Soil Management
Collaborative Research Support Program

Third Annual Report
February 11, 1999 to February 10, 2000

Cornell University
Montana State University
North Carolina State University
Texas A&M University
University of Hawaii, NifTAL Center
University of Florida

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EXECUTIVE SUMMARY

The major accomplishments of the Soil Management CRSP for the Project Year 3 (PY3) reporting period are as follows:

1. A nutrient management decision support system which enables a user to diagnose yield limiting constraints and prescribe cost-effective options to increase profits has been assembled, tested and demonstrated to potential clients. The decision support system named NuMass for Nutrient Management Support System was designed to capture, organize and combine indigenous and scientific knowledge and to make this knowledge applicable to a wide range of agro-environments on a site-specific basis. NuMass was designed for use by extension agents, consultants, NGO's, fertilizer sellers and credit lenders.
2. Soil conservation practices that effectively protect densely populated steeplands even when subjected to once in a century rainfall event have been tested and identified for widespread application. As population pressures force displaced households to occupy fragile steeplands, these proven practices offer a means to protect upstream and downstream resources from slow but inevitable degradation. In Honduras, downstream shrimp producers have initiated discussions with upstream farmers to jointly invest in the installation of soil erosion structures.
3. A new method for inoculating legumes with symbiotic nitrogen fixing microorganisms has been field tested and shown to be effective in developing country conditions. This method is especially needed in Africa and Asia where the usual peat-based inoculum is not available or too expensive. Two inoculum producers, one in Kenya and the other in India, have expressed strong interest in one of the products tested in Africa and India by host country collaborators. The best product performed better than all others in two of every three field trials.

4. A decision support system for assessing “trade-off’s between agricultural production and environmental degradation for choosing different agricultural, economic or environmental policy has been developed for testing in the Andean Region of South America. The software displays trade-offs between competing complementary policy objectives in simple two-dimensional graphs and shows how these trade-offs change under alternative policy and technology scenarios. The system is designed so that it can be generalized for application elsewhere in the world.

5. SM CRSP scientists have identified micronutrient deficiencies and soil-borne pests as major constraints to the post green revolution sustainability of the rice-wheat cropping system of South Asia. This research shows that high yielding varieties, irrigation and nitrogen, phosphorus and potassium fertilizers are not sufficient to sustain high yields. Sustainable agriculture obeys the law of the limiting. New policies are needed to focus on the new limiting factors.

6. USAID/Ethiopia signed an agreement to assist the Government of Ethiopia, in particular the Amhara Regional Authority, to design activities that will result in increased rural income, and thereby increase food security. To this end, USAID/Ethiopia requested field support from the Global Bureau's CRSP programs. After an initial meeting in Addis Ababa involving 4 CRSPs, the SM CRSP was asked to lead a team of scientists to the Amhara region with the purpose of preparing a research assessment report.

   That assessment report with a plan of action with a set of anticipated outcomes was prepared by a team of scientists from the SANREM, IPM, INTSORMIL, and Soil Management CRSPs and submitted by the latter to the mission.

SUMMARY REPORT

The Soil Management Collaboration Research Support Program (SM CRSP) completed three years of operation on February 11, 2000. This report summarizes the 3rd years progress toward attainment of program objectives and the results of a mid-term program review by an External Evaluation Panel (EEP).

The overall objective of the SM CRSP is to remove five soil-related constraints that now stand in the way of global food security and sustainable land management. These constraints, identified by an external panel of experts during the restructuring of the current CRSP, are nitrogen deficiency, phosphorus deficiency, soil acidity and metal toxicities, water deficiency, and soil erosion and degradation. Six participating universities and their U.S. and international collaborators work to create products and practices that enable customers to remove these constraints. The participating institutions, principal investigators (PIs), and project titles are listed in the table below.

TABLE 1. List of participating U.S. universities with principal investigators, collaborating institutions, and project title.

Participating Institutions	Principal Investigators	Collaborating Institutions/Countries	Project Title
Cornell University	John M. Duxbury	CYMMIT/Bangladesh, Nepal	Sustainability of Post Green Revolution Agriculture: The Rice Wheat Cropping System of South Asia
Montana State University	John M. Antle	CIP, Wageningen Agricultural University/Peru, Ecuador	Tradeoffs in Sustainable Agriculture and the Environment in the Andes: A Decision Support System for Policy Makers
North Carolina State University	T. Jot Smyth	Cornell University, University of Hawaii Texas A&M University/Costa Rica, Philippines, Mali	Decision Aids for Integrated Soil Nutrient Management
Texas A&M University	Anthony Juo	Auburn University, North Carolina State University/Haiti Honduras, Nicaragua	Soil Management Practices for Sustainable Production on Densely Populated Tropical Steeplands
University of Florida	Christina H. Gladwin	Malawi, Uganda, Ghana, Zambia, Ethiopia	Gender and Soil Fertility
University of Hawaii NifTAL Center	Paul Singleton	Thailand, Kenya Nicaragua, Philippines, Bangladesh	Improve Agricultural Productivity through Biological Nitrogen Fixation Technology and Legume Management

NITROGEN

Nitrogen is a constraint to sustainable development in at least three ways. First, it is often the most limiting nutrient in developing country agriculture. Second, it is the nutrient most often used in excess and the cause of stream and lake eutrophication and ground water contamination in the industrialized countries. And third, it is the source of two green house gases, nitric and nitrous oxides. When nitrogen fertilizer is added to a soil, it can either be volatized, denitrified, immobilized by micro-organisms, leached out of the root zone by heavy rains or absorbed by plant roots. Most farmers generally achieve nitrogen use efficiencies of 50 percent or less. No viable agriculture can be sustained without nitrogen inputs in the form of biologically- or industrially-fixed nitrogen. The SM CRSP conducts globally-applicable research on both forms of nitrogen inputs.

a. Biological Nitrogen Fixation. A new method for inoculating legume seeds with a nitrogen fixing Rhizobium is being field-tested around the world. The SM CRSP is focusing its attention on this method because, unlike most current products which are based on solid carrier materials, usually peat, the new method employs a liquid inoculum. This new method is especially needed in Africa and Asian countries where peat is too expensive or unavailable.

The aim of this year's effort was to determine whether a newly formulated liquid inoculant could perform as well as or better than local products being sold to farmers around the world. Collaborators from 16 countries agreed to conduct trials for this purpose.

A liquid inoculant, G5, increased seed yield above locally-produced inoculants over 68 percent of the time. This was associated with nodule number, which increased by 20 percent over other inoculants in 77 percent of the trials. Based on feedback from inoculant producers, there is a strong likelihood that clients will adopt some of the improved inoculant formulation and quality control technologies. One producer in Kenya already uses quality control techniques developed by the SM CRSP in his production process, and inoculant producers in India have been impressed with G5's performance and most probably will be the first major adoptees of this technology.

b. NuMass. NuMass is the acronym for Nutrient Management decision support system. The accumulated knowledge about nitrogen, phosphorus, and soil acidity is captured in NuMass and organized in a way that enables users of NuMass to employ that knowledge to achieve user-specified objectives.

After more than two years in development, NuMass version 1.0 was released in August 1999 with the primary aim to elicit user feedback. To achieve this, a workshop cosponsored by the Philippine Rice Research Institute (PhilRice) in Maligaya, the International Rice Research Institute (IRRI) in Los Banos, and the Soil Management CRSP was held on September 6-10 in the PhilRice campus at Maligaya. Fifty-five participants including representatives from Ethiopia, Gambia, Ghana, Mali, Senegal, South Africa, Tanzania, Zambia, Indonesia, Laos, Philippines, Vietnam, Bolivia, Brazil, Costa Rica, Ecuador, and Venezuela attended the workshop.

Workshop participants were grouped into teams representing humid tropical, semiarid, and wet/dry agroecological zones so that each person could judge NuMass performance in familiar soils, crops, and climates. Participants subjected NuMass to situations unforeseen by software developers and uncovered unanticipated strengths and weaknesses in NuMass. Impressions, suggestions for modifications, adaptations, and improvements suggested by participants were recorded for later analysis.

The workshop concluded with a tour of field experiments installed to compare crop response to NuMass recommended fertilizer rates with those practiced by local farmers. The area was selected because soil tests indicated soil acidity and multi-nutritional nutrient deficiencies to be the probable causes of low yields. This gave workshop participants an opportunity to observe NuMass's ability to make sound lime and fertilizer recommendations. On observing the result, PhilRice indicated its intent to apply this method to other regions of the country with problem soils.

Nitrogen and NuMass. Most of what we know about nitrogen dynamics in soils comes from experiences in temperate regions. In order to render the nitrogen module of NuMass globally applicable, it has been designed to be flexible for a wider range of clientele to use.

The latest version uses a revised Stanford equation to make nitrogen recommendation. The equation is:

$$N_{fert} = ((Y_f * N_{cr}) – [(N_{soil}) + (N_{residue} * C_r) + (N_{manure} * C_m)]/(E_f)$$

where:

N_{fert} = N fertilizer needed.

E_f = Fertilizer efficiency.

Y_f = Realistic yield.

N_{cr} = Concentration of nitrogen in the crop.

N_{soil} = Nitrogen mineralized from soil organic matter during the growing season.

$N_{residue}$ = Nitrogen mineralized from the residues, including green manures.

C_r = Proportion of N from residue, including green manures absorbed by the crop

N_{manure} = Nitrogen mineralized from the manure.

C_m = Proportion of N from the manure absorbed by the crop.

Realistic or target yield is derived from either a user-input value or a default value. Default yield values are based on factors such as crop, variety, region, country, and agricultural region and/or soil classification.

Methods for determining the soil nitrogen (N_{soil}), which is the N, derived from soil organic matter, residual fertilizer N, and atmospheric deposition are outlined below in descending order of preference.

- Best value of N_{soil} is a user-entered value;
- The second best estimate of N_{soil} is derived from the N content in the previous crop, if the previous crop was not fertilized and the previous crop is the same as the current crop; and
- The least precise estimate of N_{soil} is derived from soil test data, either %N, %OM, or %C.

Other N inputs that need to be considered are residue and manure derived N, where

- $N_{residue}$ = amount of N mineralized from residue of the prior cropping year, if the crop was a green manure or legume that was left in the field, and current applications of residues. Information include type of green manure (at a minimum) and dry weight if it is available; and
- N_{manure} = amount of N derived from current and previous year’s application of manure. To calculate N contribution from residue, the following information will be required: type of animal, weight of manure, %N content (or default value), and moisture state (moist, dry).

It is clear that to benefit from the nitrogen model, the user must provide input data. For example, extension agents or NGO staff attempting to help farmers with little experience using fertilizers will find themselves having insufficient data to operate NuMaSS. Hence, as a decision aid, NuMaSS must not only provide the rules for making effective use of nitrogen fertilizer, but it must also provide access to input data to operate the nitrogen model. An example of an input datum is the nitrogen content of a healthy maize crop, a value that will vary slightly among varieties. An extension agent making a nitrogen recommendation for the first time for a maize crop in a remote and unfamiliar region will not have ready access to such datum. That agent, however, will be able to use a default value for maize (and most other major crops) in NuMaSS. Of course, if local input data are available, that data should be used by the agent rather than the default. Why? A farmer in Iowa , for instance, who inputs values for a 15T/ha maize yield into the model will end up adding a lot more nitrogen than a subsistence farmer in Cameroon expecting a 3T/ha crop.

Models and data bases enable NuMass users to predict agronomic performance based on user inputs. The inputs could be kg of fertilizer or green manure. These inputs have land, labor, and capital costs. In the end, NuMass provides decision support by enabling users to evaluate alternative input/output scenarios and choose outcomes that suit their needs.

PHOSPHORUS

Although phosphorus deficiency is not as widespread as nitrogen deficiency, its removal is crucial to achieving food security because of its common occurrence in the developing countries of the tropics and particularly in the humid tropics. Soils formed under warm and humid conditions lose soluble nutrients such as calcium, magnesium, and potassium over time and leave behind insoluble residues of iron and aluminum oxides. In pristine natural systems, nutrients stored in forest biomass and litter are recycled to sustain life. Slash and burn agriculture brings an abrupt end to such systems, but what has disturbed ecologists most has been the repeated failures to restore soil fertility in what one early colonial naturalists categorized as “senile” soils of the humid tropical rainforests.

In senile soils rich in iron and aluminum oxide, phosphorus exists as insoluble iron and aluminum phosphates. Slow growing perennials, with the aid of symbiotic mycorrhizal fungi, can utilize this phosphorus. However, food crops that are expected to complete their life cycle in a matter of months cannot compete with weeds for nutrients, water, and sunlight even with help from human cultivators. Under ordinary circumstances, fertilizers would work in favor of the cultivated crop, but the iron and aluminum oxides act as a sponge for phosphorus and render the nutrient unavailable to all but the hardiest plants.

We have now learned that this phosphorus sponge has limits to its adsorptive capacity and when this limit is reached, soils once considered senile are rejuvenated. Thus, there is a cost to soil rejuvenation, but it is a one-time cost and can be treated as a capital cost.

Much is known about phosphorus deficiency in soils, but this knowledge is not generally known or accessible to people who need it most. The role of the SM CRSP is to enable customers who need information on phosphorus to ascertain whether they have a phosphorus problem and to find acceptable alternatives to cure the problem. In short, the CRSP aim is to enable customers to diagnose problems and prescribe solutions for them.

One goal of scientific research is to make reliable predictions. In phosphorus research, the goal is to predict yield increases associated with incremental additions of phosphorus to a soil deficient in phosphorus. To be useful the prediction equation must apply to all soils and consist of a minimum number of readily measurable soil parameters. The current model requires four chemical parameters: the initial phosphorus level in the soil; the desired or critical level; the long term retention rate of phosphorus by the soil; and the buffer coefficient or the ratio of the extractable to added phosphorus. The search for a surrogate parameter for the buffer coefficient has been the most challenging aspect in developing the model.

Improvements in the model continue to be made, and the next step is not simply to predict the phosphorus status in a soil as a function of added phosphorus but to predict crop yields as a function of applied phosphorus.

Before we take prediction too seriously, it must be conceded that absolute prediction is not possible because that implies full knowledge of events in the future. For example, if we predict yield for the coming season based on what we know about the crop, management factors to be implemented and phosphorus status of the soil, an unexpected storm may destroy the crop and the predicted results. Therefore, good predictions are possible in local situations where no major growth limiting factor, other than phosphorus deficiency, affects yields.

Reliable yield prediction is the first step towards making sound economic predictions. Farmers may be interested in high yields, yet in the end it is profit that motivates them. The model, however, must do more than predict yields and profits. Farmers are increasingly being asked to avoid contaminating streams and lakes with nitrates and phosphates, and so they must now manage phosphorus to simultaneously reduce eutrophication of streams and lakes while operating a profitable farm. For these reasons, the need for reliable phosphorus models is greater now than when the project began three years ago. Much work still needs to be done, but the agreement between predicted and observed yields, as illustrated in Figures 1 to 4, indicates we are making good progress towards enabling users to manage phosphorus more wisely.

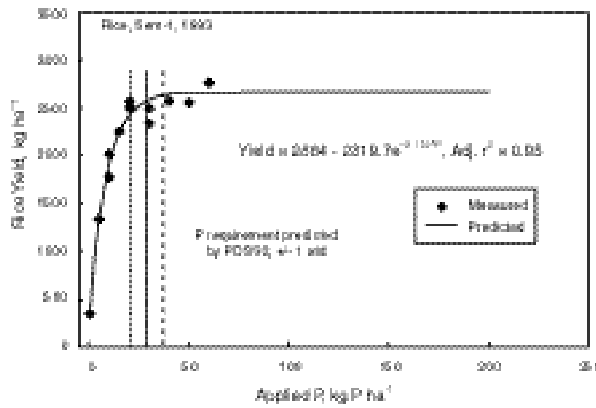

Figure 1. Comparison of P requirement predicted by PDSS2 with the experimentally determined response curve. Matazul rice, initial crop, Sem-1, 1993. Data from D. Friesen et al., IFDC/CIAT.

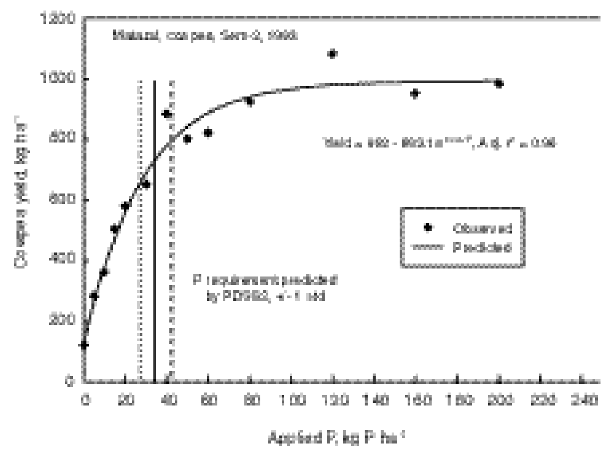

Figure 2. Comparison of P requirement estimated by PDSS2 with the experimentally determined P response curve. Matazul cowpea, Sem-2, 1994. Data from D. Friesen et al., IFDC/CIAT.

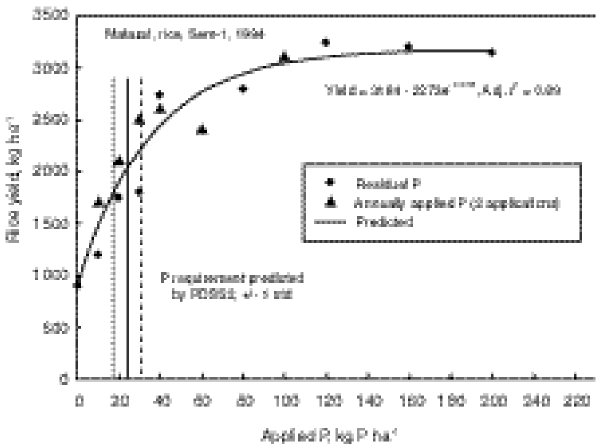

Figure 3. Response of upland rice to residual P and annually applied treble superphosphate at the Matazul farm. Data from D. Friesen, J.I Sanz, and Mariela Rivera, CIAT, Colombia.(1994)

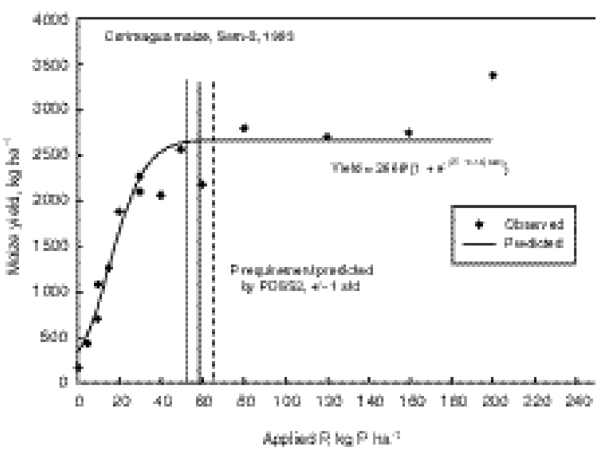

Figure 4. Comparison of P requirement estimated by PDSS2 with the experimentally determined P response curve. Carimagua maize, initial crop, Sem-2, 1993. Data from D. Friesen et al. 1994. The prediction based on initial 0.5M NaHCO3 P of 5.2, critical level for maize of 15, and 42 percent clay.

SOIL ACIDITY

Soil acidity is a constraint, not only because of its negative impact on agriculture, but because numerous exceptions to the rule result in erroneous recommendations being made, even by experts. Errors are not necessarily made from lack of knowledge, but from memory lapses. The number of factors and their interactions that must be considered in diagnosing soil acidity problems and in prescribing cures for them is so enormous that it is not surprising that faulty recommendations are frequently prescribed. The factors that one must take into account in formulating a recommendation include differences in soils, crops, degrees of acidities, sources of liming materials, their purity and fineness and costs. For example, if extension agents operating at the county level had to deal with six different soil types, eight crops, two sources of liming materials, and three degrees of acidity they must be prepared to deal with 8 X 6 X 2 X 3 or 288 possible combinations. And when they are sure every possible combination has been taken into account, they discover too late that the liming material did not meet the expected particle size or fineness requirement. While it is common knowledge that marked yield increases can be achieved by correcting soil acidity, it is not generally appreciated that expert knowledge is required to make recommendations which turn out to be profitable. Over the last three years, much progress has been made in collecting and organizing soil, plant, and management information to improve the diagnosis and recommendation of location-specific, soil-acidity problems.

Organizing knowledge about a particular topic also yields the added value of exposing knowledge gaps. One issue that emerged as a priority topic was the slow downward movement of lime applied on the surface of acid soils. Even when lime was plowed below the surface layer, the calcium ions moved little beyond the plow layer. If plants could survive on water and nutrients from the plow layer alone, the retention of lime there would create no problem. During periods of water shortage, however, the crop will suffer from water stress even though the subsoil inches away is gorged with water. It became evident that correcting subsoil acidity to make water there available to plants was an important aspect of liming which had been overlooked, since lime has chemical characteristics which prevent it from moving beyond the point of application.

Substituting a more soluble, neutral salt such as gypsum ($CaSO_4 \cdot 2H_20$) greatly increased subsoil calcium and crop yield. Gypsum is a common, naturally occurring mineral, but is also a waste by-product of the phosphate fertilizer industry. The waste product known as phosphogypsum is now widely used as a soil amendment, and serves not only as a source of calcium to reduce the negative effects of soil acidity, but also supplies phosphorus, sulfur and calcium as nutrients when these elements are in short supply. Morocco, which is a major exporter of rock phosphate and phosphate fertilizer, disposes large quantities of phosphogypsum into the Atlantic Ocean. It might be useful to investigate the economic value of this material to African agriculture.

In the final analysis, the aim is to predict the effect of lime or any soil amendment on yield. Addition of lime or calcium salt reduces the negative impact of soil acidity by detoxifying aluminum ions. The index of aluminum toxicity is the percent aluminum saturation (% Al saturation) which can vary from zero to 100 percent. Acid tolerant, or more specifically, aluminum tolerant crops and crop varieties can withstand high levels of aluminum saturation.

For some maize cultivars, yields are unaffected if aluminum saturation does not exceed 20 percent. However, if it does, yield declines sharply. With such knowledge in hand, an extension agent or staff on NGO's can inform farmers of the effects (yields) given the acidity level of soils in their fields. If farmers are unwilling to accept the predicted yield, the agent may prescribe the amount of lime needed to attain acceptable yields, recommend a more acid tolerant variety, suggest other crops that perform well in acid soils, or suggest addition of organic matter to cure aluminum toxicity. The aim of a decision support system such as NuMass is to offer farmers alternative ways to eliminate factors that limit farm performance.

WATER DEFICIENCY

The law of the limiting states that agronomic benefits from agricultural inputs are determined by the most deficient input. In rainfed agriculture, water is frequently deficient and is the limiting input. For these reasons, unlike farmers on irrigated farms, cultivators who depend on rain for water risk losing their investments in fertilizer, seed, and labor when rains fail to arrive on time and in sufficient quantity.

Water deficiency differs from nitrogen or phosphorus deficiencies in that the latter can be corrected by human intervention, whereas rainfall is a random variable over which humans have little or no control. In rainfed agriculture, farmers are compelled to gamble with nature, and so the role of the SM CRSP is to find ways to change the odds in favor of the farmers. To do so, a farmer must be able to visualize and choose outcomes from alternative management practices. Moreover, because outcomes associated with a particular practice depend on rainfall that vary randomly, the outcomes must be displayed as a whole probability distribution. Farmers who have cultivated the same crop for many years on the same parcel of land have a mental picture of a probability distribution for that crop on their farm and over the years have adjusted practices to minimize risk of crop failure.

In a rapidly changing period, however, we can not afford the 10 to 15 years of experience needed to understand how to minimize risk from low and variable rainfall. We must compress into a matter of hours experience that would normally require decades to acquire.

The SM CRSP enables researchers and policy makers to assess risk from weather variability by conducting long-term ex-ante analysis of crop performance using crop simulation models. Such models are contained in the software package assembled for the Tradeoff Model (See Soil Degradation section). These crop models use long-term historical weather to simulate crop yields for 10 to 50 consecutive years and display the result as a probability distribution. This can be repeated for many management options, including changing planting dates, varieties, plant populations, and fertilizer rates and frequency of application. The decision maker can compare means and variances of simulated outcomes and choose the one that best meets the individual's needs.

SOIL EROSION AND DEGRADATION

It took the devastation of a Hurricane Mitch to remind us of the interconnectedness of nature and how perturbations in one part of an ecosystem can cause harm many miles away. Steep cultivated uplands laid waste from erosion brought pain enough, but the destruction of large commercial farms and shrimp producers along the coast hurt the economy even more.

One positive outcome of Hurricane Mitch was that we learned soil conservation practices that can withstand severe storms are available. Cultivated steeplands in Honduras supported by vegetation contours, rock walls and tree fallow withstood the storm, but sites without supporting conservation measures were devastated by massive landslides. Soil conservation practices not only protected the land during heavy rainfall, but were the only fields that had good crop yields during the earlier drought period associated with El Niño.

Moreover, the benefits of soil conservation can be just as rewarding downstream. Shrimp farms operate sludge pumps to maintain water supply channels free of sediments. Poor soil conservation measures upstream result in increased cost necessary to pump out sediment, as well as the cost for land taken out of production for additional sediment storage. This means that upstream soil conservation is as important to downstream shrimp farmers as it is to upstream peasant farmers.

Many steepland farmers understand that conservation is effective but, nonetheless fail to invest in conservation practices because they face immediate capital and/or labor constraints or because the payoffs from sustained crop yields accrue over many years and their planning is necessarily short-term.

Given the large downstream interest, which includes not just shrimp farmers but thousands of residents who lost homes during Hurricane Mitch, rationale for public support of policies to promote steepland soil conservation exists. In order to decide whether such public involvement has merit, the SM CRSP has undertaken studies to estimate the cost of sedimentation to downstream stakeholders. One study focuses specifically on the shrimp industry.

This study, described in Technical Bulletin No. 2000-01 (Samayoa, A., A. Marcela, P. Thurow, and T.L. Thurow. February 2000. A Watershed-Level Economic Assessment of the Downstream Effects of Steepland Erosion on Shrimp Production, Honduras. SM-CRSP Technical Bulletin No. 2000-01, 21 pp., Texas A&M) concludes that downstream costs of steepland soil erosion is substantial. The cost savings of managing sedimentation would be worth $105 per hectare per year to a representative semi-intensive shrimp farm, which is land constrained, given a 50-year planning horizon and a 10 percent discount rate.

Managing sediment increases the cost of producing shrimp by an estimated five cents per pound of tail produced (two percent of the farm's day-to-day operating cost). Each week, a 2,426-hectare shrimp farm removes approximately 60,750 cubic meter of sludge from its water supply channel and pumping stations. If required to store this dredged sediment in disposal ponds within its boundaries, the productive area on a representative farm would be 41 percent smaller in 50 years.

If there were a coordination mechanism to ensure that investments in steepland soil conservation would guarantee reductions in sedimentation reaching shrimp farms then, in theory, it is possible for shrimp farmers to pay steepland farmers to curtail and control erosion by either installing conservation practices or discontinuing crop production. While there is yet insufficient information to institute a system of payment to control erosion, this study contributes to the database that is required for that to occur. Ultimately, institutional mechanisms to coordinate public and private support for steepland soil and water conservation are needed to calculate appropriate levels and types of policy, and to determine how assistance can best be transferred so that those who benefit pay.

Another objective of the SM CRSP is to develop a decision support system for assessing "tradeoffs" between agricultural production and environmental impacts of agriculture for different economic, agricultural, and environmental policies and agricultural research. The decision support system is being tested in the potato/pasture production system of the Andean region, and then will be generalized for application to other production systems in the Andes and elsewhere. This decision support system does the following.

- Provides decision makers with information on tradeoffs between key sustainability indicators under alternative policy and technology scenarios;
- Links disciplinary data and simulation models in a GIS framework;
- Utilizes minimum data necessary for decision support and policy analysis;
- Transportable, i.e., can be adapted to other applications;
- Enables results to be extrapolated or generalized in a GIS framework.

The aim of this effort is to develop a policy decision support system (the Tradeoff Model) that can be used to quantify impacts of existing and proposed agricultural practices and policies on the sustainability of Andean agro-ecosystems; utilize the Tradeoff Model to screen proposed agricultural technologies such as integrated pest management and various types of soil husbandry for their potential impact on the sustainability of selected Andean agro-ecosystem; and develop recommendations for research priorities for national and international research systems in the region.

In the past year, version 2.1 of the Tradeoff Model was completed, including a test version on a CD-ROM. This software integrates field-scale GIS-based soil and climate data with a suite of crop growth simulation models, econometric-based economic simulation models of land use and management decisions, and environmental process models (leaching, runoff, and erosion models). The software provides the basis to draw a statistically-representative sample of fields in a region such as a watershed, conduct integrated analysis, and statistically aggregate the results to a scale relevant to policy decision making. The software displays tradeoffs between competing or complementary policy objectives in simple two-dimensional graphs and shows how these tradeoffs change under alternative policy and technology scenarios. The software was documented in a report that has been submitted to the Quantitative Approaches to Systems Analysis Series. A draft version of this report is available on the project's home page at http://www.trc.montana.edu/crsp/crsp.html.

FIELD SUPPORT TO MISSIONS

The SM CRSP welcomes the opportunity to respond to requests from USAID Missions to provide technical assistance to host countries. In the past year, the SM CRSP has provided field support to the USAID mission in Bangladesh to investigate and eliminate a human nutrition problem. It turns out that rickets has emerged as a major source of disability in the Chakoria area of Southeast Bangladesh. Why is the Soil Management CRSP involved in eliminating rickets—a childhood disease primarily caused by vitamin D deficiency? In Bangladesh, as in parts of Nigeria and South Africa, the evidence suggests that low intakes of calcium is likely to be the major cause of the disease. Calcium deficiency goes hand in hand with soil acidity and aluminum toxicity. Low calcium in the soil may not in itself be sufficient to cause rickets, but when population pressures compel farmers to grow three rice crops each year at the expense of calcium-rich crops and dairy products, children with low calcium intake may be pushed over the dietary edge.

Cornell University is investigating the sustainability of the rice-wheat cropping system of South Asia. Its study of this post-green revolution agriculture indicates the high-intensity cropping system is faltering from factors including pest build-up, micronutrients deficiencies and deficiencies of the more common macro-nutrients, such as nitrogen, phosphorus, and calcium. Although soil scientists tend to focus on nutrients in soils, they are also required to assess the availability of nutrients to plants. This is as far as nutrients are usually followed in the food system. Yet, the identification of calcium deficiency and rickets enables CRSP scientists to take nutrients from soil to plant nutrition and ultimately to human nutrition.

Nutritionists and medical doctors who are involved in this project believe that metabolic bone diseases other than rickets should also occur in children living in the area. One would also expect high rates of post-menopausal osteoporosis in women and bone loss in older men. Because the factors thought to be involved in the etiology of rickets in Chakoria are all derived from food, the bone disease is properly seen as a manifestation of a deficient food system. Therefore, it is logical to look to preventing not only rickets, but also other metabolic bone diseases and nutritional deficiencies. In addition to efficacy, such approaches offer real chances of being sustainable if developed within the economic, social and biophysical context of food systems.

EXTERNAL EVALUATION REPORT

A mid-term, in-depth review of the Soil Management CRSP was completed in 1999 to evaluate performance to date and progress toward completing program objectives, and also to determine whether mid-term adjustments were necessary. To prepare for this review, USAID approved the selection of five individuals to an External Evaluation Panel (EEP). The members were as follows.

David MacKenzie (Chair)
Executive Director
Northeast Regional Association of State Agricultural Experiment Station Directors (NERA)
University of Maryland
College Park, Maryland

Will Blackburn
Area Director
Northern Plains Area

Agricultural Research Service/U.S. Department of Agriculture
Ft. Collins, Colorado

Eric Craswell
Director General
International Board for Soil Research and Management (IBSRAM)
Bangkok, Thailand

Jean Kearns
Executive Director
Consortium for International Development (CID)
Tucson, Arizona

Amit Roy
President and CEO
International Fertilizer Development Center (IFDC)
Muscle Shoals, Alabama

In preparation for the program review, all members of the EEP, the USAID project officer, and the Management Entity (ME) met in May 1999 to plan the scope of work for the evaluation, and to prepare logistics for visits to overseas and U.S. project sites.

Beginning in September 1999 and ending in December 1999, the EEP members visited five countries (Philippines, Bangladesh, Peru, Ecuador, and Nicaragua) to make site visits to each of the four, fully-funded projects. EEP members also visited the NifTAL project site on Maui, Hawaii and the University of Florida to confer with the principal investigators of two partially-funded CRSP projects.

The evaluation process was completed during the week of December 13, when all six principal investigators presented summaries of their program activities and accomplishments to the EEP. Because each EEP member was able to visit with no more than two projects, the presentations by PIs from all six projects provided the EEP with a full picture of CRSP activities.

The EEP summarized its findings in the following way.

EXECUTIVE SUMMARY

There is a strong consensus within the EEP that the SM CRSP will complete its activities on time and within budget. The resulting products and anticipated impacts will be significant and represent a worthwhile investment for USAID.

In addition to the project-specific recommendations found within this report, the panel offers the following over-arching recommendations as a consensus of our best judgements for improving an otherwise excellent CRSP.

The EEP recommends:

- More leadership provided by the ME on programmatic direction, leading to more intra-CRSP collaborations;

- Greater focus given to the integration of biophysical with socioeconomic approaches to soil management constraints, including more frequent face-to-face meetings, more discussion and dialogue among component projects, and more attempts at consensus building, perhaps encouraged by set-aside funding from the ME for travel;

- That each SM CRSP project should have a gender analysis component, in recognition of the fact that gender issues in soil management are a non-trivial, and important to sponsors as well;

- More openness on SM CRSP budget matters, and better communication with PIs on budgetary decisions, preferably as written documents containing the rationale for the decisions, rather than as phone conversations or word-of-mouth;

- More consideration to marketing the collective accomplishments of the SM CRSP to donors, clients, stakeholders, including the private sector;

- Greater support from the ME for coping with the "pipeline" management process for reallocating funds within the CRSP, including more assistance from the PIs to the ME as timely vouchering, with an understanding of federal government fund-management practices;

- Planning begin immediately for the next generation of this CRSP, with consideration for:

  1. Moving to more integrated approaches to soil management research activities within the CRSP;
  2. More focus on specific soil management constraints;
  3. Use of the existing network of collaborators (as stakeholders) to help define the next set of constraints, and plan future collaborative research activities; and
  4. Different perspectives on the organization of soil management constraints that go beyond the biophysical (e.g., nitrogen) to other dimensions (e.g., limits to adoption).

- Development of an implementation plan for the recommendations provided as a result of this external evaluation, with a timetable for activities and a plan for reporting on progress.

The EEP has looked ahead in an attempt to project the next generation of soil management research activities and concluded that the present core of scientists deserves an opportunity to plan its own destiny. This will require of USAID a commitment to honor a proposal for program renewal, under a set of mutually-agreed expectations. Among these expectations should be a firm commitment from USAID that a proposal from this coalition will be given direct consideration, in place of another round of competition. In turn, the present SM CRSP should agree to a planning process that will:

- Open the planning and decision making to experts beyond the present membership;
- Allow for appropriate project memberships, and the project-appropriate allocation of any future funding; and
- Permit new approaches to identifying a revised set of soil management constraints.

Planning for the renewal of the SM CRSP for another five-year research phase is strongly encouraged by the EEP.

PARTICIPATING AND COLLABORATING SCIENTISTS AND INSTITUTIONS/ORGANIZATIONS

National Agricultural Research Systems (NARS)

Australia
University of New England
Paul Winters

Bangladesh
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Md. Bodruzzaman
Md. A. Mannan
A.K. Maqbul Hossain
S. Parvin Banu
M.A. Rahman
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M.A. Shaheed

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Oil Crops Research Institute
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Organization of Tropical Studies
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Fundación Pastaza Ambato
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INIAP-UVTT Carchi
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Inst. Ec. De Seguro Social
Hipatia Viteri de Almieda

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South-East Consortium for International Development (SECID)
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J.D.Z. Lea

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Escuela Agricola Panamericana
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Honduras National Association of Aquaculture
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INTSORMIL CRSP
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Mario Pinto
Olman Rivera
Miguel Sanchez

Ministry of Environment
Jesus Salas

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Rual Espinal
Carlos Rosas
Hector Sierra

USAID Honduras
Peter Hearne

India
Allahbad Agricultural Institute
Tigi Verghis

BAIF
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M.H. Mehta

ICAR-Modipuram
R.L. Yadav

Krishak Bharati Cooperative Ltd.
R.N. Soni

MAHYCO Ltd.
S.C. Prabhu

National Research Centre for Soybean
Sushil Sharma

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Y. Singh

Punjab Agricultural University
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M.R. Chaudhary
P.R. Gajri
N. Jead
P.P.S. Pannu
Bijay Singh
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University of Agricultural Science
V.P. Savalgi

U.P. Seeds of Tarai
Ravi Singh

Kenya
University of Nairobi
Nancy Karanja

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Institute d'Economie Rurale
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Aminata Sidibe
Adama Coulibaly
Oumar Coulibaly
M. Keita
Zoumana Kouyate

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Nepal Agricultural Research Council
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T. Pokharel
M. Maskey
S.P. Pandey
J.D. Ranjit
R.P. Sapkota
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R. Shrestha
J. Tripathi
H.K. Upreti

The Netherlands
Wageningen Agricultural University
Jetse Stoorvogel
Johan Bouma

AB-DLO
Anton Haverkort
Robert van Haren
Paula Westerman

Nicaragua
Almesa
Jorge Salazar

National Agricultural University (UNA)
Matilde Somarriba-Chang

Bismark Mendoza
Domingo Rivas
Georgina Orozco

USAID-Nicaragua
Margaret Harritt
Paul Crawford

Pakistan
PARC
Md. Salim

Peru
INIA-Baños del Inca
Hector Cabrera
Rocio Sanchez

ADEFOR-Cajamarca
Flavio Flores

ASPADERUC-Cajamarca
Pablo Sanchez

CIP/CONDESAN-Lima
Mario Tapia

CIP/IFDC-Lima
Walter Bowen

CIP/ILRI-Lima
Carlos Leon Velarde

U. Nacional-Cajamarca
Edelvaly de la Peña
Peter Muck

Philippines
Ilagan Research Station
Quirino Asuncion
Danilo Tumamao

Mariano Marcos State University, Ilocos Norte
Sixto Pascua

Philippines Rice Research Institute
Teodula Corton
Josephina Lasquite

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ISAR, Butare
B. Cassien

South Africa, Republic of
Soygro Ltd., Potchefstroom
Voltan Senekal

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Institute of Fundamental Studies, Kandy
Gaminis Seneviratne

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P.A. Ndakidemi

Thailand
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Nantakom Boonkerd

Uganda
Makerere University
Mary Silver

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Glenn Howze
Curtis Jolly
G.L. Mullins
Dennis Shannon
C. Wesley Wood
Kyung Yoo

Colorado State University
Dana Hoag

Cornell University
George Abawi
Philippe Baveye
Robin Bellinder
Gary Bergstrom
David Bouldin
Gerald Combs
John Duxbury
Stephen DeGloria
Shelley Feldman
Steven Kyle
Julie Lauren
Michael Latham
David Lee
Ralph Obendorf
Susan Riha
Norman Uphoff
Timothy Widmer
P.K. Kataki (Cornell On-Site Coordinator; New Delhi, India)
C.A. Meisner (CIMMYT & Cornell On-site Coordinator, Dhaka, Bangladesh)

Michigan State University
Joe Ritchie

Montana State University
John Antle

North Carolina State University
Keith Cassel
Deanna Osmond
Shaw Reid
Jot Smyth
Fred Cox
Pedro Luna
Dan Israel
Michael Wagger

Texas A&M University
Richard Drees
Richard Fisher
Lloyd Hossner
Anthony Juo
Robert Knight
Amy Purvis Thurow
Thomas Thurow
Larry Wilding
Ben Wu

Understanding Systems, Inc.
Will Branch
Steve Pratt

University of Florida
Ken Buhr
Christina Gladwin
Abraham Goldman
Clifton Hiebsch
Peter Hildebrand
Max Langham
Donna Lee
Clyde Kiker
P.K. Nair
Peter Nkedi-Kizza
Andrew Schmitz

University of Hawaii
Adrian Ares
Richard Kablan
Nguyen Hue
X. Shuai
Paul Singleton
Xinmin Wang
Russell Yost

*University of the South (*Sewanee, Tennessee)
Deborah MacGrath

US Plant Soil Nutr. Lab
Ross Welch

Virginia Polytechnic & State University
Sarah Hamilton
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Uruguay
Laboratorio de Microbiogia
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Oil Plant Institute (OPI) Ho Chi Minh City
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Vietnam National University, Hanoi
Nguyen Xuan Hong

Vietnam Agricultural Science Institute, Hanoi
Pham Van Toan

Zimbabwe
Grasslands Research Institute
Michael Nyika

International Agricultural Research Centers (IARC)
CIP
Noemi Cabanillas (La Encañada)
Lucinda Chavez (La Encañada)
Charles Crissman (Quito)
Patricio Espinosa (Quito)
Greg Forbes (Quito)
Robert Hijmans (Lima)
Fabian Muñoz (Quito)
Aart Osman (Cajamarca)
Estuardo Regalado (La Encañada)
Alcides Rosas (La Encañada)
Steve Sherwood (Quito)
Nicolás Tasilla (La Encañada)

CIMMYT
E. Duveiller (Nepal)
P.R. Hobbs (Nepal)
L. Harrington (Mexico)
M. Ortiz-Ferrera (Nepal)
J. White (Mexico)

CIP-UVTT Carchi
Lilián Basantes
Luis Escudero
Mariana Pérez

ICRISAT
C. Johansen
A. Bationo (Niger)

IFPRI-Washington D.C.
Phillip Pardey
Stanley Wood

IITA
G. Tiau (Nigeria)

IRRI
Thomas George
J.K. Ladha
J. Quiton

TRAINING

DEGREE PROGRAMS

The SM CRSP provided a range of support for both undergraduate and graduate training for academic degrees from participating U.S. institutions. Students from non-U.S. locations and from the United States are fully or partially supported by the SM CRSP. Students enrolled in academic degree programs in host-country institutions are supported by the SM CRSP through their involvement in on going research activities. Both undergraduate and graduate students are included in the list below.

CORNELL

Cornell

Kaafaee Billah	Bangladesh
Medha Devare	United States
Andy McDonald	United States
Anna Marie Mayer	England
Jon Padgham	United States
Shabnam Qureshi	Pakistan
Khrishna Rao	India

IAAS Rampur

Bishnu Adhikari	Nepal
Deepak Bhandari	Nepal
Deepak Sharma	Nepal

MONTANA STATE UNIVERSITY

Montana State Univ.

Mykel Matthews	United States
Roberto Valdivia	Peru

Esc. Pol. De Chimborazo

Neidy Clavijo	Ecuador
José Negrete	Ecuador
Hernán Uvidia	Ecuador

U. Nac. de Cajamarca

Mario Cáceres	Peru
Genaro Carrión	Peru
Sara Garcia	Peru
Ernesto Rodriguez	Peru

Univ. Central, Quito

Miguel Flores	Ecuador
Roque Tapia	Ecuador

Utah State University

Cecilia Ortiz	Ecuador

Wageningen Agr. Univ.

Guillermo Baigorria	Peru
Gerben de Vries	Netherlands
Raul Jarrimillo	Ecuador
Pim Joris Kantebeen	Netherlands
Lammert Kooistra	Netherlands
Magedelena Lopez	Ecuador
David Meerbach	Netherlands
Ramiro Merino	Ecuador
Erik Meyles	Netherlands
Koen Overmars	Netherlands
Consuelo Romero	Peru
Francien van Soest	Netherlands
Martijn Veen	Netherlands

NORTH CAROLINA STATE UNIVERSITY

Texas A&M University

Yuji Nino	Japan
Rick Wesch	United States

University of Hawaii

Jocelyun Bajita	Philippines
Xiufu Shuai	China

TEXAS A&M UNIVERSITY

Auburn

Budry Bayard	Haiti
Lionel Isaac	Haiti

Pan American Univ.

Beatriz Pozo	Honduras
Claudia Urrutia	Honduras

Texas A&M University

Brad Driessen	United States
Humberto Pertotto	Bolivia
Domingo Rivas	Nicaragua
Marcela Samayoa	El Salvador
Hector Santos	Honduras
Ramesh Sivanpillai	India

National Agri. Univ.

Roberto Marachel	Nicaragua
Benigno Montez	Nicaragua
Felix Ortega	Nicaragua

WORKSHOP: NUMASS EVALUATION

Forty-three participants from Africa, Asia, and Latin America participated in a nutrient management workshop at the headquarters of the Philippine Rice Research Institute at Maligaya, Munoz, the Philippines in September 1999. PhilRice and IRRI co-sponsored the workshop with the SM CRSP. Participants are listed in the table below.

Objectives of the workshop were threefold:

1. compare among countries and regions, decision making processes used to diagnose soil nutrient problems, recommend solutions, and assess their economic feasibility;
2. evaluate the current prototype of the integrated nutrient management decision support system (named NuMaSS by participants at this workshop) software and identify future developments needed to improve its performance and usability; and
3. work with interested parties in providing pertinent data and/or designing and planning experiments to test NuMaSS to suit regional needs.

A proceedings of the workshop is scheduled to be printed by PhilRice later in PY4. The document will contain reports from participants on tasks related to objective 1. Results of testing of NuMaSS with recommendations for consideration in PY4 and PY5 were made during the plenary sessions at the workshop.

Name	Institution	Country
Agusli Taher	Assessment Institute for Agricultural Technology (Sukarami)	Indonesia
Boun-Ome Soulideth	Soil Survey and Land Classification Center	Laos
Soulasith Maniphone	Luang Prabang Rainfed Research Program	Laos
Pham Tien Dung	Hanoi Agriculture University	Vietnam
Ato Solomon Abebe	Bureau of Agriculture	Ethiopia
Ato Kindu Mekonnen	Siringka Research Center	Ethiopia
Ato Yihenew G. Selassie	Adet Research Center	Ethiopia
Mohammed Kebbeh	WARDA-Sahel	Gambia
Charles Yamoah	Council for Scientific and Industrial Research	Ghana
Mamadou Doumbia	Institut d'Economie Rurale	Mali
Aminata Badiane	Institut Senegalese de Recherche Agricole	Senegal
Alan Manson	KwaZulu-Natal Department of Agriculture	Tanzania
Gerald Kimbi	Sokoine University of Agriculture	Tanzania
Vernon Chinene	University of Zambia	Zambia
Manoel S. Carvo	EMBRAPA-CPAC Manaus	Brazil
Leo Nobre de Miranda	EMBRAPA-CPAC Brasilia	Brazil
Roberto F. Novais	Universidad Federal de Vicosa	Brazil
Alfredo Alvarado	Universidad de Costa Rica	Costa Rica
Francisco Mite	INIAP	Ecuador
Armando Ferrufino	IBTA-Chapare	Bolivia
Yamily Zavala	FONAIAP	Venezuela
Jot Smyth	North Carolina State University	USA
Deanna Osmond	North Carolina State University	USA
Russell Yost	University of Hawaii	USA
Shaw Reid	Cornell University	USA
Eric Craswell	IBSRAM	Thailand
Amit Roy	IFDC	USA
Charles Sloger	USAID	USA

Ernst Mutert	Potash & Phosphate Institute	Singapore
Eduardo Paningbatan	University of the Philippines, Los Banos	Philippines
Jovelyn Du-Quiton	University of the Philippines, Los Banos	Philippines
Perfecto P. Evangelista	BSWM	Philippines
Rogelio Concepcion	BSWM	Philippines
Jonathan T. Quiton	IRRI	Philippines
Thomas George	IRRI	Philippines
Mark Bell	IRRI	Philippines
V. Manocharan	IRRI	Philippines
Andrew Valdeavilla	PCARRD	Philippines
Danilo Tumanao	DA-CVIARC	Philippines
Quirin Asuncion	DA-CVIRRC	Philippines
Warlito Cayaba	LGU-DA Ilagan	Philippines
Bonafacio Macarubbon	LGU-DA Ilagan	Philippines
Arturo Gomez	SEARCA	Philippines
Santiago Obien	PhilRice	Philippines
Frisco Malabanan	PhilRice	Philippines
Karon Barroga	PhilRice	Philippines
Leo Javier	PhilRice	Philippines
Paterno Rebuella	PhilRice	Philippines
Teodula Corton	PhilRice	Philippines
Sergio Francisco	PhilRice	Philippines
Genaro O. San Valentin	PhilRice	Philippines
Cesar P. Mamaril	PhilRice	Philippines
Josue Descalsota	PhilRice	Philippines

PROJECT MANAGEMENT

MANAGEMENT ENTITY (ME)

The University of Hawaii serves as the Management Entity for the Soil Management CRSP. Dr. Goro Uehara serves as Director and Dr. Gordon Y. Tsuji serves as Deputy Director. As the Management Entity, the University of Hawaii administers grant funds received from the Agency for International Development under Grant No. AID/LAG-G-00-97-00002-00. The Management Entity is responsible for the overall implementation of the research program and for coordination of project activities under five sub-agreements with participating institutions and one direct project at the University of Hawaii (NifTAL). Principal investigators for the six projects prepare annual work plans and budgets associated with each of their respective project objectives and submits them to the Management Entity for transmittal to the Technical Committee for review and evaluation.

The Management Entity reports on the overall progress of program activities and represents the SM CRSP in negotiations with AID and in meetings and teleconferencing of the CRSP Council. The CRSP Council consists of directors of the nine different CSRPs managed by the Office of Agriculture and Food Security of USAID. Additionally, the Management Entity represents the interest of the SM CRSP in responding to requests for technical support and/or participation in forums received from the Office of Agriculture and Food Security and from USAID missions.

Operationally, the office of the Management Entity is in the Department of Agronomy and Soil Science in the College of Tropical Agriculture and Human Resources at the University of Hawaii. In the next reporting period, the Management Entity will be in-housed in the Department of Tropical Plant and Soil Sciences. The change is a result of changes in the academic and research agenda of the college.

Administratively, the Management Entity utilizes the services of the Research Corporation of the University of Hawaii (RCUH) to implement and manage its sub-agreements with participating institutions. The RCUH is a non-profit organization established by the State Legislature in 1965 to support "off-shore" research and training programs of the University of Hawaii. The University of Hawaii has oversight responsibilities of the RCUH.

The CRSP Guidelines established in 1985 by the Board for International Food and Agricultural Development (BIFAD) for USAID and federal regulations are used to manage the SM CRSP by the Management Entity. Those guidelines direct each of the CRSPs to establish a Technical Committee, a Board of Directors, and an External Evaluation Panel. Administrative and logistical support to members associated with each of these "bodies" are provided for by the office of the Management Entity. A description of the composition and role of each follows.

Board of Directors (BOD). The CRSP guidelines states, "The Board consists of representatives or all of the participating institutions and may include individuals from other organizations and host country institutions. The AID Program Officer and the ME Dir-ector serve as ex-officio members. The institution, which serves as the ME, will have a permanent member on the Board. Board members are selected by their participating institutions on the basis of their administrative responsibilities and relevant expertise. They should not be chosen solely to represent their respective institutions or projects, but to function in the objective interest of the CRSP. The Board operates under a defined charter to deal with policy issues, to review and pass on plans and proposed budgets, to assess progress, and to advise the ME on these and other matters. While the ME institution has the authority to make final decisions relative to program assignments, budget allocations and authorizations, the ME must, in the collaborative spirit, carefully consider the advice and guidance of the Board and other CRSP advisory groups. Any departure from the Board's recommendations should be justified, recorded in minutes of the meeting, and reported in writing by the ME."

The third meeting of the Board of Directors was held in Denver, Colorado in December 1999 in conjunction with a joint meeting with members of the external evaluation panel and the principal investigators. Members and officers of the Board of Directors include:

- Dr. Richard Guthrie, Auburn University, Chair
- Dr. Michael Walter, Cornell University, Vice-Chair
- Dr. John Havlin, North Carolina State University
- Dr. Charles Laughlin, University of Hawaii*
- Dr. Thomas McCoy, Montana State University
- Dr. Philip Thornton, ILRI, Nairobi, Kenya

*Dr. Laughlin accepted a position with USDA/CREES and resigned from the Board. A replacement is expected to be named during the current project year.

This year's meeting coincided with the mid-term review session of the SM CRSP. Board members were able to interact with members of the External Evaluation Panel and with the principal investigators as each made presentations of their respective accomplishments toward their stated objectives.

Minutes of previous meetings are available by accessing the SM CRSP web site at the following URL, http://agrss.sherman.hawaii.edu/sm-crsp.

Technical Committee (TC). The CRSP Guidelines states "The Technical Committee is established with membership drawn primarily from principal scientists engaged in CRSP activities, known as principal investigators, and host country scientists involved in CRSP or IARC activities. The ME Director and the AID Program Officer serve as ex-officio members. The TC meets from time to time to review work plans and budgets, program performance, to propose modifications in the technical approach to achieve program objectives, and to recommend allocation of funds. The TC reports its findings in writing to the ME who will share them with the BOD."

The third meeting of the Technical Committee was held in San Francisco in February 2000, two months after the mid-term evaluation report of the External Evaluation Panel in December. Members of the TC also met with the principal investigators to plan for Phase 2 of the SM CRSP as recommended in the report of the External Evaluation Panel.

A new member to the Technical Committee was Dr. John Duxbury of Cornell University. He replaced Dr. Tom Thurow formerly of Texas A&M University and now at the University of Wyoming. Other members of the Technical Committee include the following.

- Dr. E.B. (Ron) Knapp, CIAT, Cali, Colombia
- Dr. T. Jot Smyth, North Carolina State University, Chair
- Dr. Thomas Walker, CIP, Lima, Peru

Members reviewed the work plans and budgets for project year (PY) 4 from each of the principal investigators. Dr. Charles Sloger of AID and the SM CRSP Program Officer informed the group that contrary to earlier expectations, the funding level for the SM CRSP will be the same as last year or at $2.5 million. After a brief discussion among members of the TC, a uniform percentage reduction of funding for each project was recommended and accepted. The percentage reduction was determined to be 13% of the level received in PY3. Any proposed increases in funding were rejected. This year's annual progress project reports were received simultaneously with the work plans and budgets instead a month after the end of a project year. According to all members of the TC, this would be the preferred modus operandi for coming years.

The two external members of the TC joined with the principal investigators to develop a framework for the RFP (request for pre-proposal) for Phase 2 of the SM CRSP. Constraints, goals, and objectives of an integrated project involving the participating institutions were discussed and debated for two days. At the conclusion of the meetings, the ME was asked to prepare a draft of the constraints and objectives to share among the principal investigators. In addition, a list of prospective members of a panel to review the pre-proposals was developed. The two external members of the TC volunteered to serve as two members of a four-member panel.

A letter outlining the SM CRSP's strategy for Phase 2 was prepared by the ME and submitted to the Office of Agriculture and Food Security, Center for Economic Growth and Agricultural Development, Global Bureau, and USAID for concurrence subsequent to the meeting.

External Evaluation Panel (EEP). The CRSP Guidelines states "The EEP is established with membership drawn from the scientific community to evaluate the status, funding progress, plans, and prospects of the CRSP and to make recommendations thereon. In accordance with the CRSP guidelines, the panel shall consist of an adequate number of scientists to represent the major disciplines involved in the CRSP, normally no more than five members. This number will vary with program size and cost-effectiveness. The term of office shall be long-term to retain program memory. A five-year term is recommended for the initial panel and subsequently rotated off on a staggered time base. Provisions should be made for replacements for low attendance, for resignations or for other reasons. In instances where a minor discipline is not represented on the EEP, the Chairman may request the assistance of an external consultant from the ME.

Panel members will be internationally recognized scientists and selected for their in-depth knowledge of a research discipline of the CRSP and experience in systems research and/or research administration. International research experience and knowledge of problems and conditions in developing countries of some members are essential. The members are selected so that collectively they will cover the disciplinary range of the CRSP, including socioeconomic components that can influence research and technology adoption. Panel members should be drawn from the United States (some with experience in agricultural research and knowledge of the Land Grant University system) and the international community and should include at least one scientist from a developing host country. Availability to devote considerable time to EEP activities is an important criterion for membership."

Nomination of candidates was solicited by AID from the principal investigators and the ME. A five-member panel was appointed. Members of the External Evaluation Panel include the following individuals.

- Dr. Will Blackburn, Area Director, ARS/USDA, Ft. Collins, Colorado

• Dr. Eric Craswell, Director-General, IBSRAM, Bangkok, Thailand
• Dr. Jean Kearns, Executive Director, CID, Phoenix, Arizona
• Dr. David MacKenzie, Director, NERC/ CREES/USDA, College Park, Maryland
• Dr. Amit Roy, President and CEO, IFDC, Muscle Shoals, Alabama

Their tasks involved oversight, evaluation of progress toward stated objectives, and assessment of probability of success in achieving their objectives. Members present at the initial meeting agreed that all five need not travel together to be present at each of the project site visits. However, to enable all members to assess progress and evaluate performance, the EEP requested the ME to organize a collective meeting of the principal investigators at the conclusion of the site visits. Each principal investigator would present a summary report of accomplishments to all members of the EEP.

During the first meeting of members of the EEP in Washington, D.C., a tentative agreement was reached on sharing site visitation and reporting among the members. Dr. Craswell was unable to attend that first meeting and was listed to participate in two site visits at locations relatively close to his base of operations in Thailand. On the basis of that tentative listing, the following table indicates the site, EEP member(s) who participated in the on-site evaluation list and the month in which the evaluation was carried out.

Site	EEP members	Date
Bangladesh	Craswell and Kearns	Oct. 1999
Philippines	Roy and Craswell	Sept. 1999
NifTAL (HI)	Roy	Sept. 1999
Florida	Kearns	Dec. 1999
Peru/Ecuador	MacKenzie and Blackburn	Nov. 1999
Nicaragua	Blackburn and MacKenzie	Nov. 1999

Dr. Charles Sloger, the SM CRSP program officer from USAID, participated in all of the site visits. In all instances, Dr. Sloger provided important coordination for the project and EEP members to meet with representatives from the local AID missions.

A copy of the EEP report is attached as an appendix to this annual report.

At the summary meeting held in Denver in December 1999, members of the EEP acted to resolve budgetary concerns of the University of Florida and the Management Entity with the assistance of the chair of the Board of Directors. These concerns were reported in the PY3 annual report. Upon reaching mutual understanding of the concern, the University of Florida agreed to continue its participation in SM CRSP.

CRSP Council. Principal communication links among the CRSP programs are established through the CRSP Council. Directors of nine CRSPs constitute membership of the CRSP Council. Current chair of the Council is Dr. John Yohe, Director of the INTSORMIL CRSP at the University of Nebraska with Dr. Pat Barnes-McConnell of Michigan State University serving as Vice-Chair. Members of the Council are as follows.

Director	CRSP	Institution
Michael Roth	BASIS	Wisconsin
Pat Barnes-McConnell	Bean and Cowpea	Michigan State
Tag Demment	Global Livestock	California, Davis
John Yohe	INTSORMIL	Nebraska
Brhane Gedbrekidan	IPM	Virginia Tech
Tim Williams	Peanut	Georgia
Hillary Egna	Pond Dynamics	Oregon State
Constance Neely	SANREM	Georgia
Goro Uehara	Soil Management	Hawaii

The CRSP Council serves as a communication link among the nine CRSPs and as a "conduit" for information flow to and from USAID and other organizations such as NASULGC (National Association of Universities and Land Grant Colleges). Communication involves either teleconferencing, e-mail correspondence through the internet, and meetings as necessary, typically on an annual basis.

A web-site for the CRSP programs was created by the INTSORMIL staff at the University of Nebraska. The URL for the site is http://www.ianr.unl.edu/crsps/.

FINANCIAL SUMMARY

The level of core funding for the six projects remained at a level of $2.5 million for the period ending on April 30, 2000 (PY3), the same amount as the previous 12 months (PY2). In the grant proposal, $3.6 million was proposed for PY2 and $3.7 million for PY3.

The lower level of funding was further complicated by delays in receiving official notification of incremental awards in a timely manner. For example, modification #3 (mod #3) was authorized by the Office of Procurement of USAID in June 1999 but documentation was not received until August 1999. The end date of the previous incremental award, mod #2, was April 30, 1999. Funding advances from each institution were necessary to sustain project activities both on and off campus. Sub-agreements between the ME and participating institutions required nearly a month to process after receipt of the modification from USAID. Those participating institutions with agreements of their own with other U.S. institutions, CG centers, and NARS were consequently affected.

Table 1 lists the project year and the incremental funds added to the SM CRSP budget since it's inception on February 11, 1997. In last year's report, we outlined the lag time between the project year and the funding period. There is no coincidence in timing.

Award	PY	Amount	Period
Initial grant	1	2,467,975	Feb 11, 1997- Sep 30, 1977
Mod #1	1 & 2	1,131,025	Oct 01, 1997- Apr 30, 1998
Mod #2	2	2,500,000	May 01, 1998- Apr 30, 1999
Mod #2$_a$	2	200,000	May 01, 1998- Apr 30, 1999
Mod #3$_b$	2	1,000,000	May 01, 1999- Jul 31, 1999
Mod #4	3	2,500,000	May 01, 1999- Apr 30, 2000
Mod #5$_c$	3	200,000	May 01, 1999- Apr 30, 2000

Notes: Subscripts a, b, and c refer to field support funds received by the SM CRSP from the Office of Disaster Relief, the AID mission in Bangladesh, and the AID mission in Ethiopia, respectively.

The end date of the grant is September 30, 2001, 4 years and 7 months and 19 days instead of 5 years.

Fiscal Report. A summary of expenditure, cost sharing, and funding for each project is listed in the tables below. Cost sharing should amount to 25% of the grant award total less the amount budgeted to operate the ME, funds committed under terms of a formal CRSP host country sub-agreement, and costs for training of participants.

Modification #3 reflects the total field support funds from the AID mission in Bangladesh for Cornell University (see the 1998 annual report) and modification #4 included $200,000 from the AID mission in Ethiopia to the ME. Activities associated with field support activities are reported in the following section.

Financial summary statement ($ '000) of expenditures, cost sharing, and funding, for PY3 (Feb 10, 1999 to Feb 11, 2000).

a. Summary of Expenditures for PY3 (February 11, 1999 to February 10, 2000)

Institution	MSU	NCSU	CU	TAMU	NifTAL	UFl	ME/UH	Total
Total	140	1,116	1,005	346	100	165	406	3,278

b. Cost Sharing for PY3 (February 11, 1999 to February 10, 2000)

Total	0	187	194	88	96	91	0	656

c. Summary of Funding for PY3 (February 11, 1999 to February 10, 2000)

Mod #2	194	1,000	483	361	190	58	214	2,500
	0	0	0	0	0	168	32	200_a
Mod #3	0	0	0	0	0	168	32	$1,000_b$
Mod #4	39	173	604	57	36	0	91	2,500
Mod #5	142	765	773	293	143	0	384	200_c
	0	0	0	0	0	0	200	2,500

Notes: Subscripts a, b, and c refer to field support funds received by the SM CRSP from the Office of Disaster Relief, the AID mission in Bangladesh, and the AID mission in Ethiopia, respectively.

FIELD SUPPORT, COST SHARING, AND LEVERAGING

FIELD SUPPORT

Field support is also referred to as "buy ins." These are additional activities undertaken by the SM CRSP either individually by a project or collectively among participating institutions involved with the SM CRSP and/or other CRSP programs at the request of an AID mission or office with resources provided by USAID through the existing grant.

Bangladesh. Funding for field support activities undertaken by Cornell University at the request of the USAID mission in Bangladesh was received by the Management Entity. The Management Entity, in turn, increased the sub-agreement funding for Cornell University upon receipt of work plans and budgets for the project year. Funding for field support in Bangladesh was added to the SM CRSP's overall budget as modification #3. Late receipt and disbursement of funds resulted in subsequent delays in implementing field support activities. Most of the proposed activities to achieve project objectives were pushed into PY 4. Hence, remaining pipeline funds will be used to carry these activities beyond the original end date of July 2000. Funding for the activities amounted to $1 million over a two-year period.

A more complete report of accomplishments will be available in the annual report for PY4.

Ethiopia. At the request of the USAID mission in Addis Ababa, representatives from SANREM, IPM, INTSORMIL, and Soil Management CRSP traveled to Ethiopia in early summer 1999 to meet with officials from the government of Ethiopia to explore means to improve food security in the Amhara region of the country. The one-week visit ended on a positive note from both representatives of the government of Ethiopia and of USAID/Addis. Subsequently, USAID/Addis asked the Soil Management CRSP to serve as the lead CRSP for field support activities in the Amhara region of Ethiopia. Funds to support such activities were through a modification to the existing grant to the Management Entity for the Soil Management CRSP. Each of the directors of the three other CRSPs were contacted by SM CRSP director, Goro Uehara to recommend scientists from their CRSPs to form a multidisciplinary team to work with counterparts from the government of Ethiopia. The principal task assigned to the team was the preparation of a report now referred to as the "Amhara National Regional State Food Security Research Assessment." A team of nine scientists from the four CRSPs and one from the Government of Ethiopia traveled to the Amhara region of Ethiopia in February 2000.

Team members included Dr. Tegegne Azage from the Government of Ethiopia and the following individuals from the four CRSPs.

- Gladys Buenavista, University of Wisconsin, SANREM
- Keith Cassell, North Carolina State University, SM CRSP
- Fred Cox, North Carolina State University, SM CRSP
- Tom Crawford, University of Nebraska, INTSORMIL
- Brhane Gebrekidan, Virginia Tech University, IPM CRSP
- Jean Steiner, USDA/ARS, Griffin, Georgia, SANREM
- Goro Uehara, University of Hawaii, SM CRSP
- Hector Valenzuela, University of Hawaii, SM CRSP
- David Yanggen, Montana State University, SM CRSP

Their report was subsequently posted at the URL of the SM CRSP at http://agrss.sherman.hawaii.edu/sm-crsp. An excerpt from the executive summary of their report is presented below.

Summary of Amhara Assessment Report. Forty-eight of the 105 woredas of the Amhara region are drought-prone and suffer from frequent food shortages. Many households are only able to produce sufficient food to meet their food requirements for less than six months of the year.

The team assessed the availability of technology and the capacity to generate and disseminate technology for the production of field and horticultural crops, livestock, apiculture, as well as seed industry, agroclimatic analysis, watershed management, soil erosion and fertility, food science, socio-economic factors, and structure of the research system.

It is clear that land degradation from overgrazing, soil erosion, deforestation, and cultivation of steep, fragile lands has resulted in loss of biodiversity, productivity, stability, and resiliency in the region. Across the three ANRS research centers the team visited, the staff is young and enthusiastic. They expressed the need for more senior and experienced scientists who would provide leadership and guidance to them and the overall research programs. The research staff are also constrained by inadequate facilities, equipment, and supplies. The research capability needs to be strengthened in several ways, including increasing the research efficiency of the current system, along with strategic expansion and upgrading of the centers. In general, the efficiency of current research investments should be addressed first, followed by upgrading and expansion. Unless this situation is corrected, the lack of adequate research capabilities will continue to be a bottleneck for attainment of food security.

The extension capabilities for the transfer of technology packages is organizationally in place, and relatively well staffed. However, considerable capability building is required to upgrade the technological expertise of the extension staff, including subject matter specialists and development agents. The extension staff need much more technical support and research information to be more effective in their work.

Conclusion. Based on the assessment, the team has formulated a research action plan that would contribute to the reversal of the current situation and set in motion movement toward food security. The **first action** deals with institutionalizing an adaptive, participatory research methodology in which researchers, members of the extension service, and households have equal say in setting research priorities. This action will ensure that efforts of research and extension personnel are demand-driven, rather than supply-driven as it is now. This research approach should be initiated immediately and be ready for implementation in the coming cropping season.

The **second action** is designed to provide training, mentoring, and higher education opportunity for a research staff that is young and inexperienced. Isolation from the global research community, in general, and the regional and national research centers, in particular, makes it impossible for researchers to apply existing and new technologies in the region. The research libraries are virtually empty and telephones are rare. To rectify this situation, the team recommends the **third action**, the installation of a modern information, computer, and communication systems to link every research center in the region to every other regional center and to the national and global research community.

The **fourth action** calls for modernizing the research laboratories and equipment, and making provisions for timely replacement of parts and supplies. The **fifth action** recommends that the region initiate a plan to prepare a high resolution, geo-referenced database that characterizes the socioeconomic and biophysical conditions down to the village level. This human and natural resource database is needed to transfer successful technologies discovered through participatory adaptive research to other similar locations where they are likely to succeed. Without this spatial database, technology will continue to be transferred by slow, expensive, and unreliable trial-and-error methods.

But the urgency of the situation requires that immediate action be taken to lessen long-standing food security constraints with readily available technologies. For this purpose, a list of technologies for early on-farm testing is provided. These technologies address problems which farm households have repeatedly cited as causes of crop failures. It is expected that as farmers, researchers, and development agents work together to test technologies, many more existing technologies will be found suitable for local adoption.

If the CRSPs are called upon to participate in the implementation of the recommendations made, these activities are anticipated in PY 4.

COST SHARING

Cost sharing refers to the required match of grant funds from USAID with an equivalent of non-Federal funds by the grantee at a level of 25% or more. The match can be from in-kind support, such as facilities and utilities, and salaries or wages and fringe benefit costs. The minimum 25% cost sharing percentage spelled out in the "Guidelines for the CRSP under Title XII of the International Development and Food Assistance Act of 1975" printed in 1985. Principal source of funds to meet the 25% cost sharing minimum continues to be by each participating and collaborating U.S. institutions in New York, Montana, North Carolina, Hawaii, Florida, Alabama, and Texas.

During PY 3, the Management Entity received clarification from the Office of Procurement on whether funds allocated to international centers of the CGIAR through sub-agreements with the SM CRSP institutions for collaborative activities in developing countries were exempt from cost sharing as is those funds allocated to national organizations. The Office of Procurement determined that these funds were not exempt from cost sharing. Further, the ME was advised that the CGIAR centers can cost share their contributions that are not attributed to U.S. federal government sources. Full cost sharing is not reported at a 25% level for PY3 as cost sharing from CGIAR centers involved in CRSP activities are not reported here.

The cost sharing contributions from CGIAR centers have direct impact on activities and funds for three participating institutions: Cornell, Montana State University, and North Carolina State University. Agreements with CIMMYT in both Bangladesh and Nepal by Cornell, with CIP in both Peru and Ecuador by Montana State, and with IRRI, principally in the Philippines, by North Carolina State

LEVERAGING

Leveraging in the context of the SM CRSP refers to the contributions of human, fiscal, and physical resources by partners or collaborators in project activities. Much of what is reported below are attributed to our host country collaborators. The amount contributed by each is either an estimate or, as in most of the cases, we've just listed the contributor's organization rather than a currency amount. In most instances, the contributing organization is also our collaborating organization.

Africa. Research activities on the African continent continue to involve host country scientists from at least 12 countries. Estimated resources contributed by host country institutions amounted to nearly $200,000.

News of a new liquid inoculum formulation developed by NifTAL resulted in inquiries and subsequent agreement from scientists in Kenya, Tanzania, Uganda, Rwanda, South Africa, and Zimbabwe to participate in testing of the liquid inoculant under field conditions. NifTAL estimates each of these countries contributed up to an equivalent of $5000 each.

The Institut Economique Rurale (IER) of Mali is the principal collaborating institution in a country identified as an intensive site by principal U.S. scientists involved in the development of NuMaSS. North Carolina State University reports an estimated support equivalent to $100,000 from IER. This represents personnel, facilities, supplies, and administrative support. Senegal, Cape Verde, and Gambia are also involved in SM CRSP activities on NuMaSS in a related research project supported by the USAID Africa Bureau. This project is an inter-CRSP activity managed by the IPM CRSP at Virginia Tech University and implemented by the University of Hawaii.

Other reported resources committed by host country institutions and organizations include the personal time of representatives from these three countries along with another from Zambia to participate in an international meeting held in the Philippines in September 1999 on NuMaSS applications and testing. In addition to these representatives, the USAID mission in Addis Ababa, Ethiopia supported the participation of four Ethiopian scientists in this same meeting.

Asia. The Philippine Rice Research Institute in Maligaya, Munoz, an intensive site for the NuMaSS project, hosted an international meeting in September 1999. The logistical and personnel support provided by PhilRice for the meetings as well as research support during the project year was equivalent to an estimated $80,000. Much of these costs are related to scientists' time, logistics, and administrative support. The Philippine government's contribution and support at the Illagan Experiment Station amounted to an estimated $15,000 to implement, monitor, and maintain field trials to test NuMaSS outputs. Local farmers were also involved, at their own costs, in testing of NuMaSS and participated in having their location included as satellite extensive sites. Farmer contributions were estimated at nearly $10,000 which reflects their time, logistical inputs, and use of their field.

NifTAL reported similar testing of their liquid inoculants by scientists from the Philippines, Thailand, and Vietnam at an estimated equivalent cost of $20,000. In South Asia, NifTAL reported similar efforts in both Bangladesh and Sri Lanka at an equivalent cost of $10,000. The U.S. government imposed economic sanctions on India and advised the ME that no USAID funds could be expended there. The sanctions did not prevent the collaboration of Indian scientists. An estimated amount of $45,000 was provided by nine collaborators. Six are private enterprises, two from university researchers, and one government agency.

Cornell University reported continuing support of scientists and government agencies in both Bangladesh and Nepal. Between the Bangladesh Agricultural Research Council (BARC) and the Bangladesh Rice Research Institute (BRRI), Cornell reported an estimated equivalent of $17,000 were expended by both in terms of the involvement of nine scientists plus use of laboratory facilities and support personnel to carry out their work plans. In Nepal, they reported an estimated equivalent of $10,000 of support was received. The figure represented the participation of eight scientists and use of local research facilities. The USAID mission in Dhaka provided $1 million to Cornell to support food systems research over PY2 and PY3. Nutrition scientists from Cornell joined in this effort.

Latin America. Costa Rica is one of three intensive global sites for NuMaSS development and testing. Scientists from the University of Costa Rica continue to provide leadership in testing NuMaSS with a tree crop—peach palm. North Carolina State University reported an estimated equivalent of nearly $125,000 of technical, logistical and administrative support from all collaborators in Costa Rica. Similar limited research activities with peach palm are being carried out in an extensive site in Manaus, Brazil. Value of their technical and logistical support from INPA and EMBRAPA was estimated at $8000. Scientists associated with NuMaSS were invited to Bolivia to describe their program and its potential to local scientists. A total of $5800 was provided for their travel and logistical costs by their Bolivian hosts, CONCADE.

The Steeplands project of Texas A&M reported leveraging an estimated $82,000 in Haiti, $35,000 in Nicaragua, and $40,000 in Honduras in carrying out research activities of their work plans. NifTAL reported an estimated equivalent of $15,000 in support of product testing in Nicaragua, Honduras, and Uruguay. The Tradeoff project of Montana State reported the collaboration of local governments and national institutions from both Peru and Ecuador. The collaboration involved close working relationship among local scientists and local government policy makers, CIP, IFDC, and Montana State scientists in the development, application, and testing of the tradeoff model. The estimated value of this collaboration was in excess of $100,000.

Other. Scientists from participating U.S. SM CRSP institutions continue to receive unparalleled support from a number of other CRSP programs, CGIAR centers, USAID missions, and other (third country) national organizations and institutions.

The Steeplands project received logistical and technical support from both the INTSORMIL and Pond Dynamics CRSP in Honduras. CIMMYT continues to provide technical personnel, logistical and administrative support to Cornell in Bangladesh. IRRI provides similar support to the NuMaSS project in the Philippines. In addition, IRRI’s regional network provides a natural scientific link to national programs in Thailand, Laos, and Vietnam. CIP and IFDC provide technical leadership for research activities at research sites in both Peru and Ecuador.

The SM CRSP continues to receive logistical support from the USAID mission in the Honduras, Nicaragua, Haiti, Bangladesh, and the Philippines. Additional support in the extension of technology for adoption by user groups in both developing and developed countries were received from the Wageningen Agricultural University (The Netherlands), the University of Surrey (Untied Kingdom), and the Academy of Sciences (PRC).

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INTERNET

Information dissemination through the world wide web (WWW) is accessible through the SM CRSP web site at the following URL: http://agrss.sherman.hawaii.edu/sm-crsp. Linkages to each of the SM CRSP projects are available through "hot links" to each respective project site.

ACRONYMS

AB-DLO	Research Institute for Agrobiology and Soil Fertility, the Netherlands
ADEFOR	Association Civil para la Investigacion y Desarrollo Forestal
ADSS	Acidity Decision Support System
AFS	Agricultural and Food Security Office, USAID
ARS	Agricultural Research Service
ATI	Appropriate Technology International
BARI	Bangladesh Agriculture Research Institute
BINA	Bangladesh Institute for Nuclear Agriculture
BNF	Biological Nitrogen Fixation
BOD	Board of Directors
BRAC	Bangladesh Rural Advancement Committee
BRRI	Bangladesh Rice Research Institute
CARE	Cooperative for American Relief Everywhere
CGIAR	Consultative Group for International Agricultural Research
CIAT	Centro Internacional de Agricultura Tropical
CIDA	Canadian International Development Agency
CID	Consortium for International Development
CIMMYT	International Center for Maize and Wheat
CIP	International Potato Center
CONCADE	Counter-Narcotics Consolidation of Alternative Development Efforts
CONDESAN	Consortium for the Sustainable Development of the Andean Ecoregion
CRDA	Center for Agricultural Research and Documentation, Haiti
CREES	Cooperative State Research, Education, and Extension Service
CSR	Center for Social Research
CU	Cornell University
DEMASA	Derivados de Maíz Alimenticio
DME	direct microscopic enumeration
DSS	Decision Support System
EAP	Pan American School of Agriculture, Honduras
EIA	enzyme immuno assay
EEP	External Evaluation Panel
EGAD	Economic Growth and Agricultural Development
EMBRAPA	Empresa Brasilerira de Pesquisa Agropecuaria Vinculada Ao Ministerio de Agricultura
EGAD	Economic Growth and Agricultural Development
EPA	Environmental Protection Agency, U.S.
ESPOCH	Escuela Politenica de Chimborazo, Ecuador
FAO	Food and Agriculture Organization
FHH	Female Head of Household
GCTE	Global Change in Terrestrial Ecosystems
GSFC	Gujarat State Fertilizer and Chemical Ltd.
GIS	Geographic Information System
IAAS	Institute for Agriculture and Animal Science
IARC	International Agricultural Research Centers

IBSRAM	International Board for Soils Research and Management
ICAR	Indian Council of Agricultural Research
ICRAF	International Center for Research in Agro-Forestry
ICRISAT	International Center for Research in the Semi-Arid Tropics
IDB	Inter-American Development Bank
IDRC	International Development Research Council, Canada
IER	L'Institut d'Economie Rurale
IFDC	International Fertilizer Developmental Center
IF	Improved Fallow
IGP	Indo-Gangetic Plains
IFPRI	International Food Policy Research Institute, United States
IITA	International Institute of Tropical Agriculture
ILRI	International Livestock Research Institute
INIA	National Institute for Agricultural Research, Peru
INIAP	National Institute for Agricultural and Livestock Research, Ecuador
INPA	Instituto Nacional de Pesquisas de Amazônia
IntDSS	Integrated nutrient management Decision Support System
INTSORMIL	International Sorghum and Millet Collaborative Research Support Program
IPM	Integrated Pest Management
IRRI	International Rice Research Institute
ISNAR	International Service for National Agricultural Research
ISRA	L'Institut Senegalais de Recherche Agricole
LDC	Lesser Developed Country
LUPE	Land Use Productivity Enhancement Project, Honduras
MAFEP	Malawi Agroforestry Extension Project
MAHYCO	Mahrashtra Hybred Seed Co.
MARNDR	Ministry and Agriculture, Natural Resources and Rural Development, Haiti
MCC	Mennonite Central Committee
ME	Management Entity
MERC	Middle East Research Cooperation
MHH	Male Head of Household
MSU	Montana State University
NARC	Nepal Agriculture Research Council
NARES	National Agricultural Research and Extension Systems
NARS	National Agricultural Research Systems
NCSU	North Carolina State University
NDSS	Nitrogen Decision Support System
NERC	North East Regional Center
NGO	Non-Governmental Organizations
NifTAL	Nitrogen Fixation of Tropical Agricultural Legumes
NuMaSS	Nutrient Management Support System
OMB	Office of Management Budget
PADF	Pan American Development Foundation
PARC	Pakistan Agricultural Research Council
PATH	Programme for Appropriate Technology in Health (Canada)
PAU	Punjab Agricultural University, Ludihana, India

PCCMCA	Programa Centroamericano para el Mejoramiento de Cultivos Alimenticos
PDSS	Phosphorus Decision Support System
PES nets	Productivity-Enhancing Safety nets
PhilRice	Philippine Rice Research Institute
PI	Principal Investigator
PVO	Private Voluntary Organization
PY	Project Year
RCUH	Research Corporation of the University of Hawaii
RWC	Rice Wheat Consortium
SADP	Smallholder Agribusiness Development Program
SARPV	Social Assistance and Rehabilitation for the Physically Vulnerable
SECID	South-East Consortium for International Development
SM CRSP	Soil Management Collaborative Support Program
SUBSTOR	Subterranean storage crop model
TAMU	Texas A&M University
TC	Technical Committee
TNAU	Tamil Nadu Agricultural University
UFl	University of Florida
UNA	National Agriculture University, Nicaragua
UNC	Universidad Nacional de Cajmarca
UNICEF	United Nations International Children's Emergency Fund
URL	Universal Resource Locator
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WAU	Wageningen Agricultural University