

PD - AAZ-414  
6820

# Soil Management Support Services: Review & Projection

William M. Johnson

December, 1984

SOIL MANAGEMENT SUPPORT SERVICES:  
REVIEW AND PROJECTION, 1979-1992  
(Project Number AID 931-1229)

WILLIAM M. JOHNSON  
INTERNATIONAL CONSULTANT

DECEMBER 1984

## SOIL MANAGEMENT SUPPORT SERVICES

Soil Management Support Services is a project of the U.S. Agency for International Development, implemented by USDA-SCS under PASA No. BST-1229-P-AG-2178. This study was conducted under USDA-OICD Purchase Order No. 40-319R-5-00164 dated Oct. 30, 1984.

## CONTENTS

SMSS Personnel.....	2
Introduction.....	3
Methodology of Study.....	5
Status and Accomplishments of SMSS.....	7
Continuing and Future Needs of AID and LDC's for SMSS.....	16
Phase II Activities of SMSS in the Light of Future Needs..	19
SMSS Links to Other AID Soil-related Projects.....	24
SMSS Interaction with the U.S. National Soil Program.....	27
SMSS Strategies for Meeting the Needs of LDC's.....	31
Some Strategy Papers for SMSS/AID Action.....	35
Options for More Effective Organization & Management.....	39
Conclusions and Recommendations.....	41
References.....	47
Acronyms Appearing in This Report.....	49

## SOIL MANAGEMENT SUPPORT SERVICES PERSONNEL

PROJECT FUNDING: U.S.AGENCY FOR INTERNATIONAL DEVELOPMENT  
T.S.Gill, Chief  
S&T/AGR/RNR  
A.I.D.  
Raymond Meyer, Project Monitor  
S&T/AGR  
A.I.D.

CONTRACTOR: OFFICE OF INTERNATIONAL COOPERATION  
AND DEVELOPMENT, U.S.DEPARTMENT OF  
AGRICULTURE  
Greg Garbinsky, Contract Officer

IMPLEMENTER: SOIL CONSERVATION SERVICE, U.S.DEPARTMENT  
OF AGRICULTURE  
Richard Arnold, Principal Investigator  
Hari Eswaran, Program Leader  
Terry Cook, Soil Scientist  
John Kimble, Soil Chemist

## INTRODUCTION

Soil Management Support Services (SMSS) was initiated in 1979 "to provide a program of interactive assistance designed to aid the less developed countries in developing modern soil science capabilities which can support their agricultural development while at the same time furthering worldwide progress in agricultural technology, especially in the area of soil classification" (15). SMSS has functioned through technical consultations provided to less developed countries by U.S. Soil Conservation Service (SCS) and other specialists on temporary duty, and technology transfer activities designed to promote the extension of agricultural technology to less developed countries through the vehicle of the international soil classification system, Soil Taxonomy (Soil Conservation Service, USDA, 1975). SMSS was created to serve or assist LDC's and not to develop, research, or implement. It focuses on the soil as the basic natural resource of agriculture, and of course on its wise use and conservation, and considers the soil scientists of LDC's as keys to successful transfer of agricultural technologies. Among agricultural technical assistance projects, SMSS is unique and extraordinarily effective by reason of having Soil Taxonomy as a common base for developing a network of soil scientists in both developed and developing countries and as the scientific mechanism for determining where in the world specific crop and soil management systems can be applied successfully.

Phase I of SMSS covered the years 1979-1982, during which the emphasis was on (a) technical assistance to countries on

soil survey, soil conservation, soil fertility and land use; (b) assistance to AID in formulating policies and programs impacting on land use and land-use planning for food and fiber production in the LDC's; (c) activities focused on technology transfer through Soil Taxonomy.

Phase II began in October 1982 and will continue through September 1987. Emphasis continues on short-term technical consultations in developing countries and on improvement and dissemination of Soil Taxonomy as the principal vehicle for agro-technology transfer. Of course, opportunity exists to make changes in the focus and direction of SMSS activities during the nearly three years remaining of Phase II authorization and funding.

The study reported in this document was done to review objectively and evaluate SMSS activities and accomplishments during the first five years of the program, to consider ways to make the program more effective, and to project an extension to Phase III (1987-1992).

## METHODOLOGY OF STUDY

The author of this report has been associated with SMSS since its beginning in 1979. He participated in a field review of an AID-supported soil conservation project in Guatemala in 1980, in the Vth Soil Classification Workshop held in the Sudan in 1982 and in the VIIIth International Forum on Soil Taxonomy held in Jordan in 1984.

The author interviewed 45 individuals who have participated in SMSS activities during the past five years and discussed with them their perceptions of the impact and their ideas on alternative strategies for continuation of the program. These individuals include SMSS staff and management in AID and SCS; officers attached to other soil-related AID projects; staff and managers in OICD/USDA; National Soil Survey Laboratory scientists at Lincoln, Nebraska; SCS soil correlation staff at NTC's in Lincoln, Nebraska and Portland, Oregon; and teaching and research staff at Cornell and Nebraska universities. The author expresses his thanks and appreciation for the cooperation of these individuals.

Dozens of publications were read and evaluated to familiarize the reviewer with SMSS goals, objectives and accomplishments and to understand the relationships between SMSS and other programs, projects and institutions. These publications include theme papers, strategy papers, informational brochures, projections, SMSS technical monographs and SMSS progress reports.

The information from documents, interviews and discussions was analyzed and a draft report was written. The draft report

was presented to 21 reviewers at Las Vegas, Nevada during the week beginning November 25, 1984. These reviewers are members of the SMSS staff, SCS and AID managers, and members of the SMSS Advisory Panel who were in Las Vegas to attend the annual meetings of the American Society of Agronomy and affiliated societies. The written and oral suggestions for improvement of the report were considered in preparation of the final report.

## STATUS AND ACCOMPLISHMENTS OF SMSS

The information on accomplishments in this section was obtained principally from the latest progress report of SMSS (16). More details and a more complete record are available in that report. This section is organized according to the four main facets of SMSS activities: technical consultations, technology transfer, soil data bank on tropical and subtropical soils, and publications, translations and training aids.

### TECHNICAL CONSULTATIONS

157 specialists, mainly SCS scientists on TDY, served 45 countries for a total of 2,100 person-days of technical assistance during the five years (16). Requests for this assistance originated in the countries and AID missions and were transmitted to AID headquarters.

In addition, informal requests for assistance were handled directly by the Program Leader, Dr. Hari Eswaran, during his travels and by correspondence with SMSS and SCS staff.

A few typical examples of technical consultations are the following:

March 1980. El Salvador. Supply information on soil conservation practices. 2 specialists, 4 days each.

September 1980. Jamaica. Soil survey, land use and soil classification training. 2 specialists, 14 days each.

January 1981. Ecuador. Assist development of long-term soil management program. 1 specialist, 32 days.

May 1981. Indonesia. Evaluate transmigration program of Government. 2 specialists, 10 days each.

June 1981. Syria. Training course on erosion under arid conditions. 2 specialists, 14 days each.

- October 1981. ROCAP/CATIE. Application of Soil Taxonomy in ROCAP region. 2 specialists; 1 for 6 days, 1 for 17.
- June 1982. India. Assistance in characterizing benchmark soils of India. 1 specialist, 35 days.
- August 1982. Papua New Guinea and New Zealand. Preparation of soil classification training course. 1 specialist for 30 days.
- March 1983. Djibouti. Soil survey laboratory assistance. 1 specialist, 19 days.
- October 1983. Senegal. Land regeneration and agricultural intensification in the ground-nut basin. 1 specialist for 11 days.
- February 1984. Somalia. Discussion on general soil map of Somalia. 1 specialist, 6 days.
- June 1984. Jordan. Develop proposal for soil survey agency and program for Jordan. 1 specialist, 7 days.

#### TECHNOLOGY TRANSFER

Eight international committees (ICOMS) were convened and have been working on the improvement of Soil Taxonomy, particularly in respect to its application to soils of the subtropics and tropics (16). The committees are:

1. International Committee on Soils With Low Activity Clays (ICOMLAC).
2. International Committee on Oxisols (ICOMOX).
3. International Committee on Soil Moisture Regimes (ICOMMORT).
4. International Committee on Aridisols (ICOMID).
5. International Committee on Andisols (ICOMAND).
6. International Committee on Vertisols (ICOMERT).
7. International Committee on Classification of Soils With Aquic Moisture Regimes (ICOMAQ).
8. International Committee on Spodosols (ICOMOD).

The status of each ICOM is summarized in the latest SMSS progress report (16). One of the ICOMS has issued its final report and recommendations for revision of Soil Taxonomy. Some of the others are nearing completion of their assignments. It is believed that most of the work of the ICOMS will be finished by the end of Phase II in 1987.

Contractual linkages between USDA/OICD and several universities have been established to carry out SMSS activities. These include Cornell University and the universities of Hawaii, Puerto Rico and North Carolina State. Currently Cornell, Hawaii and Puerto Rico have relatively large inputs.

Linkages for SMSS activities exist with government agencies in Rwanda, India, Thailand, the Philippines, Belgium, Morocco, Jordan, Malaysia, Indonesia and other countries.

SMSS has participated in and has supported many international soils meetings, including some in New Zealand, India, England, Tanzania, Thailand and Israel.

SMSS has organized and supported and implemented workshops and training courses in modern methods of soil survey and evaluation, including applications of Soil Taxonomy. Following is the list.

SOIL CLASSIFICATION WORKSHOPS (on specific problem soils)

- I Brazil, 1977
- II Malaysia & Thailand, 1978
- III Syria & Lebanon, 1980
- IV Rwanda, 1981
- V Sudan, 1982
- VI Chile & Ecuador, 1984
- VII Philippines, 1984
- VIII Brazil, on Oxisols, to be held perhaps in 1986

TRAINING COURSES (FORUMS) ON SOIL TAXONOMY

- I Fiji, 1981
- II Morocco, 1982
- III Cameroon, 1983
- IV Thailand, 1983
- V Papua/New Guinea, 1983
- VI Costa Rica, 1983
- VII Philippines, 1984
- VIII Jordan, 1984
- IX Guam, 1984
- X - XIII planned for 1985

SMSS MEETING ON SOIL CLASSIFICATION AND SOIL FERTILITY,  
WASHINGTON, D.C., AUGUST 1982.

PUBLICATIONS AND TRAINING AIDS

- Soil Taxonomy News (quarterly; 9 issues to date)
- Bibliography of Soils of the Tropics (5 volumes)
- Soil resource inventories and development planning.  
SMSS Technical Monograph #1, 1981.
- Calculated soil moisture and temperature regimes in South  
America. SMSS Technical Monograph #2, 1981.
- Calculated soil moisture and temperature regimes in Africa.  
SMSS Technical Monograph #3, 1982.
- Guidelines for evaluating the adequacy of soil resource  
inventories. SMSS Technical Monograph #4, n.d.
- Taxonomía de suelos. SMSS Technical Monograph #5, 1982.
- Keys to Soil Taxonomy. SMSS Technical Monograph #6, 1983.
- Soil Analysis for Soil Taxonomy.
- Many individual papers in various scientific journals.
- Soil Taxonomy: a technical language of soil science (slides)
- Videotapes and 8mm and 16mm movies on Soil Taxonomy.

## DATA BANK ON SUBTROPICAL AND TROPICAL SOILS

2,559 samples from 450 pedons in 34 countries have been analyzed at the SCS National Soil Survey Laboratory. Some additional laboratories have assisted in some studies. Emphasis in sampling has been the LDC national agricultural experiment stations. The characterization data are being used

By the ICOMS to support proposals for changes in  
Soil Taxonomy;

by workshops and forums on soil classification;

for inter-laboratory comparisons for quality control;

to build an international soil data base for use in  
teaching, soil correlation and technology transfer.

Besides developing the international soil data base, U.S. laboratory personnel assist in training LDC personnel in laboratory methods and in interpretations of laboratory data. Also, they have developed field and office kits for certain chemical and physical tests, and they give technical support to national and regional soil laboratories in LDC's.

## TECHNICAL CONSULTATIONS FOR TECHNOLOGY TRANSFER

SMSS progress reports on program activities give many examples of support of technology transfer. Following are some typical examples:

January 1981. Thailand, Malaysia. Symposium on acid sulfate soils. 3 specialists, 14 days each.

April 1981. Belgium. Micromorphological evaluation of some soils of Rwanda. 1 specialist, 7 days.

November 1981. Senegal. Assistance in soil survey for fuelwood project. 1 specialist, 11 days.

February 1982. Ecuador. Assistance in soil conservation program. 1 specialist, 12 days; 1 other for 25 days.

June 1982. Sudan. Planning meeting for Vth Workshop.  
1 specialist, 10 days.

March 1983. India. IBSNAT-SMSS-ICRISAT symposium on  
minimum data sets for agrotechnology transfer.  
5 scientists for 5 days each.

April 1983. Papua/New Guinea. Vth International Forum on  
Soil Taxonomy and Agrotechnology Transfer.  
2 scientists, 13 days each.

April 1984. Australia. Testing and examining proposals for  
ICOMERT. 1 scientist, 13 days.

June 1984. Thailand. ASEAN Soils Conference.  
2 scientists, 13 days each.

#### IMPACT OF ACCOMPLISHMENTS

The impact of SMSS like that of many other agricultural assistance projects is not easy to assess even after five years of operation. Many of the benefits are intangible and most of them will extend over many years to come. Still, the resounding success of SMSS can be detected in many ways.

Staff and participants of SMSS are enthusiastic; morale is high; competition for places in the program is keen; concern for the quality and quantity of activities is great; ideas for the continuation and expansion of the program flow continuously among members of the staff and the participants.

Cost sharing is a clear indication of the support given to SMSS by other offices, agencies and institutions. For example, the IXth International Forum on "Soil Taxonomy and Agrotechnology Transfer" held recently in Guam was organized by SMSS, the University of Guam and the University of the South Pacific and was supported financially by AID, the Australian Centre for International Development, the Deutsche Stiftung für Internationale

Entwicklung, the British Commonwealth Foundation and IBSNAT. Similar lists of financial collaborators can be given for other training activities of SMSS. Individual LDC's, of course, share the costs of most of the technical assistance and technology transfer TDY's. Members of the ICOMS donate their time and expenses to the efforts of those committees because they believe that their efforts are worthwhile scientifically.

Correspondence files contain a great many testimonials to the success and lasting values of SMSS program activities, including technical assistance TDY's and the several workshops and forums held in various parts of the world. This reviewer participated in two of the regional sessions (Sudan and Jordan) and was impressed by the interest and participation of high-ranking LDC officers, AID officers and diplomatic representatives.

SMSS has been greatly used for technical assistance by AID missions and LDC's. "USAID missions have used SMSS for project identification, project evaluation, and relied on SMSS expertise for other appraisals. LDC's have requested assistance on specific aspects of ongoing projects. They have also sought SMSS inputs for developing strategies for agricultural development, strengthening institutions, or staff and facility evaluation. LDC's are assigning counterparts to SMSS initiated activities, and in some instances are funding some of these activities which clearly indicates the confidence in SMSS." (15)

Hundreds of LDC soil scientists have participated in the forums and workshops, with the result that there now exists a network among LDC and developed country soil scientists and a

tremendous volume of communication among them.

Demand for SMSS publications is great and continuously growing. The press run of Soil Taxonomy News is now 3,000 and each issue is quickly exhausted.

Working relations have been established with several of the international research centers (ICRISAT, IRRI, etc.) with some international technical assistance agencies such as ACSAD and FAO, and with many national organizations concerned with agriculture.

Improvements in Soil Taxonomy have accelerated, making it more useful in subtropical and tropical zones. The ICOMS are beginning to make substantial recommendations for changes and a growing number of changes in the system have already been approved and published.

A pool of expert and experienced soil scientists is growing in the United States as a result of participation in technical assistance and technology transfer activities of SMSS.

An increasing number of countries have adopted Soil Taxonomy as either their basic soil classification system or as the adjunct system for horizontal technology transfer and for international communications about soils. Translations of Soil Taxonomy in whole or in part have been done in Italian, Arabic, French, Thai, Spanish, Japanese and Indonesian. Translations are in progress in Chinese and Greek.

A synergistic effect of SMSS is indicated by the large number of followup activities, many of them by individual U.S.

scientists who have participated in technical assistance and technology transfer details.

An increasing number of AID missions not only request SMSS short-term assistance but are proposing cooperative endeavors in soil survey and soil conservation. Many AID contracts stipulate that soil resource evaluations will be based on soil classification according to the principles of Soil Taxonomy.

AID missions and LDC's alike have been impressed by SMSS's capability to direct major U.S. technical and scientific expertise to missions and countries for assistance in soil survey, soil classification, agrotechnology transfer, land-use planning and agricultural development.

## CONTINUING AND FUTURE NEEDS OF AID AND LDC'S FOR SMSS

The need for Soil Management Support Services continues to expand as more missions and more individuals in LDC's become aware of the assistance available in this program. Needs may be conveniently grouped under three headings.

### FOOD AND AGRICULTURE NATURAL RESOURCE ASSESSMENT POLICIES AND INSTITUTIONS IN LDC'S

The government food and agriculture policies of many LDC's are not favorable to increased efficiency and productivity of farmers. Many countries lack the institutions needed to make modern resources inventories and interpretations and to provide assistance to farmers in soil management and conservation.

Broader and better understanding is needed within LDC's of the critical importance of soil resources to efficient agriculture. Accurate soil surveys of appropriate scale correctly interpreted provide the vehicle for successful agrotechnology transfer and the basis for sound land-use planning.

As indicated before, SMSS' role is not to build institutions for soil survey, land-use planning and soil management. It can, though, take actions that will catalyze institution-building in LDC's and it can assist in the training of staff to operate such institutions.

### SOIL SURVEY

Further improvements are needed in Soil Taxonomy and the changes need to be made more rapidly. Revised editions of the "green book" are needed at regular and briefer intervals.

Training is needed in the methodology of soil survey, from legend synthesis and mapping through soil correlation, soil interpretations, sampling, and publication, with adequate quality control at all stages and in all functions.

Ways must be explored to assist LDC's in the soil correlation process, both within countries and between world regions or continents. No such correlations have yet been undertaken but they are needed. Guidelines and handbooks on correlation are a first step.

Better soil laboratory services are a must, both to support soil classification and to provide soil fertility data for management purposes. If reliable country laboratories are absent or infeasible, assistance may be provided for regional soil laboratories. Regular monitoring of laboratories is essential for optimum quality of results. A substantial amount of training in laboratory methods and in interpretation of chemical and physical data will be required for some years to come. Attention to field and office kits for certain simple physical and chemical tests will be helpful. Also, laboratory personnel can be helpful in developing and teaching methods for field estimation of moisture, permeability and bulk density values.

## SOIL MANAGEMENT AND SOIL CONSERVATION

Better soil fertility interpretations of taxonomic entities would be very helpful in technology transfer and soil management.

Improved communications between pedologists and agronomists in LDC's could lead to more effective use of soil classification in technology transfer.

Training workshops in soil management for increased production and in soil conservation can be very helpful to LDC soil scientists and agronomists. It is important to structure these training sessions to the needs and capabilities within LDC's.

Training in the systems approach to soil management, using predictive models and computerized data bases should be the goal wherever qualified modelers and data bases are available.

SMSS should strengthen its linkages with IBSNAT, TropSoils, TSMM and BNF and other soil-related projects supported by AID, especially in the training functions of SMSS.

The headquarters staff of SMSS needs a permanent, full-time soil management/soil conservation specialist to give leadership to the management/conservation facet of the program, especially now that that facet will receive more emphasis.

The SMSS Advisory Panel needs some experienced soil fertility/management specialists to provide ideas, encouragement and general guidance in this area of work. Also, SMSS should find it helpful to develop working relations with the International Board for Soil Research and Management (IBSRAM).

## PHASE II ACTIVITIES OF SMSS IN THE LIGHT OF FUTURE NEEDS

### TECHNICAL CONSULTATIONS/INFORMATION

It may be assumed that requests for short-term technical assistance and technical information for a variety of purposes will continue, perhaps increase. SMSS should continue to provide both consultations and information to the extent that its resources permit, because these activities encourage and support LDC efforts to develop their own policies and institutions and strengthen their own scientific/technical staffs. As time goes on, presumably requests for specific assistance in Soil Taxonomy will decline, as will be appropriate. Requests relating to soil management and soil conservation, as well as land-use planning and agricultural development, will increase and SMSS should encourage the changing emphasis.

### TECHNOLOGY TRANSFER ACTIVITIES

Linkages with the international centers and specialized organizations (ICRISAT, ACSAD, IRRI, ASEAN, FAO, etc.) are certainly appropriate to future activities of SMSS and should therefore be expanded and strengthened.

Similarly, linkages with other AID soil-related projects such as IBSNAT, TropSoils, BNF and TSMM offer many opportunities for cooperation and synergistic impacts, and thus should be strengthened through joint activities on training workshops, planning sessions and publications.

The eight international committees on various Soil Taxonomy deficiencies must continue their deliberations until they complete

their assignments. It appears that some of them have done so now and others are approaching completion. All of these committees should be encouraged to set a target date for submitting their final reports not later than September 1987.

SMSS sponsorship of international meetings and participation in others will continue to be an appropriate activity. The emphasis of SMSS participation in Phase II and especially in Phase III should be toward soil survey methodology and soil management and conservation.

SMSS linkages with LDC national soil surveys and agencies for land-use planning, soil research and agricultural development and universities can be mutually beneficial and should be continued and expanded wherever possible.

The soil classification workshops have been important to the scientific support of SMSS during the past five years and have been very effective in creating networks of soil scientists, but need for them is declining because the ICOMS have dealt with or are preparing to deal with the major deficiencies of Soil Taxonomy.

The training courses (forums) have been popular as means of acquainting LDC pedologists and laboratory scientists with Soil Taxonomy and as a forum for recording their ideas for improving the classification. These training sessions are an appropriate activity for continued support by SMSS (although major support has been provided by other donors). In time these workshops will naturally change emphasis from major attention on soil classification to other facets of soil survey, especially mapping legends, field mapping, soil characterization, soil interpretations and

correlation. Also, there will be more workshops on uses of Soil Taxonomy in land-use planning, soil management/conservation and agricultural development.

#### TRANSLATIONS, PUBLICATIONS, TRAINING AIDS

SMSS publications will continue to be an important and productive activity of the program. As emphasis shifts toward soil management/conservation the new publications more and more should deal with principles and practices of management and conservation adapted for LDC soil resources and conditions.

Soil Taxonomy News has been and is a valuable newsletter. Reflecting close ties with IBSNAT, TropSoils, BNF and TSMM, a single newsletter might effectively serve all five projects. More input from Soil Survey/SCS and its collaborators would strengthen the soil survey reporting.

The technical monograph series should continue. The soil climatic regime books need to cover all the continents and the major island areas. Other technical monographs on soil interpretations and soil management would support the training efforts in those fields.

The Spanish translation of Soil Taxonomy is essential to wider application of the system in Latin America. The proposed French translation should be finished, edited and published. French, Spanish and Portuguese keys to Soil Taxonomy would be very helpful.

Videotapes, slide sets and films on Soil Taxonomy have proved to be effective training aids. Additional slide sets, perhaps keyed to soil orders, would also be useful. Videotapes on soil survey methodology, soil interpretations and soil management are appropriate new SMSS products.

### SOIL ANALYSES AND DATA BANK ACTIVITIES

With the decrease in number of soil classification workshops some of the impetus for sampling and analyses will perhaps decline, yet the need for soil characterization data remains great in the LDC's. Laboratory analyses of pedons used in the training workshops will still be essential, as will analyses for characterization of pedons in national agricultural experiment stations and analyses for inter-laboratory comparisons. All of these analyses will contribute to the expansion of the international soil data bank and all are appropriate to the objectives of SMSS for the foreseeable future.

Careful selection of pedons for sampling and analysis will make the data more useful for LDC's in characterizing soil areas important for agrotechnology transfer and agricultural development. Emphasis in these investigations should be on kinds of soils that are (a) large in extent within a country and/or region, or (b) are highly significant to understanding of soil behavior in the country/region because of their particular characteristics (mineralogy, texture, structure, water relations, etc.).

SCS National Soil Survey Laboratory support of efforts to

create and/or improve national and regional soil laboratories and soil characterization programs is an appropriate activity.

Other appropriate activities for SMSS include the development of improved field and laboratory equipment and methods for soil analysis.

The SCS National Soil Survey Laboratory is developing links with other U.S. laboratories to strengthen the characterization of samples and develop improved methods for determinations of soil fertility and erodibility. The Laboratory should be encouraged to continue these efforts as a means of improving its support of LDC soil laboratories.

SMSS should find a mechanism for making the international soil data bank available in "user-friendly" form to LDC soil survey organizations and to FAO, ORSTOM, ASEAN, ACSAD and similar institutions.

## SMSS LINKS TO OTHER AID SOIL-RELATED PROJECTS

Four AID-supported, soil-related research projects present opportunities for fruitful linkages with SMSS. They are:

International Benchmark Sites Network for  
Agrotechnology Transfer (IBSNAT)

Soil Management Collaborative Research Support  
Program (TropSoils)

Biological Nitrogen Fixation Project (BNF)

Technology of Soil Moisture Management Project (TSMM)

### IBSNAT

Another AID-supported international project, the Benchmark Soils Project, was a necessary precursor. The Benchmark Soils Project demonstrated the validity of the theory that the U.S. system of soil classification, Soil Taxonomy, can be used to define agroenvironments in which crops and farming systems respond and perform in common and predictable ways. Thus, Soil Taxonomy can be used to determine where particular crop varieties and soil and crop management practices will perform similarly. It is, therefore, a reliable vehicle for agrotechnology transfer.

IBSNAT is an outgrowth of the Benchmark Soils Project. Now almost everything SMSS does is complementary to IBSNAT: soil moisture and temperature regimes; Soil Taxonomy; pedon characterization and the soil data bank; training sites for workshops in soil classification and soil management; and technology transfer. SMSS can provide much-needed laboratory data and site characterization for IBSNAT. In its turn, IBSNAT can provide soil management and soil erosion models for use by SMSS for training

and program development in LDC's. Manrique and Uehara, for example, have published a proposal for a land-suitability classification for potato (9, 10). Also, IBSNAT can provide substantial expertise for technical assistance TDY's and training workshops.

### TROPSoILS

SMSS can provide soil climatic classification, pedon characterization data and soil classification for research site selection and program support. TropSoils and SMSS personnel could collaborate effectively in the development of technical classifications of soils to reflect soil fertility. TropSoils' scientific staff would be excellent choices for instructors in soil management/soil fertility training workshops and for technical assistance TDY's.

TropSoils research sites offer much potential as sites for training workshops in soil fertility and soil management. They are:

Brasilia, Brazil	--	acid savanna (Oxisols)
Niamey, Niger	--	semiarid zone (Alfisols)
Yurimaguas, Peru	--	humid tropics
West Sumatra, Indonesia	--	Humid tropics (Ultisols)

### TSMm

This dryland research project focuses on farming systems, soil and water relations, tillage and conservation, using modeling techniques and computerized data bases. One of its aims is the development of a network of scientists in the supporting U.S. universities and the LDC's.

As in the instance of other AID-supported projects, SMSS can be very helpful in supplying pedon characterization data, soil classification and soil moisture and temperature data to the researchers. TSMM scientists constitute an expert resource for SMSS technical assistance TDY's and training sessions.

TSMM research sites could be valuable locations for training workshops in soil management.

#### BNF

This research could be tied more closely to Soil Taxonomy with mutual benefits. Much remains to be done to improve the use of legumes in rotations and tropical farming systems, and Soil Taxonomy, along with soil climatic data, can be helpful in this effort. Soil Taxonomy can also contribute to soil stress tolerance research and to soil management in tropical cropping systems by suggesting sites for technology transfer.

BNF scientific staff is a source of expertise for SMSS' technical assistance consultations and for training workshops.

## SMSS INTERACTION WITH THE U.S. NATIONAL SOIL RESOURCE PROGRAM

Three U.S. Department of Agriculture agencies manage the scientific and technical phases of the national soil resource programs. They are the Soil Conservation Service, the Agricultural Research Service and the Cooperative State Research Service.

### SOIL CONSERVATION SERVICE

SCS is the custodian of Soil Taxonomy and the final authority for making changes and publishing the official document of the system.

SCS has national leadership for the National Cooperative Soil Survey. It is the largest soil survey agency in the world, with longer experience than any other in the world.

SCS has an extraordinarily capable soil survey laboratory that is equipped with highly sophisticated hardware that is almost completely automated and computerized.

SCS has highly organized and well-defined, detailed procedures for all the activities of modern soil survey from pedon description, soil classification and mapping legend development, through field mapping at various intensities, to sample collection, laboratory characterization, predictions of soil responses to management and soil correlation, and finally to the reporting and publication of maps and text. Having trained thousands of soil surveyors over a period of more than eight decades, SCS is uniquely qualified to give guidance and training to soil survey staffs in LDC's. SCS staff who have participated in SMSS

activities have gained much valuable experience, particularly in the overseas TDY's.

SCS also has tremendous expertise and many decades of experience in soil management for moisture conservation and erosion control. It is the largest and most experienced resource conservation agency in the world. Its staff includes, besides soil scientists, engineers, hydrologists, agronomists, range management specialists, biologists, wildlife managers, foresters, ecologists, economists, waste management specialists, land-use planners, cartographers, computer scientists and communicators. No other institution here or abroad can provide the down-to-earth, practical, yet scientifically and technically sound training and guidance in soil conservation that SCS can.

Clearly, SCS is a tremendously valuable source of expertise to assist developing countries to increase their capabilities to organize, staff and manage soil surveys and resource conservation programs. It does not, however, maintain a staff of experts in soil fertility and soil management for production.

Also, unfortunately, SCS along with other Federal government agencies at this time is under considerable pressure to reduce its permanent full-time staff and expects to come under even greater pressure for reduction during the next few years. As a result, executives and managers in SCS are increasingly reluctant to release qualified scientists and engineers for foreign assignments, even for short-term TDY's. It appears likely that for the next several years, at least, SMSS will need to seek more

scientists and engineers from ARS and universities and somewhat fewer from SCS.

### AGRICULTURAL RESEARCH SERVICE

The Agricultural Research Service of USDA employs a large number of scientists and engineers working on all facets of plant, animal, soil and water research in various environments in the U.S. and abroad. Their work is at the cutting edge of modern soil management. ARS research personnel are a corps of knowledgeable and experienced people for SMSS technical assistance to LDC's, for TDY's as well as training in soil management. ARS and SMSS scientists together make a formidable team for basic studies of soil management, farming systems and erosion control.

### COOPERATIVE STATE RESEARCH SERVICE

The Cooperative State Research Service provides the link between state agricultural experiment stations and USDA. The land-grant universities cooperate closely with USDA agencies, especially in research and extension. University expertise in soil management/soil fertility is an extremely valuable asset for technical assistance to developing countries, both in short-term consultancies and longer term institution-building. Many U.S. universities already have extensive involvement in research and technical assistance in LDC's and have staff that are experienced in problem-solving in subtropical and tropical countries.

Currently USDA has contractual relations for SMSS with at least four American universities, cited elsewhere in this report.

AID-supported research depends heavily on inputs from universities. Additional opportunities exist between the National Soil Survey Laboratory and universities for cooperation in the area of soil class-fertility relations and in other basic soil management issues. University personnel already have participated in many SMSS activities. In late Phase II and in Phase III there will be need to use them even more for TDY's and in training workshops, as well as for authoring technical monographs and handbooks and preparing other training aids. In addition, state agricultural experiment station scientists are a valuable resource for technical assistance TDY's.

## SMSS STRATEGIES FOR MEETING NEEDS OF LDC'S NOW AND IN FUTURE

Strategies may be expressed in terms of institutional arrangements, program emphasis and the mechanisms and activities needed to support the emphasis.

### INSTITUTIONAL ARRANGEMENTS

AID's PASA for implementing SMSS is with USDA/OICD and all working arrangements operate through OICD. The key to effective functioning of SMSS is networking--with USDA agencies, universities, international research institutes, world-wide and regional technical assistance agencies, country institutions in both LDC's and developed countries, other soil-related AID projects, AID missions and AID regional bureaus. So much is to be gained in efficiency, credibility and effectiveness by forging strong links to other institutions, agencies and programs that it is unthinkable not to do so.

### PROGRAM EMPHASIS

The following six points of emphasis serve to point the way to the future of SMSS:

- A. Build understanding in LDC's of the role of soils in increasing food, fuelwood and fiber production and stabilizing agricultural and national economies.
- B. Create understanding in LDC's of the need for modern soil surveys to estimate country productive potentials, to provide the vehicle for agrotechnology transfer, and for land-use planning.
- C. Assist LDC's to articulate appropriate government policies for food and agriculture, especially those to

- encourage food production and promote soil conservation.
- D. Promote the development in LDC's of government programs and institutions for soil survey and soil management and conservation.
  - E. Assist in training LDC personnel in organization and management of government institutions for soil survey, land-use planning and technical assistance to farmers in soil management and soil and water conservation.
  - F. Assist soil survey research and soil data base collection efforts in LDC's.

## SUPPORTING MECHANISMS AND ACTIVITIES

### TECHNICAL ASSISTANCE

#### Personnel

1. Add another soil scientist to the SMSS headquarters staff. He should be a specialist in soil management and conservation.
2. Broaden the base of technical assistance TDY's.
3. Draw more experts from ARS, universities and experiment stations, especially in the field of soil fertility and soil managements.

#### Workshops

4. Conduct regional workshops on soil survey methodology for soil survey personnel. Include legend development, field mapping, soil sampling, quality control, correlation and interpretations.
5. Conduct regional workshops for LDC decision-makers and AID officers on soil survey, land-use planning and agricultural development. Follow up in individual countries by SMSS staff who should continue urging AID missions and LDC ministries to action on policies and institutions.

### Soil Fertility, Management and Conservation

6. Inventory LDC agencies and programs aimed at soil management and conservation and keep these inventories up to date.
7. Improve communications and ties with AID regional bureaus and regional offices in the field. This should become easier with the shift in emphasis toward soil management, soil conservation, land-use planning and agricultural development.

### International Soil Data Bank

8. Continue to support the international soil data base development through additional pedon characterizations at the SCS National Soil Survey Laboratory, through networks like IBSNAT, TropSoils and IBSRAM, and through national and regional soil laboratories.

## TECHNOLOGY TRANSFER

### Workshops

9. Conduct regional workshops for LDC soil scientists, agronomists and engineers on soil fertility, soil management and conservation, emphasizing agrotechnology transfer. Where feasible, introduce predictive modeling and computerized data bases.

### Demonstrations

10. Select one small LDC (or two) for a demonstration of the use of a 1:1 million soil map for land-use planning, soil potential evaluation, and agrotechnology transfer. Invite mainly decision makers to the demonstrations.

### Soil Taxonomy

11. Continue efforts to improve the Newhall model for calculating soil temperature and moisture regimes by taking account of additional variables.
12. Develop a refined classification of soil moisture and temperature regimes for use in Soil Taxonomy.
13. Develop ways of pulling soil fertility information out of Soil Taxonomy. Some universities are interested in this effort. The recommendations of the August 1982 workshop on "Soil Classification and Soil Fertility" could be the basis of an SMSS-university activity.

14. Ask SCS to accelerate the process of review, approval and publication of changes in Soil Taxonomy.

General Soil Maps

15. Consider supporting the update, conversion to Soil Taxonomy nomenclature, and digitization of the 1:1 million soil map of the world in the files of the SCS Soil Geography Unit. Besides the obvious value to U.S. interests, this map in computerized form would be enormously helpful to SMSS, AID and LDC's for a variety of activities, especially in land-use planning and agrotechnology transfer.

Translations, Publications, Training Aids

16. Publish more technical monographs. Needed are publications on

Soil correlation	}	Keyed to soil orders?
Soil interpretations		
Soil management		
Soil conservation		
Pedon descriptions, using horizons and features in <u>Soil Taxonomy</u>		
The Guy Smith interviews		

17. Create additional training aids, including videotapes and films, on use of Soil Taxonomy for mapping legend development, on soil interpretations and on soil correlation.
18. Encourage the SCS National Soil Survey Laboratory to develop and publish field guides for estimating soil moisture, permeability and bulk density.

## SOME STRATEGY PAPERS FOR SMSS/AID ACTION

Three documents bearing directly on the goals of SMSS were reviewed for this report. In addition, a theme paper on "fragile lands" submitted to AID by a private consultant was read.

Following are comments.

"Soil Conservation in Less Developed Countries" (7) reviews the rationale for soil conservation and presents a very general picture of the world problem and of the constraints to its solution. The paper lists six strategies for future SMSS action with emphasis on three main areas of assistance to LDC's, as follows:

- a. A multinational, coordinated information campaign to inform publics on the seriousness of soil degradation.
- b. Resource inventories, including conservation needs inventories.
- c. Training in the planning and installation of conservation systems in LDC's, including erosion control, water management and land reclamation.

The paper is too general, lacking in specificity. For example, one could start with these questions:

What kind of information effort is needed? Using which media? Directed toward whom? By whom?

How should resource and conservation needs inventories be carried out in LDC's? Where will the expertise come from? Who would pay for these inventories?

Who would receive the training in conservation systems? Who would give the training, and who would pay for it? Who decides what specific sorts of training are needed in a given LDC?

"Training personnel in developing countries in soil survey interpretations as a part of the programs of the strategy for assistance of US-AID and SMSS" (11) is a short paper, only seven pages including references, intended to "provide guidance for training personnel in developing countries in soil survey interpretations." Attached to the paper are a number of supporting documents, such as university course outlines, soil tour brochures, book advertisements, university course descriptions and a reprint of a paper on the role of computers in land-use planning. The paper does not really present a coherent strategy for either SMSS or AID in the area of soil interpretations in LDC's.

"Soil Survey in Developing Countries: Problems, Needs, and Strategy for Assistance" (12) emphasizes in the strongest terms that soil is the most important resource on earth and that nations must dedicate massive amounts of money and effort to inventory, plan, use and care for the soil or disaster will ensue. The argument that every nation should dedicate 10 percent of its national budget to soil inventory, management and conservation is unrealistic. The paper has a number of good points, though, such as the following:

- a. Every country needs the capability to inventory its soil resources and develop the interpretations of soil survey that support agrotechnology transfer.
- b. SMSS should emphasize soil interpretations in its technology transfer activities with LDC's.

- c. Decision-makers in LDC's need to be educated in appreciation of the role of soil resources in food, fuelwood and fiber production.
- d. Soil use and management are given insufficient attention in most countries but the results are more damaging in the LDC's.
- e. Priority items for U.S. assistance include:
  - Regional training courses in soil interpretations.
  - Exchange of teachers and graduate students among LDC's and U.S. universities.
  - More agricultural research in LDC's.
  - Broader dissemination of soil information within LDC's.
  - Networks and other mechanisms to coordinate soil interpretations.
  - Publication of soil surveys and interpretations reports.

"Fragile Lands: A Theme Paper on Problems, Issues, and Approaches for Development of Humid Tropical Lowlands and Steep Slopes in the Latin American Region" (5) offers "ideas and concepts for consideration rather than definitive answers." It does not discuss the so-called "fragile lands problem" in any detail, nor does it present recommendations for action nor evaluate what has already been tried. Emphasis is on economic criteria for resource degradation and on economic values. Little is said about soils; one might almost believe that the authors assume that crops are grown without soil. Nowhere are soil surveys or other soil inventories mentioned as a base for programs to develop and protect fragile lands. Instead, "structural reforms," focused on policy and institutional changes are offered as the correct strategy to promote sound soil management. The paper provides some guidance for program

proposals that deal with extension, credit, information, policy and legal reform, tenure reform, rural development institutions and critical site programs, but this guidance can scarcely be meaningful in the absence of adequate resource inventories and evaluations. It follows that SMSS has a critical role to perform before any "fragile lands" program of the kind described here could be of any utility.

## OPTIONS FOR MORE EFFECTIVE ORGANIZATION AND MANAGEMENT OF SMSS

As mentioned in the preceding section on SMSS strategies for meeting needs, another soil scientist is needed on the SMSS program staff. He should be a specialist in soil fertility, soil management and conservation. He will need to travel a lot, sharing the task of maintaining SMSS visibility among LDC's and AID missions with the Program Leader. This specialist will have an increasingly heavy load of work in organizing educational conferences and training workshops.

Proportionally fewer SCS scientists and engineers will be required for future SMSS activities and proportionally more experts from ARS and universities. This suggests that although USDA/OICD may continue to handle the major logistical support more reimburseable inputs by ARS will figure in the contract.

Other alternatives exist for logistical support. Two obvious options are:

1. Contract with an international technical assistance organization such as IADS.
2. Contract with a consortium of universities for implementation, with one of the universities handling the logistical support.

Whatever arrangement for logistical support is selected it is important to remember that SCS is going to have to play a vital role in some of the implementation, especially dealing with soil survey, Soil Taxonomy and soil conservation.

One current problem in implementing the program and one that will become more serious as expertise is recruited more from

universities is that of selecting non-government experts for technical consultations and other functions in a timely way. Bureaucratic policies and regulations in both AID and USDA/OICD require selection of individuals and institutions on the basis of competitive bids. This procedure commonly adds weeks to the time required to get an expert to an LDC for a short assignment. There is no problem, of course, when scientists are to be selected from active-duty rosters of SCS, ARS or another Federal agency. Some solution to this difficulty should be sought that is within the agencies' policies and regulations.

## CONCLUSIONS AND RECOMMENDATIONS

During its first five years SMSS has demonstrated the soundness and attainability of its objectives and the success of its efforts. Considering that there are only three permanent full-time employees on the program staff, SMSS has had a remarkable impact and achieved an enviable reputation for getting its tasks done and done well. Substantial credit for these accomplishments is due to Tejpal Gill, Hari Eswaran, Ray Meyer, Ralph McCracken, Richard Arnold, John Kimble, Fred Beinroth and Terry Cook. Of course, the contributions of many other contributors and collaborators in the United States and abroad must be recognized.

To date, SMSS appears to be right on track in its emphasis. In order to gain the benefits of a reliable, objective and consistent soil classification system it was necessary to make some improvements in Soil Taxonomy and to introduce the system in many parts of the world where no soil survey and no soil classification existed. International committees are working on the improvements needed in Soil Taxonomy. Soil classification workshops have reviewed and explored the problems of specific groups of soils and soil classification training sessions have helped LDC soil scientists become familiar with the system. To gain recognition of SMSS' capabilities in LDC's and AID missions and to implement assistance someone had to tour the world and talk to people and Hari Eswaran has done that exceedingly well. To provide technical assistance under SMSS a lot of U.S. scientists and engineers have been sent on short-term TDY's to

developing countries. To provide a minimum soil data base for workshops and forums and ICOMS and ultimately to support agrotechnology transfer a lot of soil samples were taken and analyzed in the SCS soil laboratory at Lincoln (with some assistance from other laboratories here and abroad). Finally, additional publications on Soil Taxonomy were developed, including a Spanish translation and up-to-date keys, two volumes of soil climatic classifications and many other valuable books and bulletins.

Now it is time to look ahead to the years remaining in Phase II and the years that will make up Phase III and consider what SMSS should do to maintain its momentum and to achieve even greater successes in the effort to help LDC's apply new agricultural technology and gain increased food, fuelwood and fiber production through better soil selection and more effective soil management.

The following list of recommendations is lengthy. Not all of these activities can be carried out with SMSS' limited resources. It is assumed that AID officers will assign priorities for action on the basis of agency and project goals and objectives.

## RECOMMENDATIONS

### TECHNICAL ASSISTANCE

#### Personnel

1. Add another soil scientist to the SMSS headquarters staff. He should be a specialist in soil fertility, soil management and conservation.
2. Consider arranging for special expert assistance to cover the circuit of missions "selling" technical assistance to AID and LDC's for policy and institutional development. These could be temporary, part-time positions.
3. Make arrangements for training in foreign languages of soil scientists and other experts who are working or are expected to work a lot on SMSS TDY's abroad.
4. Consider making it possible to approve technical consultations longer than six weeks' duration where necessary for effective results. Cost sharing should be emphasized in these TDY's.
5. Develop mechanisms that permit more effective responses to requests for training LDC laboratory people in the United States in laboratory methods and interpretation of laboratory data. This may require more space, equipment and contract personnel at the SCS National Soil Survey Laboratory or, alternatively, contract arrangements with one or more universities.
6. Add some soil fertility, soil management and soil conservation experts to the SMSS Advisory Panel.

#### Workshops

7. Organize regional workshops for LDC soil scientists on soil survey methodology.
8. Organize regional workshops for LDC decision-makers and AID officers on soil survey, land-use planning and agricultural development.
9. Follow up on the regional workshops for LDC and AID officers on soil survey, planning and development. SMSS representatives should maintain personal contact with LDC's and AID missions for purposes of encouraging effective government policies and institutions to promote resource inventories and evaluations.

Soil Fertility, Soil Management and Conservation

10. Shift program emphasis from Soil Taxonomy to the broader area of soil survey and put additional emphasis on the use of Soil Taxonomy in soil management, soil fertility and soil conservation.
11. Inventory LDC agencies and programs for soil management and conservation and use this information for program planning. These inventories should be kept up to date.

International Soil Data Bank

12. Continue support of soil analyses for the international pedon data bank program. Develop a long-range plan for this activity to assure maximum effectiveness.
13. SMSS should aid in collecting, interpreting and distributing data on the status, condition, trends and potential problems with soil resources. This inventory is essential for better priority setting and strategy development in AID, other international agricultural assistance agencies and the LDC's themselves.

Links With Regional Offices and Institutions

14. Strengthen SMSS ties with regional offices of AID and with regional institutions such as ACSAD and ASEAN because SMSS can have a greater impact by working through these regional entities.

TECHNOLOGY TRANSFER

Committees

15. Continue the international committees (ICOMS) until their assignments are complete but urge them to finish their work by 1987 or earlier. ICOM chairmen should all be asked for periodic progress reports.
16. Consider establishing one or more international committees to deal with problems of soil fertility, soil management and soil conservation in various soil zones but especially in the humid tropics and arid and semiarid tropics, including irrigated lands.

Workshops

17. Organize regional workshops and forums for LDC soil scientists, agronomists and engineers on soil management and soil conservation, emphasizing agrotechnology transfer. Where possible introduce the systems approach, using predictive modeling and computerized data bases.

18. Continue the soil forums (training sessions) but broaden the agenda to uses of Soil Taxonomy in the whole range of soil survey operations.

#### Demonstrations

19. Make one or two demonstrations in small LDC's of the use of a modern 1:1 million soil map for land-use planning, soil resource evaluation and agrotechnology transfer.

#### Soil Taxonomy

20. Develop ways of pulling soil fertility information out of Soil Taxonomy. Alternatives include (a) Refining Soil Taxonomy with additional differentiating criteria; (b) use of more refined soil phases; (c) use of technical classifications such as the Soil Fertility Capability Classification.
21. Ask SCS to accelerate the review, approval and publication of proposals to revise Soil Taxonomy.

#### General Soil Maps

22. Contract (with SCS to the maximum extent possible) for the updating, conversion to Soil Taxonomy nomenclature and digitization of the 1:1 million soil map of the world now resting in the files of the SCS Soil Geography Unit. This map and legend in computerized form could be tremendously useful for many of the activities of SMSS. The upgraded map would make possible lists and maps showing where specific edaphic conditions exist. 1:1 million country soil maps would be valuable as a primary base for sector studies. Several other U.S. government agencies should be approached for sharing the cost of this project. A start could be made on the map of Africa, in which there is currently much interest in the U.S. Government.

#### Links With Soil-related Research

23. Develop more and closer linkages with TropSoils, IBSNAT, BNF and TSMM by joint efforts on common problems (such as deriving soil fertility interpretations from Soil Taxonomy) and by sharing teaching tasks in regional workshops.

#### Translations, Publications, Training Aids

24. Continue publication of soil climatic regime compilations as well as the technical monograph series, with additional volumes on soil pedon description, soil survey methodology, soil sampling and characterization, soil correlation, soil interpretations and soil management.

25. Create additional training aids, including slide sets, videotapes and films on the use of Soil Taxonomy in soil surveys, on soil interpretations and on soil correlation.
26. Encourage the SCS National Soil Survey Laboratory to develop and publish field guides for estimating soil moisture, permeability and bulk density. Consider translating and publishing these in other languages.
27. Combine the newsletters for the soil-related AID research projects with Soil Taxonomy News in a single, quarterly newsletter.

## REFERENCES

1. Anonymous, n.d. "SMSS Phase II." (Probably by Holzhey and Kimble at the SCS National Soil Survey Laboratory, probably 1984.)
2. Bouldin, David R. & Matthew Drosdoff, n.d. "Soil fertility in developing countries." (draft) 6 pages.
3. Bouldin, David R. & Matthew Drosdoff, 1982. "Soil management and Soil Taxonomy -- some second thoughts." 4 pages.
4. Brown, Lester R. and Edward C. Wolf, 1984. Soil erosion: quiet crisis in the world economy. Worldwatch Paper 60. Worldwatch Institute, Washington, D.C. 49 pages.
5. Development Alternatives, Inc., 1984. "Fragile lands: a theme paper on problems, issues, and approaches for development of humid tropical lowlands and steep slopes in the Latin American Region." Washington, D.C. 98 pages.
6. Eswaran, Hari, 1984. "Soil management support services: a strategy for Phase III." (draft) 8 pages.
7. Interstate Engineering Company, 1984. "Soil conservation in less developed countries." Wahpeton, N.Dak. 37 pages.
8. Jones, Allan and Paul T. Doyle, 1984. "Multilateral strategy for development and transfer of agricultural technology in developing countries." (A memorandum addressed to Drs. Tejpal Gill and Raymond Meyer, AID) 3 pages.
9. Manrique, L.A. and G. Uehara, 1984. A proposed land suitability classification for potato: I. Methodology. Soil Sci.Soc.Am.J. 48:843-847.
10. Manrique, L.A. and G. Uehara, 1984. A proposed land suitability classification for potato: II. Experimental. Soil Sci.Soc.Am.J. 48:847-852.
11. Olson, Gerald W., 1984. "Training personnel in developing countries in soil survey interpretations as a part of the programs of the strategy for assistance of US-AID and SMSS." Ithaca, New York. 7 pages + attachments.
12. Olson, Gerald W., 1984. "Soil survey in developing countries: problems, needs, and strategy for assistance." Ithaca, New York. 168 pages.

13. Soil Management Support Services, 1980. "Annual project report for the period October 1, 1979 to September 30, 1980." Washington, D.C. 35 pages plus appendices.
14. Soil Management Support Services, 1981. "Annual report, 1980-1981." Washington, D.C. 61 pages.
15. Soil Management Support Services, 1982. "Progress report, October 1, 1979 - September 30, 1982." Illus. Washington, D.C. 40 pages.
16. Soil Management Support Services, 1984 (in press): "Progress report, October 1, 1982 - September 30, 1984." Illus. Washington, D.C. 91 pages.
17. University of Hawaii, 1983. International Benchmark Sites Network for Agrotechnology Transfer. IBSNAT Brochure 01-E. Honolulu. 11 pages.
18. Van Wambeke, Armand, n.d. "Where do we go from here?" Ithaca, New York. 6 pages.

## ACRONYMS APPEARING IN THIS REPORT

AID	Agency for International Development
ACSAD	Arab Center for the Studies of Arid Zones and Dry Lands
ARS	Agricultural Research Service
ASEAN	Association of Southeast Asian Nations
BNF	Biological Nitrogen Fixation Project
BSP	Benchmark Soils Project
CSRS	Cooperative State Research Service
FAO	Food & Agriculture Organization of the United Nations
IBSNAT	International Benchmark Sites Network for Agrotechnology Transfer
IBSRAM	International Board for Soil Research and Management
ICOM	International committee
ICOMAND	International Committee on Andisols
ICOMAQ	International Committee on Classification of Soils with Aquic Soil Water Regimes
ICOMERT	International Committee on Vertisols
ICOMID	International Committee on Aridisols
ICOMLAC	International Committee on Classification of Soils With Low Activity Clays
ICOMMORT	International Committee on Soil Moisture Regimes
ICOMOD	International Committee on Spodosols
ICOMOX	International Committee on Oxisols
ICRISAT	International Crops Research Institute for the Semiarid Tropics
IRRI	International Rice Research Institute

LDC	Less developed country
NTC	SCS National Technical Center
NSSL	SCS National Soil Survey Laboratory
OICD	Office of International Cooperation and Development
ORSTOM	Office du Recherche Scientifique et Technique d'Outre-Mer
SCS	Soil Conservation Service
SMSS	Soil Management Support Services Project
TDY	Temporary duty assignment
TropSoils	Soil Management Collaborative Research Support Program
TSMM	Technology of Soil Moisture Management Project
USDA	United States Department of Agriculture