modifier was formed; it developed the following working hypothesis for the r modifier in the FCC system as an indicator for nutrient imbalances.

Ratios of various nutrients [like Ca:Mg, Mg:K, (Ca+Mg)/K] are sometimes used in upland crops to indicate nutrient imbalances. Safe ranges have been established. In Cameroon, for perennial crops, Ca:Mg was thought safe between 1 and 5, and Mg:K between 2 and 20. This indicates a safe range for (Ca+Mg)/K of 4 to 120. In Pakistan, Ca:K and Na:K imbalances are experienced on calcareous saline sodic soils, which might be related to the role of certain clay minerals in the release and fixation of nutrient elements.

For rice, imbalances and safe ranges have not been defined. However, data presented in the field guide (Table 6) indicate that excessive (Ca+Mg)/K ratios are somehow related to Zn and K deficiencies. On site 7, this ratio was 258; 49.8 kg of K resulted in a yield increase of 2.27 t/ha. Information from the IRRI Soil Chemistry Department suggests a relationship between the Ca-Mg ratio and Zn deficiency, with Ca:Mg < 2 as a critical limit. There is an urgent need to establish the safe ranges of various ratios for rice. Ratios for elements other than those mentioned above should be investigated.

Table 6. $\frac{Ca+Mg}{K}$ topsoil ratios of soils visited on field tour in relation to INSFFER trial yields at the site.

Stop no.	$\frac{Ca+Mg}{K}$ in top horizon	Rice yield (t/ha) Dry season Control	Dry season Highest	Wet season Control	Wet season Highest	Problems
1	43	3.3	9.7	4.1	5.3	---
2	147	4.2	6.6	3.2	5.2	---
3	34	2.9	7.0	---	---	---
4	200	3.5	4.7	---	---	---
5	74	---	---	3.0	4.4	---
6	118	---	---	4.9	6.3	---
7	258	3.8		2.3	---	K
8	90	---	---	4.4	6.1	---
9	168	---	---	3.9	5.8	---
10	72	---	---	4.1	6.2	---
11	---	dryland	---	---	---	---
12	331	na		na		Zn, K
13	295	na	---	na		Zn, K
14	195	---	---	3.2	4.2	Zn, K
15	30	---	---	4.7	6.5	---
16	5	na		na		

NP = 5.73, NPK = 8.00.

Workshop on Management of Vertisols
India, 18-22 February 1985

Vertisols, which occur extensively in humid and subhumid, semiarid, and arid climates, have potentials for food production well above their present level of use. there are approximately 310 million hectares of these soils in India, Australia, the Sudan, Ethiopia, Chad, Venezuela, Argentina, and other countries of Asia, Africa, and the Americas. They contain at least 30 percent clay, and the dominant clay mineral is usually one of the montmorillonite group. These properties give rise to the primary attributes of Vertisols that affect their management by man. These include high moisture retention and high shrinking and swelling, resulting in the concomitant mechanical difficulties in handling.

The Vertisols belong to four Suborders, as defined in Soil Taxonomy:

1. Torrerts - Vertisols of deserts.
2. Uderts - Vertisols in humid areas.
3. Usterts - Vertisols in areas with essentially summer rains.
4. Xererts - Vertisols in areas with mean annual soil temperatures of less than 22 degrees C and having winter rains.

The Vertisols with xeric soil moisture regimes--in Mediterranean climates--are mainly in northern Africa (Algeria, Libya, Morocco, Tunisia), the United States (California), and the southern Australia. Uderts are found in Trinidad and Venezuela, among many other countries, and Usterts are located in Ethiopia, India, northern Australia, and the Sudan, among others. Torrerts occur mainly in the Sudan, the Sahel, and the U.S.

Table 7 lists some countries considered to have Vertisols or vertic subgroups, by climate regions, as prepared by the Workshop participants.

The purpose of the Inaugural Workshop on Management of Vertisols for Improved Agricultural Production was to launch a Soil Management Network (SMN) for Vertisols.

The workshop reviewed the important principles of improved Vertisol management technology and their applications for increasing production under diverse farming systems. The specific objectives were:

1. To review the present knowledge of both traditional and improved farming systems on Vertisols under rainfed and irrigated conditions.
2. To review the present knowledge of the characterization and classification of Vertisols.

Table 7. Partial list of countries with Vertisols and vertic subgroups, by climate zones.

Humid & subhumid (udic) (8% of area)	Semi-arid (ustic) (70% of area)	Arid (torric) (18% of area)	Mediterranean (xeric) (4% of area)	High altitudes
Argentina	Argentina	Australia	Algeria	Colombia
Australia	Australia	Chad	Canary Islands	Ethiopia
Cameroon	Botswana	Colombia	Chile	Kenya
Canada	Brazil	Egypt	Cyprus	Tanzania
Colombia	Burkina Faso	India	Greece	
Commonwealth of the Caribbean	Burundi	Jordan	Iran	
Cuba	Chad	Pakistan	Iraq	
Dominican Republic	Colombia	Somalia	Israel	
	Commonwealth of the Caribbean	Spain	Italy	
Ecuador	Cuba	Sudan	Jordan	
El Salvador	Ethiopia	Syria	Lebanon	
Ethiopia	India	United States	Libya	
Fiji	Kenya	Venezuela	Morocco	
France	Malawi		Portugal	
Guatemala	Mexico		Spain	
Guayana	Niger		Syria	
Haiti	Nigeria		Tunisia	
Hungary	South Africa		Turkey	
India	Sudan		United States	
Indonesia	United States			
Mexico	Venezuela			
Nicaragua	Zambia			
Philippines	Zimbabwe			
Rumania				
Solomon Islands				
Sri Lanka				
Sudan				
Thailand				
Trinidad				
United States				
Uruguay				
Venezuela				
Vietnam				
Yugoslavia				
Zaire				

3. To evaluate the data-base and analytical techniques needed to assess the applicability of current advanced Vertisol management techniques.
4. Based on the previous objectives, by involving national and international operational and research institutions in exchanging ideas and collaborative work, to:
   a. Investigate the feasibility of an effective network for adaptive research and testing to introduce improved Vertisol management technology;
   b. Develop linkages between institutions involved in characterization surveys and management of Vertisols to improve interpretations for their more efficient use; and
   c. Identify areas of Vertisols that need further research for better evaluation and use.

The workshop was held over 5 working days. The first 2 days were devoted to reviewing and determining the state-of-the-art. A mid-workshop field tour of sites of operational and on-farm research provided a basis for discussion of ICRISAT's experiences in the development of improved management technologies. The fourth day was devoted to group discussions for determining the research and management needs of the network. The last day of the workshop was used to formulate the outline of a network.

Workshop

The opening session was chaired by L.D. Swindale, Director General, ICRISAT. C.F. Bentley, chairman of the governing board of IBSRAM, first introduced IBSRAM and the purpose of the meeting, then discussed various aspects of the proposed Vertisol Soil Management Network. S.M. Virmani, Leader of the Farming Systems Research Program at ICRISAT, presented an approach to the management of Vertisols in the semi-arid tropics, based on the experience gained by ICRISAT over the last decade of research on these soils. Virmani pointed out that, through the application of improved methods of management of Vertisols, crop yields of over 4000 kg ha^{-1} per year have been harvested in the last 9 years at ICRISAT watersheds. In on-farm tests, the improved technology showed two to five times higher gross profits than the traditional technology. M.A. Rasheed, Head, Soils Department, National Research Centre of Egypt, chaired the second session, in which participants discussed properties, use, and management of Vertisols in different agroecological zones of the world. The four presentations in this session described characterization of Vertisols in the semi-arid, arid, subhumid, and humid, and the Mediterranean regions. Speakers presented the role of physical properties of Vertisols in

relation to their management. R. Dudal, Professor, University of Leuven, Belgium, delineated the Vertisols and vertic soil area of the world. In reviewing his 1965 map on the global distribution of Vertisols, Dudal said, he now tentatively estimates this group of soils to occupy about 300 million hectares.

The research needs and constraints to improved use of Vertisols was the topic of four papers presented in the third session, chaired by J.S. Kanwar, Director of Research, ICRISAT. Examples of dryland, irrigated use of Vertisols in Australia, the United States, and the Sudan were reviewed. Pedological research needs of Vertisols were assessed. B.A. Stewart, Laboratory Director, USDA Conservation and Production Research Laboratory, United States, presented an interesting concept on a system of limited irrigation for dryland Vertisols.

In session four, participants discussed the components of the available technologies for the improved management of Vertisols. The following aspects were reviewed: crops and cropping systems, land and water management practices, soil fertility management, and tillage practices for soil and water conservation on Vertisols. It was observed that the effective surface drainage of excess water is critical for efficient management of these soils. Responses of crops to applied fertilizers were discussed, because these soils are generally deficient in nitrogen, phosphorus, and zinc. B.A. Stewart chaired this session.

The fifth and final session of paper presentations, chaired by R. Dudal, discussed methods for transfer of improved Vertisol management technologies from the research institutes through national agricultural development systems. L.D. Swindale outlined some available approaches to agrotechnology transfer, including analogue and soil family transfer. Other approaches for transfer using classification and soil survey interpretations were discussed, and a case study of the environmental characteristics of Vertisols in Syria was presented. Finally, the socioeconomic aspects of technology transfer to farmer fields were reviewed, and some IDRC (International Development Research Center [Canada]) experiences with networks were used to present some principles for network success.

Working group discussions and recommendations

Workshop delegates separated into four working groups to discuss and recommend future research priorities for improved management of Vertisols that would increase agricultural production. The groups focused on the following general topics:

1. Evaluation of the properties, survey, and classification of Vertisols,
2. Management of Vertisols under rainfed conditions,
3. Management of Vertisols under irrigated conditions, and
4. Validation of technologies.

Group 1 discussed the questions of guidelines for characterization of representative research sites and whether to recommend lines of research for better and more transferable results. It was suggested that it will be necessary to have information on soils, climate, topography, cropping systems, and previous research results of the area under question. In case there is no previous adequate information on the area, at least a reconnaissance soil map at 1:250,000 should be made. Landsat imagery was suggested as a base map. A description of the occurrence and distribution of natural vegetation in the area can help to indirectly determine climatic and moisture regimes.

The group presented two alternatives for site selection: one is to plant experiments in farmers' fields; the other is to select a site on an experiment station. Some of the basic items to consider if experiments are planted in farmers' fields include: proximity of the field to an agrometeorological station, accessibility to the site and availability of farm machinery and equipment, a highly motivated and collaborative farmer, and, naturally, an area with the representative soil. For an experiment station, the following should be considered: accessibility of the area, proximity to a source of labor, availability of water for the station and for potential irrigation, and the existence of large areas of the representative soil plus other representative soils considered on a regional basis.

In the site selected for research, it is important to make a more detailed study of the soil(s) under question. A convenient scale is probably 1:500 or 1:1000. The aim is a clearer understanding of the local variability for improved site selection for research plots. Suggestions were listed for sample analysis in the field and laboratory, and a list of land qualities and deficiencies in their evaluation was prepared. General priorities for research on poorly drained, acid, and sodic Vertisols were drafted. Finally, the group

recommended a training workshop session and a document describing the methodology for physical characterization in the field and in the laboratory.

Group 2 discussed research priorities for the management of Vertisols in drylands. It was noted that food production is generally low in the major Vertisol areas under rainfed conditions. This is true for both high and low rainfall areas. Although the very large Vertisol areas of the Sudan, India, and Ethiopia have rainfall between 500 and 1500 mm per year, crop production is still low. The reasons for this are many, but the most obvious are surface drainage problems, lack of water in the dry season, and inadequate plant nutrients. Initial efforts should be focused on putting into place the low-input changes that can increase yields and that will also serve as a foundation for additional technological steps. At the same time, however, some studies should be carried out to determine maximum production potential by integrating all components of a production system.

The group recommended that IBSRAM, in collaboration with the international centers including ICARDA, ICRISAT, and ILCA, among others, should identify specific research locations and document existing data bases, which would serve as a basis for the formation of the network.

Several priorities for research were listed under the following categories: tillage and land configuration, water conservation and use, nutrient management, cropping systems, and integrated component technology.

Countries indicating a desire to participate in a rainfed Vertisols network include the Caribbean countries, Ethiopia, India, and the Sudan. Botswana, Zambia, and Zimbabwe expressed various levels of interest, but perhaps cannot be immediately included.

Group 3 discussed research priorities for irrigated use of Vertisols. They stated that soil and water management requirements of irrigated Vertisols are different in many respects from the dryland Vertisols and other irrigated soils. To date, in many parts of the world, irrigated Vertisols have not received the special attention warranted by the problems peculiar to them. Therefore, there is an urgent need to identify and evaluate the problems of irrigated Vertisols. The group listed current activity areas, and each individual country submitted its own priority. Egypt, Nigeria, Pakistan, the Sudan, Tunisia, and ICARDA expressed great interest in participating in an Irrigated Vertisols Network.

Research priority areas were identified as follows: drainage; salinization and/or sodicity, including alkalinity; irrigation scheduling; crops and cropping systems; soil and land management; weed control; soil testing and crop yield responses under irrigation; and standardized methods for evaluating nutrient deficiencies, as by soil testing, foliar analysis, and field trials.

Group 4 discussed the verification, testing, and validation of improved technologies developed by various institutions. They considered it essential to select the components suitable to local needs. Rather than concentrating on a given technology, components should be identified from the various improved technologies available.

It was suggested that the Vertisol Soil Management Network should include the following principles for network cooperators:

- Establish a common objective and then set priorities.
- Allocate resources by the national research programs for the network.
- Identify the comparative advantages and leadership capabilities of the various organizations having improved technologies.
- Supply coordination and logistics, such as identification of a coordinator and the necessary infrastructure.
- Look at the levels of interaction desired.
- Link national cells with international, regional, and other related institutions.
- Establish principles for selection of areas of activity.

The full group reports are included in the proceedings of the workshop, to be published by ICRISAT later this year.

Workshop on Acid Tropical Soils
Peru-Brazil, 26 April to 3 May 1985

National research institutions face severe constraints of resources and qualified personnel in their search to enhance food and fiber production capabilities, and acid tropical soils occur extensively in many countries faced with such constraints. Traditionally, acid tropical soils have been considered marginal for agricultural use, but the current thirst for land of a burgeoning population in many developing countries is expanding their agricultural development. Although considerable knowledge has been obtained on how to appropriately manage acid tropical soils, little of the new technology is being used by farmers. As a result, deforestation and severe damage to the ecosystem often occur, raising worldwide environmental concerns. Only a few developing countries are making a concerted research effort toward sustained agriculture on acid tropical soils. Even fewer international research efforts collaboratively address mutual research needs.

The acid tropical soils referred to belong mainly to the Orders of Oxisols and Ultisols in Soil Taxonomy and are known as ferralitic soils in the French classification system. (Acid sulfate soils, organic soils, Andosols, and Spodosols were not considered at the workshop as they have other kinds of constraints to use). These soils comprise about 1675 million hectares in 72 developing countries. Their distribution by geographic region and in a few selected countries in each continent appears in Table 8. These soils represent the largest block (about 49 percent) of potentially arable land in the world.

The fact that most of these soils are located in the least developed regions of the third world suggests that their immediate use will be initially with low input agriculture. A recent study by FAO projects that about one-half of the developing countries will not be able to feed themselves by the year 2000. Further, to maintain current levels of food production, an additional 200 million hectares of new land must be brought into production by the same year. Much of this land development is anticipated to take place on acid tropical soils.

The acid tropical soils occur mainly in the humid tropics and in the savannas. These two ecosystems are well defined in terms of climate, vegetation, and socioeconomic infrastructure. Any collaborative effort to study and develop technologies must clearly distinguish between the two ecosystems. In addition, and specifically in the humid tropics, sustained farming systems may rely largely on perennial crops.

Table 8. Estimates of the extent of acid tropical soils (Oxisols and Ultisols) in selected regions and countries.

Region/country	Total land area of acid tropical soils	
	Million hectares	Percentage of region or country
Tropical America	852	51
Tropical Africa	490	27
Tropical Asia	333	38
Tropical total	1675	38
South and Central America		
Brazil	571	67
Colombia	67	59
Peru	56	44
Venezuela	52	57
Mexico	6	3
Panama	5	71
Southeast Asia		
Indonesia	82	43
Thailand	42	82
Malaysia	24	72
China (tropical)	16	48
Africa		
Zaire	183	78
Zambia	34	45
Madagascar	21	36
Cameroon	20	41
Ivory Coast	19	58
Congo	17	50

Despite some differences in environments, the soils as a group have common constraints. The commonality of these constraints provides a sound basis for the development of a research network composed of national research institutions from the countries with large areas of acid tropical soils. Whatever the level of development of these institutions, each would benefit from the experiences of the others.

It is for this reason that this workshop was organized. By exposing the participants to long-term research on acid tropical soils in Peru and Brazil, and to the ideas presented in the keynote workshop papers, IBSRAM hoped to gauge the interest of the national program participants in forming the Acid Tropical Soils Management Network described in this document.

The workshop consisted of two main parts: the field tour (the first 6 days) and the meeting in Brasilia (the next 4 days). A total of 67 individuals participated in the workshop (Figures 5 and 6); of these, 30 participated in all portions.

Seven donor agencies sent representatives to the workshop: The Australian Centre for International Agricultural Research (ACIAR), the Government of France, the Dutch agency for international development (DITH), the International Development and Research Centre of Canada (IDRC), the Overseas Development Administration of the United Kingdom (ODA), the Norwegian development aid agency (NORAD), and the U.S. Agency for International Development (USAID).

The following 17 research institutes and universities were also represented at the workshop: Agriculture University of Norway, Centre International de Recherche Agronomique pour le Developpement (France), Centro International de Agricultura Tropical (Colombia), Commonwealth Scientific and Industrial Research Organization (Australia), Corporacion Araraucara (Colombia), Escola Superior de Agricultura de Lavras (Brazil), FAO, Institut de Recherche pour le Development en Cooperation (France), Instituto Interamenicano de Cooperacion para la Agricultura, International Services for National Agricultural Research (Netherlands), International Soil Reference and Information Centre (Netherlands), Cornell University, Indiana University, North Carolina State University, University of Hawaii, University of Queensland, and University of Reading.

Figure 5. In Manuas, Brazil, participants evaluate field experiments on acid soils during the Acid Tropical Soils Workshop.

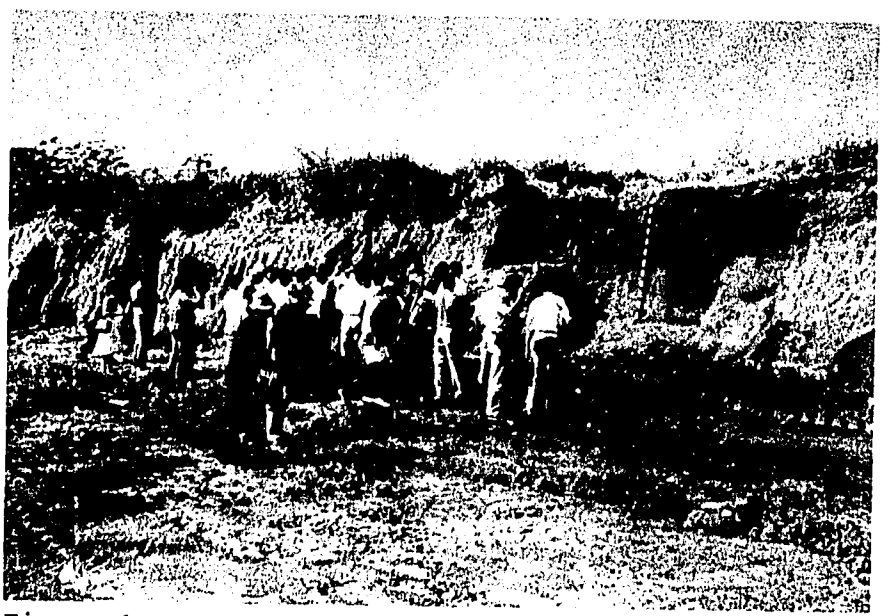

Figure 6. Participants study a typical acid soil profile in the cerradoes of Brazil. Photograph taken at EMBRAPA Station, Planaltina, Brazil.

The total distribution of participants by country where they work was: Australia (3), Brazil (17), Cameroon (1), Canada (1), China (1), Colombia (2), Congo (1), France (3), Italy (1), Ivory Coast (1), Madagascar (1), Malaysia (2), Mexico (1), Netherlands (3), Norway (1), Panama (1), Peru (9), Thailand (2), United Kingdom (1), United States (9), Venezuela (1), and Zambia (5).

The purpose of the field tour was to review ongoing work at key stations performing strategic research in the humid tropics and acid savannas of South America. Participants assembled in Lima and spent 3 days in Yurimaguas, 1 day in Manaus, and 1 day in Brasilia. The field tour route, covering approximately 6500 km, allowed participants to review two humid tropical sites: Yurimaguas, with Ultisols under tropical rainforest vegetation; and Manaus, with Oxisols under seasonal semi-evergreen forest vegetation; the Cerrado Agricultural Research Center near Brasilia has Oxisols under acid savanna vegetation. The sites also illustrated a wide spectrum of socioeconomic conditions, ranging from small farmer shifting cultivation to modern mechanized farms.

At the Instituto Nacional de Investigacion y Promocion Agraria (INIPA) Yurimaguas Agricultural Research Station, the groups were exposed to an overview of Amazon soils and ecology, computerized interactive systems, laboratory facilities, continuous cropping systems, low input cropping systems, legume-based pastures, agroforestry, and paddy rice production on alluvial soils. Visits were made to shifting cultivation sites and cattle production farms. The group was also honored by the Yurimaguas authorities at a City Hall reception.

At EMBRAPA's Manaus Agricultural Research Station, the group observed a typical Oxisol profile, a long-term experiment on soil dynamics, and field trials on phosphorus, liming, and intercropping of perennial species. The difference in soils and climate between Yurimaguas and Manaus covers a major range within humid tropical ecosystems.

At EMBRAPA's Cerrado Agricultural Research Center (CPAC), the group was introduced to the acid savanna soils and to the management of annual crops, pastures, and perennial crops. Some CPAC laboratory facilities were toured. The afternoon was spent visiting a recently cleared Cerrado region devoted mainly to soybean production.

The first day of the formal meeting was devoted to reviews of acid tropical soil research in various geographical regions. After opening remarks,

review papers were presented for the humid tropics of Southeast Asia, the acid tropical soils of Africa, the humid tropics of Latin America, and the acid savannas of South America. Discussions on these topics and on IBSRAM's network approach ensued.

The second day consisted of keynote papers relevant to the proposed working groups and overall considerations. They included pedology fertility relationships, soil fertility methodologies and nutrient dynamics, soil acidity, environmental characterization, socioeconomic considerations, and technology transfer issues.

After a conceptual review of networks, the participants were assigned to six working groups. The chairmen of the working groups presented the preliminary findings of their groups to the country representatives. This enabled the country representatives to be kept informed of developments in all the working groups. At the same time, the views of country representatives were noted by the chairmen for consideration at subsequent group deliberations. The working groups prepared formal proposals, which were then presented at a general session and accepted by the participants.

The final day of the workshop consisted of reports from each country indicating their specific level of interest and potential participation by ecosystem, their degree of interest in each of the six activity areas reviewed by the working groups, and their overall interest in forming the network. An interim Network Coordinating Committee was appointed to assist IBSRAM in implementing the Acid Tropical Soils Management Network.

Goals and Objectives of the Proposed Network

The overall goal of the Acid Tropical Soils Management Network is to serve as an international means to coordinate research on acid tropical soils, validate and transfer improved technologies, and foster their adaptation for sustained food production by farmers in developing countries.

The objectives of the network are:

1. To strengthen agricultural research on acid tropical soils for the purpose of:
    a. validating and/or developing principles of pedological characterization and their linkages to fertility evaluation;
    b. validating and/or developing soil management components of farming systems for the efficient management of soil acidity for sustained production;

c. validating and transferring soil management technologies developed for efficient use of phosphorus fertilizers;

d. developing improved management of the soil surface by physical or biological means;

e. validating and/or developing technologies that reduce degradation of soils through use and which, when necessary, rehabilitate the soil for sustained production; and

f. developing and testing research methodologies for the evaluation and dynamics of nutrients, toxic elements, and physical and biological soil properties.

2. To exchange information on validated technologies by:

a. conducting training programs for research and extension staff of national institutions;

b. publications, newsletters, and audiovisuals;

c. computerized interactive systems; and

d. workshops and seminars on specialized subject matter.

3. To strengthen national institutions by providing technical support services for problem solving, including experimental design, statistical and soil analyses, and data base design and development.

Research-Validation Activities

From the reports of the six working groups at the workshop, the major areas for research-validation activities of the Acid Tropical Soils Management Network were determined to be (a) pedology and soil fertility,(b) soil acidity, (c) phosphorus fertilization, (d) management of the soil surface, (e) rehabilitation of degraded lands, and (f) soil dynamics.

The reports of the working groups provided guidelines for specific research needs and priorities within each of these areas. It was agreed that network activity should focus on the working group reports, and that these reports should serve as the basis for the proposals for potential country participation.

The full report will be printed in the proceedings; the following is a summary of research-validation activities suggested for each major area.

Summary of Working Group A: Pedology and Soil Fertility. The network should:

- establish an international reference base for soil characterization and soil fertility parameters;
- establish and collect minimum data sets for the major experimental stations and on-farm research sites;
- examine present coverage of acid tropical soils by existing research stations and recommend new stations if necessary;

- promote research to establish better relationships between pedological characteristics and management behavior of acid soils, as well as to develop fertility capability groupings based on farming-systems information; and
- develop expert systems or other interactive computer systems that incorporate available information and use them as a tool for technology transfer.

Summary of Working Group B: Soil Acidity. The network should:

- Assess the current status of knowledge of soil activity and foster consolidation and interchange of information among network scientists.
- Develop standardized methodologies for characterization of soil acidity in relation to plant growth.
    * Direct attention toward assessment of charge characteristics and determination of species and activities of ions in the soil solution.
    * Focus on aluminum. The characterization of soil solutions can best address the question of whether aluminum toxicity or calcium deficiency limits plant growth, or, if both, under what conditions one is a larger constraint than the other.
- Promote an experimental program to ameliorate soil acidity.
    * Determine management considerations for soil amendments and develop management practices for both surface and subsurface horizons.
    * Determine implications of liming for legume nodulation, nitrogen fixation, organic-matter mineralization, nitrification, and mycorrhizal activity.
    * Determine management practices for use when liming materials are not available or are noneconomic.
- Develop a methodology for characterizating plant adaptability to soil acidity and selection of tolerant species and cultivars.
    * Establish reference collections of germplasm for both pot trials and field experiments.
    * Evaluate plant indices as indicators of tolerance to soil acidity.

Summary of Working Group C: Phosphorus Fertilization. The network should:

- Validate concepts on rates and methods of phosphorus application.
    * Conduct field plot experiments to obtain response curves on representative soils.
    * Compare band and broadcast methods of application.
    * Assess residual effects.
    * Calibrate field results with standard laboratory procedures.
- Determine the interactions of phosphorus with lime, organic manures, and green manuring.

* Measure interactions in field plot experiments.
* Assess the practical value and residual effects of liming and manuring based on local conditions and availability.

- Promote the use of cheaper sources of phosphorus.
  * Characterize locally available phosphate rock materials.
  * Compare agronomic efficiency of these materials.
  * Assess the calcium-supplying properties of available materials.
  * Assess transformation technologies of available rock phosphate materials in relation to agronomic and economic efficiency.
- Monitor nutrient balance interactions of phosphorus with macro- and micronutrients.
- Evaluate phosphate use in different farming systems through on-farm trials, and assess the socioeconomic factors involved.
- Encourage research on mycorrhiza where facilities are already available.

Summary of Working Group D: Management of the Soil Surface. The network should:

- Validate tillage practices that result in minimum surface compaction and practices to overcome existing physical impediments (deep ripping) while also providing for possible necessary incorporation of amendments.
- Where appropriate, validate existing knowledge and evolution of new technology in both the humid tropics and the savannas with emphasis on:
  * residue by tillage interactions;
  * pasture-crop rotations;
  * legume understory in perennial crops; and
  * alley cropping and managed fallows;
- Give emphasis to cover crops or mulch that have food, economic, or forage value.

Summary of Working Group E. Rehabilitation of Degraded Lands. The network should:

- Assess various degradation features of acid soils.
  * Compare basic relationships between degradation features and soil properties.
  * Study relationships between soil erodibility and rainfall erosivity.
- Develop methodologies for rehabilitation of degraded lands.
  * Evaluate management practices to eradicate undesirable weeds.
  * Compare conservation-oriented tillage practices.
  * Study fertilizer use and legume-based practices.
  * Study the efficiency of agroforestry, wooded pastures, and other cover crops, especially on steep lands.

- Evaluate socioeconomic aspects of reclaiming degraded lands, including cost of rehabilitation extension methods and their effectiveness.

Summary of Working Group F: Soil Dynamics. The network should:

- Produce state-of-the-art reviews on soil physical, biological, and chemical dynamics from currently available studies on acid soils in the humid tropics and savannas.
- Establish trials to evaluate soil dynamics under different tillage practices.
- Establish trials to evaluate soil dynamics under different cropping systems, such as arable and permanent crops, pastures, agroforestry, and fallow systems.
- Establish trials to evaluate soil dynamics under different organic-matter management systems.

International Training Forums

Three training courses were conducted in FY 1985:

a. Xth International Forum, in Rwanda/Burundi

b. XIth International Forum, in Zambia

c. XIIth International Forum, in Tunisia

The Xth Forum was for the Central African region covering Rwanda, Burundi and Zaire; the XIth was for the Southern African region of Zambia, Botswana, Zimbabwe, Malawi, and Nambia, and the XIIth was for the North African region of Tunisia, Morocco, Algeria, Egypt, and the Sudan. All these countries have an active soil survey program and most are using Soil Taxonomy.

SMSS strategy is to continue with such forums until FY 1987. By then, about 20 such forums involving an approximate total one thousand participants will have been conducted. The emphasis on Soil Taxonomy is needed because to make agrotechnology transfer become operational, a common language is essential. In Phase II commencing FY 1988, SMSS hopes to introduce fertility- and management-oriented training forums. SMSS has also received requests to organize training in selected fields such as soil analysis, soil survey methodology, and soil conservation. These will be considered in Phase III.

A summary of the three forums follows.

Xth International Forum, Rwanda/Burundi, 1-12 April 1985

As Rwanda and Burundi both have active soil survey programs, when SMSS received an invitation to organize a forum in Rwanda, it was proposed that it be a two country forum. The University of Burundi agreed to host the Burundi part of the forum, while Rwanda's part was coordinated by the Carte Pedologique Rwanda.

Rwanda and Burundi are located in Central Africa and, though they are in the tropics, their agroenvironment is distinctly different from other parts of Africa and even other parts of the world. Located at elevations of 1500 m to over 2500 m, the highlands of Central Africa have special soils. These countries also have one of the highest population densities in the world. Consequently, knowledge of the soils is crucial to agricultural development. The governments of both countries realize this and, under bilateral programs, are investing heavily on soil reserves inventories. The forum was organized in the context of the soil survey programs. At present, Rwanda is using Soil

Taxonomy in their soil survey programs, while in Burundi it is only used in their reports, though the University of Burundi offers it as a course in its soil science program.

Collaboration

Major funding for this Forum was provided by:

a. Belgian Administration for Development Cooperation (BADC),

b. USAID/Kigahi, and

c. USAID/Bujumbura.

As the forum was conducted in French, most of the resource persons were from Belgium. The resource persons that participated include:

R. Tavernier, University of Ghent, Belgium

G. Stoops, University of Ghent, Belgium

R. Frankart, University of Louvain, Belgium

J. Lozet, University of Itue, Belgium

J. Embrechts, University of Ghent, Belgium

W. Johnson, Retired, SCS, Deputy Chief

A. Touchet, SCS, Louisiana

A. Eid, FAO

G. Balasubremaniam, IITA, Nigeria

Staff of the Ministries of Agriculture and of the Universities of Rwanda and Burundi also served as guest lecturers.

Participants

Of the 45 participants, there were 35 from Rwanda, 12 from Burundi, and 3 from Zaire. Most participants were agriculture or extension officers and some worked at the universities. There were about 15 active soil surveys.

Program

The 13-day forum comprised 6 days of classroom sessions and 7 days of field tours. During the field tour, the participants were able to study a range of tropical mountain soil (Figures 7 and 8). Many of these soils have a special horizon called the Sombric Horizon. Nothing much is known about the genesis and significance of this horizon or these kinds of soils. During the forum, a special discussion was held; the report of this discussion is attached in Appendix III.

Figure 7. Hands-on training during the Xth International Forum on Soil Taxonomy and Agrotechnology Transfer for Rwanda and Burundi.

XIth International Forum, Zambia, 15-31 July 1985

The XIth International Forum on Soil Taxonomy and Agrotechnology Transfer was organized by the Ministry of Agriculture and Water, and the University of Zambia. This forum was an example of international collaboration.

The forum had the same objectives as all previous ones, but focused on soils with low activity clays as these are the dominant soils of Zambia. The field tour was organized to provide a cross section of the country commencing at the tip of Lake Tanganyika in the north to Victoria Falls in the south.

Collaboration

The following organizations were involved in funding and organizing the forum:

1. Norwegian Technical Assistance (NORAD)
2. Belgian Technical Assistance (BADC)
3. USAID/Cusaka
4. International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT)
5. TropSoils
6. Canadian Technical Assistance (CIDA)

The Soil Survey Unit of the Ministry of Agriculture is a project of NORAD with counterpart staff provided by the Ministry. The soil survey of Zambia is using Soil Taxonomy and the FAO legend in its survey program. This forum was requested by them.

Resource Personnel at Forum

Some of the world's experts on soils of the tropics were present to serve as resource persons:

Stan Buol, North Carolina State University

Goro Uehara, University of Hawaii

Rudy Dudal, University of Leuven, Belgium

Rene Tavernier, University of Ghent, Belgium

Frank Moormann, University of Utrecht, Holland

Thurmond Grove, Cornell University

Armand Van Wambeke, Cornell University

Bal Ram Singh, University of Norway, Norway

Figure 8. Discussions at a soil pit during a field tour of the Rwanda/Burundi forum held 1-12 April 1985.

In addition, scientists from the University of Zambia and the Ministry of Agriculture were invited to present lectures.

Participants

A total of 65 participants attended the forum.

Country	Participants
Zambia	48
Botswana	4
Zimbabwe	3
Namibia	3
Norway	2
The Netherland	1
United States (Virginia Polytech)	4

Three participants from Malawi were expected but did not attend. Applications were also received from Tanzania, Zaire, and Lesotho but lack of funds prevented their participation.

Program

The forum was opened by the Honorable Reuben Kamanga, member of the Central Committee of Zambia (Figure 9). The keynote lecture following the opening ceremony was presented by Rudy Dudoit on "the Role of Soil Surveys in Agricultural Development Programs." There were 8 days of indoor sessions and 9 days of field trips. Seventeen pedons were studied in the field and classified. Most of the pedons were located at agricultural experimental stations, so the classification discussions were supplemented by information on management.

At the end of the forum, the participants developed several recommendations which are included in Appendix IV. Appendix IV also contains the closing address of Hon. R. Kamanga, and of the SMSS Program Leader presented at a dinner hosted by the members of the Central Committee of Zambia.

XIIth International Forum, Tunisia, 2-14 September 1985.

The Arab Centre for the Studies of Arid Zones and Drylands (ACSAD) of Syria has the project of developing the soil map of the Arab world at a scale of 1:1 million using Soil Taxonomy. SMSS is a collaborator in this project andhas worked with ACSAD to organize workshops and training forums in the region. The XII Forum is the third to be organized in the region, the previous

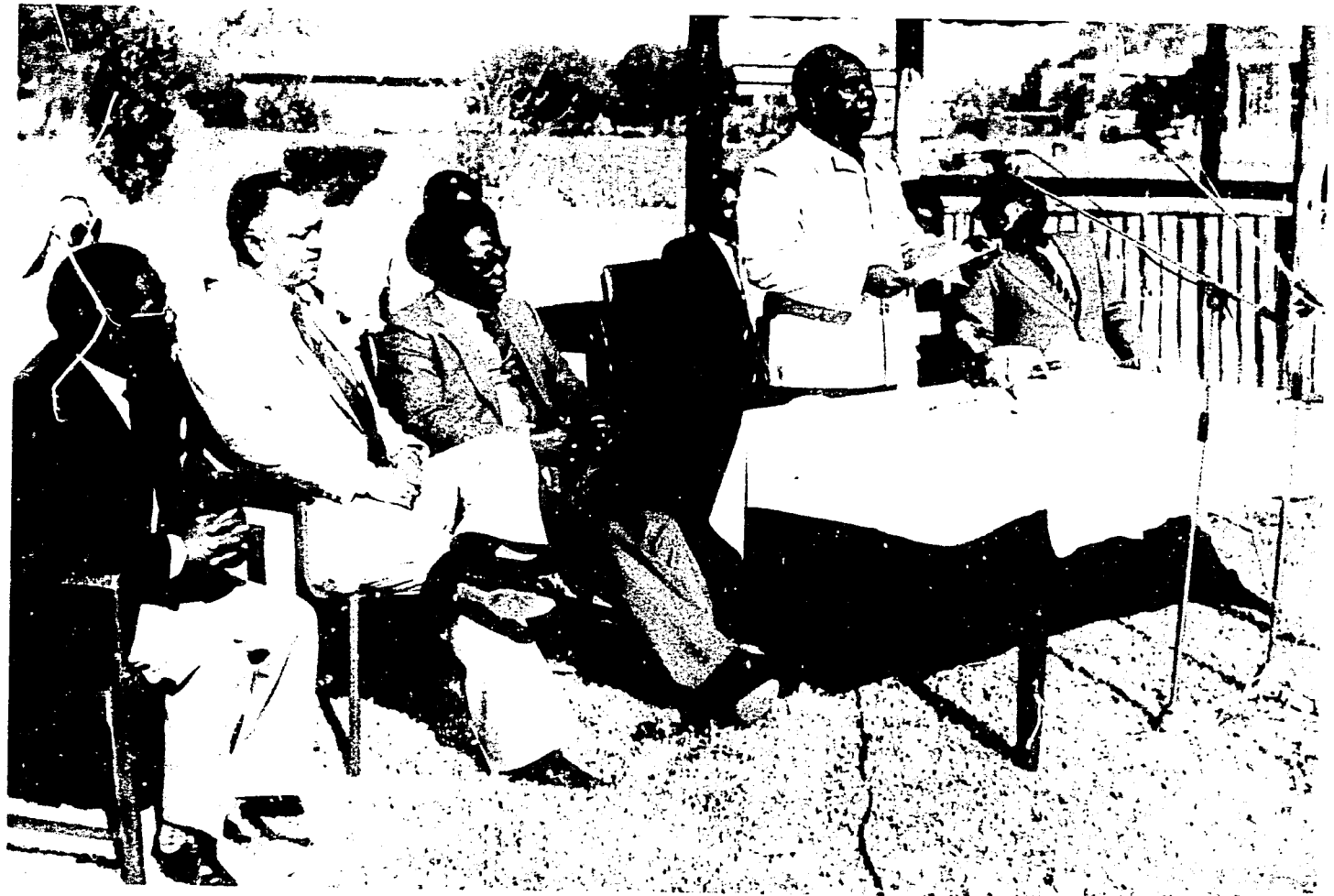

Figure 9. Opening ceremony at XIth International Forum, Zambia. Addressing the participants is Honorable Reuben Kamanga, Member of the Central Committee (standing). To his right is the Honorable General Kingsley Chinkuli, Minister of Agriculture.

two being in Morocco and Jordan. The host organization was the Soils Division of the Ministry of Agriculture.

Participants

Participants were from the following countries: Syria, Saudi Arabia, Yemen, Kuwait, Palestine, Oman, Algeria, Chad, United Arab Emirates, the Sudan, and Tunisia. There were a total of 35 partcipants of which 15 were English speaking and the remaining were French speaking. So the program was conducted in two languages with simultaneous indoor sessions in English and French. Discussions during the field tour were in English, French, and Arabic.

Program

There were 6 days of classroom sessions and 7 days of field tours (Figure 10). The field tour made a transect from the north to the south, and 16 pedons under various soil moisture and temperature regions and parent materials were examined. The highlight of the tour was the discovery of a soil with a duripan. The duripan has now been sampled for confirmation and if it is one, then it will be the first duripan described in North Africa.

All the soils were classified according to Soil Taxonomy, the French classification, and the FAO legend. A proceeding of this forum will be published by ACSAD.

On the last day of the forum, a special meeting of ICOMID was conducted. The present classification of Aridisols is not very satisfactory. This became evident during the tour. A new proposal was submitted and discussed. Copies of this proposal may be obtained from SMSS.

Figure 10. At the Tunisia Forum, cameraman Dr. A. Van Wambeke films the cracks on soils for the SMSS audiovisual training package.

World Benchmark Soils Project

The World Benchmark Soils Project (WBSP) provides characterization dates for refernce on benchmark soils throughout the world. Many of these soils are located at agricultural experimental stations in developing countries and, in many instances, this is the only complete characterization of the soils.

Although the intent is to have as many reference sites as possible characterized and documented, no special effort is made in terms of TDYs (temporary duty assignments) for this project. The samples collected to date constitute the samples collected for the training forums and the Soil Classification Workshops. In addition, SMSS has a collaborative linkage with IBSNAT and TropSoils projects where their experimental sites are also characterized. On a few occasions SMSS has characterized experimental sites of USAID projects.

The result of this project is that SMSS now has one of the most comprehensive collections of representative world soils, which have been described and analyzed in a systematic way. Table 9 summarizes the pedons which have been characterized up to FY 1985. Sampling has taken place in 34 countries. The annual sampling pattern is:

Year	No. of Pedons	No Samples
1979	27	120
1980	3	15
1981	42	221
1982	135	816
1983	123	656
1984	120	731
1985	75	450
1986	20	120
Total	545	3129

Table 10 provides the breakdown of the pedons according to soil Orders in Soil Taxonomy.

Table 9. Sampling activity of SMSS.

Project Name	Project Number	No. of Pedons	No. of Samples	Samples Received	Data Out
FY 1979					
Syria-Lebonon	CP79-FN204	27	120	79/07/30	80/12/05
FY 1980					
Senegal	CP81-FN060	3	15	80/12/02	81/08/13
FY 1981					
Rwanda	CP81-FN122	16	90	81/12/02	81/05/21
Syria	CP81-FN137	11	39	81/03/03	81/07/31
Brazil	RP81-FN155	1	4	81/03/10	81/09/21
Sudan LAC Study	RP81-FN185	5	35	81/04/21	81/09/17
Senegal	RP81-FN206	4	19	81/08/31	81/12/08
The Gambia	RP81-FN293	5	34	81/09/28	82/04/16
FY 1982					
Sudan Workshop	CP82-FN090	28	139	82/01/07	82/06/01
Mali	CP82-FN099	10	49	82/01/25	82/08/06
Morocco	CP82-FN131	4	16	81/03/22	82/04/05
Thailand	CP82-FN138	19	107	82/04/02	82/08/27
Indonesia	CP82-FN139	4	32	82/04/13	82/09/10
Philippines	CP82-FN145	3	20	82/04/13	82/09/10
CATIE	CP82-FN151		9	82/05/18	82/09/10
Guatemala 2 pedons		2			
Honduras 4 pedons		4			
Costa Rica 2 pedons		2			
Yemen	CP82-FN162	3	14	82/06/07	82/07/09
Jordan	CP82-FN187	14	83	82/09/10	83/03/16
Lesotho	CP82-FN191	15	96	82/06/18	83/04/29
India	CP82-FN210	5	41	82/97/13	83/01/10
Hawaii Benchmark sites	CP82-FN223	4	32	82/09/03	84/06/06
Papua New Guinea	CP82-FN240	16	86	82/09/10	83/08/08

Source: Analytical Characterization Projects for SMSS at the NSSL.

Table 9. Sampling activity of SMSS (continued).

Project Name	Project Number	No. of Pedons	No. of Samples	Samples Received	Data Out
Puerto Rico Benchmark sites	CP82-FN253	2	13	82/09/23	83/10/12
FY 1983					
CATIE	CP83-FN021			82/11/04	83/09/23
Panama		2	4		
Costa Rica		4	21		
Honduras		2	11		
Panama	CP83-FN078	15	80	83/01/03	83/12/09
Indonesia	CP83-FN088	18	57	83/01/17	84/03/02
Kenya	CP83-FN095	2	10	83/01/21	83/12/09
New Zealand	CP83-FN096	1	22[a]	83/01/25	84/05/03
Mauritania	CP83-FN097	11	43	83/01/26	84/02/10
Cameroon	CP83-FN124	3	20	83/03/26	84/03/09
Ecuador	CP83-FN128	13	85	83/03/18	83/12/15
Chile	CP83-FN129	13	91	83/03/23	83/12/15
Guatemala	CP83-FN131	12	51	83/03/24	84/02/14
Honduras	CP83-FN133	7	38	83/03/25	84/05/27
Cameroon	CP83-FN135		24[b]		84/05/24
El Salvador	CP83-FN136	6	27	83/03/28	84/04/03
Costa Rica	CP83-FN147	2	10	83/04/22	83/03/05
Nicaragua	CP83-FN200	10	50	83/07/13	84/07/15
Papua New Guinea	CP83-FN259	2	12	83/09/20	84/04/06
FY 1984					
Philippines Workshop	CP84-FN022	26	152	83/02/11	84/03/02
Venezuela IBSNAT sites	CP84-FN068	6	28	83/12/20	84/12/21
CATIE Costa Rica	CP84-FN074	12	65	83/11/30	85/06/13[c]
Burundi	CP84-FN077	16	74	84/01/10	84/10/17[c]

[a] Extra volcanic samples collected for methods comparison between New Zealand and the NSSL.
[b] Samples for CEC check not complete characterization.
[c] Samples estimated to arrive in Lincoln.

Table 9. Sampling activity of SMSS (continued).

Project Name	Project Number	No. of Pedons	No. of Samples	Samples Received	Data Out
Rwanda	CP84-FN091	17	106	84/02/02	85/01/23[c]
Zambia	CP84-FN132	20	123	84/04/26	85/03/06[c]
Pakistan	CP84-FN150	23	183	84/06/15	85/05/28[c]
FY 1985					
Philippines	CP85-FN153	4	22	85/04/05	85/06/14[d]
Philippines	CP85-FN154	17	112	85/04/05	85/12/27[d]
Taiwan	CP85-FN116	1	11	85/09/13	85/10/13
Brazil	---	23	--	85/07/85[e]	85/11/01[d]
Western Samoa	---	14	--	To be Sampled	July 1985
Japan	---	20	--	To be Sampled	Sept. 1985

[c] Preliminary data sent out.
[d] Project due date.
[e] Samples estimated to arrive in Lincoln.

Table 10. Pedons sampled by SMSS as listed by Orders in Soil Taxonomy.*

Order	Sampled Pedons
Inceptisols	115
Ultisols	55
Alfisols	55
Vertisols	53
Mollisols	48
Entisols	31
Oxisols	24
Aridisols	19
Spodosols	6
Histosols	3
	409

* This list does not include pedons from Rwanda, Burundi, Zambia, and Pakistan which have not been given a final laboratory classification.

UTILIZATION AND IMPACT

Project services continue to be utilized by AID Bureaus and Missions and LDC institutions. Requests for SMSS publications and the fact that over 3000 copies of the newsletter are printed is clear evidence of the usefulness of SMSS activities.

As indicated in our previous reports, impact is difficult to assess. Two major reasons are: (a) SMSS differs from other projects which are country specific; being a worldwide program our activities are spread out and even though cumulatively we have achieved outputs, our efforts with respect to any one country are not obvious, and (b) it requires a number of years for a project like SMSS to establish itself and become known.

SMSS has now been operational for 6 years; we have had contacts with institutions and scientists in more than 50 countries, and have established linkages with many organizations. Through our small publications program, we have reached many people. One of the ways we can evaluate the impact of the program and the utilization of its products is to cite specific examples.

Cost Sharing

This is perhaps the best testimony to the value of the activities of a program. In FY 1984, donors and organizations contribute more than $350,000 to SMSS activities. This ranged from co-sponsorship of workshops and training courses to cost sharing for SMSS publications. Cost sharing of technical assistance activities by USAID Missions, other USAID projects, and other donors are slowly becoming a feature of this component of SMSS activities.

The Soil Conservation Service of USDA is increasingly using SMSS technical assistance to strengthen the performance of its soils scientists. The Chief of SCS, William Scaling, recently indicated the importance to his staff of such international exposure. U.S. universities are providing their staff to SMSS at no cost for the training courses because they value the international experience the staff obtains. Similarly, universities in Europe and Australia have contributed to SMSS activities.

Follow-up to SMSS Activities

National organizations are using SMSS training packages and programs for their in-service training. Good examples are the Philippines, Zambia, Tunisia,

and Taiwan. Due to logistics problem, only a limited number of participants can attend an SMSS training course. Consequently, national institutions arrange their own training, particularly for junior staff.

The Soil Classification Workshops have also been used for other purposes. The best example is the Workshop in Sudan. Soon after it was over, FAO organized an East African soil conservation tour during which they used the SMSS tour guide and the exact sites covered during the workshop.

As indicated earlier, ACSAD has a project to make the soil map of the Arab countries. The joint training activities and workshops of SMSS-ACSAD are part of this. In October 1984, ACSAD organized a similar training course in Syria, in Arabic, using SMSS training materials. The Arab Organization for Agriculture Development (ADAD) is providing $175,000 for this one month course.

Based on reports of Taiwanese participants to SMSS forums, the Agricultural Research Council of Taiwan is planning to organize its own training course in Chinese next year.

Publications

SMSS Technical Monograph No. 6 is only a limited edition. The best compliment this publication on Keys to Soil Taxonomy received was the appearance of a pirate edition in the Philippines. The publication has now been translated into Japanese, and scientists from the People's Republic of China and from Greece are working on Chinese and Greek translations, respectively.

Soil Taxonomy News, the newsletter of SMSS, is a widely respected newsletter. Excerpts from it have been included in other newsletters, such as the one by FAO. At the University of Ghent, each newsletter is photocopied and mounted on the bulletin-board for all students to read. The International Soil Museum wishes to compile and reprint all the articles on the "History of Soil Classification" which have been published in the newsletter.

SMSS audiovisual training packages are now used by several universities, for example, University of Ghent, Belgium; University of Burundi; University of Los Banos, Philippines; University of Zambia; University of Zimbabwe; Kasetsart University, Thailand; Khon Kean University, Thailand; and University of Hawaii.

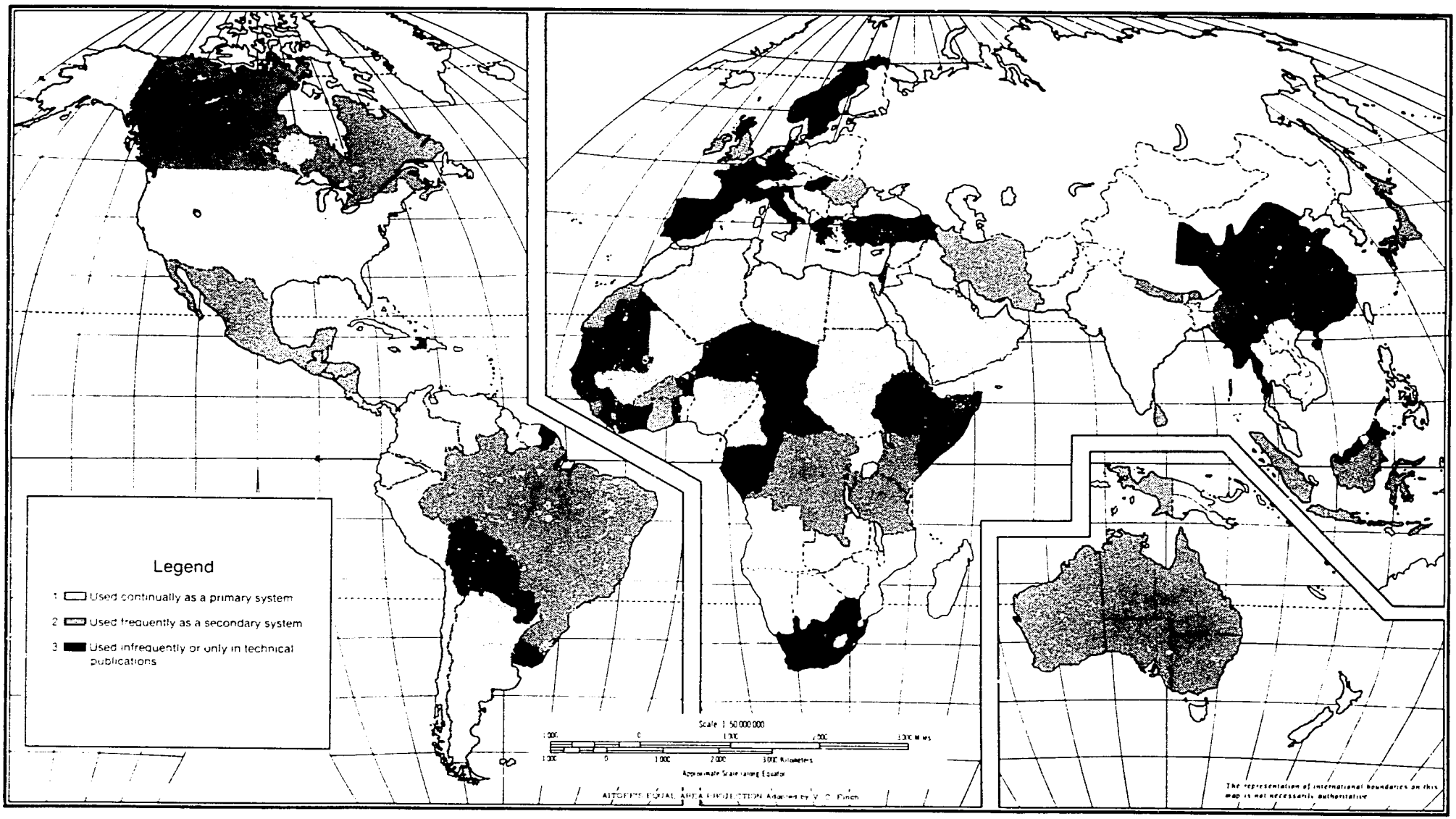

Figure 11. International Use of Soil Taxonomy (1985).

World Benchmark Soils Project

Through this project SMSS has described, sampled, and analyzed more than 500 soils from 30 countries. This is probably the most comprehensive data bank in the world with the most complete set of analyses and possibly the most reliable data. The data bank is increasingly being consulted by many workers. The Agriculture Research Service at Temple, Texas, is using all the data for testing and validating their simulation models, which they are developing in collaboration with IBSNAT. Cornell University has published a special monograph on the soils of Panama using data from this data base.

The soils in the data bank are being used by researchers for special analysis. IBSNAT used the soils for developing methods of phosphate analysis. The University of Kyushu, Japan, is performing infrared and nuclear magnetic resonance studies on some of these soils. The University of Nebraska has used them for fertility evaluations.

International use of Soil Taxonomy

All the technology transfer activities reported on until now are partly directed at enhancing the international use and application of Soil Taxonomy and accepted systems of soil classification. Figure 11 shows the situation in 1985 and may be compared with earlier years reported in the Progress Report (SMSS 1984). The assessments are based on contacts with soil survey organizations and through reports and publications. At the end of 1986, a questionnaire will be sent to all countries to develop a more accurate appraisal.

APPENDIX I

Soil Management Support Services Advisory Panel Meeting Minutes

Soil Management Support Services Review Team Meeting held in Las Vegas, 30 November 1984

The Agency for International Development (S&T/AGR/RNR) appointed a team to review the activities of Soil Management Support Services (SMSS) for the period 1982-1984. The review was held at Las Vegas on 30 November 1984, and SMSS submitted its Progress Report. The chairman of the Review Team (Armand Van Wambeke) has submitted his report on behalf of the team.

Welcome Address

In his welcome address, Dr. R. McCracken thanked the members of the Review Team for their presence at the meeting. He expressed his appreciation for the time they dedicate to SMSS activities.

He assured the Review Team that SCS continues to keep a strong interest in SMSS. More than ever before soil resource information is needed in the developing countries, and technical assistance agencies should be capable of responding immediately to their requests.

He invited the Review Team to look into the future. Perhaps SMSS should shift emphasis and develop linkages between Soil Taxonomy and other disciplines such as soil survey, soil fertility evaluation, and soil conservation. To help LDCs fight against erosion and the degradation of soil resources should be one of the major objectives.

McCracken asked whether sophisticated technologies should be recommended and also how much of the new projects can be absorbed by LDCs to make them beneficial for their development.

SMSS when broadening the scope of its activities would need to coordinate with research undertaken by IBSNAT, TropSoils, IBSRAM, and others. He suggested establishment of international committees on soil fertility and soil survey interpretation.

Presentations on SMSS Activities

In reviewing the inner structure of SMSS, R. Arnold emphasized the importance of people and their interactions both within agencies and between

agencies. He appreciated the enthusiasm SMSS has been able to generate among the people in various continents to achieve clear and meaningful objectives.

SMSS staff reviewed the achievements of several components of SMSS. Copies of the summary report were presented to the Review Team. Omissions in the list of international and national organizations, with which SMSS entertains close relationships, were corrected.

Beinroth explained the workshops' activities and indicated possible changes in their objectives and types of operations. In the future the workshops may be more specific in their objectives and may be reduced in size. Arnold explained the objectives of the Spodosol ICOM and indicated that this soil Order is important in the tropics.

The delays in publishing the proceedings of the workshops were explained by pointing out the difficulties that participating countries face. Publishing is not only the responsibility of SMSS. Host countries are involved.

John Kimble gave an overview of the laboratory work undertaken by SMSS. He added that the informationg collected through the laboratories and the workshops can be made available through diskettes and minicomputer software.

It was pointed out that the Aridisols were not well-represented in the set of pedons that had been analyzed.

T. Cook reviewed the activities of the International Committees. Questions were asked as to how the composition of the pedon data base would be balanced among soil orders if Soil Taxonomy workshops are discontinued in the future. The importance of having good profile descriptions to accompany the analytical data was stressed by the Review Team.

It was indicated that ICOM chairpersons receive only secretarial assistance as financial contributions. The Review Team requested progress reports from the different ICOMS.

J. Kimble reviewed the training program. In the selection of participants, difficulties were recognized in the accepting of students only on the basis of their technical capabilities. It was pointed out that it was not possible for the forums to include sessions on soil mapping because the forums were duration too short to develop meaningful field operations. The Review Team also recommended forums aimed specifically at decisionmakers, land use specialists, and planning officers.

The linkages with IBSNAT through G. Tsuji are at present restricted to characterizing the sites that are included in the IBSNAT network. It was

suggested SMSS also cooperate in the mapping of the geographical areas where sets of soil production factors, recognized as important by IBSNAT system analysis, would attain optimal levels.

Presentations on future SMSS Programs

The Review Team subsequently discussed the policy papers presented by H. Eswaran and by W. Johnson which identify priority areas for future operations. R. Meyer (AID/Washington) indicated that SMSS is looked upon as a service organization not as a research unit. AID's views SMSS as a unit to provide short-term assistance. SMSS can develop into a valuable asset for USAID Missions by assisting them in the preparation of country planning policy papers.

According to R. Meyer, SMSS can not only deliver direct services to missions and developing countries but it can also cooperate with workshops organized by other disciplines. By doing so, SMSS can have a significant impact on their accomplishments. Linkages were also recommended with TropSoils, IBSNAT, IBSRAM, BNF, and the Water Management Project to which SMSS could provide information on sites. This activity would strengthen the vertical transfer component of these projects. SMSS could also serve as an overall coordinating body for AID projects where soils are an important component.

Recommendations for SMSS Programs

Recommendation #1

Basically, the Review Team agrees that the scope of work of the technology transfer component of SMSS should be broadened to focus on the applications of Soil Taxonomy rather than on its inner structure. Soil Taxonomy, however, should remain the central area of interest and expertise of SMSS.

The applications to be developed first would be the ones for which Soil Taxonomy had been created initially--soil survey and soil survey interpretation. As to the applications aimed more specifically at soil fertility, the Review Team advocates a follow up of the recommendations of the 1982 SMSS Washington Soil Fertility Workshop (report attached), taking into account work done in this sector by other organizations. The review team,

however does not believe SMSS should be actively involved in setting up regional analytical laboratories to serve as centers of soil analysis and training.

SMSS response to Recommendation #1. We appreciate and concur with the team's view of SMSS increased emphasis on the application of Soil Taxonomy. This has been our general strategy, but the approach has been slow because of an initial emphasis on the correct use of Soil Taxonomy. We repeatedly point out that Soil Taxonomy is not intended to classify holes in the ground but rather it is to be used as an integral part of a soil survey program that includes mapping, correlation, and soil-related interpretations. This is a difficult message to get across because of the traditional view of soil classification as the main concern of soil survey.

Our strategy is illustrated in the Pacific region where the first training forum in Fiji focused on the structure of Soil Taxonomy; the second in Papua New Guinea considered soil survey interpretations; the third in Guam dealt with the technique of soil survey; and the fourth in Western Samoa will deal with the application of Soil Taxonomy to soil fertility interpretations.

Now that we have had 12 training forums on Soil Taxonomy and Management around the world, we are moving gradually into the next phase where we will emphasize the application of the system to soil surveys and their interpretation including soil fertility. We are considering how to move more fully into soil fertility interpretations of soil surveys and classification. We will be examining ways of correlating soil taxonomic criteria with soil fertility related parameters but do not feel that establishment of an international committee (ICOM) on this subject, in the manner and mode of those for Soil Taxonomy, is the best way. We are exploring ways of making available the necessary expertise for those types of interpretations, since experience and training in soil fertility is not now available within SCS.

Our comments on the six recommendations of the 1982 Fertility--Classification Workshop held in Washington, D.C., are as follows:

1) SMSS does not consider an ICOM on soil fertility to be consistent with existing ICOMs dealing with criteria for improving Soil Taxonomy. We consider a fertility working group one that would develop a technical grouping (interpretation scheme). This working group would be an important aspect of other AID-sponsored projects with which we could cooperate.

2) Developing software for a soil management data base is a worthy endeavor. SMSS can easily work on a format for soil and site

descriptions and on a data base for laboratory data. SMSS could offer to work with IBSNAT, TropSoils, IBSRAM, and others in jointly developing a soil management data base as it relates to soil fertility. Other management options such as conservation practices should also be considered. Plans to work with others will be developed for next year.

3) To characterize surface soil features SMSS proposes to prepare a monograph describing features and detailing procedures for their measurement, as well as slide sets to be used in training courses, either by SMSS or by other groups. We agree that the preparation and use of training materials is an important aspect of our activities.

4) We are not sure exactly what to do about information from the FAO soil fertilizer program unless the soils are adequtely characterized and can be related to Soil Taxonomy. We would appreciate further advice from the Review Team.

5) We agree that we can and should assist in site characterization. IBSNAT has published minimum data sets for model testing and model development. SMSS could compile several working examples of site and soil characterization to be used in our training, as well as help other programs, particularly IBSNAT and IBSRAM.

6) We have noted the difficulties of national and regional labs that might do soil characterization and realize that soil testing labs may be even more difficult to establish because of the variability of tests and their interpretation. SMSS will respond to Mission requests to review labs and offer suggestions for their improvement.

Recommendation #2

(A) The mechanisms to achieve the purposes outlined above include among others joint programs with regional organizations involved in soil management. For example: IBSNAT, TropSoils, the International Centers, ACSAD, ASEAN, and so forth. They are considered efficient communications channels.

(B) The Review Team considers that the strenghthening of effective linkages and active cooperation between projects (SMSS, IBSNAT, TropSoils, etc.) deserves special attention, and it recommends that SMSS increase its efforts to cooperate with these units. At the same time it invites the AID administration to organize activities that include several of these units.

(C) More specifically, SMSS is invited to (1) organize workshops dealing with application fields, preferably in joint sessions with specialists of disciplines to which the applications are directed; (2) participate and technically support workshops and conferences organized by other units in AID and national and international organizations; and (3) organize workshops directly related to specific soil constraints in crop production. Special

attention should be given to identifying the kinds of soils that contain the limitations and to recommending methods to alleviate the constraints, as far as they relate to soil properties.

(D) To attach training and publication components to all these activities.

SMSS response to Recommendation #2. (A) Most SMSS activities have involved other agencies, especially in other countries. However, it has been slower in developing joint programs because we have a more short-term focus than some of the other agencies. We consider linkages with other institutions vital to SMSS operations. Our strategy has been to utilize their expertise and thereby establish mutually beneficial and viable linkages. We will continue to develop additional joint programs. Does the team have any suggestions on getting others to take more initiative in this regard?

(B) We appreciate the team's recommendation that SMSS cooperate more with AID-sponsored projects. We will propose to AID several joint planning workshops to explore ways of joining forces without violating our individual responsibilities. SMSS has excellent cooperation and support from many other international and regional organizations and institutions. Symposia by IBSNAT have involved SMSS input and participation; IBSRAM and others' activities have had the benefit of SMSS.

(C) This recommendation is especially useful and strengthens the activities already initiated. By the end of 1987, we will have organized eight International Soil Classification Workshops. In the future, we will reduce the number of these workshops and will be introducing "Management"-oriented workshops specifically designed to identify soil constraints in crop production. Two such workshops planned for 1986 are: 1) classification, characterization, and utilization of acid sulfate soils in Senegal in cooperation with the Government of Senegal; and 2) classification, characterization, and utilization of peat lands in Thailand in cooperation with the Land Development Department.

SMSS has also collaborated closely with and supported IBSRAM in its four inaugural workshops on: 1) Vertisols, 2) Acid Tropical Soils, 3) Land Clearing, and 4) Wetlands. SMSS is especially aware of the importance of the Acid Tropical Soils Workshop and its future contribution to the linkage between soil classification, soil fertility, and soil fertility parameters. SMSS Soil Chemist John Kimble will participate in the workshop and gain knowledge that

will help develop methods for identifying soil constraints and soil properties that limit crop production as related to soil fertility.

Several articles have been prepared and presented that specifically deal with soil limitations and how they are linked to Soil Taxonomy. Additional training materials could be developed along these lines.

Recommendation #3

The Review Team repeats the recommendations made at the second Advisory Panel meeting in Anaheim, California, 1982 more specifically:

(A) 1. No new International Committees (ICOMs) should be supported by SMSS before the contributions of the first ones, which have been terminated, have been evaluated and considered satisfactory with respect to the specific objectives of their mandates.

2. In spite of (A1) above, SMSS should explore ways and means to initiate, as soon as possible, work on the classification of paddy soils.

3. SMSS should contribute to strengthen the capability of LDCs to create soil data banks by developing compatible data processing systems on pedons, soil series, and other taxa. In this way information on soil taxonomic and mapping units can readily be made available for testing of changes to Soil Taxonomy and developing interpretative groupings.

4. SMSS should contribute to the collection of reliable data on soil units in LDCs to be entered in the system described under A4 in cooperation with national institutions. SMSS should also maintain close contacts with crop performance data banks and crop modeling projects in order to be in a position to respond to requests from these groups. It was not found necessary that SMSS engage in crop modeling itself, but rather it should restrict its data processing work to the development of a soil data base. The latter should include information on past use of the land, as well as on cropping system descriptors of the pedon environment. A necessary component of the data base is the geographic distribution of the major units.

5. That SMSS should encourage the development of interpretative systems which will contribute to the increased use of Soil Taxonomy in activities such as the use of fertilizers, protection of soils against erosion, soil testing, crop adaption, and so on. These systems should give special attention to the water regime of the soil, its water storage capacity, water acceptance characteristics, and so forth. In addition, the panel recommends SMSS organize workshops on interpretation.

(B) The panel recognizes the need for research on soil genesis as well as for the intensified collection of data to test changes to Soil Taxonomy. It agrees that small grants to serve precisely defined objectives be considered by SMSS to assist the ICOMs in reaching their objectives.

(C) The panel considers that SMSS activities should be directed toward the strengthening of national institutions in the LDCs. The programs should be adapted to the needs of the individual countries. Training sessions should be selective and complement national programs rather than replace them. Regional approaches are recommended. Technical assistance should always be delivered in cooperation with the national institutions.

(D) The panel recommends that the subject matter taught during training sessions should take into account the level that the individual regions have reached. In case of advanced knowledge of Soil Taxonomy, the emphasis should be placed on interpretation methodology rather than on taxonomy itself.

(E) Soil correlation is an application of Soil Taxonomy which needs to be developed. SMSS is encouraged to act at national, regional, and international levels upon request of soil survey institutions. The panel agrees that SMSS explore ways and means to assist the ASEAN (Association of South East Asian Nations) countries in their soil correlation efforts.

SMSS response to Recommendation #3. This has been responded to in the Progress Report.

On item A2: SMSS organized a workshop with IRRI on paddy soils in 1984. We have now established contacts with Taiwan and Korea and we hope to sample some of their paddy soils soon. The data will be used by ICOMAQ.

On item A3: SMSS has initiated assistance to countries to develop soil date banks, and a specific example is Thailand. The country must have some capability to handle such a data bank and also a desire to do so. When requested, we have responded. The United States is still working on system compatibility. As it is improved, those ideas and procedures can be shared with others.

On item A4: The World Benchmark Soils Project (BSP) referred to in the Progress Report is a result of this recommendation. We have initiated a series of publications with the general title, "Benchmark Soils of . . . " The first in the series will be a joint publication of the Bureau of Soils of the Philippines, IRRI, and SMSS. SMSS provides the descriptions and routine data, BSP the geographic information, and IRRI the fertility and management information on the rice soils. Other countries are preparing such monographs.

We also have a computerized data base on all soils sampled by SMSS--500 pedons. The descriptions are being encoded as the system is improved.

On item A5: We accept and recognize the need for development of interpretive systems as recommended. Interpretive groups or systems are available for many interpretations although most are for temperate zones. We could propose having a consultant collect examples from other zones and prepare guidelines for developing interpretations. Such information would also be useful in training forums. With the impetus of the Review Team's recommendation, we will take steps to secure the help needed, consistent with the budget. We shall appreciate suggestions from the Review Team for accomplishing this, both as to names of individuals and techniques that might be used.

Recommendation #4

(A) To promote the development of interpretative systems, the Review Team considers, in A5 above, that soil fertility may be given special consideration. Essentially, they would consider the chemical and physicochemical properties of the soils as they influence soil nutrient availability together with the water supplying power of land.

(B) The Review Team also recommends that interpretations of Soil Taxonomy not be limited to crop production but concentrate equally on interpetations related to soil conservation. The evaluation of soil erodibility, methods for erosion control, and so on could be topics for technology transfer. Maps showing the areas of extrapolation of soil conservation methods shouls be prepared. SMSS is invited to place a larger part of its resources in the soil conservation interpretation area. Regional training courses to increase the technical skills of soil and water conservationists in the LCD's should be organized.

SMSS response to Recommendation #4. An interpretive system is available for some aspects of soil fertility such as those properties that influence soil nutrient availability and water supplying power. We could begin with a report on how to structure and develop such an interpretation.

We appreciate the recommendation to increase efforts in the area of soil conservation. This is a difficult area as many LDCs do not see this as a problem. Through the Soil Taxonomy News, we have tried to create awareness. We have several temporary duty assignments to countries which have requested assistance, but we do need a more organized effort.

Recommendation #5

The Review Team recommends that the Technical Assistant component of SMSS (A) assist USAID Missions to recognize the importance of land resources distribution in establishing country policy planning priorities; (B) assist the less developed countries in the evaluation of their land and water resources by

the appropriate soil survey methods; (C) stimulate the exchange of information on soil management practices between countries.

SMSS response to Recommendation #5. We have mixed reactions when dealing with USAID Missions although it is an ongoing activity of SMSS. Missions frequently have very well-defined projects based on Country Development Strategy Statements (CDSS) and approved by the local government. It is often difficult for them to deviate. SMSS strategy is to evaluate the CDSS and determine how best we can influence or assist them in their work.

Recommendation #6

The Review Team recommends that SMSS should organize regional workshops for LDC decisionmakers and AID officers on soil survey and land use planning to highlight applications of physical resource inventories in regional planning.

SMSS response to Recommendation #6. Does the team feel it would be worthwhile to prepare documents that would help Missions and their counterparts in recognizing the value of soil resource information in CDSS? Ways may be suggested how they might obtain, collate, and summarize such information if it seems appropriate.

We concur with the team's suggestion for creating a greater awareness among LDC decisionmakers and Agricultural Development Officers (ADO) of missions. We could organize a meeting of directors of agriculture or land use. We seek inputs from the SMSS Advisory Panel as to the scope of the meeting.

The ADOs of the Asia Bureau of AID will be meeting in the Philippines at the end of April 1986, and the Project Leader of SMSS will be addressing them on this subject. When the opportunity arises, we hope to address the ADOs of the other bureaus.

SMSS has supported work on a data base to test ICOMAND proposals and will support a workshop on Andisols with Japan.

A team to work with the national institute in Indonesia has reported its recommendations to further strengthen the Soil Research Institute.

The progress reports attempt to illustrate how the training material has been adapted to the audience and how they responded to the material. As the program continues we are accumulating materials appropriate for different levels of training.

Recommendation #7

The Review Team recommends that a progress report on the International Committees be submitted to the Advisory Panel members, including the time of

the completion of their work and a summary statement on the rationale of the changes which are being submitted.

SMSS response to Recommendation #7. In the past, SMSS policy has been not to pressure the ICOMS. They have not been given any deadlines and were allowed to operate on their own. As all activities are conducted through correspondence, this approach is justified. In consultation with the Chairman of the ICOMS and with the USDA/SCS national leader for soil taxonomy, a tentative schedule of activities and milestones will be prepared to guide future deliberations and complete each committee's objectives. It is not feasible to prepare, at this time, statements on the rationale of the changes that are being submitted. Those changes being proposed will be forwarded to the team as they are received. The ICOMLAC proposal and rationale should have been received by the team.

We do attempt to present a status report of the ICOMS in our annual or progress reports.

Recommendation #8

The Soil Taxonomy News should keep its identity as a publication and should concentrate on matters directly related to Soil Taxonomy and its application. Whether it can be published jointly with other newsletters issued by other AID soils projects is a matter of finance and logistics. The Review Team is concerned about the possible loss of identity of the soil classification component in a joint publication, directed at too wide an audience with different kinds of interests.

SMSS response to Recommendation #8. We concur with the concerns expressed by the Review Team. There are advantages and disadvantages to publishing a joint newsletter with IBSNAT.

Following the advice of the Team, as expressed by some members privately, we will continue to publish Soil Taxonomy News until the end of SMSS Phase II and then review the situation.

Recommendation #9

The Review Team considers that SMSS is not a technical assistance program for delivering long-term support, but rather a mechanism to initiate corrective measures in the development programs in LDCs. The Review Team agreed, however, with a 3 month duration on temporary duty assignments.

SMSS response to Recommendation #9. We will inform AID of this recommendation and apply it when feasible. ASEAN is serious in attempting a map and text, and SMSS will assist whenever requested. Correlation is a difficult process and usually very time consuming. SMSS might prepare some guidelines to assist those countries in these deliberations.

Recommendation #10

The Review Team wants to be informed on the progress made on:

(1) development of training packages which emphasize the interpretive aspects of Soil Taxonomy;

(2) preparation of a monograph on the use and management properties of one of the major soil orders; and

(3) Bibliography of Soil Taxonomy in cooperation with the National Agricultural Library.

These activities were mentioned in the 1982-84 SMSS Progress Report as being initiated.

SMSS response to Recommendation #10.

1. We do have plans to develop training packages for interpretive aspects of Soil Taxonomy. The difficulties are several, and the main one is obtaining a qualified person to produce them. We are open to suggestions from the panel. We have prepared lecture materials and slide sets but as yet they do not constitute a "package."

2. We have now initiated monographs on major soil orders. The two which are being prepared are:

   (a) E. Bornemiza. Management properties and management of Andisols.

   (b) R. Dudal. Management properties and management of Vertisols. Again we welcome suggestions for authors and other subjects.

3. The Bibliography of Soil Taxonomy is still being compiled by the National Agriculture Library. Retrieval is from the AGRICOLA and CAB data bases, and we have to sort out some copyright problems with the latter. Further, CAB indexes with the FAO legend require us to complement with manual search.

Commendation

The Review Team commends SMSS and the cooperating agencies unanimously for the effective implementation of the project's objectives, the excellence of their performance, and the number and quality of their activities.

The Review Team expresses its gratitude for the excellent organization of the review session, the welcome and hospitality extended to them at Las Vegas, and wishes SMSS to continue its activity with the same enthusiasm which contributed so effectively to the development of many nations in the tropical world.

The Review Team suggests for the Advisory Panel members to be kept informed about the future activities of SMSS. The Review Team considers that for the Advisory Panel, to be effective, they should meet periodically at approximately 2 year intervals.

SMSS Concluding remarks

We greatly appreciate the Review Team's comments and more specifically the attention given to details. The latter enables us to evaluate our modus operandi and streamline our efforts to be more cost-effective and timely. Such a critical evaluation of the project with the accompanying commendations gives it credibility and enables us to proceed with greater confidence.

We will be initiating the documents necessary to develop Phase III of SMSS. For contractual purposes, we may have to develop an entirely new project, and we seek your advice and assistance.

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APPENDIX II

Activities of SMSS

TT--Technology Transfer

TC--Technical Consultation

TA--Technical Assistance

APPENDIX II

Activities of SMSS - FY 1985
TA - Technical Assistance
TC - Technical Consultation
TT - Technology Transfe.

Date	# of Days	Activity	Country	Name	Purpose
10/84	6	TT	Brazil	Hari Eswaran	To develop initial plans for the VIII International Classification Workshop. To develop program for Acid Soils Workshop.
10/84	12	TA	Jamaica	George Holmgren Steve Base	Assistance to the Jamaican Soil Survey Program and soils laboratory methods and procedures.
10-11/84	15	TA	Indonesia	Ken Hinkley Bill Reybold Tom Priest	Assistance to the Indonesia Soil Survey Program.
10/11/84	5	TA	Western Samoa	Hari Eswaran	To develop the program for the International Training Forum.
11/84	12	TA	Thailand	Hank Wyman	Assistance to watershed project in northern Thailand, attend international Soil Erosion Seminar, assist in media programs and public relations.
11/84	8	TA	Thailand	Charles Onstad	Participate in the International Workshop on Soil Erosion and its Countermeasures in Chiangmai.

Appendix II (continued)

Date	# of Days	Activity	Country	Name	Purpose
11/84	5		USA, Las Vegas, NV	Hari Eswaran Richard Arnold John Kimble Terry Cook Ray Meyer	Attend ASA meeting and Review Team of SMSS.
12/84	12	TA	Philippines	Hari Eswaran	Attend IRRI Workshop on Physical properties of rice soils and discuss XIV International Training Forum with PCARRD.
12/84	3	TT	Malaysia	Hari Eswaran	Develop plans for proposed Workshop on Peat land.
1/85	5	TT	Netherlands	Hari Eswaran	Discuss LABEX program with ISRIC staff; with staff of Agricultural University discuss Acid Sulfate Soils Symposium; confer with chairman of ICOMAQ on future activities.
1/85	5	TA	Zambia	Hari Eswaran	Preparations for the IX International Training Forum.
1/85	27	TA	Philippines	Ron Yeck	Sample soils for the XIV International Training Forum.
1/85	4		Hawaii	John Kimble	Attend TropSoils phosphorous-lime modeling workshop.
1-2/85	24		New Zealand	John Kimble	Develop international laboratory data base and methodology for retrieval and collection of lab data, for the Aridisol proposal (ICOMAND).

Appendix II (continued)

Date	# of Days	Activity	Country	Name	Purpose
2/85	4	TT	Senegal	Hari Eswaran	Develop plan for the International Symposium on Acid Sulfate Soils.
2/85	5	TA	Pakistan	Hari Eswaran	Finalize program for the XIV International Training Forum.
2/85	6	TT	India	Hari Eswaran	Participate in IBSRAM-SMSS-ICRISAT Workshop on Vertisols.
2/85	5	TT	Thailand	Hari Eswaran	Attend workshop on dryland agriculture at Khon Kean. Discuss with staff of Land Development on collaborative program with SMSS and develop plans for a workshop on peat lands.
3/85	5	TT	USA, Fort Worth, TX	Terry Cook	Attend Soil Data Base Management Workshop.
3/85	6	TT	Taiwan	John Kimble Hari Eswaran	Participate in FFTC-SMSS-IBSNAT Workshop on Soil Taxonomy and Characterization of Tropical Soils.
3/85	2	TA	Belgium	Hari Eswaran	Discussion with staff of University of Ghent on French translation of Soil Taxonomy.
3-4/85	16	TA	Peru	Luis Manrique	Assist in the assessment of Fragile Lands, in the Sierra, high selva, and humid low areas of Peru.
4/85	21	TA	Rwanda	Hari Eswaran Arville Touchet William Johnson	Participate in the Xth International Training Forum.

Appendix II (continued)

Date	# of Days	Activity	Country	Name	Purpose
4/85	18	TA	Burundi	Hari Eswaran Arville Touchet William Johnson	Participate in the Xth International Training Forum.
4/85	5	TA	Philippines	Hari Eswaran	Attend ADO meeting of Asia Bureau of AID.
4-5/85	30	TA	Brazil	Steve Holzhey	Sample soils and prepare for the VIIIth International Soils Classification Workshop.
4/85	5	TA	Peru	John Kimble	Participate in IBSRAM-SMSS Workshop on acid tropical soils.
5/85	5	TA	Brazil	John Kimble	Participate in IBSRAM-SMSS Workshop on acid tropical soils.
5/85	5	TA	Indonesia	Hari Eswaran	Follow-up SMSS TDY's and develop program for IBSRAM-SMSS Workshop on
5/85	3	TA	Japan	Hari Eswaran	Initial planning meeting on the IXth International Classification Workshop.
5/85	4	TA	South Korea	Hari Eswaran	Initial planning meeting on proposed International Training Forum.
5/85	7	TA	Peru	Jeffrey Vonk	Provide administrative analysis and recommended oversight to developing Peruvian National Soil and Water Conservation System.
6/85	5	TA	Tunisia	Hari Eswaran	Planning meeting for the XIIIth International Training Forum.

Appendix II (continued)

Date	# of Days	Activity	Country	Name	Purpose
7/85	12	TT	France	Hari Eswaran	VIth International Workshop on Soil Micromorphology.
7/85	21	TA	Western Samoa	Terry Cook	Describe and sample soils for the proposed International Training Forum.
7/85	18	TA	Zambia	Hari Eswaran Stan Buol	Participate in the XIth International Training Forum.
7/85	5		USA, Fort Collins, CO	John Kimble	Participate in the National Cooperative Soil Survey Conference.
8/85	1	TA	USA, Miami, FL	Hari Eswaran	Meet with Fred Beinroth to plan for the VIIIth International Classification Workshop.
8/85	3	TA	Belgium	Hari Eswaran	University of Ghent - Evaluation and description of this sections for Zambia and Pakistan.
8/85	20	TA	Indonesia	Richard Arnold	
9/85	13	TA	Tunisia	Hari Eswaran	Participate in the XIIIth International Training Forum.
9-10/85	21	TA	Japan	George Holmgren	Sample soils in preparation for the Classification Workshop planned for 1987 in Japan.
9-10/85	3	TA	USA, Hawaii	Hari Eswaran	IBSNAT review.

APPENDIX III

Xth International Forum on Soil Taxonomy and Agrotechnology Transfer

Rwanda and Burundi, 1-12 April 1985

Report of a discussion held on 10 April at USAID Kajondi Farm.
Subject: Sombric Horizon.

Introduction

In the highlands of Central Africa, specifically in the region of Rwanda, Burundi, and the northeastern part of Zaire, many of the soils are characterized by the presence of a subsurface horizon, termed the Sombric Horizon. The term was introduced by Belgian pedologists working the Ituri and Bukavu provinces of the former Belgian Congo in the late fifties and sixties and was adopted by Soil Taxonomy (for a complete review, see Eswaran and Tavernier 1980). Few or no detailed studies were available then, and the concept and definition included in Soil Taxonomy is considered tentative.

At the IVth International Soil Classification Workshop in 1981, a few of these soils were presented to the participants and the consensus of opinion was that these are buried A horizon. In the circular letter of ICOMOX (No. 4), a summary of the properties and a tentative definition was presented. Since then, with the systematic soil survey of Rwanda, by the Carte Pedologic Rwanda (CPR), more information is available. CPR has been using the tentative definition of ICOMOX in their mapping legend.

During the Xth International Forum, participants were shown a range of other soils with the Sombric Horizon. On the last day of the field tour an open discussion was held and this report is based on this discussion.

1. Should it be a diagnostic horizon?

   Opinion was almost unanimous that the Sombric Horizon should be considered a diagnostic subsurface horizon. Reasons include the following:

   (a) In these leached and highly weathered soils, the subsurface horizon enriched with organic matter has a higher CEC and a higher amount of Ca and Mg. This is very significant for plant growth.

(b) They are mappable features and useful diagnostic features for soil survey.

(c) They occupy specific positions in the landscape and are useful indicators for the geomorphic evaluation of landforms.

2. Definition

A "sombric horizon" is a subsurface horizon exclusive of the spodic horizon, which has an increase in organic matter as compared to the overlying horizon. The higher organic matter content imparts dark colors by which it can be recognized as a distinct horizon. It may share some properties of andic soil materials such as low bulk-density and high NaF pH, but does not have sufficient reactive aluminum to meet the KOH Al or the Oxalate Al of andic soil materials.

It normally occurs in the cambic, oxic, or argillic horizons. If a stone line is present, the horizon may transgress the stone line. The upper boundary is not abrupt and may have tongues of organic-stained material. It may form part of the epipedon but is recognized by a lighter colored overlying horizon.

Some sombric horizons may be formed purely by tongues of organic materials extending to the saprolite. To qualify for a sombric horizon, the material in the tongues must meet the requirements provided below, and also the tongues must occupy more than half the bodies termed as sombrovites (see ICOMOX Circular Letter No. 4 for definition). These sombrovites or the enclosing soil material must meet the requirements given below and occupy more than half the pedon.

Requirements

(a) The sombric horizon has a color value of less than 4 and a chroma of less than 4 moist, a value of less than 5.5 dry, and the value and chroma are more than 1 unit darker than the overlying horizon.

(b) There is at least 0.6 percent organic carbon and an absolute increase of more than 0.2 percent organic carbon than the overlying horizon.

(c) The horizon is at least 25 cm thick unless there is a lithic or paralithic contact within 50 cm of the soil surface, when it is at least 10 cm thick.

APPENDIX IV

XIth International Forum on Soil Taxonomy and Agrotechnology Transfer

Zambia, 15-31 July 1985

Commendations and Recommendations

A. Commendations

The participants in the XIth International Forum wish to record their appreciation to the Ministry of Agriculture and Water Development of Zambia for hosting the forum and providing logistical support and also to the University of Zambia and CYPAC. Additional funding and logistical support was provided by the following organizations, and their collaboration and cooperation is gratefully acknowledged:

a. Soil Management Services, USA

b. NORAD, Norway

c. Belgian Technical Assistance, Belgium.

d. Agency for International Development, USA

e. International Benchmark Sites

The participants also wish to record their appreciation of the resource persons who attended and contributed to the forum.

B. Recommendations

1. Realizing the constraints on the soil scientists in the southern African countries and appreciating the value of such forums for strengthening institutions in the region, the participants recommend a follow-up forum within a reasonable period. The University of Zimbabwe has indicated its willingness to host such a forum, and it is requested that appropriate action be taken to invite Soil Management Support Services and other regional and international organizations to collaborate in its organization.

2. As soil surveys are the basis of agricultural development, the participants recommend that Soil Management Support Services consider organizing training courses in the southern African region at regular intervals. The subject matter to be covered includes soil survey methodology, soil survey interpretations, methods of soil characterization, and so on. It is felt that special courses are needed for soil survey and laboratory technicians.

3. The forum has clearly established the need for field manuals on soil surveys, soil survey interpretations, methods of soil analyses, and similar texts. There is an urgent need for such publications, and Soil Management Support Services is urged to develop these for use by the scientists in third world countries.
4. Soil acidity is one of the major constraints to soil use in Zambia and, in this respect, the participants welcome the formation of an international network on management of acid soils by the International Board for Soil Research and Management (IBSRAM). The participants strongly recommend that IBSRAM considers countries in the southern African region for membership in the network.
5. Confronted by similar constraints in the countries of the southern African region, the participants welcome the collaboration of IBSNAT with Zambia, but request that IBSNAT evaluate the feasibility of developing a mini-network in this region. With similar aspirations and agricultural problems, agrotechnology transfer will be a very welcome solution, and in collaboration with IBSNAT, a network of collaborating agricultural institutions will contribute to the general agricultural development of the region.

Speech by Honorable R.C. Kamanga, Member of the Central Committee Chairman of the Rural Development Committee at the Dinner of the XIth International Forum on Soil Taxonomy and Agrotechnology Transfer Held at Hotel Intercontinental, 30 July 1985

Comrade Chairman

Comrade Minister for Agriculture and Water Development

Comrade Permanent Secretary of the Ministry of Agriculture and Water Development

The Royal Belgian Ambassador

The NORAD Representative

The USAID Representative

The IBSNAT Representative

The SMSS Representative

Conference Participants

Ladies and Gentlemen

It is my honor and pleasure to host this dinner on the occasion of this International Forum. It is my sincere hope that you had successful technical discussions both in the field and during the lecture sessions held at the Commonwealth Youth Programme Africa Centre.

I am sure that three weeks ago many, of you here tonight had little idea of what soil taxonomy and agrotechnology transfer meant. But now, however, you should be experts. Quite apart from attending a rigorous course of lectures, you have traveled the length of the country from Mbala, touching Mpulungu, to Livingstone in the company of some of the foremost soil scientists in the world. I am told that the discussions were lively to say the least.

I hope that nobody was shy to venture an opinion, because the informal nature of any discussion held in the field is an ideal forum to pick the brains of experts. I am informed that our distinguished visitors brains have been well and truly picked during the forum.

On the other hand, I hope that they have learnt a little about Zambian soils and our problems in utilizing them, so that at future forums in other countries they can bring experience gained here to bear on the problems of others. That is what international cooperation is all about.

Mr. Chairman, the purpose of classification is to organize knowledge so that we can predict the behavior and performance of the objects we classify. I have been informed that after two weeks of using the Soil Taxonomy classification intensively, the soil classification system can be viewed from two different angles. First, I would like to quote the English philosopher Pope who said the first law in heaven is that there must be order. Now where is there more order than in a good taxonomy? In fact, the Soil Taxonomy is full of order, with its ten taxa at the highest level, followed by Suborders, Great Groups, etc.

To some of us, it may resemble disorder and that is the reason I would also like to quote Einstein who said "what we can observe is determined by theory." This quotation underlines all your quarrels about Alfisols, Ultisols, and numerous others. As long as the theory is not improved, the problems of where to draw the line between different soils will not be solved. I, therefore, urge you to continue the study of Zambian soils and contribute to the improvement of the Soil Taxonomy.

Mr. Chairman, Zambian agricultural development will depend heavily on agricultural technology transfer from other regions of the world. To do this successfully, Zambia will need a precise inventory of its soil and climate resources. Soil Taxonomy is the common language that will enable us to make our soil inventory.

It is apparent, Mr. Chairman, that as we Zambians are learning more about the soil taxonomy system of classifying soils and are applying it here in Zambia more regularly, some of the difficult terminology is gaining popularity. I have just been informed of one enterprising and eager young Zambian soil surveyor who was considering the possibility of naming his born son Alfi or Oxi. Both names being from Soil Taxonomy.

The future of the nation lies in its natural resources--and as far agriculture, now the cornerstone of our economy, is concerned--the primary resource is the soil. To make the optimum use of this resource in order to successfully exploit it for crop production and to conserve it wisely, we need to study the nature and distribution of our soils. We have already taken great strides to meet this end. With the help of NORAD, our soil survey unit is now operating near capacity in all the provinces. A similar effort is being followed at the University of Zambia, utilizing various donor agencies such as USAID, Belgian Administration for Development Cooperation (BADC), and the International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT).

We also need to be able to relate our soils to those in other parts of the world so that we can investigate the potential of importing and testing agricultural technologies developed in other parts of the world on soils similar to our own.

The soil taxonomy system will one day be a universal tool for the transfer of knowledge about the world's soils. At present, it is rather country specific, and especially suiting the USA. Once the system has been refined, however, through forums such as these, it will be a really important tool for us. In the meantime, we must learn the system and utilize those parts of it that suit our local conditions.

Mr. Chairman, I am informed that during the field tour you encountered some problems of our soils that need mentioning. We have long been aware of the need for lime and phosphate, especially in northern Zambia, if sustained farming is to continue. However, the knowledge of the researchers has sometimes only been slowly implemented due to lack of resources, and sometimes a lack of awareness of the seriousness of the problem among the administrators.

During the field tour, distinguished visitors who have experience far beyond many of our own experts strongly reiterated the vital necessity to provide our northern farmers with lime and phosphates.

The natural conditions of the soils in the north dictate that without these inputs, over and above the standard fertilizers, yields will decline inexorably and the promise of production which we now see will wither away.

In the central and southern provinces, the widespread "Sandveldt" soils were recognized to be difficult to manage, and above all, year after year our soils are eroding away due to poor and careless management. It will never come back. It is vital that our planning officers go out in the field and implement soil conservation measures wherever necessary.

It is vital that our extension officers clearly understand the processes behind erosion, and the ways to advise farmers to combat it. This can only happen if we greatly increase the training of our field staff. Forums like this are a vital tool in our drive for development.

Mr. Chairman, His Excellency the President announced last week that irrigated agriculture in Zambia has the chance to be revolutionized. He was referring to a simple irrigation design demonstrated by an American farmer in the Zambezi Valley. The idea, worked out, could be applied by small scale

farmers in Zambia and could make it possible to extend the nations irrigated lands. I hope your findings will allow us to identify those soils most suitable for irrigating so as to complement rainfed agriculture in the country.

A point worthy of mention, Mr. Chairman, is that this is the last year of the International Womens Decade now culminating with the United Nations Womens Conference in Nairobi. It seems to me that very few women are involved in soil survey in the work and, as far as I know, we have none in Zambia. It sometimes takes a special kind of logic known as women's intuition to make sense out of the problems which men often create.

I wonder if you should encourage more women to join your profession to sort out your quarrels over Soil Taxonomy.

On the last note, Mr. Chairman, I would like to sincerely thank the donor agencies for their considerable financial and technical support, and not to forget the advisory, steering, and organizing committees that did a commendable job in bringing about the XIth Forum on Soil Taxonomy and Agrotechnology Transfer to its successful conclusion. And I wish both the foreign and local participants continued efforts in solving the world's sustained food production. Bon voyage.

Closing Address of Hari Eswaran, 30 July 1985
Program Leader, SMSS, USA
at
XIth International Forum on Soil Taxonomy and Agrotechnology Transfer

Hon. R.C. Kamanga, Member of the Central Committee and Chairman of the Rural Development Committee.

Hon. Minister of Agriculture and Water Development

Hon. Director of Agriculture

Distinguished Guests

Ladies and Gentlemen

About two weeks ago, on July 15, the Honorable Member of the Central Committee opened this forum and made a very impressive speech, and I like to cite a few lines. He said, "the need to increase and improve food production has been Zambia's preoccupation for a long time now. There is a great urgency to seek self-sufficiency in food production in order to forestall possible hunger. Agriculture has become the lifeblood of this country, especially when the country's benefits from copper are declining."

During the last 9 days, the participants of this forum traveled from Mbala in the north to Livingstone in the south. We got a sample of the 75 million hectares (ha) of land in Zambia. We have been told that of the 60 percent which is arable, only 15 percent is being cultivated. Mr. Joseph Mutelo, Assistant Director of Land Use, told us there are over 10 million hectares of potentially irrigable land although only 20 thousand ha is currently under irrigation. We have been told that the farmers' yields of corn and wheat range from 1-1/2 to 2 tons ha^{-1}, while the commercial estates produce 3 to 4 tons ha^{-1}. When we look at population projections, it appears that the population of Zambia will double by the end of this century. The Member of the Central Committee also spelled out the government's strategy to forestall hunger and prepare the country's food production capability for the new century.

While we were at Kasama, the Provincial Permanent Secretary Mr. Manda, and the Provincial Agriculture Officer Mr. Kampamba joined us for dinner and asked our opinion on how agriculture development in the province can be accelerated. The participants provided a range of options and I would like to summarize some of their observations.

First, as we all know as soil scientists, moisture stress in the soil was considered the number one constraint to food and fiber production. A short-term solution is to introduce drought resistant varieties, but for the long-term solution, government capital investment is crucial. The amount of irrigated land must be increased from the current 20 thousand ha. The farmer cannot afford this; consequently there is need for massive government investment.

Second, many of the soils suffer from Ca deficiency or of Al toxicity. Supply of lime fertilizers to farmers must be considered as a necessary capital investment, just as irrigation is.

Third, the goal of the national planners should not be merely one of seeking self-sufficiency. Zambia can and should set a higher goal. Many of us believe that Zambian soils have fewer constraints than many other countries. In addition Zambia has tremendous water potential. The Rivers Zambezi, Kafue, Luangwa, and Chambeshi; and the Lakes Kariba, Mweru, Tanganyika, Iteshiteshi and Banweulu offer vast irrigation potentials. Zambia's goal should be to become the breadbasket of Southern Africa and we believe this can be achieved.

The groundwork needed to achieve this goal is already being laid. A first step is the evaluation of the soil resources of the country, and the NORAD-funded soil survey of Zambia project is preparing this inventory. A second step is research--an area which requires much more attention in Zambia. With the stress the government is placing on agricultural development, there is a real need and perhaps an urgency for a Zambian Institute of Soil Research (ZARI). The soils of the Southern African Plateau on which Zambia is locate, extend beyond Zambia and consequently any research conducted by such an institute will have useful applications beyond its borders. A regional center of excellence in Zambia with capabilities to conduct research, develop training, and provide services will be a positive step to increase agricultural production not only in Zambia, but also the Southern African Development Cooperation Committee (SADCC) countries as a whole. Technical assistance projects which have a short life span and are necessarily created to solve specific problems. Based on such projects, perhaps the time is ripe to develop an infrastructure that is more permanent and that will pave the way for Zambia to enter into the next century with the confidence of an export capability in food and fiber.

Mr. Chairman, I have digressed a bit but I believe that most of the foreign participants will share my opinion. Coming back to the forum, I must say that this has been a delightful experience. When I came here two years ago, to make the initial plans, I had my doubts if it would be successful. The program was ambitious and the 9-day field tour was like a nightmare. I can confidently report to you that the forum proceeded with clockwork precision. The field tour was magnificently handled and the whole meeting was very professionally organized. The credit goes to Mr. Robert Magai and his team. This is the eleventh forum that I have organized and, without doubt, one of the best. The logistics can be perfect, but a forum cannot be considered a success if the participants did not participate. Even on this count, I am extremely satisfied. What we taught in these two weeks is what is given at a United States university in one year. Yesterday, when we visited the University of Zambia (UNZA) Farm, we saw the rewards of our work. The participants classified the soil with no help from the resource persons and, more importantly, they could derive all the constraints to soil use from the classification.

Mr. Chairman, at this forum we also talked about agrotechnology transfer. The work being done by Dr. Chinene and his colleagues at the UNZA Farm is a clear example. They have been able to obtain 8 to 9 tons/ha of corn, which is well above the national average. UNZA is clearly providing the leadership in research with backstopping through the Belgian Technical Assistance Program and collaboration with other international organizations.

Mr. Chairman, I am going to leave the pleasant task of thanking all the organizers to my colleague Dr. Rudy Dudal. However, on behalf of the U.S. Agency for International Development and Department of Agriculture, I would like to express our deepest appreciation to the government of Zambia for hosting this forum. I would also like to express our sincere thanks to you, Honorable Kamanga, and to the Minister of Agriculture and Water Development for your personal interest and support on this forum. In two days, we will leave this beautiful country and we can assure you this XIth Forum will be a landmark in our knowledge of tropical soils and that all of us will leave with the fondest memories.

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