Deutsche Stiftung für internationale Entwicklung
German Foundation for International Development
Fondation Allemande pour le Développement International
Fundación Alemana para el Desarrollo Internacional

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Gesch.-Zeichen:

From: Feldafing Workshop Participants

Date: June 15, 1995

SOIL, WATER AND NUTRIENT MANAGEMENT INITIATIVE: A GLOBAL, INTEGRATED PLAN WITHIN THE ECOREGIONAL FRAMEWORK

We have the honour of submitting copies of a significantly revised proposal for the Soil, Water and Nutrient Management (SWNM) initiative. In this document representatives from 56 organizations, including 20 national programmes, 7 CGIAR centers, and 29 other agricultural research and development agencies, have addressed the earlier suggestions and questions of TAC.

The spirit and ideas of earlier underpinning activities of the SWNM initiative (Greenland document, Zschortau Plan, Rome meeting) have coalesced in the present document. Every effort in the four day Feldafing workshop, partly funded by the DSE (Deutsche Stiftung für internationale Entwicklung), was made to guarantee that the activities of this new initiative are harmonised among the four proposed consortia and with the ecoregion mandate of the CGIAR. The four consortia are concerned with management of acid soils, replenishing soil fertility, managing soil erosion, and optimising soil water use.

Initially, the four thematic consortia will focus their thrusts in selected ecoregions. The organizational framework of the consortia is geared towards complementarity with the ecoregional structures. However, the ecoregional programmes are at different stages of development and thus are also reflected in different structures of the thematic consortia.

...

We hope and trust this document will be carefully considered at TAC 67. We look forward to an opportunity to implement the plans.

The Feldafing group worked well together and readily reached consensus on the key issues. They are also keen to initiate action in 1996.

Yours sincerely,

M. Latham
Coconvenor SWNM
Initiative

R. Havener
Coconvenor SWNM
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Soil, Water and Nutrient Management Initiative:

Report from the Feldafing Consultation

Convened by:
DSE
IBSRAM
CIAT

June 12 - 15, 1995

Table of Contents

1. Introduction

Agenda 21 has set an uncompromising challenge for agriculture stating that within 30 years the world's population will rise to 7 - 8 billion people and the capacity of available resources and technologies to satisfy the demands of this growing population for food and other agricultural commodities remains uncertain.

A specific call is given to strengthen the scientific basis to provide knowledge for sustainable production systems, enhance scientific understanding, improve long-term scientific assessment, and build scientific capacity (Chapter 35). Furthermore it calls for determining research priorities at the national, regional and global level. In chapter 14 Agenda 21, it requires a coherent policy framework for sustainable agriculture and rural development (including policy advice).

The possible expansion of agricultural land is limited to a few areas of South America and Africa, but the production potential of much of this unexploited land is likely to be marginal, due to inherent constraints of soil structure and rapid nutrient depletion. Production increases from fertile lands are also reported to be declining. Additionally, both marginal and fertile lands are currently undergoing varying degrees of degradation, including nutrient depletion, soil acidity, soil erosion and poor use of soil water. As much as 1.2 billion ha of the earth's vegetated surface has been estimated to suffer from moderate to serious degradation, effects which cannot always be compensated, even partially, by the application of fertilizers. Hence soil quality and enhanced fertility need to be maintained and conserved through proper management of natural resources.

The Need for a New Approach

In order to address the problems of research on the management of natural resources, the CGIAR devised the concept of an eco-regional[1] approach to research. The eco-regional approach to research as recommended by TAC (1993), has the following three key principles:

1 applied and strategic research on the foundations of sustainable production systems;

2 improvement of productivity by drawing in appropriate global research activities;

3 strengthening of cooperation with national partners and the development of transnational mechanisms of collaboration.

[1] An ecoregion is an agro-ecological zone, regionally defined

Research on the foundations of sustainable production systems with minimal environmental degradation will require a new dimension of increased global research with emphasis on issues of soil, water and nutrient management (SWNM). It is envisaged that this global program will link and complement the ecoregional programs much in the same way that global research activities on integrated pest management are being designed to feed into the ecoregional programs.

The need to establish a coordinated research program on the management of soils, water and nutrients has recently been recognized in a number of documents including the CGIAR Task Force report on marginal and degraded lands (as part of the CGIAR's response to UNCED/Agenda 21), the IBSRAM position paper on SWNM (the Grëenland Report), the Zschortau plan presented at ICW 94 and the implementation plan for the SWNM research initiative developed at the CIAT/IBSRAM-convened meeting in Rome (December 1994). A need for a stronger, more coordinated effort on SWNM research was also endorsed by the Center Directors Committee at ICW 94, and more recently soil and water management research was included as a high priority item in the CGIAR action plan from the Ministerial-level meeting held in Lucerne, Switzerland in February 1995. In May 1995, the CGIAR mid-term meeting in Nairobi supported the recommendations of the sustainable agriculture task force that research on soil water and nutrient management be expanded. The Group also endorsed the TAC and Center Directors recommendation that the SWNM initiative move forwards within the ecoregional framework, and with a minimal structure.

In the case of SWNM the approach should be different from other CGIAR initiatives, because the current skill mix of CGIAR staff is not commensurate with the magnitude of the effort required on natural resources management research. Furthermore the current work is fragmented and needs better coordination. The CGIAR would benefit substantially, if the considerable expertise of research centers and Advanced Research Organizations (AROs) outside the system that could be harnessed in a coordinated global research effort.

In this chapter we describe the rationale, goals and objectives, the principal research themes, the organizational structure of the research themes and overall program coordination. In the subsequent chapters, the proposed consortia are described in detail outlining the implementation plans and funding requirements to be considered by TAC 67.

Rationale

The Greenland and the CGIAR Task Force on Agenda 21 Reports conclude that the improvement of SWNM, in addition to requiring further technological advances, also require an improvement in the rates of adoption of existing technologies by consideration of the social, economic and policy conditions pertaining to different regions threatened by declining productivity and environmental deterioration. In the past, insufficient contact has been established amongst the farmers, technical advisors and researchers. Indigenous knowledge and equity considerations, especially gender, have not received adequate attention. Existing research on SWNM is currently fragmented with little coordination at the regional, national and international levels.

Hence, the present proposals for a global SWNM program will evolve improved technologies in a participatory mode, develop and standardize common methodologies for quantifying the on-site and off-site effects of land management practices and develop indicators of sustainable land management that can be used for monitoring the health of the land resource base.

The SWNM program which shall be implemented through the ecoregional approach, focuses on problem-solving through interdisciplinary activities of several IARCs in collaboration with a full range of partners inside and outside the CG system.

Expected Benefits

By initiating the global SWNM Program, as detailed in this document, the following benefits will be added to the ecoregional programs of the IARCS:

- providing a linkage for focused research on SWNM at benchmark sites within the ecoregional programs and across ecoregions;
- addressing priority SWNM problems in selected ecoregions, the results of which will have a significant potential for extrapolation and adoption in similar eco-regions;
- increasing the efficiency of the research system through effective collaboration between NARS, IARCs and AROs and through capacity building in NARS;
- avoiding duplication of research and saving of time in technology generation;
- creating a critical mass of scientists in resource management disciplines by bringing together currently fragmented expertise;
- accelerating the rate of scientific advance through shared experiences common methods, data bases and models across regions;
- utilizing holistic approaches to SWMN issues to strengthen the research projects already in place in the various ecoregions.

Overall Program Goal, Objectives and Outputs

The coordinated efforts of SWNM will contribute to the following **program goal**:

Landusers apply technologies and sustainable management systems to

- increase long term productivity
- reduce poverty
- conserve and enhance the quality of land and water resources both on-site and off-site

The program will achieve each of the following **general objectives** and outputs according to their specific themes. These objectives are:

1 effective, efficient and environmentally sound land use management, land conservation technologies and systems are developed and made available to farmers and other users;

2 new mechanisms which encourage the adoption of sustainable land SWNM technologies;

3 stronger partnership and capacity of all stakeholders of the Ecoregion Programs (NARS, NGOs, IARCs, and AROs) in order to plan and implement research and dissemination programs for sustainable land management systems;

4 workable policy options and advice, including issues concerning equity (gender, resource access, tenure) to enhance adoption.

The corresponding **generic outputs** linked to program objectives are:

1 economically viable, socially acceptable and environmentally sound technologies for SWNM

2 improved methodologies and diagnostic tools for SWNM research

3 impact assessment methodologies including indicators for sustainable and unsustainable land use systems to monitor environmental, social and economic impacts

4 easily accessible decision support systems (models, expert systems, GIS, global data bases etc.) for generating, testing, and extrapolating SWNM options

5 critical mass of trained human resources capable of implementing SWNM programs and policies

6 framework for full cooperation and partnership between stakeholder groups in the coalition

7 Policy options that promote sustainable SWNM practices

8 Mechanisms for training and information

Proposed Consortia

During the Feldafing meeting, four consortia proposals were developed out of the priority themes. They built on prior and existing programs and therefore provide a way to strengthen ongoing activities, adding value to them. Two other themes proposed in Rome - enhancing carbon sequestration and identification of soil quality indicators - were considered in Feldafing as integral part of the four above-mentioned themes. The four consortia are briefly described below:

1 Combating Nutrient Depletion

This theme deals with innovative approaches to improve the availability and efficiency of nutrient use, including nutrient replenishment. The consortium is convened by TSBF and IFDC. It is designed to develop integrated nutrient management practices, policy guidelines, and pathways for adoption. This theme will initially focus on two ecoregional initiatives, the African Highlands and the West African Moist Savanna consortia, convened by ICRAF and IITA, respectively.

2 Managing acid soils

This theme deals essentially with the replacement of degraded acid savannas by agropastoral systems which integrate crop and livestock production. The consortium built around his theme is convened by CIAT and EMBRAPA (Brazil). It is designed to evaluate the land area available for these improvements, to identify indicators for the successful transformation of these savannas and to define successful agropastorial systems. It will operate initially within the Tropical Latin American Lowlands convened by CIAT and the Alternatives to Slash and Burn (ASB) program convened by ICRAF.

3 Managing soil erosion

This theme tackles on-site and off-site effects of soil erosion within catchment studies. The consortium built around this theme is convened by IBSRAM and PCAARD (Philippines). The consortium aims to harmonize existing research activities and to develop management practices to minimize soil erosion which are acceptable to land users. It will be linked with the IRRI-led ecoregional program on humid and subhumid tropical Asia.

4 Optimizing soil water use

This theme deals with crop water use efficiency and water harvesting. The proposed consortium is led by ICARDA, ICRISAT and IER (Mali). It envisages to search for increased production of the agricultural and pastoral system of the Sub-Saharan and Mediterranean regions and for an increased supply of clean water.

It will operate within the Desert Margins Initiative led by ICRISAT and the WANA ecoregional initiative convened by ICARDA.

In the context of the SWNM program, a consortium is understood to be an open collaborative gathering of research groups working on a common program, problem or theme, in line with the agreed CGIAR research agenda. The membership is open to researchers from within and outside the CG system including NARS, IARCs, ARO´s and NGO´s

Program Coordination

Because a wide range of issues are simultaneously addressed by the four consortia there is a need for an overall coordinating function which would provide the following services with a minimal structure:

- continuity of activities across different consortia and ecoregions through Cross- theme Working Groups;
- common activities on training and information;
- provision of a focal point on SWNM issues in and outside the System.

The Program Coordination will be executed by the convening center assisted by a Global Steering Committee composed of Consortia and Ecoregional Program leaders, donor representatives and special advisors from NARS and AROs. It will be implemented by a Global Coordinator located at that center.

Cross- theme working groups will be convened as needed to link with the various stakeholders.

Integration of SWNM activities with eco-regional Programs

The SWNM program provides additional strengths to the activities of the eco-regional programs in the area of soil, water, and nutrient management research. Areas of complementary include collaborative surveys conducted jointly to define priorities, the use of common-data bases, sharing of ecoregional benchmark areas and sites, joint working groups, and participation at eco-regional or SWNM meetings. Decision on SWNM research programs will as far as possible be reached through a concertation between eco-regional groups and SWNM consortia through joint Ecoregional- SWNM working groups. These working groups will specifically

- determine joint workplans based on priorities assessed by the ecoregional program and the consortia
- prepare joint proposals for multi- and bilateral funding
- ensure that implementation of the activities is collaborative and based on the comparative advantage of the different institutions

Budget for Program Coordination

Initial Budget for Year 1996 (in US$)

Convening Meeting	$60000
Consultants	20000
Program Coordinator	20000
Total	**100000**

1996 Funding Request for Soil Water Nutrient Management Initiative

	Global	Replenishing Nutrient	Soil Water	Managing Acid Soils	Erosion
Planning Workshops	60,000	120,000 a)	60,000	60,000	60,000
Literature Reviews		40,000	90,000	60,000	
Consultants	20,000				70,000
Communications Coordination	20,000	30,000	90,000	30,000	30,000
NARES Project Preparation					70,000
Site Selection/ Characterization		40,000		75,000	
Total	**100,000**	**230,000**	**240,000**	**225,000**	**230,000**

a) includes one meeting for Africa Highland Initiative and one meeting for Africa Humid Tropics (EPHTA).

Theme 1: Combating Nutrient Depletion: Nutrient Replenishment Through Integrated Management of Soil Fertility

1 Executive Summary

Soil nutrient depletion is a global problem. Deficits in essential elements have been detected for field, district and national levels in many countries of Africa, including those of the 'bread-basket' areas of the moist savanna zones.

The soil nutrient gap is a product of the spiral of poverty as much as of a lack of technical information. Despite abundant research on nutrient management, little impact has been observed in terms of increased productivity in many areas. This low adoption is due in many cases to a failure to link recommendations for nutrient management to farmers' actual socioeconomic and environmental circumstances.

This proposal seeks to advance the adoption and impact of nutrient management technology and to improve the range of technical options through research.

The proposal seeks to bring together a consortium of institutions and scientists to implement a collaborative programme which combines five elements of research: integration of technology development with farmer's practices, needs and opportunities; Increasing the availability and access to nutrients; Improving the efficiency of on-site nutrient use; Regulation of on and off-site environmental impacts of nutrient management; Policy dimensions of nutrient management.

The technical research will focus on two particular approaches; recapitalisation as a means of economically increasing the stock of nutrients in agroecosystems; and the use of mixtures of organic and inorganic nutrient sources to improve nutrient use efficiency and diminish off-site environmental effects.

It is proposed that the SWNM Theme on Combatting Nutrient Depletion be launched in sub-Saharan Africa with a focus on the high potential regions of the moist savanna zone. The research will be conducted as part of the activities of two Ecoregional Initiatives - those of the Ecoregional Programme for the Humid Tropics of Africa (EPHTA) convened by the IITA and the East African Highlands Initiative (AHI) convened by ICRAF. The nutrient depletion research will be conducted in benchmark areas and sites within each ecoregion in collaboration with scientists from the ecoregional initiatives. On farm and on-station sites suitable for nutrient depletion research will be selected on criteria for representativeness which include both biophysical and socioeconomic factors.

2 Problem Statement

Manipulation of nutrient inputs and outputs is one of the major factors determining whether high agricultural production can be realized, and whether production can remain high in the long run. Some fertility practices constitute merely a **saving** of nutrients from being lost from the system (e.g. recycling of crop residues, manure of farmers' livestock), whereas others result in an **addition** of nutrients to the land (e.g. mineral fertilizers and organic inputs from outside the farm). The efficiency of utilization of nutrients within farming systems is usually very low and major losses of nutrients from cropping fields, cattle pens and other production components have been recorded. These losses may also have negative environmental effects off-site in terms of pollution of ground water and eutrophication of streams.

There is abundant evidence that very large areas of previously fertile soils are characterized by significant nutrient deficits. Commonly, nutrient outputs exceed nutrient inputs, rendering many agro-ecosystems non-sustainable. A FAO-initiated assessment of the nitrogen, phosphorus and potassium budgets for 35 crops in 38 SSA countries, for example, revealed that the mean annual losses per hectare were widespread and considerable.

The moist savanna zone of Africa and the african highlands are characterized by the predominance of Alfisols and a growing period between 180-269 days. This zone includes the Guinea savannas of West Africa and areas of East and Southern Africa stretching from Kenya to Zimbabwe. The Alfisols in the undisturbed state are relatively less leached and are higher in bases compared to the Oxisols and Ultisols of the humid zone. When the physical and chemical properties are well managed, the moist savanna zone is the potential bread basket of sub-Saharan Africa However, as a result of intensified cultivation, the majority of soils under agricultural use in sub-Saharan Africa are now, and increasingly, deficient in one or more essential nutrient elements. These are the initial target agro-ecological zones selected for this project on SWNM.

High population growth rate (in excess of 3%) combined with increased stocking rates (eg. an estimated increase of more than 76% between 1963 and 1983 in the northern part of this zone in West Africa) has put enormous pressure on the finite land base. Intensification of agriculture without addition of plant nutrients to replenish those removed by crops from the already impoverished soils has resulted in "nutrient mining" and subsequent land degradation.

For example, in the guinea savanna zone of south Mali, economists estimate that roughly 35% of the farmers' income is derived from mining the soils of plant nutrients. Losses of plant nutrients through plant uptake are exacerbated by annual bush burning which leads to increased losses of such nutrients as N and S. This practice also contributes to global warming.

There is very large body of research results on the topic of nutrient management but the impact on the level and sustainability of production in smallscale farming has been low. The poor adoption rate of recommended practices and technology is a matter of critical concern and has been attributed to inappropriate recommendations bearing little relationship to farmers' circumstances or needs, coupled with low access to resources.

Actual input and output levels in agricultural production are not determined by agronomic aspects alone. Socio-economic conditions at both the macro-level (e.g. market access) and at the micro-level (e.g. price ratios between inputs and outputs) are major factors governing the decision-making process at the farm household level. Furthermore, the state of infrastructure as well as public and private institutions clearly affect the farmers' ability to take the necessary actions at the right time. Based on the recognition of the broad range of factors affecting the deterioration of soil fertility, this proposal has been formulated to determine options and constraints for the adoption of fertility preserving agronomic systems as well as proposing a holistic approach to development of nutrient management practices for smallscale farms.

3 Research Rationale

Research to develop effective, efficient and adoptable means of solving the nutrient depletion problems in the moist savannas and other eco-zones of the tropics requires an integrated approach incorporating the elements described below. The technical research is driven by two hypotheses which propose innovative approaches to improving the availability and efficiency of nutrient use.

3.1 Integration of technology development with farmer's practices, needs and opportunities.

The conventional approach to developing recommendations for nutrient management has largely been fertiliser package recommendations for a given soil-type/climatic zone. This has often been unsuccessful because of failure to recognise the variation in farmers' circumstances, needs, aspirations, opportunities and capabilities. Technology development which builds on knowledge and understanding of these circumstances, obtained through participatory research, will have a higher chance of producing adoptable solutions to soil nutrient problems.

3.2 Increasing availability and acess to nutrients.

The availability and farmers' access to sources of nutrients is one of the major factors inhibiting productivity and resulting in soil nutrient depletion. Access to inorganic fertilisers is largely determined by economic and policy factors and to organic sources by the additional features of cropping system design and resource allocation within and between farms. Both elements of research are required to develop means of increasing nutrient inputs for soil management.

Nutrient recapitalisation represents an innovative approach to the solution of this problem. The basic principal entails a large, one-time application of nutrients to replenish nutrients that have been depleted over the last 25 years or so. This involves an investment, in contrast to recurrent costs associated with conventional, annual fertiliser applications at levels commensurate with annual removal. If the new capital is retained in the soil by mechanisms of physical and biological immobilisation coupled with mechanisms of release, nutrients will be

available to the plants over a large number of years. This approach particularly applies to P and N coupled with appropriate cropping system design (eg the incoporation of perennials or cover crops) but is not feasible for elements such as K which are easily lost from the soil. This concept leads to the first hypothesis related to nutrient replenishment.

Hypothesis 1:

More rapid, more economic and more sustainable increases in productivity can be achieved by investment in nutrient recapitalisation rather than by recurrent fertilisation.

3.3 Improving the efficiency of on-site nutrient use.

Nutrient deficits can only be made up by application of inputs that match or exceed outputs. Significant fractions of fertiliser added to cropping systems is frequently lost through processes such as run-off, leaching and volatilisation. Nutrient recovery in crops from organic inputs are rarely higher than from inorganic fertilizers but a greater proportion is retained in the ecosystem through immobilisation in organic matter. The continual addition of carbon together with sufficient levels of nutrient results in the progressive build up of soil organic matter which immobilises nutrients and reduces losses in leachate and thence the negative off-site effects on water quality, as well as contributing to other aspects of soil fertility on site. This element of research is related to the second hypothesis of nutrient replenishment:

Hypothesis 2:

Management of soil by integrated use of organic and inorganic sources of nutrients will lead to greater productivity, increased efficiency of nutrient use and cycling and reduction of negative on and off-site impacts on the environment and natural resource base.

3.4 Regulation of on-and off-site environmental impacts of nutrient management.

Hypothesis 2 offers a means of reducing off-site effects of nutrient losses as well as improving on-site nutrient use efficiency. The assessment of the these effects requires research at the catchment and landscape levels as well as at the farm and field scales.

3.5 Policy dimensions of nutrient management.

Implementation of improved means for nutrient access and use is dependant on decisions made by farmers and farming communities that are often dependent on decisions made at national and supra-national levels by policy makers. Technology development must take place in full partnership with the local decision makers and in interaction with those at the higher levels.

The problems associated with nutrient deficits have differing characteristics at different scales. At a minimum investigations need to be conducted at three scales;

The field scale permits factor analysis of the biophysical processes determining nutrient flows and the interaction with the cropping system design and mangement practices utilised by farmers.

The farm scale represents the level at which decisions are made by the farmer concerning allocations of nutrients between ecosystem compartments based on production goals as well as being the unit at which externalities, including extension advice, become highly significant in regulating nutrient availability.

The catchment is a hydrologic unit which enables the integration of nutrient budgets within well defined boundaries which represent the product of interactions of physical, biological and socioeconomic drivers of nutrient flux across the landscape. This scale also often approximates to the that at which important decisions are made concerning the allocation and use of resources over the landscape by the village or farming community.

The sustainability of any nutrient management practice can only be judged in the long-term. In particular the outcome of the two central hypotheses requires testing over a minimum period of five to ten years in representative sites. Provision will be made in the workplan to establish long-term experiments that will enable the measurement and monitoring of changes in the nutrient status and dynamics of candidate cropping and farming systems.

It is proposed that the SWNM Theme on Combatting Nutrient Depletion be launched in sub-Saharan Africa with a focus on the high potential regions of the moist savanna zone and the african highlands. The research will be conducted as part of the activities of two Ecoregional Initiatives - those of the Ecoregional Programme for the Humid Tropics of Africa (EPHTA) convened by the IITA and the East African Highlands Initiative (AHI) convened by ICRAF. The nutrient depletion research will be conducted in benchmark areas and sites within each ecoregion in collaboration with scientists from the ecoregional initiatives. On farm and on-station sites suitable for nutrient depletion research will be selected on criteria for representativeness which include both biophysical and socioeconomic factors.

The consortium will also address global issues of nutrient replenishment and will plan to extend research into other ecoregions in year three or four of the program. In addition, advances will be made in nutrient replenishment research in other regions through interconsortial working groups within SWNM on issues such as interactions of soil nutrients and water, nutrient depletion and generation of soil acidity, and combatting soil erosion through soil nutrient management.

4 The Nutrient Depletion Consortium

There is a wide range of expertise globally in nutrient management research. One of the reasons for forming the consortium is to bring together this expertise and to combine and coordinate efforts in confronting this worldwide problem. The international convenors for the

theme are the International Fertilizer Development Centre (IFDC), Lome, Togo and the Tropical Soil Biology and Fertility Programme (TSBF), Nairobi, Kenya. Both institutions work in partnership with scientists from national programs and institutions in the target zone: the West African Fertilizer Management and Evaluation Network (WAFMEN) of IFDC and the African Network for Biological Management of Soil Fertility (Afnet) of TSBF. The research and development activities of the nutrient depletion theme will build on the complementary strengths in these two networks. In particular it will bring together the TSBF focus on organic and biological aspects of soil management research with that of IFDC on inorganic fertiliser policy and management research. The Institute for Agricultural Research (IAR), Samaru, Nigeria, and the Kenyan Agricultural Research Institute (KARI) have been identified as national co-convenors of the consortium.

At the Feldafing meeting additional partners joined the consortium including IARCs (IITA, ICRAF), NARO (National Agriculture Research Organization of Uganda) AROs (CIRAD/ORSTOM with extensive experience in nutrient management research in West Africa, Wageningen University, Netherlands and IACR-Rothamsted and Silsoe Research Institute with expertise in modelling and advanced analytical techniques). A planning meeting will also be held to identify other partners from extension groups, including NGOs, and the private sector.

5 Objectives

1 Integrated nutrient management practices that redress nutrient imbalances and environmental degradation are developed.

2 Policy guidelines for integrated plant nutrient management are established and promoted.

3 Farmers adopt improved nutrient management practices.

6 Expected Outputs

1.1 Guidelines and decision support systems for selection and management of fertilizers and organic inputs for improved nutrient management.
1.2 Environmental impact indicators for assessing nutrient management practices.

2 Improved policy guidelines for integated nutrient management.

3.1 Linkage framework between farmers, extension groups, and researchers.
3.2 Adoption of integrated nutrient management practices by farmers.

7 Main Activities

1.1 Diagnostic survey

Field-level participatory characterization and literature review of indigenous and current nutrient management practices, fertilizer and organic input availability, soil fertility-based production constraints, socioeconomic constraints that inhibit sustainable nutrient management. Most of the information will be collected as part of the ecoregional activities and the information will be used to indentify knowledge gaps, constraints and opportunities to production. From this synthesis a research plan relevant to the nutrient management theme will be developed.

1.2 Development Research

Strategic research includes interactions between organic and inorganic nutrient sources and resulting nutrient-use efficiency, soil organic matter dynamics and carbon sequestration, and crop productivity. Specific activities include:

1 processes regulating nutrient availability from integrated use of inorganic and organic sources of nutrients with particular emphasis on organic-N / inorganic-P interactions;
2 development of a database characterizing the nutrient release patterns, or 'fertilizer equivalency' of farmer-available organic resources;
3 evaluation of the impact of different organic inputs and combinations with inorganic fertilizers on crop response, soil organic matter dynamics and residual soil fertility effects;
4 modification of soil organic matter and nutrient dynamics models for regional extrapolation of the results from benchmark area.

Adaptive (participatory) research involving farmers, research and extension workers will be used to develop methods for integrated use of inorganic fertilizer and organic inputs for enhancing crop production, nutrient replenishment, soil carbon storage. Monitoring nutrient stocks, flows, and balances and quantification of the socioeconomic and on- and off-site environmental impacts will identify the more efficient nutrient management practices. Specific research topics include:

1 evaluation of different fertilizer sources and combinations, including effectiveness of locally-occurring phosphate rocks, to improve soil fertility;
2 evaluation of different farmer-available organic resources (crop residue, manure, composts, residues, prunings from trees) and methods of application (with and without inorganic fertilizer) in terms of short and long-term soil nitrogen supply and crop responses;
3 monitoring nutrient stocks, flows, and balances in different cropping systems, through new and existing long-term trials on long-term fertility status of soils;
4 quantification of the medium and long-term socioeconomic and on- and off-site environmental impacts of different nutrient management systems;
5 development of decision support tools on nutrient management for extension workers.

2 Policy Research

Results from previous strategic and applied research on soil fertility management has not been widely adopted often because the policy environment does not allow farmers the options. In order to have successful adoption of soil nutrient management there must be an understanding of the policy constraints and policy options that would create a more enabling environment. Activities to accomplish this include:

2.1 Identification of policy related factors that decrease incentive to adopt improved integrated nutrient management practices: including macro- and micro-economic policies that affect fertilizer production, distribution and marketing, such as exchange rate policies, farm output marketing policies.

2.2 Formulation and evaluation of alternative policies to enhance adoption of improved nutrient management practices, such as creating open and competitive markets for inputs and farm outputs.

2.3 Promote revised policy options among policy makers through workshops and seminars.

3 Capacity and Institutional Building

The success of this project lies on the ability of all parties involved in the agricultural development process - the farmers, extension agents, NGOs, research scientists, buyers and sellers of both farm input and output and policy makers - to clearly understand the goals and objectives of the project and the various steps components needed to attain the goals and objectives. For this to happen, a free flow of information among the participants must be established and training provide in several areas including techniques for effective participatory on-farm research; use of decision support systems on nutrient management; developing effective frameworks for linkage and communication among researchers, extension groups, including NGOs, and farmers; and monitoring of on and off-site environmental impacts of nutrient management.

8 Organizational Framework

The Nutrient Depletion Consortium will link closely with the structure of the agroecosystem consortia exisiting in the ecoregional programs to:

- secure full collaboration on the nutrient depletion research,
- avoid duplication,
- bring together the necessary disciplinary mix to address the objectives of this consortium,
- profit from complementary research being conducted through the AES consortia
- rationalize on institutional structures by working within the AES consortia set-up.

The Nutrient Depletion Consortium will convene an expert group composed of scientists in integrated nutrient management and biological process controlling nutrient availability from IARCs, NARs, and AROs. The group will be the link to the Agroecosystem consortia and Nutrient Depletion consortium. The combined working group will:

- determine joint workplans based on priorities as assessed by the two consortia.
- prepare specific proposals for multi- and bilateral funding.
- ensure that implementation of the activities are collaborative and based on comparative advantage of the different institutions.

The activities of the specific proposals coming out of the Nutrient Depletion Consortium will be concentrated at the Agroecosystem benchmark areas and country study sites.

9 Budget:

Initial Budget for Year 1996 (in US $):

1. Activities with EPHTA

1.1 Research Review	40 000
1.2 Joint Planning Meetings	60 000
1.3 Diagnosis/characterisation (start)	20 000

2. Activities with AHI

2.1 Joint Planning Meetings	60 000
2.2 Diagnosis/characterisation (start)	20 000

3. Coordination and management (IFDC/TSBF)	30 000

TOTAL 230 000

Theme 2: Managing Acid Soils Consortium

1 Executive Summary

Acid soils cover a high proportion of the tropics, including 51% of Latin America and the Caribbean, 38% of Asia, and 27% of Africa. These acid soils areas usually have favorable rainfall and other good growing conditions, but acid soils often seriously limit productivity due to low nutrient reserves and toxic levels of aluminum and manganese. Moreover, large areas of acid soils have been significantly degraded by unsustainable agricultural systems that have depleted soil organic matter and deteriorated soil physical characteristics.

This consortium aims to develop highly productive and sustainable systems for these problem soils and to restore degraded soils by means of improved cycling of the nutrients already in these systems; by increased efficiency in the use of on-farm and external inputs; and by the introduction of germplasm adapted to acid soils. Management of the dynamics of soil organic matter is likely to be of particular importance.

Improved systems for the management of tropical acid soils will be knowledge based and management intensive. The productivity of these soils depends on intricate interactions that are poorly understood between management and a complex of soil chemical factors, which can not be analyzed or managed in isolation. Deeper understanding of these relationships is needed to identify sustainable. Because these systems will be management intensive, they will have to be crafted to meet the needs of farmers. Consequently, farmer participation in the design and evaluation of these systems will be essential.

No single institute has the full range of capacities needed to develop management systems for the wide variety of farmers conditions. This consortium brings together a set of institutions that will work in concert to develop the strategic principles for the management of these soils. It will build initially on an existing research consortium with a record of research on neo-tropical acid soils of the savannas. Methods and principles derived from this research will be disseminated, tested, and adapted to local conditions world wide through the SWNM consortium.

2 Background

Tropical soils are predominantly acid as a result of intensive weathering with the main acid-soil types, the oxisols and ultisols, covering 51% of the tropics in Latin America (852 m ha), 27% of Africa (490 m ha) and 38% of Asia (333 m ha). In many tropical regions acid soils are the infertile common ground of the moist savannas, hillsides and forest margins. These soils are generally low in productivity, low in plant available nutrients, contain toxic levels of aluminum and manganese for plant growth and are prone to degradation via accelerated erosion, crusting and compaction, loss of organic matter and nutrient depletion.

In the savannas the old *status quo* of extensive ranching is giving way to new systems of unsustainable monocropping and equally vulnerable grass pastures. In Brazil as much as 50 million ha of crop and pasture lands have been estimated to be undergoing some form of degradation. If these lands can be restored with more productive systems then exploitation of one of the last frontiers available for agricultural production may either be prevented or substantially slowed to reduce the risk of a loss of savanna biodiversity. The latter is particularly important for the Brazilian cerrados which has the most species- rich content of woody savanna plants.

Agropastoral systems that integrate crop and livestock production have proven potential to be more productive and more efficient than either cropping or pastures alone and permit more prudent management of savanna soils. Innovations such as agropastoral systems could convert large areas into regional bread baskets thus satisfying the food needs of rural and urban consumers, contributing to economic growth and providing an alternative destination for immigrants and capital flowing into the forested areas.

The main land users of acid soils are resource-poor farmers who are caught in an ever-tightening cycle of low inputs and low productivity resulting in further impoverishment of the resource base - their soils and water, and the accompanying stock of biodiversity. To break that cycle agricultural production must be increased substantially by restoring and enhancing the productive capacity of soils in an economic, socially acceptable and sustainable way. The challenge is to provide farmers with the means of producing sufficient food from the same land without exacting socially unacceptable environmental costs, thus breaking the cycle of impoverishment.

3 Research Rationale

There is an urgent need to clarify the biophysical and socioeconomic driving forces behind land degradation and to develop and introduce improved production systems which can reverse these deleterious changes and which are productive enough to attract both capital and human resources which may otherwise be involved in deforestation and encroachment into ecologically sensitive ecoregions.

Judicious use of soil and water resources requires understanding of the principles of soil, water and nutrient management at an ecosystem level along with use of improved germplasm to generate prototype, environmentally benign technologies for sustained food production within a framework of appropriate socioeconomic and policy considerations.

There is a lack of an appropriate information system and methodology to further characterize the land use capability, assess the extent and cause of degradation and to collate the information on the management of acid soils which will be of use globally.

The main hypothesis to be tested in the project is that improved agropastoral and/or crop rotations can be more productive, are capable of restoring degraded soils to higher production levels, and are more conducive to enhancing environmental quality than existing systems. An

enhanced understanding of properties and processes of acid soils will facilitate development of improved technology, systems to restore degraded soils, and facilitate the use of soils for environmental and regulatory functions.

4 Justification for Consortium Approach

None of the consortium partners by itself has a critical mass of scientists or laboratory and field facilities to develop and implement a meaningful program. Therefore the proposed consortium will develop a critical mass of scientists forming interdisciplinary teams comprising soil scientists, agronomist, crop physiologists, economists and social scientists who will investigate processes that underpin sustainable use of acid soils, evaluate production-conservation interactions at the farming system and watershed levels and assess farmers' responses to market forces, social pressures and policies.

Presently the research being conducted on soil, water and nutrient management is fragmentary, *ad hoc* and uncoordinated. The consortium will develop a coordinated effort to address critical issues, and develop the cutting edge scientific program efficient and effective manner. The consortium will benefit from economies of scale by conducting multi-institutional long-term experiments on key benchmark sites in the region. The consortium will also strengthen collaborating institutes by providing opportunities for training and human resource development.

The initial consortium partners have been comprised from both developed and developing country institutions in liaison with regional and international centers, on the basis of their comparative advantages.

5 Objective

The principal objective is to enhance food production and farmer well being and to monitor the impact of existing and new systems on soil and water quality. More specifically MAS research is aimed at the following objective:

Vast areas of low productivity and degraded acid soils of the tropics are transformed into managed areas that are characterized by

- the conservation and efficient use of soils, water and nutrients;
- increased productivity and farm income;
- enhanced environmental quality based on knowledge of soil and water resources

6 Outputs and Activities

I. Prototype agropastoral and crop rotational systems developed and their environmental impacts assessed.

   A. Selection and testing of crop/forage germplasm adapted to acid-soils and agropastoral/rotational systems
   B. Choice of agropastoral components/systems and validation and acceptability of prototype systems with farmer participation
   C. Assessment of impact of improved technology on target beneficiaries
   D. Appraisal of policy environment in relation to adoption and consequence of improved technologies
   E. Development of improved methods of validation and technology transfer
   F. Validation and development of models for predicting yield potential and long-term effects of improved systems

II. Estimate land areas suitable for agropastoral/rotational systems.

   A. Assessment of land capabilities for potential and constraints
   B. Evaluate risks of degradation by different processes
   C. *Ex ante* analysis of crop options

III. Identified environmental and soil quality indicators based on an understanding of soil-based processes.

   A. Quantify nutrient and water dynamics in traditional and improved production systems
   B. Study soil organic matter dynamics
   C. Study soil acidification processes in relation to nutrient uptake and productivity, determine critical limits for plant growth
   D. Assess fate of pollutants on- and off-site
   E. Evaluate soil physical properties and processes
   F. Evaluate the contribution of soil fauna to nutrient cycling, soil organic matter dynamics and physical structure
   G. Quantify soil erosion and its on- and off-site effects

IV. Interactive information systems established.

   A. Identify additional expertise and activities for the management of acid soils
   B. Organize regional workshops
   C. Publish a quarterly MAS bulletin/newsletter

Sites and scales

Initially the project will be established at three study areas (or benchmark areas), one in each of Brazil, Colombia and Venezuela. A watershed study may be initiated within one study area only, while in the other areas research will be conducted from plot to farm scale.

In Brazil the study area will be Plantaltina at the research station of EMBRAPA-CPAC and the area around Uberlandia for strategic and on-farm participatory research. Soils are oxisols with about 2 cmol Al/kg and around 1500mm annual rainfall. In Colombia studies will be sited within the area of influence between the Carimagua CIAT-CORPOICA research station and the town of Puerto Lopez. Soils are oxisols with around 2 cmol Al/kg and 2200 mm rainfall. In Venezuela the study area will be El Tigre-Puerto Ayacucho on ultisols with around 1 cmol Al/kg and 1100 mm rainfall.

Additional sites in other regions which may be included in the project at a later date when relationships with the CGIAR ecoregional initiatives have been established are listed below; For plot scale studies sites at Sitiung, Sumatra on oxisols/ultisols with 2 cmol Al/kg and 2700 mm rainfall (with IRRI, ORSTOM and CRIFC) and Koret, Thailand on an oxisol with 1 cmol Al/kg and 1200 mm rainfall (with IBSRAM and DLD) have been suggested. Further sites for adaptive research include Central Mindanao, Philippines and Becede, Ivory Coast subject to discussions with partners of other consortia and ecoregional initiatives.

7 Organizational framework

The consortium for managing acid soils addresses a global theme of the SWNM. It is open to the participation of all interested institutions worldwide. Initially, though, as agreed at the December 1994 Rome SWNM meeting of the Directors of the CGIAR and associated centers, the consortium will focus its activities in tropical America where the ecoregional program for the humid lowland tropics has already prioritized acid soils as a major concern. Consequently, the SWNM Program will launch its managing acid soils theme by building upon the activities of the existing MAS consortium for the neo-tropical savannas which is under the umbrella of the ecoregional program for the humid lowland tropics of Latin America and the Caribbean.

The participating members in the MAS consortium for the savannas of South America are:

NARS - CORPOICA, EMBRAPA, FONAIAP

IARCs - CIAT, CIMMYT, IFDC.

Universities and Advanced Research Organizations

- Uberlandia(Brazil)
- Univ. Central (Venezuela)
- Bayreuth (Germany)
- Ohio State and Cornell (USA)
- ORSTOM/CIRAD

Each research site will have its own regional group of researchers and will supply a representative to the Steering Committee of the MAS Consortium. This committee will oversee the technical and reporting activities and ensure the quality of the research. It will meet annually to review results of research, training and information requirements, propose revision and enhancement of the research program. A single institution will coordinate the activity of the consortium on a rotational basis as decided by the Steering Committee. This task will initially be undertaken by CIAT.

The research will be planned and executed within the framework of the ecoregional initiative on Latin America and the Caribbean. Within this ecoregional program research carried out in the savannas agro-ecosystems will in the first instance be linked with the agro-ecosystems consortia for the Forest Margins and Hillsides also within the framework of Ecoregional Program for the Humid Lowlands of the America.

Through the global SWNM the research on acid soils in the Americas would in the future establish collaboration with researchers in other ecoregions of the world who share a concern with acid soils. The global SWNM would make these links through the other ecoregional initiatives in Africa and Asia leading to the establishment of regional cells of the MAS consortium.

Moreover, through the SWNM ecoregional researchers in Latin America and Caribbean will be linked with global research carried out on soil erosion and nutrient depletion in the SWNM. For example, it is foreseen that both the soil erosion and acid soils themes of the SWNM could share benchmark sites in Central America as part of ecoregional program in the hillsides agro-ecosystem.

8 Budget

Initial Budget for Year 1996 (in US $)

1. Planning workshop	60,000
2. Global reviews on acid soils	60,000
3. Site selection/characterization	75,000
4. Consortium coordination	30,000
Total	**225,000**

Theme 3: Managing Soil Erosion Consortium

1 Executive Summary

Soil erosion on sloping land in Asia is a critical social and environmental problem. Soil losses exceeding 100 t/ha/yr have a large effect on productivity, while off-site impacts on water storage reservoirs, household water supplies, and fisheries can represent a significant individual and societal cost.

Although technologies to reduce soil loss are widely available, they have not been accepted by land users for a number of technical, economic and social reasons. The proposed consortium is designed to facilitate adoption by using an integrated, participatory approach to land management research.

By exploring new frontiers of the soil erosion dimension to sustainable land management, the consortium aims to provide cutting edge methods and approaches which are globally transferable.

The objective is to develop management practices acceptable to land users, and which minimize soil erosion and detrimental off-site effects. This will be addressed through harmonization of existing and new representative catchment projects supported by strategic research.

The consortium will be governed by an Assembly and an Executive Committee, supported by a Secretariat. Budget for the Year 1996 is US$ 230,000 to allow information collation and a planning meeting. The Operating budget in subsequent years is approximately US$ 550,000.

2 Background

Substantial areas of cultivated land in Asian countries, such as Bangladesh, Nepal, India, Pakistan, People's Republic of China (PRC), Philippines, and Thailand have been seriously affected by soil erosion resulting from over-intensive land use and cultivation of steep and sloping lands. For example, soil losses of greater than 100t/ha/year have been measured from field plots in the IBSRAM ASIALAND Management of Sloping Lands network which has been in operation for seven years.

The Asian experience is replicated in the hill and mountain lands over extensive areas of Africa and Latin America where millions of impoverished farmers eke out living within a rapidly degrading environment. The poverty and environmental implications - as well as downstream impacts on rivers, lakes, and coastal areas - are of enormous global proportions.

Soil losses, often difficult to quantify, are often not cognizant to the human populations which depend on the soil resource until the possibility of reversibility is lost. The challenge is to change how decisions are made regarding land use from the individual land user to national and international policy makers. On-site, soil loss reduces chemical fertility of the soil (by nutrient depletion and in some cases by the exposure of acid subsoils) and physical fertility (by removing surface soil and reducing soil depth). These soil changes will, in time, reduce crop yields and hence farm income and household nutrition.

The off-site effects of soil loss often have broader economic and environmental implications and include:

- increased sediment and nutrient loads in streams, degrading the quality of household water supplies
- siltation of dams and irrigation channels in the basin area of the catchment, resulting in reduced security of water supply for irrigated crops
- sediment deposition in off-shore fisheries, reducing the availability of food supplies.

In addition, land degradation associated with soil erosion increases surface runoff, often resulting in flooding, which displace human populations in low-lying areas.

Land management research has provided a range of technologies which can reduce soil loss to acceptable levels. Unfortunately, sustainable adoption of these technologies has been very limited. For example, although alley cropping technologies have been promoted in the Philippines for many years, very few farmers have taken up the technology.

A new paradigm for research is needed which ensures that the whole range of stakeholders, from land users to policymakers, are involved in the development and adoption of improved land use practices. The proposed Consortium on Managing Soil Erosion addresses this need by linking existing and new projects and activities in an effort to capitalize on the expertise and knowledge of multidisciplinary scientists who will work with national and local organizations.

3 The Need for a Consortium

The process of land degradation through soil erosion is serious in Asia and has already stimulated a number of research projects on different aspects of the problem. For example, many NGOs, such as the Mag-uugmad Foundation in the Philippines, promote conservation farming in most of the countries in the region. Most NARES and universities in the region have some hillyland/mountain agriculture programs studying different aspects of land degradation.

Developed countries have bilateral cooperation on the subject - the most important being ACIAR, GTZ, France (in Vietnam), Japan, Norway, ODA (in Nepal), Sweden, and the USA. International efforts are conducted through the FAO/ASOCON project, the IBSRAM network on Management of Sloping Lands, the ICIMOD network on Conservation Farming Systems,

the IRRI Upland Rice Consortium, and the ICRAF Alternative to Slash and Burn initiative. The consortium would also provide an effective focal point for a link between several of the ecoregional initiatives underway or planned by CGIAR Centers and on the theme of SWNM.

The fragmented nature of much of the research effort calls for a need to harmonize the efforts and to be more efficient in addressing farmers'/land-users' problems. Current work should be reviewed as a matter of priority, as a basis for new national projects on controlling soil erosion, and this can readily be done through the consortium.

4 Research Hypothesis

That user acceptable technologies for minimizing soil erosion can be developed if biophysical, socioeconomic, institutional, and policy impacts are understood and managed under appropriate time and scale regimes.

5 Objective

Appropriate land management practices which minimize soil erosion and detrimental off-site effects, which are acceptable to present land users, and which do not compromise future land use opportunities.

6 Activities

1.1 Identify conditions under which land users conserve or degrade their land
1.2 Document information on technologies available to reduce soil loss
2.0 Collect information and conduct socioeconomic and biophysical research on farms in selected benchmark areas to develop protocols
3.1 Establish field experiments to test prototype systems and monitor sediment fluxes
3.2 Monitor on-site and off-site effects of tested systems
3.3 Demonstrate technologies to user groups
3.4 Conduct cost-benefit analysis of appropriate and acceptable technologies
4.0 Provide information on social, individual, and inter-generational benefits of improved land management practices.

Details of activities are as follows:

6.1 Inventory of indigenous knowledge and scientific techniques for soil erosion management

As a preliminary to project planning and implementation, the consortium will sponsor knowledge-collation activities which will constitute Phase I of the overall project. These will also provide the basis for developing the linkages required for effective integration of existing networks and projects.

This will include: a) an inventory of existing knowledge on conservation farming for controlling soil erosion on sloping and steep lands including indigenous knowledge and scientific techniques, and approaches to combining these two, and b) an inventory of past and present initiatives/projects and their outputs.

6.2 Design and development of appropriate research and extension protocols for soil erosion management

The design and development of an appropriate research and extension protocol will take into account existing technologies, socio-economic conditions of the farmers, and policy and environmental issues. The consortium will consider the outputs of past and present projects, and, if necessary, conduct further studies. It will consider projects conducted at different scales and how these could be related to each other.

6.3 Testing and Evaluation of Soil Erosion Management Technologies

The proposal for NARES and NGOs to initiate new research as part of the consortium will allow the impact of improved farming practices to be evaluated and demonstrated more clearly. Preference in selecting a catchment project should be given to those where planning is complete and institutional arrangements are in place. This will reduce the lead time in establishing field experiments. Involvement in larger catchment projects with a number of objectives will also improve the available range of indicators of farming-system impact. Although project activities will concentrate on sloping lands, both upland and lowland issues will be considered in impact assessment.

Where possible, the research should be conducted on a catchment basis and would focus on a) the dynamics of soil, water, nutrient and pollutant transport and their effect on the environment and, b) on-site and off-site effects of soil erosion management practices to increase productivity and conserve and enhance water resources

On-farm, participatory adaptive research on locally-applicable conservation farming systems for soil erosion control is the core component of national projects within the proposed consortium. This research will be conducted by the NARES and will have a strong input from farmers and NGO's. Effectiveness will be enhanced by underpinning strategic research from the IARCs and AROs.

The aim of the national project is to study technologies to enhance productivity of marginal sloping lands through the application of appropriate biophysical conservation measures. This enhanced production will improve the livelihood of farming communities depending on these lands. In addition, benefits are shared by the population living downstream by way of availability of adequate and clean water sources.

The catchment is the appropriate unit for assessing the impact of improved farming systems because the problems of soil and water degradation are associated with the hydrology of this unit. Also, the success of activities in the lower part of the catchment (commonly termed the basin) depends on soil and water management in the upper part or watershed.

On-farm, participatory research sponsored by agencies with national responsibility for land and water resources will be carried out on discrete sub-catchments within the sloping lands of the main catchment. This will allow the impact of farming systems to be assessed at different scales within the catchment.

The consortium will undertake a number of underpinning activities in support of the various national projects, such as addressing strategic research needs, developing databases and information, training and quality assurance. Strategic research will address issues which can potentially improve the outcome of the applied/adaptive national projects.

Strategic research needs

Three areas of strategic research have been identified, which underlie the current attempts to find soil erosion control practices which are sufficiently attractive to users.

These are: productivity aspects of soil erosion management, downstream impacts of conservation farming, and socioeconomic issues. The research areas are based on the perception that there is a potential conflict of interest between lowland and upland users.

Soil productivity aspects of erosion control

Erosion-deposition leads to transfer of fertility (topsoil and nutrients) along the slopes with implications to soil productivity and water quality. This occurs at a range of scales, from microplots to field, and from toposequence to catchment. Two options are: minimizing any movement (this implies permanent mulch, a crop cover, and no food crops) or accepting movement at some scale, but intercepting the sediment elsewhere (biological terrace formation, rice paddies, sedimentation dams). Productive use of this fertility is often low (except for rice paddies). Depending on top-soil depth and climate, productive opportunities are missed by current terrace-forming practices. A critical analysis of existing farmers as well as improved practices is needed in this respect. Also, quantitative data on the impact of past erosion on crop yields will be obtained to assess the on-site effects on productivity.

Downstream impacts of conservation farming

The effects of various soil conservation practices on the quantity, regularity, and quality of water and sediment flow from catchments are insufficiently known in many tropical countries. The contribution of water, nutrient, soil, and pollutant movement at different scales in the upper part of a catchment to the outflow of the catchment is inadequately understood. There is an urgent need to evaluate and model the downstream impact of soil erosion control measures as a basis for decision making.

Socioeconomic issues

The hypothesis that the benefits for lowland water users of soil erosion control farming in the uplands exceeds the direct, on-site productivity benefits for upland farmers should be tested. Mechanisms for cost-sharing between lowland beneficiaries and upland actors are needed. Socioeconomic issues will also require increasing attention.

6.4 Formulation of policy/planning guidelines for soil erosion management

The evaluation of the bio-physical, socio-economic, and environmental impact of the technologies will now be used to come up with guidelines for policy-makers and planners.

7 Outputs

1 An analysis of the conditions of present land-use practices

2 An inventory of indigenous and scientific land-management technologies

3 Protocols for conducting research and extension for soil erosion management

4 A pool of tested, appropriate, and acceptable technologies to reduce soil loss

5 Well-informed user groups

6 Guidelines for policy and planning aspects of soil erosion management

8 Organization of the Consortium

Strategy of the consortium

- Regional approach -- initially sloping lands and mountain areas of Asia, but subsequently expanding to East Africa and Latin America..
- Utilize and build on existing activities based on a comprehensive review of ongoing work.
- Research on biophysical, socioeconomic, and policy issues linked to national projects on soil erosion control on sloping and steep lands and downstream impact.
- Strategic, applied, adaptive, and on-farm multi-disciplinary research, concentrated on selected catchments.
- Phased implementation of consortium activities.

Phasing of the consortium

It is envisaged that the development of the consortium, as opposed to project development, will occur over a two-year period, followed by an implementation phase. Activities during the development phase will include a review and inventory of existing research, linkage of relevant on-going activities, assisting national programs in project preparation (including catchment studies), and development of priorities and foci for the consortium. The implementation phase will have a more integrated approach, with common activities, including linking strategic research with national initiatives and the development of support activities, e.g., databases and information.

Membership of the consortium

Membership will consist of the following types of institutions or organizations: research and development agencies and organizations, including national and non-governmental organizations involved in land, water, and forestry resources and environmental research and extension; advanced research organizations; and international research centers.

The following criteria will be used as a basis for acceptance as a member of the consortium:

- Sharing a common goal with the consortium.
- Implementing an agreed project or activity.

Observers may participate in some activities of the consortium. The consortium will establish appropriate linkages with donors and other cooperating non-member organizations, as well as with other consortia in the overall SWNM initiative.

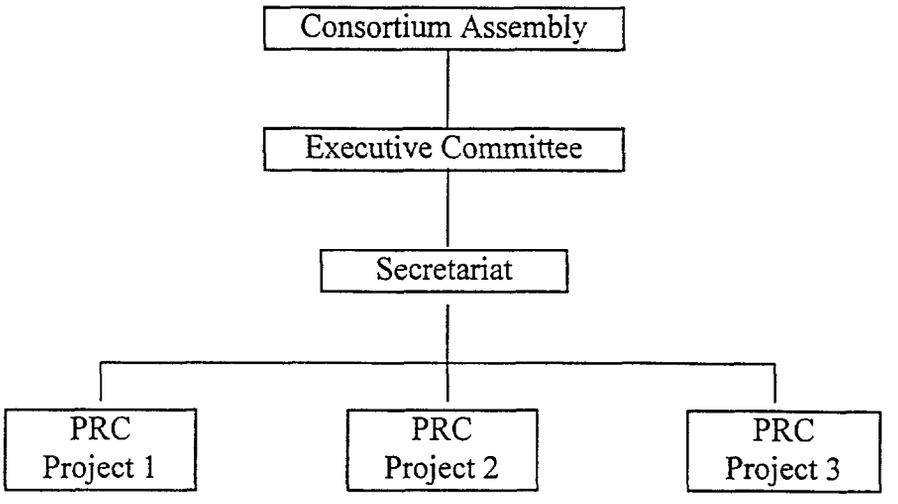
The Consortium Assembly consists of all members of the consortium. It will elect members of the Executive Committee, adopt/approve policies and programs, and review decisions of the Executive Committee.

The Executive Committee will be established by the Consortium Assembly and it is proposed that it will include 2-NARES, 2-IARCs, 2-NGOs/others, 3 members at large, and the Executive Secretary, who will head the Secretariat. It will implement policies, nominate the Executive Secretary, and guide the work of the Secretariat.

The Secretariat will be based initially at IBSRAM and will report to the Executive Committee. It will provide information, establish a database, organize training, administer consortium activity on a day-to-day basis, have contact with donors and members, and coordinate general consortium activities.

The Project Review Committees (PRC) will provide technical advice for specific projects. A small Interim Steering Committee will be established by the co-convenors of the consortium to initiate and manage first-year activities.

Structure and management framework of the consortium



NARES from the following seven countries have been identified as potential collaborators: China, India, Indonesia, Nepal, Philippines, Thailand, and Vietnam. Further discussions are required to identify the specific organizations which are likely to be involved but these will probably cover a range of interests and expertise. For example, for the Philippines it is likely that the following will be involved: PCARRD, UPLB, NEDA, Mag-uugmad Foundation, and SEARCA; for Thailand the Department of Land Development, the Royal Forestry Department, the Department of Technical and Economic and Cooperation, the National Environment Board, and Naresuan University will probably be involved.

The following IARCs have expressed an interest in joining the consortium: CIAT, IBSRAM, ICIMOD, ICRAF, IFPRI, and IRRI.

Advanced Research Organizations in developing and developed countries who have expressed interest include CSIRO Division of Water Resources, DPI Queensland and Griffith University (Australia), Lumle Agricultural Research Centre (Nepal), ORSTOM (France), SANRAM, University of Georgia (USA), Ohio State University (USA), University of Berne (Switzerland), ZALF (Germany) and Silsoe Research Institute (UK).

FAO, the International Potash Institute (Switzerland) and the Phosphate and Potash Institute (Singapore) are likely to join the consortium.

Linking the Soil Erosion Management Consortium with Eco-Regional Programs and other Consortia

The consortium will collaborate with a range of international and national research agencies. Of particular importance to avoid duplication of effort is collaboration with eco-regional programs operating through IARC's. Initially, the consortium on managing soil erosion will concentrate its efforts in South East Asia, will collaborate with the Asia Humid Tropics program coordinated by IRRI.

Subsequently, regional cells of the consortium will be developed in Africa and Latin America, collaborating with the following eco-regional programs:

- Africa Humid Tropics/Inland Valleys (IITA)
- Africa Highlands (ICRAF)
- Latin America Lowland (CIAT)
- Global Mountain Agriculture (CIP)
- and with Central America's Hillsides Program (CIAT)

Linking with the Nutrient Depletion, Managing Acid Soils or Water Use, thematic consortia will also be critical because of the commonality of soil factors and processes of interest to the consortia. For example, nutrient depletion is both a cause and a result of soil erosion. Soil Erosion often exposes more acid subsoils, and management systems for these degraded pools must be developed to minimize further erosion. Also, increased run-off generation from soils degraded by erosion has a very significant effect on the landscape water balance. The methodologies developed in the Water Use consortium could be used to address this issue.

9 Budget Estimates

Initial Budget for Year 1996 (in US$)

a)	Project preparation	
	NARES costs for collecting and preparing information	70,000
	Consultants (1 soil/agronomist, 1 hydrologist, and 1 socioeconomist) for 105 man-days	70,000
	Sub-total	140,000
b)	Planning meeting and meeting of Consortium Assembly (preferably in late 1996)	60,000
c)	Administration and communication (15%)	30,000
	TOTAL	(US$) **230,000**

Theme 4: Soil Water and Nutrient Management Initiative - Optimizing Soil Water Use

1 Executive Summary

Agriculture in the semi-arid and arid areas of the tropics is characterized by low productivity and high risk, largely due to low water supply. Resource poor, subsistance farmers, which comprise the majority of the population in these areas, are often plagued by short life expectancy and high enfant mortality, due in part to unreliable supplies of clean water.

1 This consortium addresses the problems of the resource poor farmer in semi-arid and arid zones by integrating the expertise of existing CGIAR systemwide ecoregional initiatives (DMI in SSA, and Water husbandry in WANA) with the work of NARs, NGOs, AROs, and IARCs (particularly ICARDA, ICRISAT and bilateral programmes).

2 The objectives, outputs, and activities of the consortium address the problems of how to improve the agricultural productivity and minimize risks in arid and semi-arid subtropics and tropics through water optimising technologies, cropping strategies, and integrated soil water and nutrient management technologies.

3 The consortium requires a budget of US $ 240, 000 for its operations and programme in the 1st year. The programme for the 1st year will conclude with a workshop which will generate an inventory, identfy knowledge gaps and outstanding researchable constraints and formulate a gender sensitive forward work programme.

4 The consortium will assemble a critical mass of experts applying biophysical and socio-sciences to the production of outputs enabling optimal use of limited soil water in arid and semi-arid tropical and subtropical areas. Achievement of the objectives will contribute to the goals of raising producitivity, alleviation of poverty and sustained use of natural resources in these deprived areas.

2 Background

The Soil Water and Nutrient Management (SWNM) initiative identified a need to establish a Soil Water Management Consortium to address issues related to soil water management. The following is a concept paper to form a consortium on optimizing soil water use within SWNM. This consortium will be complementary to, and link with, three other consortia in this initiative, namely: (i) combating nutrient depletion; (ii) controlling soil erosion (with empasis on East Asian countries); and (iii) management of acid soils (limited to Latin America). While these three consortia will focus on humid and sub-humid zones this consortium will focus on management of soil water in semi-arid and arid zones. Since soil fertility is a major production constraint in semi-arid and arid zones, this consortium will link closely with the nutrient depletion consortium.

A large volume of research is conducted on optimizing water use in dry areas by NARS, IARCS (particulary ICARDA and ICRISAT) and in Advanced Research Organisations. This will be further supported by eco-regional research proposals submitted to the TAC by ICARDA (water husbandry in West Asia and North Africa) and ICRISAT (Desert Margins Initiative). The research planning and dissemination of results takes place thruouhg existing research and training networks of ICARDA and ICRISAT.

This consortium will establih close linkages and research cooperation among those involved in research on optimizing water use and among research groups in tropical and subtropical semi-arid and arid zones; it will be based on the outcome of the proposed inventory and diagnostic work, identify researchable gaps in knowledge and finance researc; rationalize duplication in research among its partners; optimze the use of limited human, financial, and institutional resources; and will make maximum use of existing networking mechanisms to disseminate research information among participants.

3 Justification

Arid and Semi-Arid areas occupy a large proportion of the Sub-Saharan Africa (SSA) and WANA. The population in these areas consist mainly of resource poor, subsistence farmers. Farming is characterized by low productivity and high risks. Moreover, access to clean water for domestic needs (a pertinent gender issue) is poor and unreliable. These problems can be alleviated by improving the management of soil and water, the two fundamental limiting natural resources in the region.

Experience has shown that no single institute can adequately address the complex biophysical and socio-economic constraints which have trapped the resource poor farmers in these areas into a cycle of poverty. The constraints would better be addressed by the synergistic combination of experts within a consortium of specialists from AROs, IARCs and NAR'S.

The consortium on optimizing soil water use will address the issues of low productivity, high farming, risks and the quantity and quality of domestic water supply by :

1 increasing soil water supply to farming systems through water harvesting and the use of techniques such as micro-catchments, rock catchments, zai pits, trapezoidal pits, planting pits, ridging, tied ridging, furrows, flood diversion, runoff diversion and indigenous techniques focusing on efficient water capture, storage, and use;

2 increasing crop water use efficiency through soil amendments (soil organic matter management, fertilizer use, liming and other means of ameliorating acidity), soil surface manipulation; (tillage, bunding, zero tillage, residue incorporation, mulching); cropping system strategies (rotation, intercroppping, use of drought tolerant/escaping crops, alley cropping, multiple storey cropping and timeliness of planting); and

3 improving the quality and reliability of the supply of domestic water through roof and rock catchments water harvesting, improved domestic water storage, and separating the supply of water for human and livestock use;

This consortium will foster links with existing programmes of NARS, and networks in SSA and WANA but will bring in additional scientific dimensions. An advantage to this approach is to add value to results obtained by other programmes consortia and networks by developing integrated water use packages and promoting their use widely.

4 Research Rationale

The consortium addresses the hypothesis that low water availability and inefficient water use are the main causes of low, erratic and declining productivity in the semi-arid and arid tropics and subtropics. This consortium will develop and/or identify option for the most efficient use of the limited rainfall in these areas through understanding and manipulating crop soil water balance. This balance will be managed to increase crop water use efficiency, reduce water loss by evaporation, improve soil water storage and availability and by harvest rain water.

5 Objectives

The objectives are:

1 Productivity of farming systems increased and crop/livestock production risk reduced in arid and semi-arid areas through improved soil water management.
2 Access to clean water for domestic purposes increased.

6 Outputs

1.1 An inventory of existing knowledge on soil water management in Arid and Semi-Arid and Land (ASAL).
1.2 Data base and baseline data on soil water management information in ASAL areas.
1.3 Identification of outstanding, researchable constraints to improve soil and water management in ASAL.
1.4 Water use optimizing research protocols.
1.5 A range of tillage, water harvesting, soil amendment and cropping technologies for ASAL.
1.6 A range for options on soil water management in ASAL identified.
1.7 Decision making tools for improved and sustainable soil water management based farming systems.
1.8 Improved research capacity of NARS in ASAL countries.
1.9 Increased understanding and adoption of soil water management options by farmers.
2.1 An inventory of existing knowledge on water management in Arid and Semi-Arid and Land (ASAL).
2.2 Data base and baseline data on water management information in ASAL areas.
2.3 A range of options for capturing and storing water for domestic purpose.
2.4 Improved research capacity of NARS in ASAL countries.
2.5 Increased understanding and adoption of soil water management options by farmers.

7 Activities

This programme will use previous basic and strategic research whenever possible, adaption and validating is where necessary. Wherever possible, the research will be on-farm and participatory but there is also a need for on-station controlled research in some circumstances. Livestock management will be an integral part of every research activity in this programme. This research will utilize drought resistance/escaping varieties and other technologies developed by ARO's, IARC's and NARs, thus adding value to existing technologies.

1 Survey 'grey' and published literature and synthesize of existing information on cropping strategies soil and water management in ASAL;

2 At the end of year one, hold a workshop to identify to gaps, researchable constraints, benchmark sites and develop the future research programme and its protocol;

3 Conduct experiments on ways of improving soil water management:

7.1 Soil surface management:

- Can tillage be used to reduce soil evaporation?
- What are the trade-offs between early tillage and early planting?
- What is the optimal method of tillage for different soil textures to maximize infiltration and reduce runoff?
- What are the roles of different organic matter fractions of crop residues in maintaining soil structure and increasing soil water availability?
- How much residue does it take to increase soil water holding capacity of soils of different texture; How much time?
- What are the social constraints to adoption of previously developed tillage methods?

7.2 Farming Systems

- Match crop phenology to soil water availability patterns.
- Use drought resistant germplasm developed by NARS, ICRISAT and ICARDA;
- Develop cropping systems which achieve early canopy development to reduce soil evaporation losses;
- Study the role of livestock in managing risk during dry years and increasing crop water use efficiency (through residue management) during favorable years.
- Study methods of managing water to increase amount and quality of forage for livestock;
- Develop methods of increasing root growth;

7.3 Water Harvesting;

- Adapt previous strategic research on water harvesting technologies to meet regional needs in Sub-Saharan Africa for agricultural and domestic needs;
- Assess the impact of livestock management on water quality of community wells.

7.4. Further Activities

- Study water quality in ASAL.
- Conduct adaptive research on improved water harvesting and storage for domestic purposes.
- Socio-economic studies and impact assessments of soil water use optimizing options.
- Socio economic studies and impact assessment of improved domestic water supply particularly targeting women.
- Undertake risk assessments of traditional and improved soil water use optimizing options.
- Develop models utilizing relevant data.
- Human resources development through training.
- Dissemination of research results.

8 Organization of the Consortium

The consortium will have a clearly identifiable structure and a convener (to be identified). It will, have a steering committee, comprising of representatives of key collaborating IARCs and NARS. The consortium will incorporate the work of existing networks and link with the other SWNM consortia. The consortium will foster linkages and collaboration with existing AROs, IARs, NGOs and other relevant bodies. This collaboration will ensure that a critical mass of experts is established, and thereby ensure maximum impact at minimum costs.

9 Budget

Initial Budget for a Year 1996 (in US$)

	Item	Estimated cost
1	Consortium Coordination	90,000
2	Workshops	60,000
3	Literature survey/inventory	90,000
	Total	**240,000**

Inputs for subsequent years.

The cost inputs for the subsequent years will be developed following identification of the future programme during the workshop at the end of year 1.

10 Partners

Partners in this consortium will include, IARCs, NARS, NGOs and AROs. Partnerships and collaborators will be identified after an open invitation has been sent to IARCs, NARs, and AROs'. The IARCs which have already expressed interest include: ICARDA and ICRISAT but others identified include ILRI, ICRAF and IFPRI. The ARO's identified include CIRAD, Reading University (UK) Ohio State University. NARs which have expressed interest include: The Kenya Agricultural Research Institute (KARI), Soil Services of Senegal (BPS), and Institute d'Economie Rurale of Mali (IER). Other NARS will are expected to become partners.

List of Acronyms Used in the Text

ACIAR	Australian Centre for International Agricultural Research
AES	Agro Ecosystems
AFNET	African Network for Biological Management of Soil Fertility
AHI	East African Highlands Initiative
ARO	Advanced Research Organisation
ASAL	Arid and Semi-arid Lands
ASOCON	Asian Soil Conservation Network
BPS	Bureau de Pedologie du Senegal
C	carbon
CATIE	Centro Agronómico Tropical de Investigación y Enseñanza
CDC	Center Directors' Committee
CG	as below
CGIAR	Consultative Group on International Agricultural Research
CH_4	methane
CIAT	Centro Internacional de Agricultura Tropical
CIFOR	Center for International Forestry Research
CIMMYT	Centro Internacional de Agricultura Tropical
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement
CO_2	Carbon Dioxide
CORPOICA	Corporación Colombiana de Investigación Agropecuaria
CPAC	Centro de Pesquisa Agropecuaria dos Cerrados
CPATU	Centro de Pesquisa Agropecuaria do Trópico Umido
DMI	Desert Margins Initiative
DSE	Deutsche Stiftung für internationale Entwicklung (German Foundation for International Development)
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuaria
EPHTA	Ecoregional Programme for the Humid Tropics of Africa
FONAIAP	Fondo Nacional de Investigaciones Agropecuaria, Venezuela
FU	Facilitation Unit
GIS	Geographical Information System

GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
Ha	Hectares
IAR	Institute for Agricultural Research, Samaru, Nigeria
IARC(s)	International Agricultural Research Center(s)
IBSRAM	International Board for Soil Research and Management
ICARDA	International Center for Agricultural Research in Dry Areas
ICIMOD	International Centre for Integrated Mountain Development
ICRAF	International Centre for Research in Agroforestry
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICW94	International Centers Week, 1994
IER	Institut d'Economie Rurale du Mali
IFDC	International Fertilizer Development Center
IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture
IRRI	International Rice Research Institute
KARI	Kenyan Agricultural Research Institute
MAS	Managing Acid Soils
N	Nitrogen
NARS	National Agricultural Research Systems
NARES	National Agricultural Research and Extension Systems
ND	Nutrient Depletion
NGOs	Non-Governmental Organisations
NO_x	an oxide of nitrogen
ODA	Overseas Development Agency
ORSTOM	Institue Français de Recherche en coopération pour le Développement
PCARRD	Philippine Council for Agriculture, Forestry and Natural Resources Research and Development
PRC	Programme Review Committee
PROCITROPICOS	Programa Cooperativo de Investigación y transferencia en los Trópicos
PSC	Program Steering Committee
SANREM	Sustainable Agriculture and Natural Resource Management
SC	Steering Committee

SOM	soil organic matter
SSA	Sub Saharan Africa
SWNM	soil, water and nutrient management
TAC	Technical Advisory Committee to the CGIAR
TSBF	Tropical Soil Biology and Fertility
UNCED	United Nations Commission on Environment & Development
WAFMEN	West Africa Fertilizer Management and Evaluation Network
WANA	West Asia North Africa
WG	working group

IBSRAM/CIAT/DSE Workshop on
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