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Why STAR?

N. C. Brady, Senior Assistant Administrator for Science and Technology, A.I.D.

In these days of shrinking research dollars, administrators and scientists must be prepared to address more directly than ever the question: so what? What is the project accomplishing? What were the research findings? How were they applied? What difference did they make?

The U.S. Agency for International Development (A.I.D.) supports research and development activities around the world. In A.I.D.'s Bureau for Science and Technology, the Office of Agriculture (S&T/AGR) funds agricultural research work worldwide. Much has already been accomplished and many valuable projects are underway. Project reports are written. Seminars and workshops are held. Research results are published in scientific journals. New technologies are adapted for use in specific locales.

Although research findings are disseminated and applied in both international and domestic settings, not everyone reads the scientific articles and technical reports. Many stories of success reach only a small audience.

The Science and Technology Agricultural Reporter (**STAR**) will concisely document and regularly share what's going on with a broad audience. Each quarter, **STAR** will briefly highlight several of the research efforts that S&T/AGR sponsors. In short articles, **STAR** will share research findings, explore applications and discuss accomplishments.

Explaining agricultural research is a difficult task. Research is painstaking and time-consuming. Years of effort may be required before big breakthroughs occur. Yet those of us who have been involved with research know that changes do occur, that research applications are assuring a better livelihood for the rural majority throughout the world.

We can't do all the research that needs to be done or all the research we want to do — but we can acknowledge, share and disseminate our successes and the lessons we learn. Low-cost technology diffusion depends on your collaboration. Let us know how A.I.D.-funded agricultural research is making a difference and **STAR** will help spread the word. ★

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Highlighting the CRSPs

David Bathrick, Director, Office of Agriculture Bureau for Science and Technology, A.I.D.

In the mid-seventies, the Agency for International Development (A.I.D.) established Collaborative Research Support Programs (CRSPs) to link the capabilities of U.S. agricultural universities to the needs of developing nations worldwide.

Current CRSPs include projects devoted to aquaculture, marine stock assessment, beans and cowpeas, peanuts, small ruminants, soil management and sorghum and millet. Also the Office of Nutrition manages a nutrition CRSP. Each CRSP addresses priority constraints to food production, distribution and consumption in developing nations.

Finding solutions to these problems takes time, patience and money. Initial A.I.D. grants to CRSPs are for a five-year period, with extensions possible. U.S. universities, host country institutions, and A.I.D. missions also contribute financially to CRSPs (in finances or in kind). Several CRSPs have been extended to allow promising research to continue.

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Collaborative Research Support Programs

Each CRSP is a true research partnership. Multidisciplinary teams with personnel from a number of U.S. universities, international agricultural research centers, and developing country institutions work on multisectoral, biological, physical, social and economic problems. They consult with farmers to gain practical insights and ensure that research responds to on-farm needs. International Agricultural Research Centers (IARCs) assist several CRSPs by sharing germplasm and research technology and by participating in relevant cooperative activities.

Each CRSP is also a training partnership, with particular advantages to both U.S. and developing country partners. Training takes many forms, degree and non-degree, formal and informal, in-the-classroom and on-the-job. Host country scientists and students study and work with U.S. professors who are conducting research in the participants' own country. U.S. faculty and students have the opportunity to focus their research on agricultural constraints in developing countries and strengthen their capabilities in research and development.

Over time, the CRSP research and training partnerships are finding significant solutions to agricultural problems and contributing to the strengthening of agricultural institutions in both the U.S. and developing countries. CRSPs are also building extensive networks of some of the world's leading scientists who are highly motivated to continue addressing pressing problems in agricultural research.

This issue of **STAR** highlights some of the many important research developments observed under the CRSP program. In subsequent issues, other research accomplishments sponsored by A.I.D.'s Office of Agriculture will be highlighted. ★

Increasing Bean Yields Through Biological Nitrogen Fixation Research

Russell Freed, Michigan State University

Beans are an important source of protein for low-income families. Many farmers in developing countries grow beans, but their yields are often low, because soils have been cropped intensively and contain insufficient nitrogen. Nitrogen fertilizers would increase yields, but they are extremely expensive for farmers to buy. The Bean/Cowpea Collaborative Research Support Program (CRSP) is addressing the problem of low bean yields with funds provided by the Agency for International Development (A.I.D.).

University of Wisconsin researchers working under the Bean/Cowpea CRSP, have collaborated with the national program in Brazil (EMBRAPA) to develop dry bean lines that fix 80 kilograms of nitrogen per hectare. Researchers also cooperated with the Escuela Agricola Pan America in Honduras, under an A.I.D./Cooperative State Research Service grant. "We found a way to increase bean yields without increasing production costs," says Dr. Fred Bliss, leader of the project.

"We found a way to increase bean yields without increasing production costs."

Dr. Bliss has also worked with Dr. Frank Dazzo of Michigan State University to identify improved strains of rhizobia that fix nitrogen from the atmosphere. The combination of superior cultivars and improved strains of rhizobia increases yields 50-70 percent.

Enhancing the capability for beans to fix nitrogen for themselves is an attractive alternative to fertilizer use. In order to obtain a relatively high bean seed yield of 2000 kilograms per hectare, the bean plant and the mature seed must take up and accumulate approximately 100 kilograms per hectare. Nitrogen-poor soils supply less than half this amount and, under most field conditions, less than 50 percent of nitrogen available from applied fertilizer is taken up by the plant. Using improved cultivars with improved strains of rhizobia makes it possible for farmers to provide nitrogen supply at very little expense.

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Principal Investigator Dr. Pedro Pereira of the National Research Center for Rice & Beans (CNPAF/EMBRAPA), inspects a new experimental line of black beans growing in Brazil.

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Researchers have conducted regional and local trials on elite bean lines, testing for superior fixation potential and other desirable traits. Several black bean breeding lines have performed well and will soon be released jointly by EMBRAPA (Brazil) and the University of Wisconsin, Madison. Seed with enhanced capability for nitrogen fixation is being made available as new cultivars or for use in breeding programs in the U.S., International Agricultural Research Centers (IARCs) and national agricultural research programs.

The research continues. Dr. Dazzo has expanded the field sites for evaluation of rhizobia and is exploring their other contributions beyond nitrogen fixation. Other studies are assessing nitrogen nutrition as a limiting factor on farmers' fields, examining the ability of local cultivars to support nitrogen fixation and studying the efficiency of native rhizobia in the soils. Research is emphasizing improvement of the host plant because many local cultivars have low ability to fix nitrogen. Genetic improvement is central to increasing the potential of the whole system. ★

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Sorghum, a Promising Substitute for Maize

Fred Miller, Texas A&M University

In Mexico, tortillas have always been made with maize — but in the future, they may be made with sorghum. Why? Because Mexico simply cannot grow enough maize to feed its growing population and sorghum can also be used in tortillas.

Through the Sorghum and Millet Collaborative Research Support Program (CRSP), scientists at the University of Sornora in Mexico and Texas A&M University have identified sorghum germplasm that produces high quality tortillas. The sorghum may also be used in soups, cookies and beer. The research has broad application in Latin America and the Caribbean.

Hundreds of thousands of hectares of arid lands in the region are unsuitable for maize production but suitable for sorghum. Although sorghum yields are currently low, scientists are working to increase yields. Researchers in Honduras and the United States have collaborated to develop a new hybrid that is tolerant to drought and resistant to diseases and insects. Drought, disease and insects often cause changes in grain quality, making sorghum undesirable for food use. The new hybrid also gives superior yields of food quality sorghum when compared with traditional varieties.

The CRSP's research agenda extends beyond plant breeding and beyond the Americas. In fact, research on food quality sorghum is only one small part of the CRSP's extensive research agenda. More than 80 scientists from eight U.S. Universities are collaborating with scientists in developing countries on various problems of sorghum and millet production. Major developing countries include: Niger, Sudan, Botswana, Honduras and India.

The CRSP also gives financial support to the Sorghum Newsletter in order to facilitate sharing of information among the many participants. By linking institutions and scientists with common interests, the Sorghum and Millet CRSP is advancing research on two food crops of major importance to the most marginal agricultural areas of the world. ★

Dr. Santiago Bedello (trained at Texas A&M University in Cereal Technology/Quality) discusses the sorghum kernel response to dry milling. Dr. Lloyd Rooney (Texas A&M Cereal Quality Scientist) looks on from end of table.

Dr. Fred Miller, Texas A&M University Sorghum Breeder, interacts with agronomist and breeders at Celaya Research Center for sorghum in Baja, Mexico. A good example of international research collaboration is this transfer of methodologies and germplasm.

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TropSoils Researchers Bring Out The Social Side of Soil Science

Neil Caudle, North Carolina State University

By blending the nitty gritty of soil science with the people perspective of the social sciences, researchers are finding ways to tailor new agricultural technologies to farmers in developing countries.

Dr. Carol Colfer, an anthropologist, worked with re-settled farmers in West Sumatra, Indonesia, under the University of Hawaii part of the A.I.D.-funded Soil Management (TropSoils) CRSP. She studied how different ethnic groups view important concepts such as soil, rice, water, and fertilizer. Her findings show that ethnic and cultural factors are important to the design and adaptation of new soil-management technologies. For example, all settlers liked legumes, but different ethnic groups had different preferences. With knowledge of a farmer's ethnic group, extension personnel could make appropriate recommendations on the use of legumes for soil improvement.

Colfer and her colleagues, who lived and worked with re-settled-farmers periodically for several years, also studied diet and income, the seasonal variation of domestic and agricultural activities, preferences for crops, information exchange, and the division of labor between sexes. They found that women's roles are very important, especially in home gardens, and that farmers (male and female) can contribute good ideas and new information to the research program. For example, farmers in her study could identify dozens of local weeds.

Social science research is an integral part of the TropSoils research program to develop soil management technology and adapt it to user groups. U.S. researchers collaborate with personnel in selected developing countries to select topics, plan and conduct research and interpret the data.

Several suggestions from farmers about crops, soil and planting have been incorporated into research plans. "Agricultural scientists can benefit by recognizing the social factors in farming systems," notes Dr. Colfer. "It may well be that the farmers' longer experience in that environment has taught them things that scientists can use and build on." ★

←Indonesian farmers exhibit ethnic and cultural differences in how they view important concepts such as soil, water, fertilizer, rice and legumes. Suggestions from farmers about crops, soil and planting have been incorporated into research plans.

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Women are very important in Indonesian farming, especially in home gardens but also in the field, as illustrated by this young Indonesian farmer. Both male and female farmers can contribute good ideas and new information to research programs.

Improving Peanuts Around the World

David Cummins, University of Georgia

When Southerners in the U.S. reach for a snack, they often make the same choice that people in Thailand make: boiled peanut. A few years ago, U.S. and Thai scientists discovered this common taste and began working together to develop a new cultivar of peanut that was especially suitable for boiling. Their efforts resulted in improved cultivars in both countries — varieties that are now enjoyed in homes throughout the southern United States and Thailand.

These new cultivars are among the accomplishments of the Peanut Collaborative Research Support Program (CRSP). Through collaborative research among U.S. and developing country universities, the Peanut CRSP is relieving constraints to the production and utilization of peanut. The Peanut CRSP receives primary funding from the Agency for International Development(A.I.D.).

Since peanut is 25 percent protein, it has important nutritional value. Around the world, peanut is eaten raw, boiled, roasted, used in soups and stews and made into peanut butter. When peanut oil is extracted for cooking, the remaining oilcake is used for animal feed. Peanut plant stems and tops are excellent forage.

Peanut is also an important source of cash income. In Southeast Asia, for example, rice is the primary cash crop, but farmers also grow peanut, because peanut can be harvested and sold to generate cash in between rice harvests. Peanut uses residual soil moisture, improves soil fertility, and can be an important component of a sustainable agricultural system.

Philippine peanut breeder Ed Redona, a CRSP collaborator, explains superior characteristics of a newly-released cultivar to Drs. Ken Garren and Max Milner, External Evaluation Panel members. The new cultivar is now in a farm pilot program for farmer observation and seed increase.

The Peanut CRSP works in three regions: Southeast Asia, Semi-arid tropical Africa and the Caribbean. In each region, the common emphasis has been breeding and selection. Scientists have been searching for high-yielding cultivars that are tolerant to pests and drought. New cultivars must be suitable for use by small farmers in developing countries, but the program also benefits U.S. farmers through the feedback of superior germplasm. To date, plant breeding efforts have resulted in the release of seven superior cultivars — one in the Philippines, one in Jamaica, two in Thailand, and three in the United States.

Through the Peanut CRSP, countries with common problems are communicating as they had never done before. Research teams at North Carolina State University cooperate with researchers at the University of the Philippines and at two universities in Thailand — Khon Kaen and Kasetsart. Texas A&M University cooperates with research institutes in Senegal, Burkina Faso, Niger and Mali, working especially on drought tolerance, a problem that affects peanut production in both Texas and the Sahel. University of Georgia scientists are cooperating with scientists at the Caribbean Agricultural Research and Development Institute (CARDI) in Antigua, Belize, Jamaica and Trinidad.

The International Crops Research Institute for the Semi-arid Tropics (ICRISAT) has been integrally involved in the Peanut CRSP since the beginning. As the only International Agricultural Research Center with a mandate to research peanut, ICRISAT shares technical advice and germplasm, and provides support for training programs and workshops. ICRISAT and the Peanut CRSP cooperate to publish the *International Arachis Newsletter* to facilitate the dissemination of information throughout the world peanut research network. By sharing research findings and germplasm, the Peanut CRSP fosters cooperation among scientists, reduces duplication of effort and expedites the search for solutions to common problems. ★

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Overfishing Hazard Requires Careful Research

John Rowntree, University of Maryland

For centuries, people in the village of Bolinao in the Philippines took their fishing resources for granted. The catching, processing and marketing of fish provided a livelihood for thousands of villagers. And for everyone, fish provided a relatively cheap source of animal protein.

Within the past ten years, this situation has changed. Fishermen report they are catching half as many fish and the fish they do catch are small. A recent study suggests reasons for the changes. Overfishing has depleted fish stocks and illegal fishing methods (mainly dynamiting) have degraded the ecosystem, essentially killing the coral reefs that support fish populations. Bolinao is in danger of losing its fishing industry. The village is so poor that it has been unable to even repair its existing water system.

Bolinao's situation is replicated in many other fishing villages in the Philippines and around the world. "A real danger," says Gerald Sylvester, Professor at The College of Fisheries of the University of the Philippines, "is that overfishing will deplete fish stocks and they many never come back. Fish resources can be replenished and sustained by careful planning and management, but techniques for obtaining data on multispecies, tropical fisheries are inadequate."

Three years ago, an A.I.D.-funded Collaborative Research Support Program (CRSP), called the Fisheries Stock Assessment CRSP, began to address this problem. Researchers in the U.S. and selected developing countries are now developing techniques and computer models that will enable managers to plan for the rational management of fisheries resources on a sustainable basis. The techniques apply specifically to multispecies, tropical fisheries.

For example, researchers from the University of Washington and the University of Costa Rica have developed methods for determining fish stock abundance and behavior in shallow, muddy-water environments. The new methods depend on hydroacoustics, receiving and recording sound waves indicating the presence of fish. The researchers have also developed new techniques for assessing the age of tropical fish, an important issue in planning for harvest without reducing reproductive capacity. The technique involves examination of the inner ear bony structure (otoliths) with a stereomicroscope and counting annual growth rings.

In the Philippines, the Fisheries Stock Assessment CRSP is cooperating with a coastal resources management project, an A.I.D. project with ASEAN (Association of South-East Asian Nations), to develop practical ways to apply research findings and reduce overfishing.

Research and management activities to restore and sustain the world's fisheries are important for both economic growth and human health. Developing nations catch about half of the world's fish and provide almost half of the world's fish exports. Fish are a valuable source of protein; over half of the people in developing countries obtain 40 percent or more of their animal protein from fish.

As world population expands, the demand for fish products will certainly increase. Already, the world produces more fish than beef and poultry together. Valuable fish resources must be maintained. The Fisheries Stock Assessment CRSP aims to help Bolinao and other Third World villages make changes before it's too late. ★

Dr. John Rowntree (right, seated) interviews fisherman (left, standing) on Gulf of Nicoya, Costa Rica. Rowntree is the CRSP Management Entity Director.

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STAR responds to a demand for regular communications between A.I.D.'s Office of Agriculture and a worldwide audience. It provides current information on collaborative research programs sponsored by A.I.D. S&T/AGR. **STAR's** objective is to increase professional collaboration, avoid duplication of professional effort, and facilitate the transfer of agricultural technology.

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The Sorghum Revolution in Honduras

by Daniel H. Meckenstock, Department of Soil & Crop Sciences, Texas A&M University.
(Pan-American Agricultural School, El Zamorano, Honduras)

Hybrids of maicillos criollos promise to revolutionize sorghum production in Central America. They are expected to provide a low-cost alternative for increasing yield on roughly 235,000 hectares. Cost to the farmer? Based on intercropping, seed could be obtained at the equivalent of one or two chickens per hectare, about one-third the cost of a bag of fertilizer!

Maicillos criollos — a colloquialism for landrace sorghum cultivars in Central America — grow ten to fifteen feet tall, are late maturing, and have low but dependable yield. Yield enhancement of native maicillos began in 1981 when the Honduran Ministry of Natural Resources convened a collaborative research program with the International Sorghum and Millet Program (INTSORMIL), a USAID Title XII CRSP (Cooperative Research Support Program). The Pan-American School of Agriculture (EAD) joined this effort in 1985.

Sorghum yields in Honduras are less that 1.0 t/ha — the lowest in the region. This is not surprising considering that more than ninety percent of its 62,000 hectares planted annually to sorghum are maicillos intercropped with maize on marginal land, maturing after the maize crop. Subsistence farmers prefer maicillos because they are uniquely adapted to maize intercropping and the grain can be substituted for maize to make tortillas.

Hybrid maicillos offer the exciting prospect of overcoming the low yield plateau which has maintained a strangle hold on resource-poor farmers. Unlike other new technology which tends to be dominated by affluent farmers, hybrid maicillos are targeted for the poor farmer.

Improved maicillos are derived from the wide crosses between maicillos criollos collected throughout Honduras, Guatemala, and El Salvador

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Sorghum Breeder, Dr. Dan Mackenstock from Texas A&M points to a field of experimental improved maicillos crillos sorghum at EAP/INTSORMIL breeding nursery, El Zamorano, Honduras.

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and elite germplasm introduced from the INTSORMIL program at Texas A&M University and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). The elite materials contribute genes for reduced plant height, improved disease resistance, and increased yield potential. The new maicillos are called maicillos majorados (improved indigenous varieties) or maicillos enanos (dwarf indigenous varieties) to denote their transformation. Shorter maicillos with resistance to common diseases produce more grain and perform more consistently across environments.

Improved maicillos yield 24% to 58% more than their maicillo ancestors at low levels of nitrogen application. Hybrid maicillos are expected to perform even better. When intercropped, one advantage of their short stature is that this characteristic permits higher maize yields, presumably because of less interference by the hybrid sorghum. Since maize is preferred, this indeed is a significant gain.

Although hybrid sorghums have been used since 1957, this is the first time that maicillo germplasm has been used as parental lines in hybrid combinations. Short combine height lines are used to produce hybrid seed that can be mechanically harvested. The hybrid plants are taller because of complementary height genes and can be used in the traditional maize-sorghum intercropping system.

Farmers can expect to see commercial hybrid maicillos within two to three years. Multi-location testing of experimental hybrids will begin in 1989 and on-farm trials will follow in 1990. ★

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From Famine to Surplus: Cowpea Research in Senegal

By Russell Freed, Michigan State University

Supplies of food in Senegal are traditionally low during August and September, just prior to cereal harvest. This year they were expected to be lower due to the poor millet crop. In the past droughts have caused most of the people to eat their food reserves. However, today farmers have a marketing and storage problem — how to deal with a surplus of cowpeas!

The Bean/Cowpea CRSP is developing strategies and technologies to deal with the serious drought prevalent throughout the Sahel region. Cowpeas, especially adapted to these conditions, can play a very important role in the food strategies of many countries. Subsistence and low-input farmers can very easily adopt the production practices of this legume crop into their farming systems. Cowpeas are a short-duration (60-day) crop; more drought-tolerant than peanut or millet; and high in protein.

Entomologist Dogo Seck of ISRA (front, kneeling), (Institut Senegalais de Recherches Agricoles), and ISRA agronomist Samba Thiaw (rear, kneeling), and two farmers (standing), observe an on-farm cowpea trial.

In 1985 the Senegalese farmers did not have an adequate supply of peanut, millet, or cowpea seeds to plant their fields. The government of Senegal decided that cowpeas would be a better crop to plant for several reasons. However, sufficient seed of local cowpea varieties was not available. Dr. Tony Hall, plant physiologist/breeder at the University of California at Riverside, has worked with Senegalese cowpea researchers since 1976. He and his colleagues identified an early California cowpea variety that yields well in Northern Senegal.

"In the past, droughts have caused most of the people to eat their food reserves. However, today farmers have a marketing and storage problem — how to deal with a surplus of cowpeas!"

The introduction of the new variety, along with improved production practices, increased cowpea production from 16,000 tons in 1984 to 66,000 tons in 1985 even though the rainy season was short. With funds from USAID and the EEC, 700 tons of CB5 were shipped from California to Senegal. A major project distributed seed to farmers and advised them of the appropriate agronomic practices. This project provided approximately 100,000 farmers with seed to plant.

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Introducing seed of an exotic variety was appropriate given the impending famine, severe shortage of local seed, and research which indicated that the exotic variety could be successfully grown. By 1988, most of the cowpea area in Senegal was planted to improved local varieties with a modest area devoted to the early variety from California which provides food during the traditional hunger period.

For the future, the most effective approach is to develop improved local varieties. In 1985, the CRSP project initiated a major on-farm research project evaluating improved local varieties and multiplying seed. Dr. Hall and his colleagues are developing varieties of cowpea that have heat and drought tolerance. They are using several techniques in breeding including early flowering with delayed leaf and bud-senescence, improved water-use efficiency, and long roots that get moisture as deep as five feet .

"The most important outcome has been that drought-stricken farmers in the north were able to obtain food from the early cowpea during August and September, the period of predicted famine. Even so, much more practical work needs to be done on heat tolerance, especially if temperatures increase in the future as has been projected by some studies," said Dr. Hall. ★

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Sharing Small Ruminant Knowledge in Andean Highlands

by Dr. James Oxley, University of California at Davis

"Walking bank accounts" could be a name for an estimated 2,500,000 alpacas, 14,500,000 sheep, 800,000 llamas, and 1,750,000 goats owned by Peruvians. These animals are also important to the economies of Bolivia, Ecuador, and Chili, while sheep and goats are significant to the well-being of Venezuela and Colombia.

Such small ruminants are the backbone of the highland agricultural system and are vital to its sustainability. They provide farmers in the Andean highlands with meat, milk, fiber, fertilizer and hides. Alpacas and llamas are primarily used for their fiber and as a means of transportation. They have the ability to survive on non-competitive feed resources that have few alternative uses. These animals can then become a source of high-quality protein especially in the diets of Peruvians.

An interdisciplinary program was initiated in 1979 with A.I.D. funding, under the Small Ruminant Collaborative Research Support Program (SR-CRSP), matched by resources from several U.S. universities. Why Peru? Peru was interested in collaborating in a research effort aimed at improving the productivity of sheep and alpaca in the highlands. Peru is representative ativeativeativeof the Central Andean agriculture and a country from which research results could be applied to other countries in the region.

Studies have shown that llamas and sheep complement each others' grazing habits, while alpacas tend to compete directly with them under certain range conditions. Animal health research is focused on the following concerns: chronic respiratory diseases in sheep; contagious lung tumor (ovine pulmonary carcinoma), which is responsible for severe losses; a viral disease in goats known as caprine arthritis encephalitis; and a bacterial disease called clostridium perfringens Type A (CPA), which causes neo-natal mortality in alpacas. The SR-CRSP scientists can now identify these diseases and are working towards developing tests for carrier animals, with the ultimate goal of

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In the Andean highlands of Peru, alpacas and llamas are often produced along with sheep and cattle, with the former gaining importance as the altitutde increases. Alpaca are kept primarily because of the value of their fiber. White and light-fawn colors often fetch higher prices at the international markets.

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developing vaccines where appropriate.

Of the approximately 85 Peruvians trained in the U.S. and Peru under the SR-CRSP many are now collaborating scientists and continue to conduct interdisciplinary research in the animal and social sciences.

Peruvian scientists and their U.S. counterparts are developing "technological packages (teck-packs)" that summarize the research results. They also publish recommendations in Spanish for implementation by extension agencies and educational institutions. The ultimate beneficiaries of the "tech packs" are farmers and pastoralists who have limited resources with which to deal with their production programs.

Peruvian animal scientists recently shared their discoveries at a series of seminars in Lima and Arequipa, Peru with over 150 attendees (approximately 100 in Lima, and 50 at Arequipa). Another 150 attended sessions in La Paz, Bolivia. The seminar in Bolivia was the first time an SR-CRSP international symposium extended knowledge gained in Peru to another country with similar conditions, limitations, and production problems.

Most of the attendees were sheep and goat producers. Peruvian and Bolivian agricultural organizations and the SR-CRSP sponsored the meetings. The speakers covered a wide range of topics including nutrition, breeding, and reproduction in sheep and alpaca; range management and improved forages; diseases and health management; and social socio-economic aspects of production.

The Peruvian outreach program is a model for other countries where small ruminant scientists work. Currently, research programs are also located in Morocco, Kenya and Indonesia. Eventually, a network of small ruminant scientists will be linked together around the world. ★

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Soils Network Open to Latin American Researchers

By Neil Caudle, North Carolina State University

A new network of collaborative research has taken root at ten sites in seven Latin American countries. Its purpose — to improve the management of tropical soils.

The network, RISTROP (Red de Investigation en Suelos Tropicales), links 28 scientists from Bolivia, Brazil, Costa Rica, Guatemala, Honduras, Panama, and Peru. It connects projects in such areas as low-input cropping, agroforestry, mechanized continuous cropping, improved grass-legume pastures, and paddy rice.

RISTROP grew out of a 21-day workshop conducted in Yurimaguas, Peru by TropSoils (the Soil Management Collaborative Research Support

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Researchers from the Guatemalan Institute of Agricultural Science and Technology (ICTA) and the University of San Carlos are shown characterizing the soil at the RISTROP experiment site in the Isabal Province of Guatamala. Next step will be a low-input continuous cropping experiment. Mario Breauner (left), Head of Soils & Plant Analysis Laboratore at ICTA is in charge of the collaborators.

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Program). The workshop drew 31 participants from 15 national institutions in ten countries. Participants in the workshop planned a series of related experiments, the results of which will be useful throughout Latin America.

Jot Symth of N.C. State University (NCSU), a TropSoils' principal investigator in the networking project, says the network's main goal is to spread new soil-management technologies beyond the primary TropSoils research site at Yurimaguas, Peru. In turn, he says, feedback from the network helps TropSoils refine its research programs to be more useful to the national research institutions.

"We felt it was time to share what we'd learned at Yurimaguas, so that researchers in other countries would have a chance to validate our results at the local level," Symth says.

An example is low-input cropping, which has created great interest across Latin American since techniques were developed at Yurimaguas. Network research in Brazil, Bolivia, Costa Rica, Guatemala and Peru is aimed at adapting soil management techniques that maintain crop productivity with minimal inputs.

With funding from A.I.D., TropSoils coordinates network activities, promotes the flow of information among participating institutions, and provides technical backstopping. This backstopping has included, for example, visits by TropSoils staff to help the collaborators select research sites and adjust experimental methods to local conditions. In addition, soil samples taken at each site have been sent to NCSU for detailed characterization, providing for a better correlation of research results among the studies. Each participant in the network finds research support locally.

The network is serving as a means for distributing germplasm that has been screened by TropSoils for use on acid soils. Rice and peanut cultivars, selected in Yurimaguas for tolerance to aluminum and acid soils, are now being used by collaborators in Bolivia, Brazil, and Panama. Mucuna is a legume green manure identified by Cornell University as an outstanding nitrogen fixer with high drought tolerance. It was tested at a TropSoils site near Brasilia and is now being evaluated by collaborators in five countries, namely Brazil, Costa Rica, Guatemala, Panama, and Peru.

African soil scientists may benefit eventually from the type of information in the RISTROP network and database, as a result of their attendance at the RISTROP workshop in Yurimaguas, Peru. The commonality in soil resources and soil constraints between the humid and subhumid tropics of Africa and South America is becoming well established.

Smyth points out that participation in RISTROP is not limited to scientists who attended the inaugural workshop. The network is open to any Latin American national research institution interested in evaluating management technologies, for acid, humid tropical soils. ★

For more information, or a free copy of** ristrop bulletin, **write:

RISTROP
Tropical Soils Research Program
Box 7619
Raleigh, NC 27695-7619

Peanut Research Networking Stretches Funds

By David G. Cummins, North Carolina State University

Stretching limited funds has become a common concern among agricultural researchers. Networking, collaborating, and cooperating among institutions help to attain the common goal of making scarce funds go farther. The Peanut CRSP and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) represent a keen example.

Peanut CRSP and ICRISAT cooperation became a reality when the ICRISAT Groundnut Program Leader, Dr. Ron Gibbons, joined the Peanut CRSP planning grant advisory panel in 1982. As a member of the CRSP Board of Directors since that time, Ron has been instrumental in helping the Peanut CRSP to strengthen its global focus. A Peanut CRSP/ICRISAT agreement signed in 1984 now facilitates formal cooperation.

In 1986, ICRISAT developed a Sahelian Center (ISC) in Niger to address specifically the agroclimatic issues of West Africa. By joining forces with ICRISAT, the Peanut CRSP has with little additional cost — extended its outreach beyond Senegal, Burkina Faso, Niger and Nigeria. In a very cost effective regional approach, a test program together with short-term training of scientists and technicians have been extended to a total of 12 countries in West Africa. Benin, Cameroon, Togo, Ghana, Guinea Bissau, the Gambia, Mali, and Chad have been drawn into the Peanut CRSP/ICRISAT research network. This would not have been possible with existing Peanut CRSP funding without ICRISAT collaboration.

The arrangement benefits ICRISAT, as well. In addition to providing its own technology, the Peanut CRSP serves as a conduit for ICRISAT technology to host-country programs. An example of direct help is the Peanut CRSP comprehensive entomology program in Burkina Faso, which enhances the work of an ICRISAT entomologist. Joint efforts

continued on page 6

West African peanut research network participants on tour of ICRISAT/INRAN research station in Niger, 1988. Representatives from 12 West African countries and seven international groups, including U.S. Peanut CRSP and host country scientists, were represented.

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are also hastening progress towards the release of peanut cultivars with substantial tolerance to aflatoxin, a worldwide problem.

In short, Peanut CRSP and ICRISAT networking stretches available funds which increase the forward momentum of research and dissemination. This very cost-effective collaboration has also: (1) Held workshops and seminars, such as the West Africa Groundnut Research Workshop first held in Niamey at the ISC in 1988 with about 60 participants from12 West African countries; (2) Trained five Peanut CRSP host-country researchers in research techniques at ICRISAT; (3) Implemented West Africa Germplasm Testing Network with superior lines/cultivars from ICRISAT, the Peanut CRSP and host-country programs; (4) Cooperatively published the *International Arachis Newsletter* at ICRISAT-India with partial funding from the CRSP. It continues to communicate research results to scientists and administrators worldwide.

Is this peanut research network limited to Africa? Far from it. In Canada, the Peanut CRSP and the International Development Research Centre (IDRC) have cooperatively supported research in Thailand since the inception of the CRSP. In Australia, the Centre for International Agricultural Research (ACIAR) and the CRSP have jointly planned and supported the implementation of research on peanut strip virus in Thailand, Philippines, and Indonesia. ICRISAT has also cooperated in this effort. A recent cultivar release was fostered by the Peanut CRSP through the network developed by the Caribbean Agricultural Research and Development Institute. Virus research is facilitated through a network involving the Peanut CRSP, ICRISAT, Nigeria, West Germany and Scotland. Peanut CRSP efforts in West Africa are also coordinated with the French program through the Institute for Oilseeds Research (IRHO).

In summary, networking works. It complements and strengthens collaborative research. The Peanut CRSP, ICRISAT, other donors, host-country, and U.S. university and research institutions all benefit from the application of this money-saving effort. ★

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★ VOLUME 1 NUMBER 4 SUMMER 1989 ★

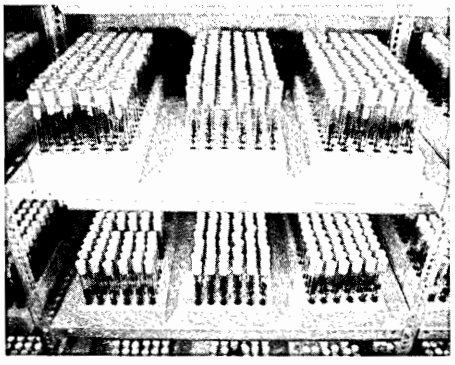
Conserving Potato Germplasm for Future Development

By John H. Dodds, International Potato Center, Lima, Peru

"Genetic erosion" refers to the loss of existing genetic diversity for the improvement of all crop plants, including the important potato crop. Such basic crops may be exposed to numerous biotic and abiotic stresses worldwide. These stresses include the destruction of natural habitats by grazing animals, by pests and diseases, by farming/construction activity, and by such natural disasters as frosts, hail storms, drought, landslides, and flooding.

CIP, the International Potato Center, plays a key role in preserving wild and primitive potato and sweet potato genotypes that contain the gene pools for tomorrow's improved varieties. CIP has joined with 13 other Collaborative Group of International Agricultural Research Centers (CGIAR) to collect, evaluate, and preserve wild and primitive crop genotypes.

Many major crop plants, such as rice, maize and wheat, are propagated routinely by seed. However, several other crops must be propagated asexually. This is because some crops do not regularly produce seeds, and the material has to be maintained clonally by vegetative propagation.



In vitro germplasm storage.

Since the mid-1970's, CIP has built a clonal collection of more than 3,000 potato accessions in the field. Each year, this complete collection is planted, maintained, harvested and tubers stored until the following season. The process poses several recurring problems familiar to producers and others in the agribusiness community: 1) cost of labor and space, 2) risk of infection by bacteria, fungi and viruses, 3) risk of damage by insect pests, 4) risk of damage by hail, frost, wind, and 5) seasonal availability of materials.

To meet some of these maintenance challenges, CIP has developed a methodology for clonally conserving potato germplasm *in vitro*. Our aim is to restrict the amount of labor required to keep the material in good condition. Usually, *in vitro* potato cultures in a standard propagation medium require subculture at least once every two months. However, if regulatory compounds (for example, Mannitol 4%) are added, this subculture period can be extended to 10 months. If the storage temperature is reduced to 60°C, the subculture is needed only once every two or three years.

This plant material must be monitored visually, at least once a month, for the following characteristics:

1. Contamination — any contaminated plantlets must be removed from the growth room and destroyed.

2. Growth rate — analysis is made of the plant development rate under these storage conditions, and predictions are made as to the date on which the material will need to be subcultured.

3. Physiological status — visual analysis is made of the physiological state of the material (for example, some clones begin to turn yellow after several months while others begin to tuberize *in vitro*.).

These observations are compiled in a computer database, together with codes to date introduction, status (propagation, conservation, risk of loss), growth rate, predicted transfer date, and location of duplicate cultures. Such information is a vital part of an integrated *in vitro* germplasm management system with several thousand accessions.

The principal objective of CIP's

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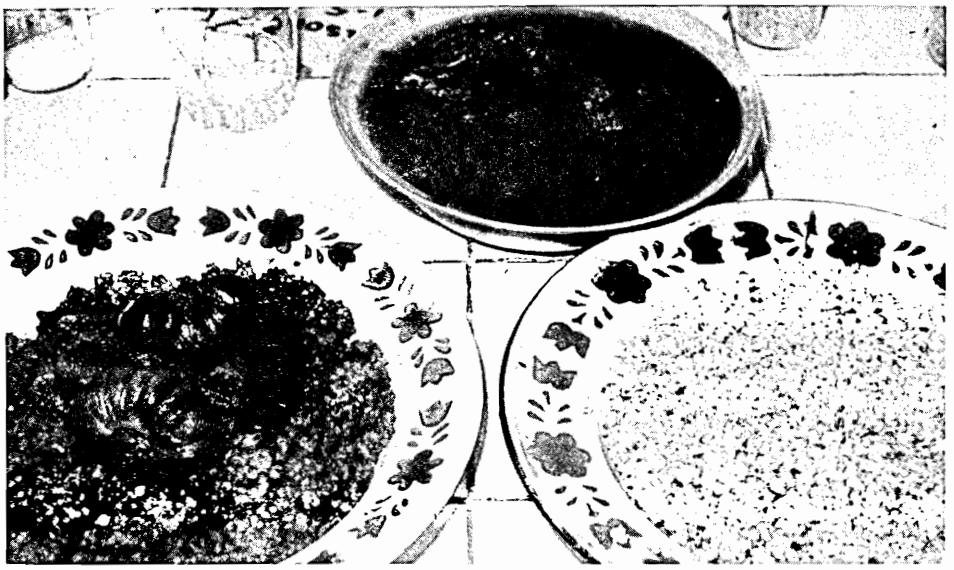
SORI — A New Rice Substitute from Sorghum

Professor Lloyd W. Rooney and Robert Young, Cereal Quality Laboratory, Texas A&M University
M. Haidara, Food Technologist, IER Republic of Mali

In Africa, rice is a consumer preference, but is in short supply. "SORI" (a contraction for Sorghum/Rice) is a rice substitute that can be prepared at relatively low cost, could be introduced in sorghum and millet-consuming areas.

The SORI process is simple, produces a unique new product from sorghum, and can be applied at the village level using existing equipment. The process was developed as part of the S&T/AGR-sponsored Sorghum/Millet Food Technology Research. It is related to the parboiling process applied to rice, and differs mainly in method and length of soaking, cooking and drying.

The decorticated (de-hulled) kernels can be steamed or cooked by certian methods used to prepare rice. The low-technology SORI process simply involves boiling the sorghum in water, steeping it for 12 hours and then boiling it again, followed by ambient temperature drying and decortication. Parboiling procedures normally used for rice do not work for sorghum.



SORI cooked in the stew (lower left) and ready for consumption (lower right) with peanut sauce (top).

Dry parboiled sorghum (SORI) can be milled using traditional dehulling procedures or by mechanical dehullers. Slightly more times is required for hand dehulling; but yields are higher.

Cooking sorghum requires energy, but drying can be done using ambient conditions by placing the cooked grain in the sun. Once dried, the grain should have good storability. Thus, cooked grain can be accumulated during the dry season for use in the wet season, when ambient drying might not be possible.

The SORI process was applied very successfully to three local Malian sorghums in the Food Technology Laboratory in Bamako, Mali. Milling yields were greatly increased, especially for soft sorghums. Thus, the process can improve the quality of cultivars with poor decortication characteristics. Field trials in Mali to evaluate its true potential are underway by Malian food technologists who are part of the Sorghum/Millet CRSP.

The texture of cooked SORI is firm, resembling typical long-grain rice. The kernels are intact, dry, fluffy, and do not stick together. The color and texture of the cooked SORI is very acceptable. The shape and size depends on the sorghum variety and the decortication methods. Taste trials show that the SORI product has significantly improved texture, color and taste over "pitimi," a rice-like product widely consumed in Haiti. The heating and drying treatments greatly reduce the sticky characteristics compared to pitimi.

Special varieties of sorghum with hard texture and small kernels are presently grown for preparation of rice substitutes. These varieties are generally low-yielding. The partial cooking and drying of the sorghum kernel produces a harder kernel that significantly increases yields of decorticated intact kernels. This method could be a way of converting higher-yielding cultivars with softer texture into a superior product resembling rice. ★

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Continued from page 1

clonal germplasm collection is to maintain intact, specific gene combinations. If, after a period of storage, the genotype is not the same as the original material introduced, the validity of the system must be questioned.

The measure of stability is, however, only as good as the methods used to analyze it. In the identification of potato varieties, great emphasis is placed on the soluble protein electrophoresis of tuber storage protein. Protein and isoenzyme electrophoresis has shortcomings, but CIP researchers have found this method simpler and more easily reproducible than morphological analysis or other methods, for large scale screening of *in vitro* germplasm.

CIP scientists remove materials in its *in vitro* germplasm collection every two to three years. Tubers are induced, either *in vitro,* or *in vivo,* and protein profiles prepared. The pattern is compared with the original tuber sample to see if any variation can be detected. To date, in all samples analyzed, no detectable difference has been identified in *in vitro* conserved material after five years in storage. Restriction fragment length polymorphism (RFLP) may be used in the future to analyze the genes themselves and not the products of some of those genes.

Transfer of the resulting technologies from these research activities to the *in vitro* preservation of vegetatively propagated crops is immediate. Conserved germplasm will then be available for development of future improved varieties. ★

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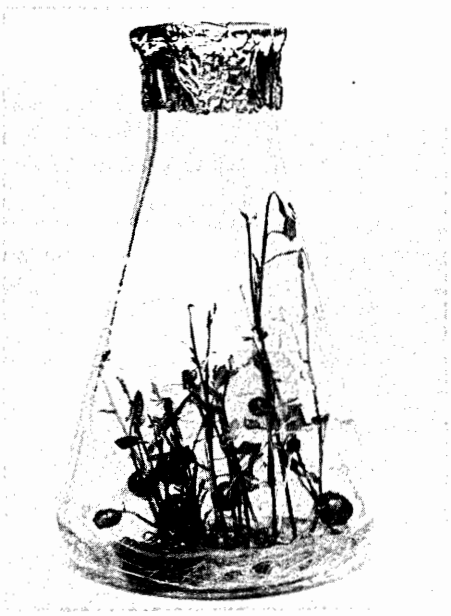

Production of tubers in vitro for protein electrophoresis.

New Microcomputer Programs Enhance Agricultural Research

Dr. Russell Freed
Bean/Cowpea CRSP, Michigan State University

Microcomputers in agricultural research programs are no longer a rarity. Their use is increasing worldwide, together with customized software programs.

Researchers are now able to do productive research on personal computers (PC) at their desks. While standard software such as Lotus 1-2-3 is often sufficient, agricultural researchers are discovering other tools, such as the four representative software programs described below:

1) Michigan State University (MSU) released a revised version of ***Microcomputer Statistical Program*** (MSTAT) in March 1989. This software program facilitates the design, management and analysis of agronomic research experiments. MSTAT has been used by agricultural researchers in over 100 developing countries, such as Senegal, Ecuador, Indonesia, Sri Lanka, Tunisia and Egypt, as well as by International Agricultural Research Centers (IARCs) typified by CIMMYT in Mexico, CIAT in Colombia and IRRI in The Philippines.

Targeted for field locations, it requires a PC with 512k of RAM and a hard disk. The cost is $295 plus a $100 license fee for non-profit organizations. One-week MSTAT Workshops are periodically held at MSU or overseas.

2) The International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT) has developed the software program ***Decision Support System for Agrotechnology Transfer*** (DSSAT). The program provides easy access to soil, crop and weather databases along with crop models and application programs. The DSSAT weather generator utilizes historical data to forecast the effects of future weather patterns. This enables users to evaluate technology for a period of 10 or more years.

Data and crops models for four commodities maize, soybeans, peanuts

continued next page

Dr. George Acquaah, post-doctoral fellow with the Bean/Cowpea CRSP and Dr. Russell Freed, MSTAT Director and Deputy Director Bean/Cowpea CRSP, discuss how to use MSTAT to design and analyze bean experiments.

continued from page 3

and wheat are currently available. DSSAT can calculate multi-year management and policy decision outcomes at both farm and national levels. For example, DSSAT can simulate a comparison between a native variety and a new variety. Outcomes between the two varieties can be compared for two soil types, for three different planting dates, and at three different nitrogen fertilizer application rates. Thus, long-term consequences on stability and sustainability of production can be predicted.

DSSAT can be run on an IBM-compatible PC with a hard disk and 640k RAM. There is no cost to developing countries and $200 for all others.

3) The Office of Agriculture (S&T/AGR) Agricultural Policy Analysis Project (APAP) has recently released four microcomputer tools: ***POLYANA*** analyzes market policies for a single commodity; ***GESS*** analyzes alternative commodity subsidization and taxation for multiple commodities; ***BORDER PRICE CALCULATIONS*** uses in-country market information; ***MUSHA*** evaluates potential activities to select those policies which optimize net income under the specified scenario.

IBM-compatible PC's with hard disks are required. Contact S&T/AGR/EPSA for loan copies of these four tools or programs.

"While standard software is often sufficient... agricultural researchers are discovering other tools."

4) The ***General Purpose Simulation Model*** (GAPS) software program has been developed by Soil Management CRSP researchers at Cornell University. GAPS simulates the flow of water through plants, interprets field experiments, and compares modeling techniques and alternative water-flow factors.

GAPS estimates hourly temperatures, evaporation, photosynthesis, soil water flow and plant water uptake. Processes are simulated based on available date, level of complexity, and the objectives specified. Input files contain climate, location, and soil and water data. After the user selects the input and resource scenario, the GAPS model simulates the various soil-plant-atmosphere processes.

GAPS requires an IBM-compatible PC color graphics capability and 256k of RAM. The cost is free to non-profit organizations. ★

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DSSAT— Dr. Tejpal Gill, S&T/AGR/RNR, A.I.D./W (703)875-4307
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GAPS —Dr. Susan Riha, Cornell University (607)255-1729

Letters to the Editor...

With this fourth issue, **S T A R** has surpassed the 1,600 mark and is headed towards 2,000 circulation. Editorial staff has utilized input from reader survey cards for selection of articles with a common interest to this worldwide, technically-oriented audience. Response from **S T A R**'s readers has been positive, as the following examples illustrtate:

"The latest issue of International AGSIEVE, published by Rodale Instutute, lists the 'Fortune 50' of sustainable agriculture periodicals. Your publication is among that select group." (United States Information Agency).

Voice of America's Mr. Bob Bowen, Agricultural Report Editor, writes that, "—your publication would make an ideal source of information for our weekly agriculture report—which is heard in more than 100 countries around the world."

Dr. Ben Bohlool, NifTAL Project, University of Hawaii, states in part: "The **S T A R** serves a valuable purpose in providing more in-depth information about A.I.D. project accomplishments in developing countries and their impact on the quality of life of rural people."

Dr. John J. Nicholaides III of the University of Illinois writes, "**S T A R**: It is attractive, clear, and concise. Just what the doctor ordered."

From Nigeria, Mr. M.A. Adegboyega, of the Nigerian Agricultural Insurance Company, writes, "—**S T A R** will be of immense relevance to the achievement of the objectives set for the Nigerian Agricultural Insurance Scheme (NAIS)."

Mr. Anselmo Castaneda, Agronomist for the Belize Enterprise for Sustained Technology writes in part, "The information from **S T A R** will be most useful in our training activities."

From Valerie Lamont, Winrock International comes the following, "I have enjoyed receiving **S T A R**. It helps keep us in touch with activities that overlap our On-Farm Seed Project in Senegal and The Gambia. I like the newsletter and think it is an excellent idea—."

G. E. Pilz, Escuela Agricola Panamerican, Tegucigalpa, Honduras writes, "There have been some ideas for student thesis that have come from your publication. We have several projects at EAP, including INTSORMIL, IPM, Bean Projects. **S T A R** allows for interaction. Keep the worldwide perspective."

continued on page 6

New Fortified Soy Flour Enhances Nutrition

Rob Wynstra, Food Technologist, International Soybean Program (INTSOY), University of Illinois at Urbana-Champaign

In the poorest countries, there is desperate need for additional sources of protein. Partially defatted soy flour is high in protein, making it nearly ideal for supplementing the staple foods — cereal grains, roots, and tubers — of many developing countries.

Commercial processes are available to convert soybeans into full-fat flour, but these involve high milling costs. Conventional milling equipment cannot produce a flour with particles small enough for easy blending with cereal flours because of the relatively high oil content of soybeans. The oil in full-fat flour also causes storage, handling, and packaging problems, in part from a high rate of rancidity. The flour has a brownish color that adversely affects the appearance of some food products.

Most of these problems can be overcome by using partially defatted soy meal, according to Utilization Research Program Leader Alvin I. Nelson of the S&T/AGR-funded International Soybean (INTSOY) Program. Because of its lower oil content, this meal can easily be ground into flour with conventional milling equipment. Produced by using a single-screw dry extruder with a simple mechanical oil press, the resulting meal contains only about five percent oil and almost 50 percent protein.

The milled soy flour is a pleasing light yellow and presents few handling and storage difficulties. The equipment for producing the soy flour is widely available and relatively inexpensive, allowing for flexibility in developing decentralized manufacturing operations. The same process also produces a high-quality edible oil, which can be readily marketed as an additional value-added product.

In **India**, for example, the staple unleavened bread known as chapati is made from wheat or other cereal flours. INTSOY research, conducted in collaboration with visiting Indian scientist Surendra K. Mittal, confirmed that chapati could be fortified with as much as 20 percent soy flour and show only minimal changes in taste, color, and texture. The research further showed that low-fat soy flour could replace 30 percent of the milk solids or khoya used in the preparation of the popular Indian sweet product, gulab jamun.

In the African nation of **Zambia**, the major staple is mealy meal, which is made from waxy corn flour. This bland product is cooked in the form of porridge or nshima. Tests by INTSOY showed that 15 percent partially defatted soy flour could be added to the mealy meal without affecting the taste or color of the final cooked products.

Experimental results show that the protein content of bread fortified with 12 percent defatted soy flour is increased by 25 percent over bread made from wheat flour alone. For cookies and other unleavened baked goods, fortification up to 25 percent is possible, resulting in a 55 percent increase in protein. The nutritional quality of the bread is already enhanced by the amino acids present in wheat and other cereal flours.

The product could be retailed for use in the home or wholesaled to bakeries in the form of a blended soy-cereal flour. Building a market for this defatted soy flour depends upon continued demonstration that it supplies protein at a reasonable cost and causes minimal changes in the taste, texture, and color of local foods. ★

Acceptable Fortification Rates with Defatted-Soy Flour

Twist Breads	18%
Banana Cake	25%
Biscuits	12%
Carrot Cake	12%
Croissants	10%
Plain Cake	25%
Doughnuts	10%
Muffins	12%
Pizza Crusts	12%*
Pie Crusts	25%*

*Preliminary results.

For further information, contact:

Dr. Harold Kauffman, Program Director or
Rob Wynstra, Food Technologist
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Visiting researcher Marise Galerani displays a wide variety of tasty, baked products made from partially defatted soy flour.

Soils Data Base: An Underexploited Resource

By Hari Eswaran, Program Leader, Soil Management Support Services Project (SMSS)

More than 40 nations are already using the Soil Taxonomy system to classify their soils. Developed by the U.S. Department of Agriculture, the system is becoming a common language among scientists worldwide. Its acceptance has been increased among developed and developing nations by the S&T/AGR-sponsored Soils Management Support Services Project (SMSS), which has particularly helped improve methodology applicable to the tropics. However, this system needs to be extended.

An important constraint to effective agricultural research, planning and land use in many less developed countries (LDCs) is the lack of soils resources information that can predict their problems and potentials. This is particularly true of Africa, where data may be absent altogether. Such information is needed to transfer technology from research sites to farmers fields, to provide the basis for soil conservation programs, and to reduce the present necessity for site specificity of agronomic and plant breeding research.

Without reliable generic soils data, most agronomic and plant breeding research cannot be reliably extrapolated to other areas. At present this is the modus operandi and results in the inability to utilize many valuable research findings.

This situation can be remedied through the use of an existing and reliable data base consisting of more than 650 soils characterized for sites in 25 countries. These detailed data on world soils were developed by the SMSS project. Site characterization and documentation of research and transfer sites should be viewed as a priority in any agricultural development activity.

Reliable soils data is the base layer of information necessary for predicting agricultural productivity via crop models and for effective utilization of remote sensing information of and Geographic Information Systems (GIS) for larger areas. With reliable data bases and relatively inexpensive computers, developing countries will have the capability to identify key areas with severe land degradation problems. They may then improve utilization of their limited funds by introducing optimal management to restore ecological diversity and improve agricultural productivity.

Future training efforts by the project will increasingly address these areas. A.I.D. Missions interested in training courses or technical assistance in this subject area may contact S&T/AGR or the author. ★

For more information, contact:

Dr. Hari Eswaran, Program Leader
Soil Management Support Services Project
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Washington, D.C. 20013
Telephone (202)475-5333

Dr. Eswaran (center of photo) explains the classification of a highly weathered soil to the participants of a training course in Burundi, East Africa.

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Letters to the Editor...

From the Pakistan Agricultural Research Council, Islamabad, Pakistan, Dr. Muhammad Anwar writes in part, "—contents were extremely interesting and informative—."

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SCIENCE & TECHNOLOGY AGRICULTURAL REPORTER

★ VOLUME 2 NUMBER 1 FALL 1989 ★

New Steps to Improve Aflatoxin Management

by Robert E. Pettit, Department of Plant Pathology and Microbiology, Texas A & M University, Timothy D. Phillips, Department of Veterinary Public Health, Texas A & M University, Robert E. Brackett, Department of Food Science and Technology, University of Georgia, Robert E. Lynch, Department of Entomology, University of Georgia

Aflatoxin, a naturally occurring poison, capable of causing liver cancer in both human beings and animals, is produced by two strains of molds, *Aspergillus flavus* and *Aspergillus parasiticus*. Growth of these molds on various plant seeds like corn, grain, sorghum, peanuts, pecans, beans, and rice, can result in aflatoxin contamination.

In the United States, monitoring levels of aflatoxin contamination has shown excessive levels in several feeds and foods. In 1988, for example, one-third of the official corn samples tested in Iowa and Illinois were found contaminated with aflatoxin.

Tolerances for aflatoxin contamination in food have been established by the Food and Drug Administration. For aflatoxin, the maximum allowable level is 20 parts per billion. This minute quantity is equal to a level where a single corn kernel (0.3 grams) is sufficient to contaminate 625 bushels of corn, rendering them unfit for consumption.

Village-scale oil press expelling peanut oil in Senegal. CRSP studies use clay to remove aflatoxin from crude unrefined peanut oil.

Aflatoxin is 100 times more carcinogenic (having a cancer causing potential) than the widely publicized industrial pollutant, polychlorinated biphenyl (PCB). Laboratory experiments show that test animals raised on a diet containing a few millionths of a gram of aflatoxin can develop liver cancer in a few weeks.

Examples of poisoning and death of humans and animals have been reported in many parts of the world. As early as 1974, a report from Western India revealed that over 1,000 villagers became sick when consuming mold damaged corn. In this report, close to 100 died.

The aflatoxin contamination problem is severe in the tropical regions of

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Rediscovered: the Crops of the Incas

Half a millennium ago, prior to the Spanish conquest, the Incas created an agricultural production system in the Andes cultivating an estimated 70 species of crops—almost as many as the farmers of Europe and Asia combined. The conquistadors, however, forced the Andean natives to replace their crops with European species like wheat barley and carrots. With the exception of the potato and the lima bean, the wide diversity of Incan agricultural crops sank into obscurity.

Lost Crops of the Incas, a recently published book by the National Research Council, identified 31 of the most promising but overlooked native Andean crops which are still grown in the more remote gardens of South America.

Many of these nutritious plants can

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BEST AVAILABLE

Crop Physiology Research Improves Millet and Cowpea Yields in Niger

by Paresh Verma and Jerry Eastin, Department of Agronomy, University of Nebraska and Mamane Nouri, Idrissa Soumanna and Cahndra Reddy, INRAN, Niger

The Sorghum/Millet Collaborative Research Support Program (INTSORMIL), works closely with the Institut National de Recherches Agronomiques du Niger (INRAN) to improve sustainable cropping systems, increase agricultural production, preserve the environment, enhance the economic condition of farmers and provide affordable food for consumers.

Collaborative crop physiology research is focused on improving millet and cowpea production through intercropping and using crop residue to improve the soil environment.

The people of Niger depend almost entirely on rainfed agriculture for the food they eat, but rain is unreliable in the semi-arid tropics of West Africa. Most of Niger's cultivated areas receive about 400-600 mm of rainfall annually. Moisture is adequate only during an 82-day period from July through September. Moreover, the predominantly sandy soil contains little organic matter and is, consequently, poor in fertility. Use of traditional unimproved production technology is an added limitation to agricultural yields, particularly in an environment subject to repeated drought and desertification.

More than 80 percent of the cropping systems involve pearl millet. The most common millet/legume intercropping system involves cowpea. Cowpea, usually grown for grain and forage, has recently replaced peanuts as the most important cash crop. In some regions, cowpea forage is more important to farmers than cowpea grain.

Traditionally, farmers have practiced intercropping with millet and cowpea and have used extremely sparse configurations-5,000 to 7,000 hills of millet per hectare and 2,500 to 3,000 hills of cowpea-in order to minimize competition between the crops and to allow space for the local spreading varieties of cowpea.

Crop physiologists associated with INTSORMIL have experimented with denser planting configurations to increase production with limited fertilizer usage. By arranging cowpea in a way that increased the crop's exposure to sunlight, researchers were able to increase cowpea yields by 25%, while simultaneously increasing water-use efficiency of the cowpea canopy. These intense systems, however, require fertilizer inputs which are out of reach of most farmers.

U.S. and Nigerian research efforts show that improved cropping systems can help realize gains in agricultural productivity in Niger.

To meet the immediate needs of farmers, another system is currently being researched for low input or no fertilizer situations. This system consists of paired rows of millet (8,000 hills per hectare) alternating with single rows of cowpea (8,000 hills per hectare). Millet and cowpea yields in this system were significantly higher than the traditional farmers' system (42 and 53 percent, respectively).

By using crop residue for soil improvement, crop physiologists have been able to achieve improvements in soil fertility and productivity. One, two and three tons per hectare of crop residue, for example, have increased millet grain yield by 306, 458 and 545 percent respectively (over a no residue treatment). Researchers are now measuring the effects of crop residue on soil temperature, soil moisture holding capacity and soil fertility.

Collaborative INTSORMIL research efforts underscore the fact that production in the deteriorating climate of the West African Semi-Arid Tropics can be stabilized by use of improved cropping systems. These efforts also make it clear that sound agronomy/physiology research is highly critical to realizing immediate gains in agricultural production in Niger and other Sahalian countries.

INTSORMIL research funded by the Bureau for Science and Technology, Office of Agriculture (S&T/AGR) also benefits U.S. agriculture. New short season millet cultivars soon to be released in the midwest may make wheat millet double cropping possible in the U.S. ★

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Integrating Application and Conservation of Genetic Resources

by Joel I. Cohen, Bureau for Science and Technology, Office of Agriculture, (S&T/AGR), U.S. Agency for International Development (A.I.D.) and Christopher S. Potter, AAAS Fellow, S&T/AGR

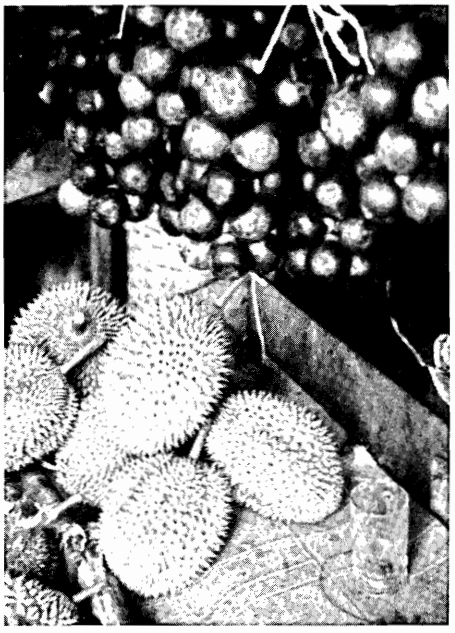
Genetic resources include plants and animals likely to contain germplasm of economic value. Due to the rapid loss of global biological diversity, the U.S. Congress recently proposed expansion of conservation efforts for genetic resources through legislation which emphasized the need to "identify, study and catalogue animal and plant species, especially in the tropical environments," and to develop "sound wildlife management and plant conservation programs." Including genetic resources within global biological diversity forms a critical link between these renewable resources and their economic application.

Given the increased importance of sustainability and conservation of biological diversity, new initiatives have been catalyzed by the Bureau of Science and Technology, Office of Agriculture (S&T/AGR) at the U.S. Agency for International Development (A.I.D.) to identify and enhance agricultural systems which sustain natural resources. In addition, the Office of Forestry, Environment and Natural Resources has taken a leadership role in providing a focal point for biological diversity funding at A.I.D.

In many cases, development of sustainable agricultural systems requires the integration of what have previously been separate approaches to either the conservation or economic application of genetic resources as well as their long-term impact on environmental quality of soil and water resources.

An experiment in the integration of conservation and application of genetic resources is now underway, designed by S&T/AGR and supported through funds approved for the conservation of biological diversity. The objective is to enhance the interaction between management and conservation of genetic resources and ensure their application within a sound soil and water use management plan.

Among the new initiatives is a study of ecology, management and conservation of Indonesia's native and cultivated fruit aimed at tapping their full potential for management. The tropical forests of Kalimantan (Borneo) offer habitat for a great variety of edible fruits, including durian *(Durio zibethinus),* mango *(Mangifera mangostana),* rambutan *(Nepheium lappaceum)* and many little-known species of considerable economic potential. The project will identify economically promising species, study the methods by which farmers now manage these crops and develop guidelines for cultivating or managing them *in situ*. The study will involve specialists in human ecology, agricultural economics, anthropology and the ecology of tropical plants.



Example of mixed agro-forestry plots in West Kalimantan, Indonesia illustrating use of indigenous fruit trees for commercial production.

Christine Padock

A final phase of the study, will compare advantages of *in situ* management to propagation in agricultural plots or agroforestry systems. Indigenous agricultural systems will be evaluated so that development agencies will be more likely to recognize the potential contributions that systems of indigenous knowledge can make toward modernizing agriculture.

A second project will study the diversity of genetic resources in Ecuador's semi-protected Sumaco National Reserve. A management plan will be constructed for *in situ* conservation, management, and use of wild crop relatives. Research will be conducted by biologists from the U.S. Department of Agriculture, Nature Conservancy and the Ecuadorian conservation organization Fundacion Natura. Linkages with gene banks are planned through INIAP, Ecuador's national germplasm program, to ensure that material will be collected and conserved within national germplasm facilities. Agronomic links will also be established with crop improvement programs to hasten use of germplasm with potential agronomic significance.

A third project expands the conservation of genetic resources in agriculture to include fisheries, and will undertake a biological diversity assessment of coastal marine and coral reef communities in the Philippines. It will examine of destructive fishing methods used in some Philippine waters and study their effect on marine communities. Changes in biological diversity of coral reef and shallow water fish communities subjected to blast fishing will be measured and approaches developed to assess the resilience and recovery time of marine environments that have sustained damage. Guidelines will be produced for more effective protection, use and management of marine coastal environments in the tropics.

Continued on next page

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By bringing together conservation biologists, agriculturalists, anthropologists and ecologists, A.I.D. promotes the application of genetic resources for sustainable agricultural development. As a result, the needs of species preservation are met while biological resources contribute to economic growth. ★

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Asian Nations Establish Network To Share Small Ruminant Information

Scientists from 11 Asian countries and representatives from five potential donor agencies met in August in Kuala Lumpur, Malaysia, to discuss the desirability and feasibility of establishing a Small Ruminant Production Systems Network in Asia (SRUPNA). As a result, plans are now underway to base the network in Bogor, Indonesia, site of an already operational national small-ruminant network established with support from the Bureau of Science and Technology, Office of Agriculture (S&T/AGR) of the U.S. Agency for International Development (A.I.D.).

The network's objectives will be to increase the flow of information about small ruminant animals, strengthen participating nations' agricultural research and development capabilities and promote collaborative research as well as both formal and informal training. The next steps in creating the network will be: soliciting donor support; identifying staff and support needs; and establishing a documentation center.

Membership in the network will be open to persons responsible for coordinating small-ruminant research and development programs in each of the participating Asian countries.

The Kuala Lumpur workshop was attended by representatives from

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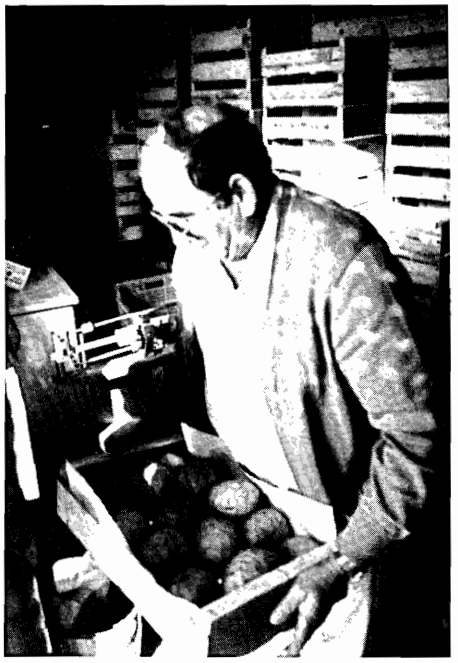
also be cultivated in the United States. Among them are a green-skinned fruit called the cherimoya which is already grown in California; several varieties of multi-colored Andean potatoes; and the pepino, a small yellow and purple fruit that tastes somewhat like a honeydew melon. Nunas, similar to a bean version of popcorn, have the potential to be a nutritious snack food.

The Incas developed crops suited for a variety of soil and climatic conditions. They managed their agricultural system with transplanting, terracing and irrigation systems. The Incas even practiced a crude form of freeze drying root crops such as potatoes for long-term storage.

While considerable basic research will be required to develop the full potential of many Incan crops, these crops stand to increase the variety of human foods and to reduce risk of crop failure by providing an opportunity for farmers to diversify. Unlike other fruit and vegetables grown in the tropics, Incan crops can be grown in cool temperatures since they flourish at high altitudes. This makes them promising as potential export crops in mountain regions in developing countries.



Inca fruit like these Cherimoyas sold in Malaga, Spain are finding new markets in Europe and the United States

Steven R. King

Among the members of the National Research Council's panel on the crops of the Incas were Hugh Popenoe, a scientist at the University of Florida's International Program in Agriculture, Steven R. King of the Nature Conservancy, Jorge Leon, a Costa Rican plant geneticist and Luis Sumar Kalinowski, a Peruvian agricultural scientist. Staff support costs for the study were provided by the U.S. Agency for International Development (A.I.D.).

For more information about *Lost Crops of the Incas* or to request a copy of the book, please write to: Board on Science and Technology for International Development, Publications and Information Services (HA-476E), Office of International Affairs, National Research Council, 2101 Constitution Avenue, N.W. Washington, D.C. 20418. ★

New Technology for Milkfish Spawning

by Lamarr B. Trott, Bureau for Science and Technology, Office of Agriculture, (S&T/AGR), U.S. Agency for International Development (A.I.D.)

A new technology for accelerating the milkfish spawning cycle promises to increase both fish production and income for fish farmers in some developing countries.

As a result of 10 years research supported by the Bureau for Science and Technology, Office of Agriculture (S&T/AGR) at the U.S. Agency for International Development (A.I.D.), scientists at the Oceanic Institute in Hawaii have successfully induced milkfish to spawn in captivity by inserting hormone pellets into the back musculature of the fish. The slow release of chemicals causes early maturation of sexual gametes allowing spawning.

Milkfish normally do not reach sexual maturity until they are at least five years old. Natural spawning has occurred in captivity but only with brood stock at least ten years old. Farmers are thus required to feed their potential brood stock for ten years before deriving any income from them. Induced spawning that can halve the age for reproductive maturity and extend the season, can be immensely beneficial to fish farmers.

The first major trials of the technology developed in Hawaii are being conducted at the north Bali Gondol laboratory of Indonesia's Research Council for Coordination of Fisheries. The laboratory, built with World Bank funds and partially equipped through a USAID/Jakarta agricultural development project, has been the site of Bureau for Science and Technology, Office of Agriculture sponsored cooperative milkfish research with the Oceanic Institute for the last two years. Researchers at Gondol have induced spawning 13 times since November 1988 with brood stock purchased from Javanese farmers.

An earlier USAID/Jakarta milkfish project under the direction of Dr. William von Stone was able to spawn milkfish naturally but only once. Some 200 progeny produced from his project are kept in the holding tanks at Gondol. As the fish are now four years old, they can be expected to be

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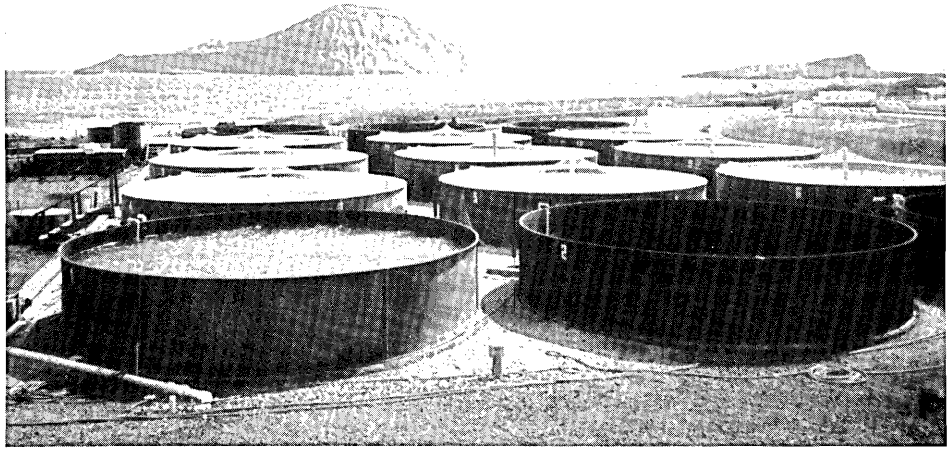
New technologies for accelerating milkfish spawning at the Oceanic Institute in Hawaii are being tested at the North Bali Gondol Laboratory in Indonesia. Dr. Clyde Tamaru demonstrates to Gede Sumiarsa (left) the techniques of rotifer identification.



Experimental holding tanks at the Oceanic Institute, Hawaii, (right) where milkfish spawning has been induced through hormone implants.

A.I.D. and Mississippi State University: Partners in Seed Technology

by James C. Delouche Department of Agronomy, Mississippi State University and Frank Mertens, Bureau for Science and Technology, Office of Agriculture (S&T/AGR), U.S. Agency for International Development (A.I.D.)

Seed technology plays a major role in economic development. Improved seed provides more food, increases income and raises the living standards of the world's rural poor. Countries that have developed their seed industry like India, Thailand, Colombia, Brazil and Taiwan are now largely self-sufficient in food crop production.

In the development assistance era that began in the 1950s, seeds became a basic ingredient in agricultural improvement strategies such as: new crop introduction; crop diversification; improvement of existing crops; and, in recent years, sustainable agriculture.

As the catalytic role of seed in agricultural development was recognized early in U.S. foreign aid programs, U.S. agronomists have made significant contributions to economic development through assistance in seed production and supply systems and the introduction of improved crop varieties. Caribbean maize varieties, for example, were introduced into Thailand, Indonesia and other areas in the Far East and South Asia while better varieties of wheat and forages were introduced into the highlands of South America.

The partnership between Mississippi State University (MSU) and the U.S. Agency for International Development (A.I.D.) and its predecessors has, since 1956, played a leadership role in the development of seed programs and industries in the developing world. Mississippi State University serves as an informational resource and a center of expertise, applied research and training. The A.I.D./MSU partnership has been involved in many of the key advances in crop agriculture in the last three decades and exemplifies the wide ranging impact of a successful long-term collaborative relationship.

The partnership has contributed to the multiplication and widespread distribution of many high-yielding seed varieties, supported extensive technical assistance and training efforts and has resulted in the development of numerous successful seed improvement projects.

Mississippi State University has, for example, provided short-term assistance to more than 51 countries and long-term assistance in seed-industry development to Brazil, India, Thailand, Indonesia and Egypt. The University has contributed to increased seed production and supply in more than 22 countries and provided in-depth and short-term training to specialists from 72 countries in the developing world. As a result, centers of seed expertise in many countries today are staffed by MSU trained specialists who also occupy important positions in the seed program or industry of the various countries.

A number of seed improvement projects have generated major benefits. In Thailand, for example, where MSU has trained seed technologists for more than 30 years, a seed project, established in 1976, has produced $130 million in benefits to about 200,000 Thai farmers. The project has also stimulated the development of six private seed companies, which are now concentrating on corn, sorghum and vegetable seed production. Other private companies are now trying to enter the seed industry and other donors have made substantial contributions.

With better seed, peanut production in Cameroon should increase by 15,500 tons per year, corn by 23,400 tons and sorghum by 22,900 tons—a net benefit of $25 million. The Cameroon seed program was both assisted

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Improved seed provides more food, raises income and living standards of the world's poor.

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in its formative stages by MSU and periodically since then.

Through a succession of cooperative agreements with A.I.D., the University has established a long-term relationship with the Honduran Ministry of Agriculture and the Escuela Agricola Panamericana (EAP), one of Central America's most important and influential agricultural colleges.

Since 1966, MSU and EAP have collaborated on seed-technology training and applied research. With buy-in assistance from the Central American regional office of A.I.D., MSU helped establish training facilities, a germplasm bank and a small seed business. Further collaboration is now underway with Kansas State University to assist EAP in developing an international seed and grain science center for humid, tropical countries.

Since the late 1960s, the focus in the seed program has been on establishing stable bases for exploiting genetic improvements. Increasingly, emphasis is being placed on development of a greater role for the private sector both in seed improvement and in improved seed distribution.

New roles are also emerging for seed technology. The growing interest in environmental preservation, for example, is leading to demand for greater supplies of seeds for regenerating forests and grasslands, planting of fast growing trees for fuel as well as other conservation and restoration efforts. Seeds are also rapidly becoming the delivery system for products of plant centered biotechnology. For development assistance agencies and their partners in the academic community, such new roles present both an array of challenges and opportunities to stimulate economic growth and maintain a healthy environment for generations to come. ★

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a major potential broodstock in just a few years. When they spawn, it will be the first time a second generation spawning of milkfish has been accomplished.

"Indonesian fish farmers consider the possibility of induced spawning a miracle," says Gede Sumiarsa, a researcher at the Gondol laboratory. Sumiarsa studied the techniques of inducing milkfish spawning and related subjects at the Oceanic Institute.

A workshop was held at Gondol in December 1989 to disseminate information on induced spawning to farmers and extension agents, as well as Indonesian researchers and to initiate a pilot hatchery program.

Milkfish are cultured primarily in Indonesia, the Philippines and Taiwan, but occur throughout the tropical Pacific and Indian Oceans. These three countries also currently supply most of the world's milkfish harvest. Because milkfish grow rapidly and feed low on the food chain (primarily from green and blue-green algae during their developmental stage) they can be raised to harvest in one year to a size of one pound relatively inexpensively.

At present, world milkfish production (using 1986 FAO statistics) is estimated at 328 thousand metric tons, of which a third is produced in Indonesia. Milkfish account for about four percent of total world fish production, which, in 1987, was estimated at 93 million metric tons.

In Indonesia, a growing aquaculture industry is engaged in farming milkfish in shallow coastal ponds, which the Indonesians call "tamboks." More than a million people are thought to be engaged in the aquaculture industry in Indonesia with milkfish being a major cultured species. ★

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Bangladesh, the Peoples Republic of China, India, Indonesia, Malaysia, Nepal, Pakistan, the Philippines, Sri Lanka, Thailand and Vietnam. Also attending were representatives from technical assistance agencies of Australia, Japan and the Federal Republic of Germany.

The Small Ruminant Production Systems Network is expected to increase opportunities for information exchange

The Small Ruminant Collaborative Research Support Program was represented at the workshop sponsored and chaired by the International Development Research Centre (IDRC). A paper on future networking opportunities was presented at the workshop by J.W. Oxley, Director, Small Ruminant Collaborative Research Support Program, University of California, Davis, L.C. Iniguez, Project Liaison Officer, Small Ruminant Collaborative Research Support Program, Bogor, Indonesia and H.C. Knipscheer, of the Winrock International Institute for Agricultural Development in Morrilton, Arkansas.

The development of the network will maximize the opportunity for the A.I.D. assisted Small Ruminant Collaborative Research Support Program institutions to share their results with colleagues and to benefit from experiences abroad. ★

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the world including Southern Asia, Central Africa, and Central and South America. In some years, it is serious within temperate regions. In the early 1980s, for example, 20 people in Kenya were reported hospitalized for aflatoxin poisoning and 12 later died.

Increased changes in aflatoxin contamination occur in peanuts harvested in tropical and sub-tropical regions where plant stress has increased susceptibility to aflaxtoxin producing molds. In Thailand, Senegal, India and the Philippines, conditions are highly favorable for contamination because of drought during the growing season, poor drying conditions during harvest, insect damage during curing and storage as well as generally poor storage facilities. A recent survey in the Philippines concluded that approximately 27 percent of the country's processed peanut products and 55 percent of the raw peanuts were contaminated with aflatoxin.

The U.S. Agency for International Development (A.I.D.), Bureau of Science and Technology, Office of Agriculture (S&T/AGR) supported Peanut Collaborative Research Support Program (CRSP) has several projects looking at possible methods of managing the aflatoxin problem. Texas A&M University, in collaboration with researchers in West Africa, found that management must involve an integrated approach; including prevention of contamination through resistant variety development, monitoring for possible contamination with improved detection techniques (selective absorbed mycotoxin assay procedure) for diversion out of the food and feed trade, and detoxification through the addition of high affinity sorbents such as industrially modified clays.

Researchers at Texas A&M found that modified clay sorbents added to animal feeds bind aflatoxin and thereby remove its toxicity. Also, their addition to dairy animal feed reduces aflatoxin contamination in milk. In Senegal, researchers discovered that adding clay to unrefined peanut oil, followed by filtration, renders oil safe for consumption.

At the University of Georgia, studies were conducted to determine the potential of using bisulfite and ammonia to detoxify contaminated peanut products. However, this altered the color, aroma, and texture of the food product.

Other efforts are underway to devise sorting techniques for removing of contaminated seeds. Hand sorting in the Philippines and Thailand has, for example, removed nearly 100 percent of the contaminated kernels.

Contaminated and immature kernels are generally less dense. Thus, when a batch of peanuts is placed in water, contaminated units tend to float on the surface. The problem with this sorting procedure is that uncontaminated peanuts must be dried again before storage.

A more promising approach for decontaminating of processed peanut products is to use a bacterium, *Flavobacterium aurantiacum*, which can metabolize aflatoxin. Adding this bacterium to the peanut product could reduce contamination levels.

A third project supported by S&T/AGR has resulted in the discovery by University of Georgia researchers in West Africa that reducing soil insect (termite) damage to pods through timely harvest, significantly lowers the level of *Aspergillus flavus* and *Asperfillus parasiticus* invasion into the pods. However, once contamination does occur, the most promising solution is to sort out all moldy seeds before consumption and to add aflatoxin sorbents (modified clays) to processed feeds and/or foodstuffs before use.

The ultimate solution to the aflatoxin problem is to grow crop plants under stress free environments (free of drought, heat, and nutrient deficiencies) and plant crop varieties which resist invasion by the aflatoxin producing fungi or prevent aflatoxin formation once the molds have invaded the seeds. Researchers in Texas, North Carolina, Georgia, Burkina Faso, Senegal and the Philippines have proven that an integrated approach is needed to reduce the aflatoxin contamination problem. Proper harvesting, curing and storage of various seeds is a key to prevention of contamination. ★

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Improved Animal Vaccines Through Biotechnology: Mutual Benefits for the U.S. and the Developing World

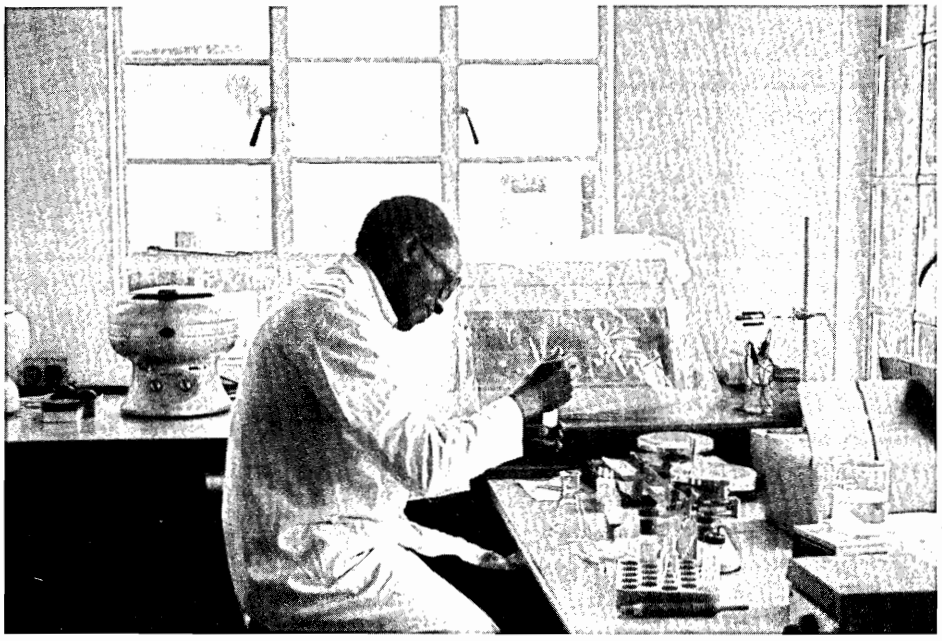
by Joel I. Cohen, Biotechnology and Genetic Resources Specialist, Bureau for Science and Technology, Office of Agriculture (S&T/AGR), U.S. Agency for International Development (A.I.D.) and Judith A. Chambers, AAAS Fellow specializing in application of biotechnology, S&T/AGR

Recent developments in the production of genetically engineered animal vaccines illustrate the potential of biotechnology to solve old problems by innovative and often more effective means.

Historically, conventional vaccine production has been hampered by problems relating to efficacy, stability, safety and production costs. Such problems are frequently compounded in the developing world by inadequate transportation, storage, delivery systems as well as by a lack of essential personnel and resources to produce and administer vaccine.

Genetically engineered or recombinant vaccines are comprised of known antigenic determinants linked to infection-competent viral vectors. They offer significant advantages over conventionally produced vaccines. They are less costly and easier to produce since standard fermentation techniques, rather than costly tissue culture techniques are used. More importantly, since genetically engineered vaccines generally consist of one or a small number of antigenic agents, as opposed to entire infectious organisms, they do not pose the same hazards associated with adverse side effects or actual transmission of disease which is often characteristic of conventional vaccines.

With these advantages in mind, the Bureau for Science and Technology's Office of Agriculture (S&T/AGR) of the U.S. Agency for International Development (A.I.D) initiated two recombinant vaccine projects for the control of livestock diseases important in the developing world.



Genetically engineered vaccines offer significant advantages over conventionally produced vaccines.

The diseases selected and the recommended recombinant technologies employed were based on a study commissioned by A.I.D. and performed by the National Science Foundation in 1985.

The first project involved the production of a recombinant vaccine for rinderpest, an acute, highly contagious viral disease responsible for the death of up to an estimated two million cattle annually in developing countries. This cooperative agreement was awarded to Dr. T. Yilma at the University of Califor-

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nia, Davis in September, 1986.

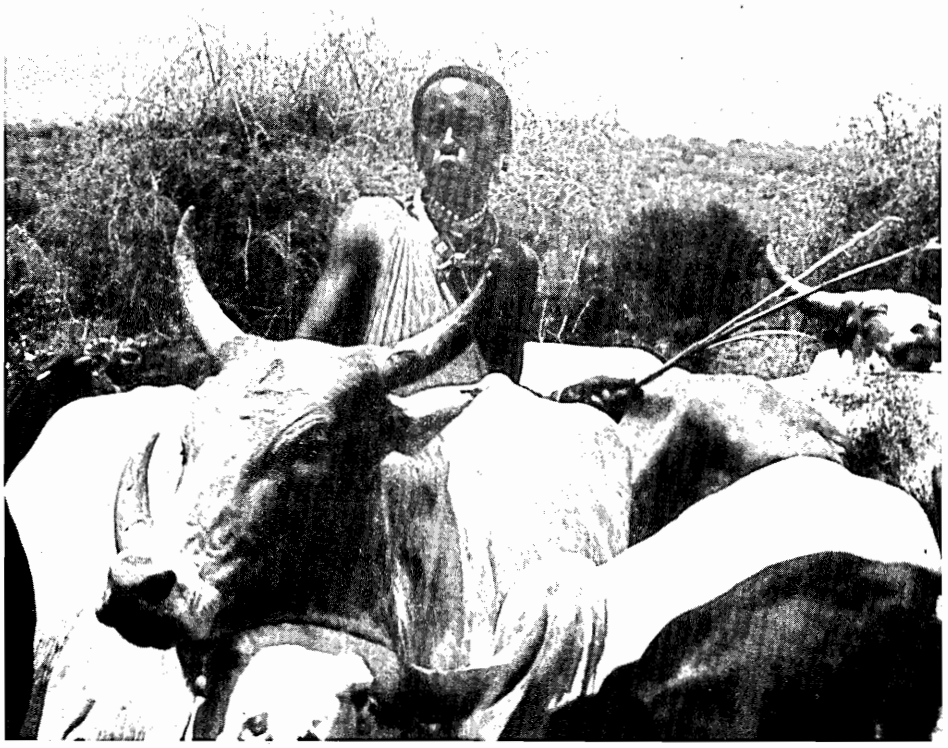
Although the conventionally produced Plowright vaccine is currently being used to control rinderpest, it requires continual refrigeration for its dissemination and sophisticated methods of production. Both are difficult to provide in many developing countries.

The recombinant vaccine developed in fall 1988 by Dr. Yilma, with scientists at U.S. Department of Agriculture's Animal and Plant Health Inspection Service, the Plum Island Animal Disease Center, and Cal Biotech (a commercial biotechnology venture) has been engineered in a vaccinia virus vector. It is thermostable and therefore should be easier to disseminate.

Vaccinia-based recombinant vaccines offer other advantages through attenuation accomplished by insertional inactivation or deletion of genes responsible for virulence. Furthermore, unlike other vectors, vaccinia-based vectors have a large coding capacity allowing for the construction of multi-valent vaccines simultaneously effective against several diseases.

Dr. Yilma was recently awarded the Ciba-Geigy prize for Research in Animal Health for progress made in the development of the recombinant rinderpest vaccine. The prize was awarded in February 1990 in Basel, Switzerland.

The second project supported by the Office of Agriculture concerns the control of two other haemoparasitic diseases, anaplasmosis and babesiosis. This cooperative agreement was awarded in September 1987 based on the results of a peer review panel organized by the National Research Council. The project receives overall direction from Dr. Michael Burridge of the University of Florida, and was awarded to three collaborating universities: the University of Florida; University of Missouri; and, Washington State University. The arrangement brings together a team of principal scientists including Drs. David Allred, Tony Barbet, Gerald Buening, Jim Henson, Doug Jasmer, Travis McGuire, Martin Meltzer, Guy Palmer and Ed Stephens.



In much of the world, the loss of livestock can mean hungry people. Loss of milk and meat is a loss of a major source of dietary protein.

As part of this project, surface proteins providing protection of cattle are being identified. Genes which express these proteins will be cloned. Their effectiveness as protective immunogens will be tested in recombinant vaccinia constructs.

Nucleic acid probes to detect subclinically infected animals, or carriers are being developed. They will be used for economic impact studies and provide the ability to differentiate vaccinates from infected animals. In addition, research teams will develop diagnostic tests of high sensitivity and high specificity to conduct epidemiological surveys in developing countries.

Both vaccine projects have established linkages with scientists from developing countries who have been participating in research at the post-doctoral and doctoral level. Their experience in advanced techniques of molecular biology is preparing an important base of expertise from which to test and develop new vaccines in the developing world. For the anaplasmosis project, linkages have been established with Thailand, Kenya, Mexico and most recently Costa Rica. Participants have been identified and already received advanced research experience at one of the three cooperating universities. Dr. Yilma's research has supported one post-doctoral associate from Kenya, Dr. Moses Limo, pursuing valuable research on diagnostic tests for rinderpest. Human resources development in the anaplasmosis project has been supported through post doctoral research for Dr. Sathaporn Jittapalapong from Thailand. Doctor-

al candidacy is supported for Patrick Sankale Shompole and Reuben Kipngeno Soi from Kenya. Other candidates are being identified from Costa Rica. The high caliber of candidates involved in these projects demonstrates the priority placed by their host countries on acquiring these new technologies.

Many of the collaborations under the A.I.D.-supported projects are formalized within the Anaplasmosis Babesiosis Network (ABN) which has over 125 member institutions from 63 countries interested in controlling these diseases. The ABN gathers and transfers information about recombinant vaccine development, antigen isolation and epidemiological data in developing countries. The ABN has just compiled, edited and distributed a comprehensive bibliography of these diseases. In addition, the ABN publishes a quarterly newsletter to disseminate information regarding scientific advancements, biosafety concerns, conferences and other topical issues.

Important contributions derived from these project were recently presented at the first "National Plant and Animal Biotechnology Conference for Kenya." Presentations by Drs. Yilma, McGuire, Barbet and Limo were featured. The sessions on recombinant vaccine technologies were of great interest and were indicative of the excitement generated by the new possibilities for better control of these serious threats to livestock health.

These projects clearly illustrate the potential for mutually beneficial collaboration in biotechnology between scientists in developing and industrialized nations. For example, nucleic acid probes being developed for anaplasmosis will be just as valuable in the United States as they will be in the developing world. The recombinant technologies being pioneered by Dr. Yilma offer new advances not just for cattle diseases but for other significant viral diseases. ★

TropSoils: Finding Ways to Slow Desertification

by Neil Caudle, Program Coordinator for TropSoils Communications, North Carolina State University

Research by scientists of the Soil Management Collaborative Research Support Program (TropSoils) is helping identify options for combatting desertification in the Sahel of Africa. By focusing on the entire soil-crop-climate system, studies by scientists from Texas A&M University and collaborators in Niger and Mali are providing some of the information necessary for stabilizing agriculture, conserving forests, and slowing the advance of deserts. The research is supported by the Bureau for Science and Technology, Office of Agriculture of the U.S. Agency for International Development (A.I.D.).

Firewood is in such demand that Sahelian forests have become seriously degraded. Reforestation projects help address the problem.

Throughout the Sahel, sustaining crops and forests requires making the most of scarce rainfall. In practice, this means trying to predict the timing and distribution of rainfall and then efficiently using the rain when it falls.

Baseline studies of soil and climatic conditions can help establish rainfall probabilities for many locations in Niger.

TropSoils scientists have gathered data on such factors as the temporal variation and distribution of rainfall and then length of growing season. The researchers have measured the physical and hydrological properties of major cropped soils in Niger and have used climatic data to estimate the evapotranspiration rates of economically important crops.

The results can help establish rainfall probabilities for many loca-

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tions in Niger. They can also be used by plant breeders, who must adapt crops to growing conditions.

In addition to these baseline studies of soil and climatic conditions, TropSoils has investigated ways to manage water in cropping systems. One promising technique, known as "contour-strip rainfall harvesting" (CSRH), increased the grain yields of cereal crops from 56% to 120% on experimental plots in Niger. Fertilizing with nitrogen and phosphorous was necessary to get the most benefit from the rainfall.

The principle of CSRH is to concentrate runoff from water harvesting contour strips onto adjacent cultivated strips. Because the technique promotes deeper rooting and increases the plant's capacity for absorbing water and nutrients, rainfall harvesting has potential for increasing grain yield in regions with limited rainfall and sandy soils.

While a lack of rainfall is a serious constraint to crop production, it is not the only cause of drought stress in Sahelian food crops. Deficiencies in nutrients limit the plant's water-use efficiency and greatly constrain crop production on semiarid lands. Also, some cultivars use nutrients more efficiently than others. Soil management practices to increase the amount of available water will be more effective when nitrogen and phosphorous deficiencies are corrected and when responsive cultivars are used.

Another strategy for relieving drought stress is to reduce the effect of desiccating winds. TropSoils scientists have found that neem tree windbreaks can reduce wind speed by as much as 41%. Crops protected by the windbreaks produced more grain and dry matter than did unprotected crops.

Neem tree windbreaks offer another advantage, as well. With selective harvesting, they can provide firewood--a precious commodity in the Sahel.

In fact, firewood is in such demand that Sahelian forests have become seriously degraded. Soils in denuded areas typically form hard, barren pans.

In cooperation with the A.I.D.-supported Forest Land Use Project, TropSoils scientists compared several methods of reforestation in the

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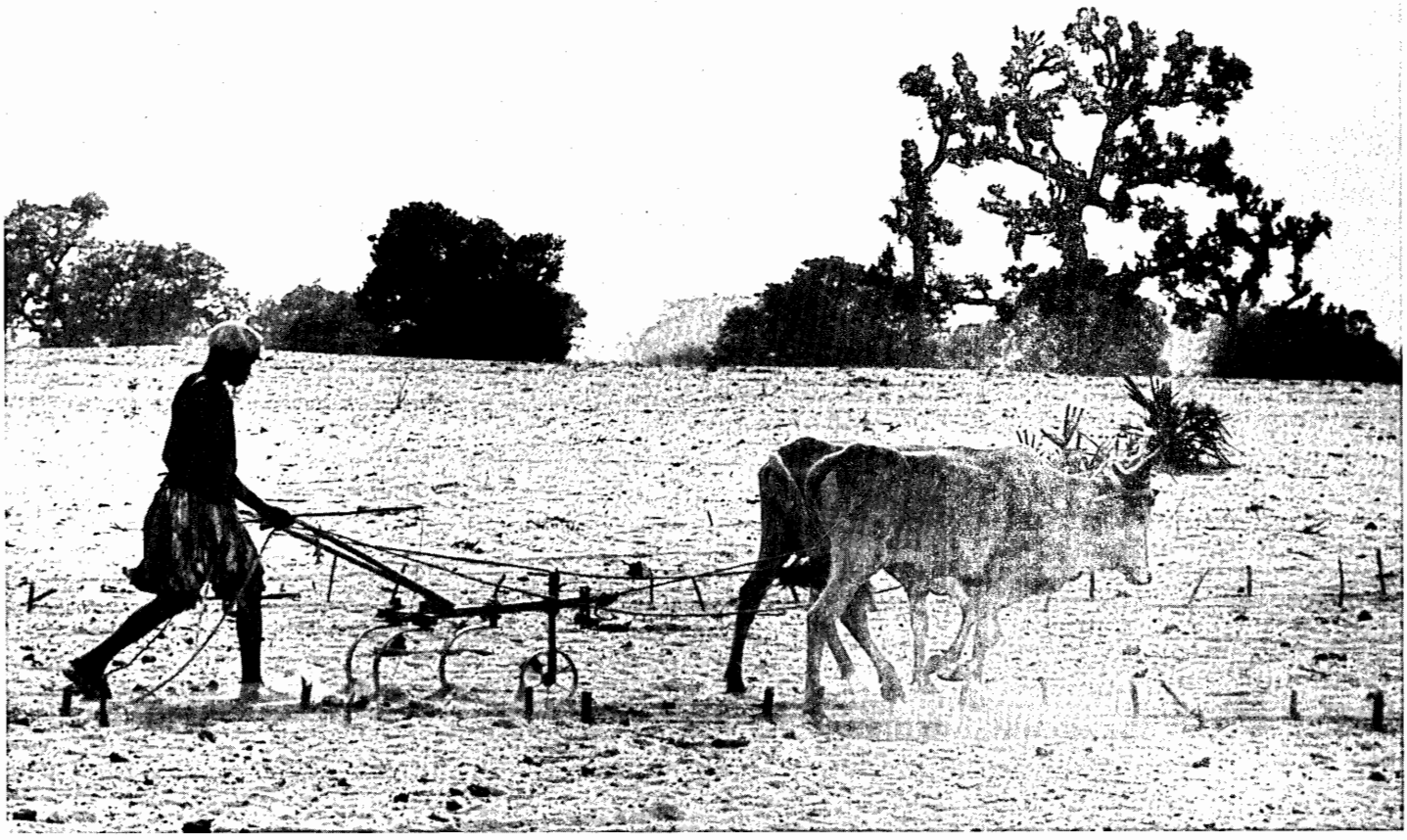

Throughout the Sahel, sustaining crops and forests requires making the most of rainfall.

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Wheat Research Results Bring Multiple Benefits

by Warren E. Kronstad, Distinguished Professor of Plant Breeding and Genetics, Center for Gene Research and Biotechnology, Oregon State University and Frank Mertens, Bureau for Science and Technology, Office of Agriculture (S&T/AGR), U.S. Agency for International Development (A.I.D.)

Farmers in both developing countries and in the United States are benefiting from an Oregon State University (OSU) collaborative research project to enhance and disseminate wheat germplasm. This unique program brings together a U.S. university, two international centers, and over 100 cooperators in developing countries in a complementary effort to share genetic materials and to disseminate appropriate technology.

The project, supported by the Bureau for Science and Technology, Office of Agriculture of the U.S. Agency for International Development (A.I.D.) since 1974, focuses on enhancing wheat germplasm to provide for greater disease and insect resistance, higher and more sustainable yields especially in stressed environments and improved nutritional and end use quality.

Wheat is the world's leading cereal crop, contributing more calories and protein to the diet than any other food crop. It is the staple food in many countries.

Recognizing the importance of wheat in the developing world, A.I.D. has worked with Oregon State University's cereal improvement scientists for more than 23 years. In 1967, support was provided to introduce semi-dwarf spring-type wheats developed in Mexico into the coastal areas of Turkey. The following year A.I.D. supported an OSU dryland wheat improvement program for the Anatolian Plateau of Turkey. These programs resulted in a dramatic increase in wheat production in Turkey from 7 million metric tons in 1967 to 17 million metric tons in 1975.

The current A.I.D.-supported spring x winter wheat germplasm enhancement program is an outgrowth of the successful Turkish experience where wheat is used as a vehicle to stimulate the agricultural sector in developing countries.

The project has developed a new shuttle breeding scheme to selectively screen new gene combinations with unique and superior traits across many different environments.

The collection and evaluation of nearly 10,000 wheat cultivars has enhanced genetic diversity, the life blood of all plant improvement programs. For example, materials from the People's Republic of China have been found to be sources of resistance to the plant disease Scab

Nobel Peace Prize Recipient, Dr. Norman Borlaug, speaks with a group of OSU graduate students and Oregon farmers.

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Guesselbodi Forest near Niamey, Niger. One of the most effective--and least costly--of these methods was mulching the barren soils with tree branches left over from woodcutting operations. The mulch trapped seeds and windblown sand and also attracted termites, which are beneficial because they increase soil porosity and therefore rainwater penetration, and because they incorporate organic matter.

Individually, none of these techniques for conserving and using scarce moisture will curb desertification and restore productivity to degraded soils. But taken together, they represent a practical, comprehensive approach toward conserving natural resources and sustaining the productivity of forests and food crops across the Sahel. ★

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(*Fusarium spp.*) as well as earliness and spike fertility. Resistance to Black Chaff (*Xanthemoas translucens*), an increasingly serious bacterial disease worldwide, has been identified from genetic lines from Argentina.

Sharing of genetic materials is a significant aspect of the international spring x winter wheat germplasm program. It is enriched by the inclusion of the countries of eastern Europe and the People's Republic of China which are important sources of enriched germplasm but formerly did not participate in the program.

The spring x winter wheat project has also developed a new, effective "shuttle breeding" scheme to selectively screen new gene combinations with unique and superior traits across many different environments. Sites in Oregon, Kansas, Mexico, Turkey and Syria are all employed to identify materials with promising attributes. Such an approach has also provided for more durable and multisource disease and insect resistance and greater sustainable yields even under adverse growing conditions.

In addition to providing improved winter and facultative wheat germplasm to cooperators, enhanced winter parental material from OSU is recycled through the program to make additional winter x spring crosses and has been instrumental in improving spring wheat disseminated by the International Maize and Wheat Improvement Center (CIMMYT). It is estimated that over 100 million hectares of spring type wheat originating from the spring x winter program are currently grown.

Farmers in the United States will benefit from the project's research in crossing of winter with spring wheats. Nineteen breeding programs in the U.S. received enhanced materials from the OSU program. Promising cultivars have been identified for the improvement of winter wheat. For example, researchers at OSU will soon release a hard red winter cultivar adaptable to Oregon wheat growing conditions. Given the greater demand for high protein wheats, this development will complement the soft white wheat (low protein) which has dominated wheat production in this area of the United States. As a result, U.S. farmers can benefit through potentially significant economic returns. Such efforts can also help broaden the marketing base for U.S. farmers by better enabling them to meet the non-traditional food needs of growing economies in the developing world and to hedge their bets against such natural threats to agriculture as pests or climatic stresses.

Farmers in the U.S. will benefit from research in crossing winter with spring wheats.

Both U.S. farmers and developing countries benefit from the research conducted at OSU. The support for the spring x winter wheat program from organizations such as the Oregon Wheat Growers shows that partnerships between U.S. farmers, international centers, an American university and collaborators in the developing world can, through appropriate technologies, help shape the course for a better future for all. ★

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for Food and Agriculture (S&T/FA)

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VOLUME 2 NUMBER 3 SPRING 1990

Agricultural Policy Research: Meeting the Development Challenge

by Chris Brown, U.S. Agency for International Development (A.I.D.), Bureau for Science and Technology, Office of Agriculture, Economic Policy Division

The Agricultural Policy Analysis Project (APAP), is a ten year, $17.5 million initiative to bring the expertise of some of the nation's leading economic policy experts in agriculture to bear on the challenges facing the U.S. Agency for International Development (A.I.D.). In the seven years since APAP has been under way, the project has assisted the Agency and over 30 of its overseas missions in analyzing needs and options for policy reform and in developing institutional capacity for conducting agricultural policy analysis. The project has also generated an impressive body of cross-cutting research on a wide range of state-of-the-art issues and methodologies in the field of agricultural policy reform.

Abt Associates, Inc., which administered the first five years of the project, embarked in 1989 on the project's second five-year phase. Abt is leading a team of universities and firms including the Harvard Institute for International Development; the International Food Policy Research Institute; Stanford University's Food Research Institute; North Carolina State University; Abel, Daft and Earley, Inc.; and the International Science and Technology Institute, Inc.

At the heart of the project is a three-pronged worldwide strategy to:

- provide policy project support to A.I.D. field missions;
- build a strong base of applied research and appropriate methodologies to improve policy analysis; and
- train policymakers and disseminate research findings broadly.

Helping conserve tropical rain forests like this one in Panama will be one of the benefits of A.I.D.'s Central American Regional Environmental and Natural Resources Management Project. APAP is implementing the data and policy dimension of the project.

Demand for APAP Technical Advisors

Although most of the APAP technical support efforts have been short-term policy studies for A.I.D. missions, the project is now engaged in several sustained and larger-scale initiatives. There are long-term advisors stationed for three years in Pakistan and the Philippines, coordinating a series of policy research and staff training efforts. The project has a long-term buy-in relationship with USAID/Niger.

APAP is also implementing the data and policy dimension of the Central American Regional Environmental and Natural Resources

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Deep Liming Reduces Drought Stress

by Lalit M. Arya, University of Hawaii, Tom Dierolf, University of Hawaii, Agnus Sofyan, Center for Soil Research (Bogor) and IPG Widjaja-Adhi, Center for Soil Research (Bogor)

TropSoil scientists found that corn yields progressively increased with depth and lime incorporation. Corn is a key crop in many parts of the developing world.

TropSoils scientists supported by the U.S. Agency for International Development, Bureau of Science and Technology, Office of Agriculture have found that the deep placement of lime can increase the yield of food crops in the Sitiung area of West Sumatra, Indonesia. In one experiment, corn yields progressively increased with depth of lime incorporation.

Despite an average annual rainfall of 3,000 mm and a high soil water-holding capacity, food crops in Sitiung often suffer from drought stress. This is because the acid and highly aluminum-saturated subsoils limit most food-crop roots to the top 10 to 15 cm of soil, reducing the plant's ability to absorb subsoil water and nutrients.

The structure of these acid soils contributes to the rapid loss of nutrients. Because of highly stable aggregates in the surface and a network of macropore flow channels in the subsoil, rainwater moves rapidly downward, leaching fertilizer nutrients. The nutrients lost to the subsoil are beyond the reach of aluminum-sensitive plants, which are typically shallow-rooted. Only deep-rooted plants, such as native trees, grasses, and weeds, are able to retrieve and recycle these leached nutrients.

Adding lime to the soils neutralizes aluminum, improves the soil chemical environment, and promotes root growth. However, studies show that lime applied to the surface and incorporated by hoeing only reaches a depth of 5 to 10 cm. Lime movement into the subsoil is quite slow. Even when lime does reach the subsoil, the concentration is not adequate to promote root growth. Rooting density in the surface increases, but rooting depth does not.

To address these problems, TropSoils scientists began testing deep placement of lime as a means of increasing rooting depth and water and nutrient availability. In one trial, lime at rates two, four, and six t/ha was applied so that all of a given rate was distributed in the top 10, 20, 30, 40, or 60 cm of the soil. Therefore, the amount of lime per unit depth was reduced with increasing depth of incorporation. For a given amount of lime, grain yield substantially increased as the depth of incorporation increased.

In another experiment, yields were higher when there were more roots in the subsoil. In contrast, yields were not higher when more roots grew in the topsoil. When lime was deep incorporated, water absorption by the roots increased.

Having established the benefits of deep liming, TropSoils scientists developed a method of deep liming based on ridge-furrow beds. After lime is mixed in the surface 10 to 15 cm of soil, the soil is formed into

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Toward Sustainable Agriculture in Honduras

by Francisco Gomez, National Sorghum Program, Department of Natural Resources (SRN), Choluteca, Honduras; Miguel Lopez-Pereira, International Center for Improvement of Corn and Wheat (CIMMYT); and Daniel H. Meckenstock, INTSORMIL/Texas A&M University, SRN and the Pan American Agricultural University (Zamorano).

The Land Use and Productivity Enhancement Program (LUPE) and the joint sorghum program with the Department of Natural Resources of Honduras (SRN), the Pan American Agricultural University (Zamorano) and the International Sorghum/Millet Collaborative Research Support Program (INTSORMIL) are working together to help build a foundation for sustainable agriculture in southern Honduras.

The two projects -- supported by the U.S. Agency for International Development's Bureau for Science and Technology, Office of Agriculture -- are helping to produce soil conservation technologies and improved sorghum cultivars.

In hilly southern Honduras, maize is very susceptible to drought and is often lost due to irregular rainfall. Sorghum, by contrast, is more drought tolerant and is an important food crop for many small farmers, especially in years when maize is lost. Sorghum is, therefore, intercropped with maize.

A first step in creating a sustainable agriculture is conserving the natural-resource base by preventing hillside soil erosion. In the last decade, a predecessor project to LUPE helped farmers in the area build soil-and water-conservation structures on about 2,400 ha. Adding labor-intensive soil-erosion-control structures, however, did not produce short-run profit increases for farmers. Through the SRN, three high-yielding, early-maturing, high quality food-type sorghum cultivars -- "Tortillero," "Catracho," and "Sureno" -- were released in the early 1980s and extensively tested on farmers' fields. Model results now show that these cultivars can substantially increase yields and farmers' expected incomes by as much as

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A.I.D. support is helping build a foundation for sustainable agriculture in southern Honduras.

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22 percent. When combined with improved agricultural policies, such as reducing the post-harvest-price collapse, the income effect of both is a 70 percent increase. The use of such short-season, high-yielding sorghum cultivars is already having an impact as intercropping gives way to pure stands of maize and sorghum. Almost one-third of the farmers sampled had planted the new cultivars.

New cultivars alone, however, cannot create a sustainable agricultural system. Without the water-conservation devices, the farmers' fields wash down into the valleys. Forty-three percent of the farmers sampled now utilize some of these labor-intensive, erosion-control devices.

Experience gleaned through the project also has shown the need to complement the development of technologies aimed at increasing the productivity of small farms with an effective program to reduce the substantial grain-price instability.

To address these needs, the LUPE project, begun in 1989, aims to promote improved storage facilities to enable farmers to hold onto their sorghum until the price recovers after the post-harvest collapse. Storage would be in small bins on the farms, with technical assistance and credit provided by LUPE. Another technique to increase the value of cereal production will be more utilization of the grains in on-farm animal production.

The soil-conservation measures on the steeper slopes include stone walls and ditches to prevent rainfall runoff and erosion. These facilities have been built with the joint labor of the community and the wages paid in food by the predecessor to the LUPE program. Later the ridges created are supplemented with grasses or bushes at the borders and even with legume trees. Once the farmland is secured, new sorghum cultivars and the removal of the post-harvest-price collapse are able to substantially increase small-farmer incomes. This combination of technologies is expected to have a large effect on sorghum production and small-farmer incomes in southern Honduras over the next decade. ★

Preventing hillside erosion is a first step in creating sustainable agriculture.

INTSORMIL and NAARP: A Partnership for Research and Training

by J.W. Clark, Visiting Assistant Professor at Purdue University and Plant Breeder for the Niger Applied Agricultural Research Project in collaboration with the Institut National de Recherches Agronomiques du Niger (INRAN)

Nigerian farmer with sorghum harvest.

The International Sorghum Millet Collaborative Research Support Program (INTSORMIL) began working with the Institut National de Recherches Agronomiques du Niger (INRAN) in 1983 through an agreement facilitated by the U.S. Agency for International Development (A.I.D.) and supported by the A.I.D. bilateral Niger Cereals Research Project (NCRP). Purdue University was the prime contractor for this project while Alabama A&M University was the sub-contractor.

The combined resources of INTSORMIL and NCRP complemented each other in strengthening INRAN's institutional capacity for agricultural research.

The Niger Applied Agricultural Research Project (NAARP) was initiated by A.I.D. as a follow-on in 1988. Purdue University again was the prime contractor with Alabama A&M University, Winrock International and the University of Nebraska as sub-contractors. This mutually beneficial and continuing relationship has led to a number of significant achievements in research and training.

It has, for example, led to the identification of three sorghum cultivars [two open pollinated varieties and one F1 hybrid] which have excellent potential for adoption by Nigerien farmers. The cultivars are: SEPON 82 -- a high yielding variety suitable for either rainfed or irrigated production systems; SRN 39 -- a *Striga*-resistant variety for use in areas where *Striga hermonthica*, a serious parasitic weed pest of sorghum, is a constraint to sorghum production; and AT x 623 x MR 732 F1 -- a hybrid with both stable and high yield characteristics for rainfed and irrigated production systems.

The three cultivars are currently being tested in on-farm trials (pre-extension) prior to extension service release to farmers which is expected within the next two years.

The INRAN Cereal Quality Unit found that the grain of these cultivars can be used to produce food products of acceptable quality and offer promise for use by consumers. They have been entered into the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) regional varietal trials and are available to the 17 countries of the West and Central African Sorghum Research Network.

The development and introduction of two of the three cultivars resulted directly from INTSORMIL-supported graduate student research.

The NCRP supported 22 fellowships for training of INRAN staff at universities in the United States. Six of these students conducted graduate thesis research in Niger through the INSTORMIL-NCRP-INRAN collaborative relationship. Five other graduate students and post doctoral fellows supported by INTSORMIL were involved. In addition, numerous short-term training programs given at INTSORMIL member institutions were developed and financed by NCRP and NAARP in areas such as plant physiology, cereal quality, entomology and plant pathology.

The NCRP and NAARP projects have benefitted from the specialized technical expertise provided by INSTORMIL scientists while the Collaborative Research Support Program has gained from the logistical support provided by Iran and the two A.I.D. funded projects in Niger. Niger and INRAN, in turn, have benefitted from the addition of trained scientists, supplemental equipment, technical expertise and innovative plant materials which are being incorporated into improved agricultural production systems. ★

Continued from page 1

Management (RENARM) Project. RENARM conducts a series of country inventories of policies affecting natural resources and identifies both country specific and regional priorities for policy reform.

A.I.D. bureaus have called on APAP to help with their core research and strategic planning. The project has just undertaken, for example, to provide a team to help the Latin American and Caribbean Bureau prepare its Agriculture and Natural Resources Strategy. For the Europe, Asia, and Near East Bureau, APAP is conducting a series of collaborative research studies on agricultural trade trends, the profitability of irrigation investments, price stabilization schemes and changing patterns of food demand. In Africa, the project has just completed a study of the comparative advantage of selected countries in export cash crops.

There is a growing demand for high-caliber economic policy analysis for agriculture worldwide.

Investing in Research and Methods

Abt Associates is now at work reviewing and synthesizing A.I.D.'s experience over two decades of agricultural policy reform and structural adjustment. The primary distinction between efforts in the 1970s and the 1980s was the dramatic shift from a micro to a macroeconomic focus, with the later efforts combining a wider range of A.I.D. resources to affect a broader policy agenda.

Several methodological guidelines have also been published, and a new effort, currently under way, will develop and disseminate the capability to integrate a wide range of environmental and natural resource considerations into the popular Policy Analysis Matrix microcomputer food policy model, developed with A.I.D. support.

Training and Information Sharing Also a Priority

Harvard and Stanford continue to run their popular annual courses on the macroeconomic aspects of agricultural policy and on agricultural policy analysis methods, respectively. Customized training for policymakers and trainers is under way in several countries.

In May, 1990, APAP coordinated the Agricultural Sector Council's Senior Seminar for the Administrator on Global Agricultural Issues, which briefed A.I.D. Administrator Roskens on the key issues affecting world agriculture in the 1990s.

Twice a year, the project publishes technical notes (*Technotes*) and a newsletter (*Newsbriefs*). These publications help to keep the Agency and broader professional community informed of the efforts currently under way.

APAP has also developed a computerized roster of agricultural policy consultants which will soon provide A.I.D. with an international "Who's Who" of experts in the field.

A Look to the Future

There is clearly a growing demand for high-caliber economic policy analysis for agriculture worldwide. With the emergence of nations around the world whose economies must be transformed from centrally-planned to open market systems, the opportunities for assistance in setting the agenda in this area could expand significantly.

As we enter the changing international economic policy environment of the 1990s, technical service capabilities such as those provided by APAP will continue to play a major role in the development of sound agricultural policies and practices. ★

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ridges, exposing the subsoil in the furrows. The subsoil is limed and tilled to an additional 10 to 15 cm depth. The soil is leveled and the entire procedure is repeated, placing ridges where there were furrows, and furrows where there were ridges until the entire area has lime incorporated into the subsoil.

While deep incorporation of lime is labor-intensive, the potential for increased crop yields may make the approach worthwhile for some farmers. Meanwhile, efforts are under way to design and test an animal-drawn plow, which may make deep liming more practical. ★

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★ VOLUME 2 NUMBER 4 FALL 1990 ★

Competition in Bangladesh's Fertilizer Market Promotes Efficiency

by Marie K. Thompson, writer-editor, International Fertilizer Development Center, Muscle Shoals, Alabama

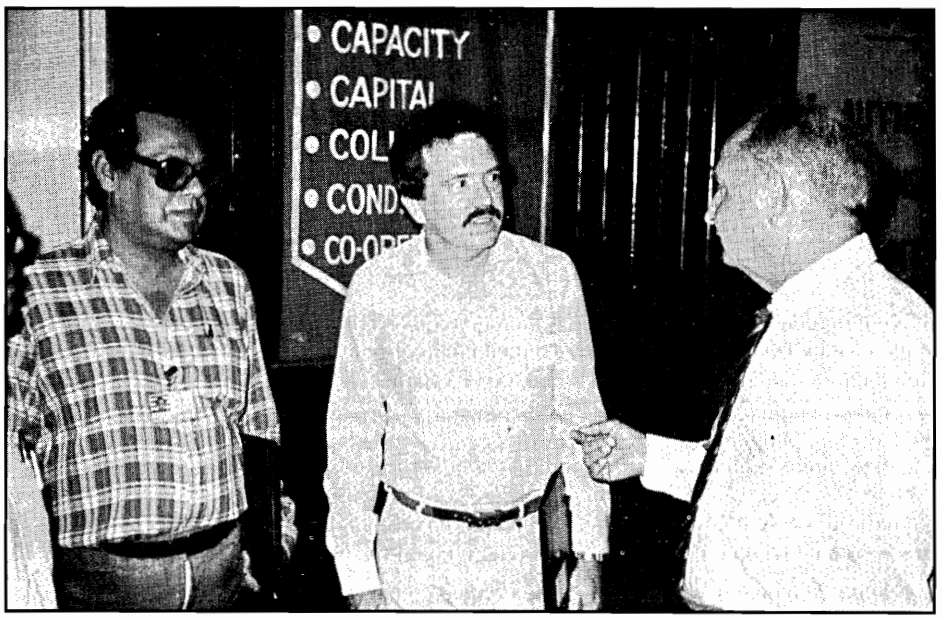
Today, a headline in Ittefag, a Bangladesh newspaper, might read "Private Sector Plays Major Role in Distribution of Fertilizer." The story would point out that eighty percent of the 1,500,000 metric tons of urea sold in Bangladesh in the past fiscal year was sold by private sector distributors who purchased it from factories and ports.

Two years ago, this newspaper story would have been phrased differently since all fertilizer marketing and distribution was then handled by the public sector.

A partnership forged in 1979 between the Government of Bangladesh, the U.S. Agency for International Development (A.I.D.) and the International Fertilizer Development Center (IFDC), promoting a free and competitive marketing system for fertilizers in Bangladesh, has gradually made a difference. Over 50,000 private dealers rather than the public sector are now marketing fertilizer.

Policies pursued by the Government of Bangladesh under this collaborative venture are resulting in savings for the country and its farmers. "Through a project started eleven years ago, the private sector is now making fertilizer more readily available to the farmers and at a lower price," says Kenneth L. Moots, Chief of Party, IFDC/Dhaka.

"Fertilizer will play an increasingly important role in agricultural production in Bangladesh," Moots says. Available land for crop production is limited, so the only way to produce more food is to raise per-unit productivity of the presently cultivated land through increased fertilizer use.



From left, N.U. Ahmed and Dr. Ray Renfro of USAID/Dhaka and Kenneth L. Moots, Chief of Party, IFDC/Dhaka, discuss the Marketing Workshop (May 1990) and other related issues at the Bangladesh Agricultural Reseach Council.

Record-breaking yields in crop production during the past three consecutive cropping seasons represented significant increases over the previous best year's production in Bangladesh, according to Moots.

Fertilizer sales in Bangladesh totaled 2,043 thousand metric tons in 1989-90 (a 22% increase over the previous year) with an average use of 145 kilograms of fertilizer product per cropped hectare.

Even though fertilizer use continues to grow, average consumption in Bangladesh remains low in comparison with

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that of other Asian countries like China and Pakistan.

Substantial savings to the national economy have resulted from the Government's policy shift to involve the private sector in fertilizer marketing and distribution. During 1989-90, the total overall saving to the economy was over US $14.5 million in fertilizer.

The goals of the project are to remove constraints on the supply side of fertilizer, while ensuring adequate fertilizer availability at the farm level at competitive prices. Major (Retrd.) Mohammad Abdul Hakim of M/s. Layla Enterprise, Par-Naogaon, reports that the fertilizer distribution business in Bangladesh is "highly competitive, which causes profits to be marginal but sharpens dealers' business capabilities and is of tremendous benefit to farmers."

Although the Government, through the Bangladesh Agricultural Development Corporation (BADC), still determines the kinds and amounts of fertilizer imported, the AID/IFDC project has opened the marketing and distribution of fertilizer to the private sector. The over 50,000 private dealers (retailers) operate without any licensing requirements or restrictions on price or sales territory. Merchandise credit is commonly provided by wholesalers to dealers and by dealers to farmers.

"Privatization or the development of an open, free, and competitive fertilizer sector was introduced in phases beginning in 1979, with technical assistance from IFDC and financial support from A.I.D.," Moots says.

Prior to this time, the fertilizer marketing and distribution system suffered from excessive government intervention and control, and the residual effects of these policies continue to impact on the system. Dealer appointment involved a time-consuming selection procedure. Dealers were restricted to selling fertilizer within a defined area, and account books were subject to periodic inspection. Though a number of justifications were given for these restrictions, the overall effect was one of dampening dealer initiative.

Bangladeshi farmers buy urea supergranule fertilizer from a distributor's shop.

As fertilizer use began to increase significantly in the 1970s, the heavily subsidized price created a serious budget problem for the Government. By 1977, the fertilizer subsidy amounted to four percent of Bangladesh's total expenditures.

With erratic and inadequate domestic fertilizer production, poorly programmed imports, chronic foreign exchange deficits, and limited national storage capacity, the Government could not hope to meet fertilizer demand without donor assistance. As a result, the Government of Bangladesh and A.I.D. began negotiations in 1977 for a project to increase fertilizer use on an equitable basis through the development of a competitive, open, free market in fertilizer distribution. Since 1979, IFDC has been responsible for consultancy services in fertilizer marketing, distribution, credit, and dealer training.

"With technical assistance from IFDC, Bangladesh has expanded the role of private fertilizer distribution and retailing, decontrolled retail prices, eliminated the licensing of dealers, increased storage capacity, improved movement logistics, improved commercial credit disbursement, and increased management and technology skills of the private sector," Moots says.

IFDC has organized 'train-the-trainer' courses/workshops and developed curricula/course materials for dealer training. The Dhaka-based consultants have also advised and assisted BADC in the production and distribution of promotional materials for dealers' use.

"We have found that some dealers make very good extension agents," Moots adds. "When a farmer comes to a dealer's shop to buy fertilizer, he doesn't rush off to find an agricultural extension agent to find out how to use it. He first will ask the advice of the dealer from whom he buys it."

As a result of collaborative efforts of the Bangladesh Government and IFDC, a dynamic private-sector distributor/dealer network has developed, creating improved fertilizer availability at competitive prices for Bangladeshi farmers. Withdrawal of restrictions on fertilizer movement has made marketing more responsive to shifts in demand and supply. Competition among dealers, sales promotion activities, and better customer services have contributed to demand creation and growth in sales.

"During 1989, the market structure underwent a radical transformation," Moots says. "Over 360 private distributors from all over the country started purchasing fertilizer directly from factories, and their share of the urea market

steadily increased from 6.14% in March 1989 to over 90% in January 1990."

"The experience of private distributor marketing over the past year has eased the concerns about the emergence of monopolies and removed doubts about the capability of the private sector to undertake fertilizer sales on a large scale," Moots says. "The market is highly competitive, and access of new entrepreneurs is in no way obstructed. Rapid capture of the urea market and expansion of their share of triple superphosphate, muriate of potash, and gypsum sales are indicative of the private sector's capability, dynamism, and willingness to participate in competitive fertilizer marketing."

The next major step toward achieving a fully competitive, cost-effective, and market-oriented fertilizer marketing and distribution system in Bangladesh is the entry of the private sector into fertilizer import. Private distributors, wholesalers, and dealers now have to depend on BADC for the import of fertilizers. This reduces flexibility in obtaining supplies and limits product access.

The Government of Bangladesh has already accepted in principle to allow private-sector participation in the import of phosphate, potash, and other fertilizers by withdrawing current restrictions and amending import regulations.

As policy reform to develop a free and competitive fertilizer marketing system progresses toward its final stages, the size of the fertilizer operations of the private sector and their credit requirements are becoming larger and larger. To meet these growing needs, major policy reform in the central bank and the commercial banking sector has been taking place with assistance from IFDC.

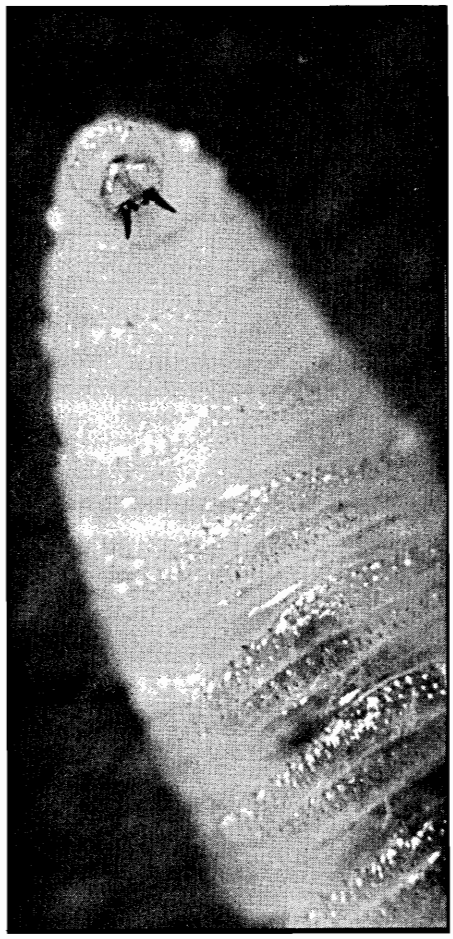
"We expect private-sector import to bring in benefits similar to those realized from direct purchasing of urea from factories," Moots says. "An IFDC/Dhaka study has identified these potential gains to be lower internal movement and handling costs, improved seasonal availability in all regions, improved product quality, and expanded services to farmers using fertilizers." ★

Screwworm Threatens Livestock in Africa, Asia and Europe

by William Overholt, Bureau for Science and Technology, Office of Agriculture, U.S. Agency for International Development

The New World screwworm fly, (Cochliomyia hominivorax), known in the Western hemisphere for the serious threat that it poses to warm-blooded animals including cattle, sheep, goats and even humans has recently appeared in North Africa for the first time.

The parasite was spotted in Libya near the capital of Tripoli in 1988 and was thought to have been accidentally introduced into the country by livestock imported from South America.



Screwworm larvae burrow into the body of a host animal. If untreated infestations can be fatal.

If steps are not rapidly taken to meet the screwworm threat in Libya, the infestation is likely to spread. "Effects on livestock production will be devastating," says Allan Showler, an entomologist with the Office of U.S. Foreign Disaster Assistance at the U.S. Agency for International Development (A.I.D.). "The epidemic could spread throughout all of Africa, the Middle East, parts of Asia and southern Europe at virtually any time."

The current infested area is estimated to be 20,000 square kilometers and there are strong indications that it is expanding. In 1988, there were 30 confirmed cases and 300 unconfirmed cases of human infection in Libya. Last year, 1,938 cases of livestock infestation were reported — mostly in sheep, goats, camels, and equines. In the month of August 1990 alone, 2,145 positive cases have been reported.

The epidemic could spread throughout all of Africa, the Middle East, parts of Asia, and Southern Europe at virtually any time.

To deal with the potential threat, the Food and Agriculture Organization of the United Nations (FAO) has mounted an

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eradication program. Technology developed in the United States and tested in Mexico will be used by the FAO when the program gets underway in the fall of 1990. A.I.D. has contributed $3 million to this effort.

The FAO approach follows the strategy developed by scientists at the U.S. Department of Agriculture (USDA) which relies on sterilizing screwworm flies with radiation. After a sufficient number of sterile males are released, the majority of matings result in infertile eggs. The population declines and eventually becomes extinct.

The FAO eradication program will release sterile flies, control animal movement out of the infested area, and treat infested animals. These efforts will be complemented by an intensive survey effort to monitor the program's progress. FAO specialists predict that the fly can be eradicated from North Africa in two years or less.

Sterile screwworm flies will be provided at cost for use in North Africa through the United States-Mexico Commission for Screwworm Eradication. The Commission is responsible for overseeing a southern Mexico based facility — currently the only one of its kind — which has the capacity to produce sterile screwworm flies.

Funds provided by A.I.D. for the eradication program will be used primarily to upgrade the production facility in Mexico in order to assure that a sufficient number of flies can be provided for the program in North Africa as well as for on-going efforts in Central America.

The eradication program is not only expected to cover the estimated 20,000 square kilometers currently infested but will include a 20,000 square kilometer buffer zone surrounding the infested area.

"There's really no technical reason why the program should not work without a flaw," says Dr. Richard Peterson, a USDA screwworm expert on temporary assignment with the Asia and Near East Bureau of A.I.D. Studies have shown that the African female fly will mate with Mexican sterile male flies. Moreover, FAO has shown that the flies can withstand the long aircraft journey from Mexico to Africa.

The most critical factor to the project's success is timing. Any delays in initiating the project would greatly increase the chance that the screwworm fly will spread from Libya into other countries in the region. If the distribution of the fly becomes to extensive, eradication may then become technically and eco-

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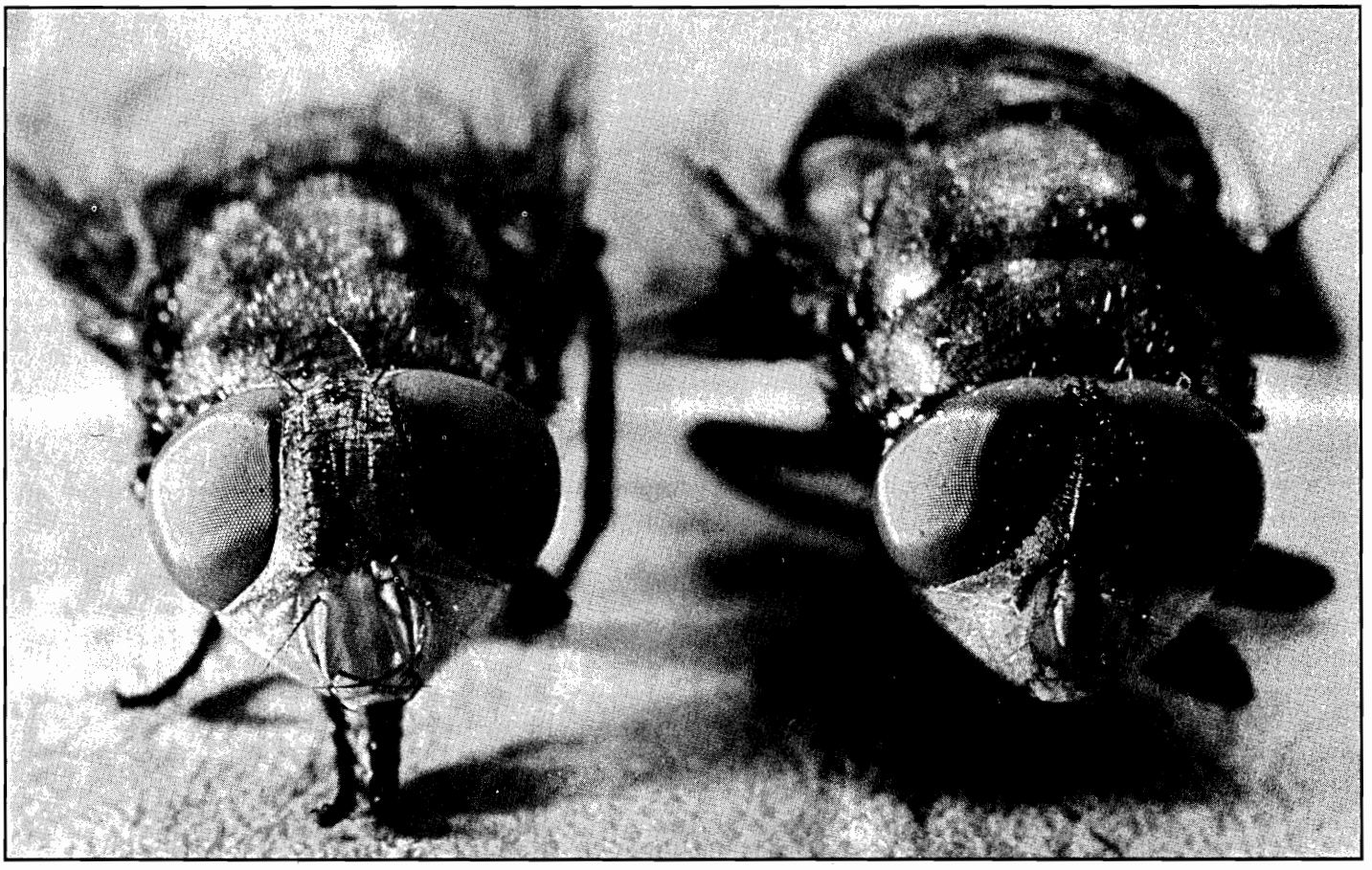

The Screwworm fly, which recently appeared in North Africa for the first time, can pose a serious threat to cattle.

Tissue Culture: A Tool for Sustainable Agriculture

by Reagan M. Waskom, Field Research Coordinator and Julie L.F. Ketchum, Operations Director, Tissue Culture for Crops Project, Colorado State University, Fort Collins, Colorado

Working to meet the increasing need for food around the world is a focus of the Tissue Culture for Crops Project (TCCP) at Colorado State University. Recently, research under the project supported by the U.S. Agency for International Development, Bureau for Science and Technology, Office of Agriculture (ST/AGR), has paid off.

Two sorghum lines tolerant to fall armyworm feeding developed under the project have been accepted by the American Society of Agronomy for release as registered germplasm. This shows that tissue culture can produce variants which can be used by U.S. and developing country farmers to increase crop yields.

Since 1950, about four-fifths of the growth in world food production has resulted from increased land productivity. However, FAO, in 1983, reported that by the year 2000, many countries will not be able to feed themselves from their own resources. This will be true even if all arable land were brought into production and were used to grow food for the domestic population, and if a higher level of agricultural technology were adopted. Tissue culture, a method of rapid propagation that can be used to select desirable mutants in vitro, is a way of altering the plant to suit the environment when the limit of the land's productivity is reached.

The goal of the TCCP is to expand and accelerate the application of tissue culture research to crop production problems in developing countries by strengthening their capacity in this field and by linking and coordinating worldwide research. This is accomplished through research, training and networking.

In tissue culture research, the project focuses on regeneration systems, protoplast technology, anther culture, cytogenetics and molecular biology with the broad goal of advancing the knowledge and tools for improving stress tolerance in field crops. Application of these technologies will eventually enhance the ability to sustain agricultural productivity while minimizing ecological degradation.

Much effort at TCCP has been focused on the use of in vitro selection techniques for improving crop tolerance to saline, acidic or arid soil conditions. In theory, cell lines which are tolerant to the in vitro stress will proliferate in the media containing the stressing agent. These tolerant cell lines are subsequently regen-

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Improved Hegari regenerant showing tolerance to fall armyworm feeding.

Non-regenerant Hegari check under artifical fall armyworm infestation.

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nomically impossible.

The New World Screwworm fly is an obligate parasite of all warm-blooded mammals. Female flies lay eggs in wounds as small as tick bites. The deposited eggs hatch within 24 hours. The resulting larvae burrow into the body of the host animal.

If untreated, infestations can be fatal to afflicted animals. In the Americas, it was found that some 20% of infected animals die. Full-grown cattle can be killed within as little as 10 days after infection. Newborn animals are particularly vulnerable as screwworms are attracted to the blood associated with birthing.

The screwworm fly is considered to be the most serious insect pest of livestock in the Western Hemisphere with annual losses estimated at hundreds of millions of dollars. ★

Continued from page 5

erated into putative tolerant plants. Field testing and screening of these regenerated plants are required to determine the efficacy of this technique.

The TCCP has pursued its mandate to develop tissue culture technologies for improving the productivity of major food crops by conducting numerous fields tests over the last several years. Beginning in 1986, TCCP has evaluated regenerated sorghum, millet, wheat, rice, pigeon pea and tepary beans at 15 domestic and 24 international test sites. Collaborative research has been established with plant breeders, agronomists, and soil scientists at seven U.S. universities, four international crop improvement centers, and nine international institutions. Field tests have included normal soils, salt-affected soils, low and high pH soils, arid environments, and sites with disease or insect pressure. This extensive research has produced significant results which should benefit crop improvement efforts both domestically and in developing countries.

Recent field tests have provided valuable feedback on laboratory procedures and have produced useful plant material. Selections from tissue culture regenerated durum and bread wheats are currently being utilized by CIMMYT wheat breeders in Mexico for development of improved cultivars. Salt-tolerant wheat germplasm developed through tissue culture is also being utilized by breeders in both Mexico and Pakistan. Development of acid soil-tolerant sorghum through tissue culture has been confirmed and is in advanced stages of testing before release as improved germplasm. A number of selections of acid soil-tolerant sorghum have been made from two diverse genotypes. The original parent lines are highly susceptible to these conditions but the regenerated lines are demonstrating significantly improved levels of tolerance. It is anticipated that several improved selections of these lines will be released as acid soil-tolerant germplasm in the near future.

Collaboration between the University of Georgia, Colorado State University and A.I.D. led to the identification, development and release of insect-tolerant sorghum germplasm developed through tissue culture. Callus culture of the sorghum line "Hegari" was maintained in vitro for 17 months. This culture produced a somaclonal variant with tolerance to leaf feeding by the fall armyworm (Spodoptera frugiperda), an insect which causes significant crop losses in tropical and subtropical regions of the world. Improved tolerance to this pest arms farmers with a tool which may enhance yield without causing environmental degradation. A joint release of two insect-tolerant sorghum lines was approved and signed this year by the A.I.D.'s Office of Agriculture (ST/AGR), The University of Georgia and the TCCP. This represents the first registration of improved germplasm by an A.I.D.-sponsored project.

In addition to performing on-site tissue culture research, the TCCP trains scientists in the U.S. and developing countries. Graduate students at the TCCP have come from a number of countries including India, Indonesia, Pakistan, the Philippines, and Thailand as well as the United States. In addition, over 40 persons have completed non-degree training programs at the TCCP and dozens have attended affiliated courses at CATIE in Costa Rica and IAV Hassan II University in Morocco. Upon completion of their programs, the students return to their own countries to contribute to research.

The International Plant Biotechnology Network (IPBNet), established by the TCCP in 1985, links researchers by disseminating information to over 1,500 persons worldwide interested in plant biotechnology, and by holding biennial conferences.

Projects like TCCP are helping to make a difference in meeting the world's food needs and in building a foundation for sustainable agriculture.

Distribution of germplasm from the insect-tolerant sorghum lines is handled by Dr. Ronny Duncan. Requests for seeds should be addressed to Dr. Duncan at the Georgia Agricultural Experiment Station, Griffin, GA 30223. ★

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Indonesia: Small Ruminant Farmers Increase Productivity

by Joyce Turk, Office of Agriculture, Bureau for Science and Technology, U.S. Agency for International Development.

An innovative project in Indonesia is helping farmers, like Pak Mamad, increase their productivity and income through improved animal management practices. The Outreach Pilot Project (OPP) was initiated in Indonesia in 1984 under the Small Ruminant Collaborative Research Support Program (SR-CRSP) supported by the Bureau for Science and Technology, Office of Agriculture (S&T/AGR) of the U.S. Agency for International Development.

When the project first got underway, Mamad and two other farmers formed a group that received five ewes and a ram as well as a subsidized loan to build a barn. When the farmers decided to separate shortly thereafter, Mamad kept a ewe and ram. Today, he cares for his animals following management advice offered by OPP extension workers. In the past five years, he has sold more than 20 animals. With part of the income, he was able to renovate his house with new roofing and by tiling the dirt floor.

The experiences of farmers like Mamad show that small ruminants incorporated into small-scale farming systems in Indonesia can help generate new opportunity for economic improvement.

OPP has integrated and introduced multidisciplinary research findings to farmers in Indonesia, the Asian country with the largest population of small ruminants — 10 million goats and five million sheep.

The project has helped farmers in West Java adopt improved management practices. As a result, average lamb mortality fell from traditionally high levels of 30-60 percent to levels below 12 percent while farmers' incomes expanded.

The project also led to a substantial reduction of the lambing interval from the typicalvillage average of 12-15 months to eight months or less — a net increase of 50 percent. In West Java, assuming one lamb per lambing with an 85 percent rate of survival, the change in lambing interval potential could represent a production of 5.1 million lambs per year compared to the present 3.4 million, thereby not only helping to improve farmer income but the nutrition of farm families.

Through OPP, Indonesian extension workers established a dialogue with more than 45 farmers who were given sheep and encouraged to participate as partners in the project. OPP showed farmers that a combination of shorter lambing intervals, lower lamb mortality rates and a higher proportion of ewes being bred raised reproductive performance consistently. Farmers who are the best producers in the project increased their flock sizes from an average of 3.9 to 6.5 head.

The Outreach Pilot Project also provided farmers with the first sheep and goat production handbook written in the Indonesian, Sundanese and Javanese languages. In addition, a series of technology information packets were developed to address specific problems and concerns raised by farmers during village meetings and farm visits. The handbooks and technology information packets were so successful in teaching farmers improved management practices that other donors have adopted them for their own programs.

Small ruminants like sheep and goats can help generate new opportunities for economic improvement for farmers.

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For Indonesia's small-scale farmers, raising small ruminants provides a wide range of benefits including meat, milk, fertilizer, fuel, social status and recreation. Goats and sheep require low maintenance costs and relatively simple care. At the same time, they are highly prolific and readily marketable providing income security against low crop yields or crop failure.

Despite such advantages, small ruminant resources in Indonesia have not been used to their full potential. Meeting this challenge has been a central focus of the Small Ruminant Collaborative Research Support Program. Since 1979, the SR-CRSP has worked with the Research Institute for Animal Production (RIAP) in West Java to improve the productivity of small-ruminant farmers in Indonesia.

Interdisciplinary scientific research supported by the SR-CRSP is helping provide a wide range of practical information to farmers. It was found, for example, that the Javanese Thin-Tail and Sumatran Thin-Tail Sheep have the potential to breed year-round and are suitable for intensive production systems — the former for cut-and-carry based feeding and the latter for grazing forage under tree crops such as rubber. On-farm technology testing showed that farmers can reduce lambing intervals from 14 months to less than nine months by proper rotational distribution of available rams as well as through estrus detection of ewes.

Nutrition-related research has shown that supplementing animals' diets with readily available agricultural by-products and incorporating some new feeding practices can improve growth and reproduction at low cost to the farmer. A number of feeding technologies have been developed to increase production. These include:

- supplementation with tree legumes such as gliricidia, leucaena, and sesbania;
- supplementation with several locally available agricultural by-products, such as residues from soybean curd, rubber tree seed, oil palm kernel, kapok seed, molasses, and others; and
- incorporation of salt and minerals as a common feeding practice.

Rubber seeds, a previously overlooked source of protein and energy, have been processed and used successfully as a feed supplement for lactating ewes and lambs.

Research on integrated production systems involving sheep and rubber plantations is another part of the SR-CRSP effort. Experimental data identified the Sumatran Thin Tail sheep as a suitable animal for integration with tree crops, particularly rubber. A cost-benefit analysis of sheep production in this area revealed an average profit per farm of US $150 per year.

Also, grazing sheep under rubber reduced the need for and use of herbicides by as much as 50 percent.

Social scientists have defined the roles of various family members in crop/livestock farming systems and determined the sociological and economic constraints on labor. Indonesian social scientists gathered information on pricing and marketing data for livestock markets, slaughterhouses, and on middlemen and farmers' marketing strategies.

Indonesian farmers are clearly reaping the benefits of combining multidisciplinary research with an effective outreach program that results in higher meat production and increased cash availability.

★

Congressional Reports on Pest and Pesticide Management

The Bureau for Science and Technology, Office of Agriculture (S&T/AGR) at the U.S. Agency for International Development has recently completed publication of two interrelated reports to Congress about pest management in developing countries.

Integrated Pest Management: A.I.D. Policy and Implementation **discusses the rationale for supporting programs aimed at decreasing the losses due to agricultural, livestock and human health pests. It describes A.I.D.'s policies and regulations governing pest management activities and examines possible future programs.**

Pesticide Use and Poisoning: A Global Review **is focused on the problem of human pesticide poisoning in developing countries. The report reviews the literature on pesticide poisoning and concludes that the incidence of poisoning is disproportionately high in developingcountries. Some of the possible reasons for the high incidence of poisoning in developing countries are discussed, along with the efforts of A.I.D. and other organizations to improve the situation.**

Copies of these reports are available from: The Office of Agriculture, Bureau for Science and Technology, Agency for International Development, Washington, D.C. 20523-1801.

Research Network Thrives in Latin America

by Neil Caudle, Program Coordinator for TropSoils Communications, North Carolina State University.

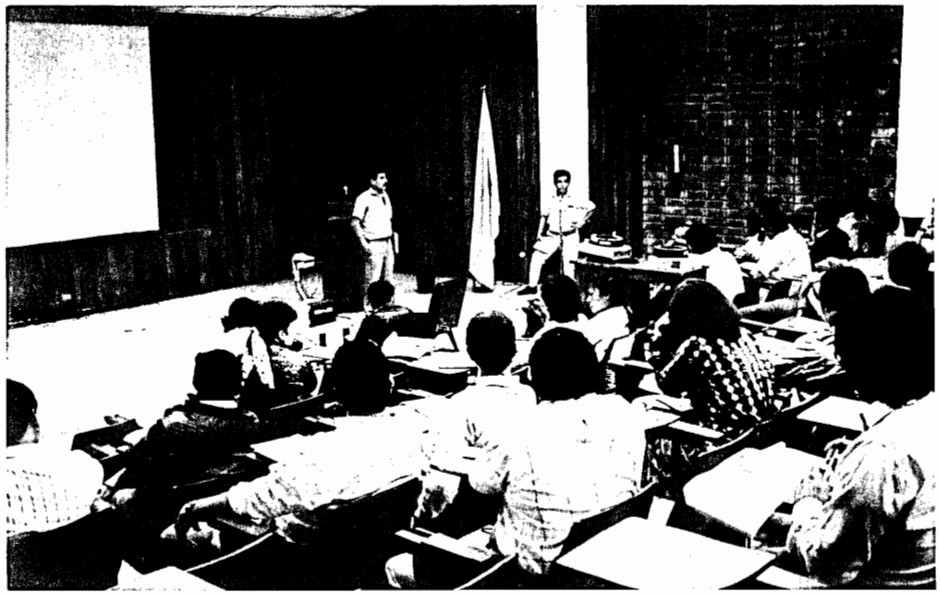
Since its inception in 1986, the RISTROP soil-management network (Red de Investigacion de Suelos Tropicales) has matured into a vigorous, cost-effective organization for promoting research, training and technology transfer in Latin America. While A.I.D. provides support for network coordination and backstopping through TropSoils (the Soil Management CRSP), RISTROP's research sites operate with local funding and personnel. By focusing and encouraging network activities, TropSoils' modest contribution has served as a catalyst for major advances in the quality and quantity of Latin America's soil management research and information-transfer programs.

Some of these advances became apparent this summer, when 103 scientists representing 43 institutions from 15 countries gathered in San Jose, Costa Rica for the second Latin American Workshop on Tropical Soil Management.

"The network has really matured," says Dr. Jot Smyth of North Carolina State University, TropSoils' network coordinator. "In 1986, when we started the network, the participants were primarily interested in running simple field trials with standard treatments. Now they're more process-oriented, looking for the limiting factors in each of their systems, learning how specific soil processes are mediated by local conditions."

At the workshop, representatives from network sites reported on studies related to low-input cropping, mechanized continuous cropping, grass-legume pastures, paddy rice, agroforestry, and the Fertility Capability Classification system. Discussion groups developed recommendations for future network activities and agreed on common research topics and methodologies.

The workshop, which was sponsored by USAID/San Jose, TropSoils, CIMMYT, and the University of Costa Rica, combined the activities of two Latin American networks-RISTROP and CIMMYT's Strategic Agronomic Trials network in the Caribbean and Central America. According to Smyth, covering both networks in one workshop broadened the scope of discussions, provided new opportunities for collaboration, and enabled TropSoils to strengthen its ties with CIMMYT. Many of the participants were members of both networks.



RISTROP workshop, University of Costa Rica, San Jose.

"We wanted to blend together CIMMYT's commodity-research program with a soils research program," Smyth says. "It's a big advantage to bring this blend to the national-institute collaborators."

Smyth said the workshop also benefitted by having representatives from, among others the Soil Management Support Service, the Potash and Phosphate Institute, A.I.D., the Latin American Program on Tropical Soil Biology and Fertility, and the Sulfur Institute.

Smyth feels that RISTROP has helped to promote a systematic, coordinated approach to soil-management research in Latin America and has encouraged professional development among the participants. According to Smyth, feedback from the network helps ensure that TropSoils research is relevant to the needs of the collaborating scientists and institutions. For example during a hands-on demonstration of TropSoils' prototype decision-support systems for liming and phosphorus management, participants provided comments and information that will help Dr. Russ Yost of the University of Hawaii refine the software to better meet the users' needs.

For many representatives, the workshop provided a rare opportunity to increase scientific collaboration and coordinate research with colleagues across Latin America.

"One national institute collaborator in Central America said that this was the first opportunity she'd had to work with South American scientists," Smyth says. He point out that Latin American scientists especially appreciate the opportunity for the kind of professional development and exchange offered by the workshop.

"This was one of the few meetings many of them had attended that specifically addressed soil management." ★

Improved Dryland Agricultural Technology: Toward Food Security in Botswana

by Dr. Naraine Persaud, INTSORMIL Soil Physicist, Department of Agriculture, Sebele, Botswana; Dr. Lucas Gakale, Director, Department of Agricultural Research, Sebele, Botswana; Dr. Douglas Carter, INSTORMIL Agronomist, Sebele, Botswana: Mr. Louis Mazhani, Sorghum and Pearl millet breeder, Sebele, Botswana and Dr. R.L. Vanderlop, Agronomist, Kansas State University

A collaborative research program that brings together INTSORMIL (the International Sorghum and Millet CRSP) and agricultural research scientists in Botswana is helping to contribute to one of Botswana's major goals — achieving food security.

Since the program got underway in 1983, significant gains have been made in soil and crop management technology for dryland sorghum and millet production and several new and improved crop varieties have been developed.

Close collaboration with Texas A&M University and with the SADCC ICRISAT sorghum and millet project and the University of Nebraska has, for example, led to the development of new and improved varieties of sorghum and pearl millet.

A genetic resource base for these crops has been built by introducing and selecting germplasm, collecting local landraces and hybridizing promising local and exotic lines. A local variety has been converted into a cytoplasmic-male-sterile female parent from which new hybrids can be developed. Experimental varieties and hybrids are currently being evaluated in various agroecological zones in Botswana.

On farm trails are also being conducted to test several promising soil-moisture conservation tillage/soil fertility improvement systems to promote deeper moisture and root penetration as well as to develop better weed control and healthier crops. Some of these systems may have the potential to conserve sufficient moisture to permit growing of maize.

Crop residues used in conjunction with manure and fertilizers have been shown to havea favorable effect on crop growth by moderating the impact of environmental constraints. Yields can thus be stabilized at a higher level.

Manure at nine metric tons in combination with crop residues either as mulch or soil-incorporated was applied each year on trial plots at five sites between 1984-85 and 1987-88. Data showed that observed yield increases were due mainly to improved soil fertility from the manure and residue application.

Dryland agriculture is possible in Botswana's arable zone —land along the narrow north/south strip of the country's Eastern border as well as around the Okavango delta. This zone covers about 20% of Botswana's 580,000 square kilometer land surface and receives between 400-600 milimeters of rainfall annually. A wide variety of crops are produced here including sorghum, maize, millet, jugo beans, groundnuts, cowpeas, sunflower and various melons.

The semiarid agroclimate, however, results in seasonal soil moisture deficits and a high risk of crop failure. Soils are deficient in major plant nutrients and have a low capacity to retain moisture.

Dryland farmers respond to such production constraints by using low cost and low risk soil and crop management techniques. For farmers, however, a fair return is dependent on well-distributed seasonal rainfall and is therefore infrequent.

In developing their collaborative research program, scientists from Botswana and INTSORMIL recognized the primary need for practical and sustainable technologies to deal effectively with the twin primary constraints of soil moisture and soil-fertility deficits.

As a result, their program centered around four main themes: rainfall harvesting; soil-moisture conservation tillage and soil fertility improvement; manure and crop residuemanagement; and the development and selection of early maturing, stable-yielding genotypes suitable for Botswana's rainfall climate.

In implementing the collaborative program, researchers utilize both on-station and on-farm research sites.

Such research efforts can help make a significant impact in meeting Botswana's food needs. ★

Research helps stimulate agricultural productivity in Africa.

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SCIENCE & TECHNOLOGY AGRICULTURE REPORTER

★ VOLUME 3 NUMBER 2 SPRING 1991 ★

Toward Sustainable Agriculture: A.I.D. Charts A Future Course

by Vincent Cusumano, Chief of the Economic Policy and Planning Division, Office of Agriculture, Bureau for Science and Technology, U.S. Agency for Interna tional Development

Investments in agriculture are among the principal development tools of the U.S. Agency for International Development (A.I.D.) to assist developing countries meet the food and income needs of a growing population. Over $1.2 billion of the Agency's $6.6 billion FY 1990 budget was aimed at providing financial, technical assistance and food aid to increase the income of the poor majority and expand food availability and utilization while maintaining and enhancing the natural resource base.

The promotion of broad-based and environmentally sound economic growth and elimination of hunger are two goals sought by the Agency in its agricultural development projects. Sustainable development is an equally important goal.

Population pressure and income growth are threatening the long-term capacity of the world's agricultural economies to continue to provide for the food needs of a growing population. Since a large part of the world's population growth is taking place in developing countries where both pressures on limited resources and potential for income growth are the greatest, A.I.D. promotes and institutionalizes the concept of long-term sustainability in making its agricultural program decisions. This reinforces the Agency's fundamental focus on the needs of people and adds a complementary concept that whatever is supported by A.I.D. must be sustainable over time.

Sustainable agriculture is defined as the successful management of resources (including soils, crops, water and fish, livestock, forestry) to maintain and improve their productive capacity over time. The concept is dynamic. It includes the need to consider the demands of future generations on present programmatic choices. And, it calls for decision making that takes account of the natural resource base as a condition for continued economic growth.

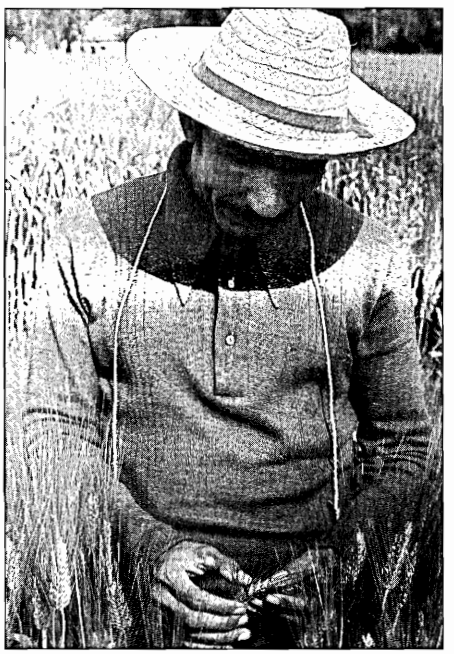
The Setting

Agricultural sector development is critical to the economy. It provides not only food, fiber and fuel, but also employment, income and savings to a large percentage of the population. Without a growing and dynamic agricultural sector, overall development lags behind. The formulation of sound, sustainable agriculture policies requires an understanding of prevailing conditions in developing country agriculture.

Agricultural Production

Growth in total food production has increased in both developed and countries during the forty year period ending in 1990. In fact, total production increases took place more rapidly in developing countries than in developed nations. Cereal production (wheat, rice, coarse grain), for example, increased from 1.3 billion metric tons to 1.8 billion metric tons during 1971-1985.

When population growth is factored in, the picture changes. Stated in per capita terms, developing countries experienced only a 10 percent production increase during the decades of the sixties and seventies. The poorest countries in Africa and the Near East actually experienced no growth or a fall in per capita food production since the mid-seventies. Hunger and malnutrition are still problems. Income growth, which averaged 3.5 percent per year, has put additional pressure on total food demands. Countries in Latin America, Asia and Africa that were, at one time, exporters of cereal grain are now finding themselves net importers. Demand for agricultural commodities has also increased as a result of



Sustainable agriculture calls for decision making that takes into account of the natural resource base as a condition for continued economic growth.

the accessibility of markets in Central and Eastern Europe.

By the beginning of the eighties, food imports through commercial and development assistance channels began to play an important role in the food balance of trade in the developing world. Foremost for many policy makers in developing countries is the problem of how to obtain food security from local sources, and, in the food deficit countries, where to find the foreign exchange for importing cereal grains from North America and other international markets. Increasing debts, and balance of trade problems, however, are limiting the ability of developing countries to import needed cereal grains. Pressures are now mounting for expanding the agricultural frontier into areas which are marginal at best, often resulting in increased cost of production per unit crop produced.

Environmental Impacts

Agricultural expansion and a production-led orientation in modern agriculture are often promoted with little regard for the long-term sustainable use of the land. Tropical forests (open and closed) are being removed at a worldwide rate of more than 11 million hectares per year to create new areas for cultivation and provide fuelwood and timber needs. These activities pose grave implications for the loss of valuable biological and genetic resources for future crop and forestry development. Removal of forest cover and inappropriate use and overexploitation of crop and range lands contributes to high annual rates of soil erosion (100 tons/hectare in the highland regions of Guatemala and even higher in Haiti). Pollution of surface and groundwater and other off-site effects resulting from the over use of pesticides and fertilizers are disrupting hydrologic systems and cause extreme damage to biological systems. In irrigated lands, salinization and waterlogging are critical problems threatening what used to be highly productive areas.

Technological Development

Increases in yield through technological improvements, which either expand production and often reduce per unit costs, contribute to growth in world food production.

During the initial years of the Green Revolution (1966–1978), for example, yields in developing countries increased significantly. However, high input requirements of new crop varieties has limited their adoption in developing countries to those areas where irrigation or high valued inputs are available. The current rate of research spending will not result in a rapid technological breakthrough for the more marginal and dryland areas of the world. Although promising for future application, such research efforts as the improvement of photosynthetic efficiency in plants through genetic changes and developing cereal varieties which fix nitrogen directly have not yet advanced to the point where the technology can be made available in developing countries. Modern agriculture practices continue to rely on sustained use of fertilizers, insecticides and water.

Institutional Capacities

Effective institutional capacity in research, training, extension and policy of developing countries is critical for long-term sustainable agriculture. Many developing country institutions--usually understaffed and underfunded are generally unable to develop and implement sound research and outreach programs. Farmers, especially those on fragile lands, have little access to technical information. Lack of credit, financial incentives and land tenure arrangements all contribute to inappropriate land use and long-term resource degradation.

Other Factors

Lack of political stability in some developing countries is a deterrent to sustainable agricultural development. Inappropriate economic policies also have a negative influence on the resource use decisions for agricultural production.

The A.I.D. Response

A.I.D. has taken a number of positive steps to incorporate natural resource and environmental concerns into development programs, policy and planning. The Agency is now putting into place a new agricultural focus which establishes as a goal, the long-term maintenance and enhancement of the natural resource base. This includes efforts to establish sustainable farming systems that are capable of responding to the changing conditions for continuing gains in the economic and social welfare of the people in the develop-

Effective institutional capacity in research and training is critical for long-term sustainable agriculture.

ing world.

The development of the Agency's strategy for sustainable agriculture takes into account a number of factors such as: the need for a better understanding of sustainable agricultural systems at all levels in the developing world; the promotion of biological diversity within farming systems; a long-term commitment to sustainable agriculture issues especially in those areas of the world where environmental degradation is eroding the productive capacity of the natural resource base; the need for policy support for the concept of sustainability in agricultural development; and the key role of private sector participation in implementing sustainable agriculture initiatives.

A.I.D. supports projects which promote stable agricultural production systems over time which are productive and profitable. These systems minimize downstream costs by reducing off-farm contamination of air, water and land by nutrients and toxic materials. Sustainable agriculture efforts promoted by the Office of Agriculture in the Bureau for Science and Technology help provide supportive information and methodologies.

Long-term sustainability will become an increasing part of A.I.D.'s agricultural programs. The Agency will continue to work closely with other institutions, both public and private, to help developing countries make maximum progress toward implementing programs for sustained agricultural development. A.I.D. will strengthen its efforts to share information on sustainable agriculture and to promote coordination among donor agencies to maximize interest in and program funding for sustainable agriculture.

The development of an agriculture sector which can continue to provide food and incomes for the world's growing population is a major challenge. A.I.D.'s leadership efforts in working toward a viable strategy for integrating sustainable agriculture concerns into its economic development program will help assure that not only are the world's food needs are met today but that they are met for generations to come. ★

New Device to Measure Underwater Explosions May Help Prevent Biological Diversity Loss

by Dr. Saul Saila, International Center for Marine Resource Development, University of Rhode Island

An unfortunate measure of man's tenure on earth may be the large decrease in biological diversity caused by his actions.

Large scale habitat conversion and destruction is proceeding at different rates in different regions and environments.

Tropical forests are estimated to be decreasing more than 40,000 square miles per year. The degradation of coastal zones of the marine environment may be occurring just as rapidly.

Over two thirds of the surface of the planet is covered by ocean. The biota of the oceans are essential to the structure and function of the global ecosystem. The global coastal zone covers about eight percent of this planet's surface--slightly more than the estimated six percent area covered by tropical forests.

Over 50 percent of the human population lives within or very near to coastal zones which also yield some 90 percent of the annual production of living resources taken from the sea. The biological diversity of this zone is very high as indicated by the fact that of all living species of vertebrates, the class which includes bony fishes contains the largest number of species --more than 18,000 compared to a total of about 4,000 species of mammals currently present on earth.

Tropical coral reefs and shallow waters (especially in Southeast Asia) contain the most diverse fish assemblages in the world, with over 2,000 species reported on some reef areas.

The loss of biological diversity in the marine coastal zone is a rapidly growing concern, addressed, in part, by the A.I.D., Bureau for Science and Technology, Office of Agriculture Fisheries Development Services Project. The project, which has been active for about a year, provides information on the consequences of destructive fishing practices (such as the use of explosives) in coralline and shallow marine environments of the Philippines. It develops and tests new methodologies for quantitatively assessing changes in biological diversity in such environments.

Using the data logger to collect blast fishing data.

Blast fishing, which involves the use of explosives to capture fish, is one of the most common forms of illegal fishing in the Lingayan Gulf in the Philippines. Destructive fishing practices are common in other parts of the Philippines as well as in other developing nations. Blast fishing can pose a serious threat to fishery resources through habitat destruction and reduction of species diversity.

The project has focused on the development of techniques for quantifying the frequency of blast fishing activities, and the development of a mathematical model to describe and predict the recovery of fish assemblages in coral communities damaged as a result.

Because such fishing is illegal, it is difficult to obtain accurate and precise estimates of the magnitude of this activity. To obtain objective information on the amount of blast fishing, a data-logger, an instrument for measuring the frequency of underwater explosions was developed.

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The cylindrical data-logger is about three inches in diameter and 18 inches in height and can be placed underwater where illegal fishing takes place. It can operate completely unattended for up to one week, will record underwater explosions within a radius of about 1 kilometer and save the records for further analysis.

The major components of the data logger are an acoustic hydrophone, an interface electronics board, a microcomputer board, battery pack and a waterproof underwater housing. The instrument is designed to function as an underwater listening device with a software selected threshold.

When an explosion exceeds the threshold, the instrument's computer logs the time, data and four consecutive analog to digital conversions of the input signal. Data stored in the memory of the data logger can be transferred to any compatible computer. A cable can be connected from the instrument to a host computer after recovery from deployment to allow discharge of data. The internal battery of the instrument is recharged overnight and the data logger can then be redeployed.

Successful testing of the data logger instrument has already been completed in the Philippines.

Other aspects of research conducted under the project include field studies to estimate the magnitude of damage to coral habitat by blast fishing, and the recovery rates of the coral environment. A mathematical model for the recolonization of coral reef fish assemblages from blast fishing is being developed to provide information on the time rate of recovery as well as the probable composition of the news assemblages of fish.

Further work on this project will include additional model development, analysis of specific bio-responses of fish and other marine organisms to underwater explosions and estimates of coral growth rates. ★

Environmentally Sound Fertilizers for Developing Country Agriculture

by Marie K. Thompson, writer-editor, International Fertilizer Development Center, Muscle Shoals, Alabama

There is growing concern that nitrogen fertilizers contribute to environmental degradation. Specifically, they can lead to problems of nitrate water pollution, to pollution of the earth's atmosphere with oxides of nitrogen and they can potentially contribute to the "greenhouse effect" or global warming.

When nitrogen, in either synthetic or natural fertilizers, is applied at rates that greatly exceed the amounts used by plants, nitrate can move below the crop rooting zone and may eventually contaminate ground waters. This is particularly true on sandy soils receiving large amounts of water through natural rainfall or irrigation.

According to the Food and Agriculture Organization of the United Nations (FAO), some developed countries use as many as 700 kilograms of synthetic fertilizer per hectare of arable land, endangering both the soil and water resource base.

The situation is vastly different in developing countries. For example, African countries use an average of 11 kilograms per hectare, Latin America nations use 48 and Asian nations 62 kilograms--not enough to restore the nutrient loss of crop uptake, which FAO estimates to be from 100 to 150 kilograms of plant nutrients per hectare.

In South and Southeast Asia, rainfed and irrigated transplanted rice occupies nearly two-thirds of the agricultural area and produces more than 80 percent of the paddy rice. In these areas, prilled urea conventionally applied by farmers is very inefficiently used by transplanted rice primarily because of serious losses of nitrogen (up to 60 percent of applied nitrogen) through loss as gases as well as

Use of urea supergranules, if widely adopted in the developing world, can help increase food production in an environmentally sound manner.

leaching and/or runoff. This represents a huge financial loss to rice farmers and is a potentially serious problem for the environment and for sustainable agriculture.

In 1975, the International Fertilizer Development Center (IFDC) proposed the use of large urea particles, commonly referred to as urea supergranules (USG). Deep placement of USG when followed by immediate sealing of the holes left at the placement sites helps retain nearly all urea-nitrogen in medium-to-fine-textured rice soils with low percolation rates.

For the past 13 years, with support from A.I.D.'s Office of Agriculture in the Bureau for Science and Technology, IFDC has worked to evaluate and promote the effective use of USG as an efficient nitrogen source for transplanted lowland rice. The IFDC-developed USG agrotechnology consists of an affordable supply of the right kind of USG fertilizer and an efficient methods for its deep placement.

In 1986-87, IFDC worked in Indonesia to test and modify a village level briquetter for producing pillow-shaped USG. (Briquetting, a special type of compacting process, is a cost-effective method for producing USG).

By the end of 1989, IFDC designed and constructed an improved version of the village-level briquetter with a capacity of about 200 kilograms per hour. The briquetter is currently undergoing tests to examine its performance under continuous operating conditions and to determine if it needs to be further developed before making the technology available outside IFDC. Estimates show that the production cost of USG by briquetting ranges from 5-10 percent more than that of prilled urea.

To provide an efficient method for deep placement of USG, IFDC has developed a plunger-type, completely hand-operated polyvinyl chloride applicator. Its proper use for mechanical deep placement of urea briquettes in transplanted rice will nearly eliminate all nitrogen losses.

Field trials conducted in the Philippines and India demonstrate that small-

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Strategies for Sahelian Watersheds

by Neil Caudle, Program Coordinator for Communications, Soil Management Collaborative Research Support Program (Trop Soils), University of North Carolina

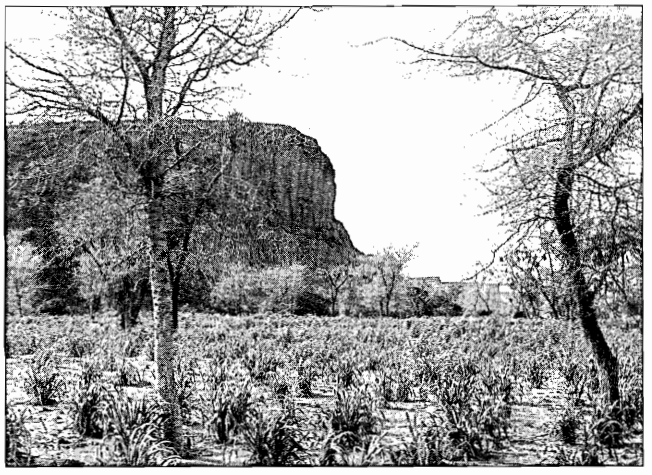
Recognizing that sustainable agriculture depends on a finely tuned harmony of people, landscapes and technology, the Soil Management Collaborative Research Support Program has embarked on innovative new research in an entire Sahelian watershed. The goal of this effort, supported by A.I.D.'s Bureau for Science and Technology, Office of Agriculture, is to develop an integrated, comprehensive management system that will help farmers conserve resources as they increase and sustain food production.

The watershed-495 hectares of plateaus and sand valleys in western Niger--is typical of many landscapes in the Sahel. Wind and water erosion threaten food crops, which are primarily millet and cowpea. Forty-one families from four villages depend on the watershed for at least a part of their subsistence.

So far, researchers from Texas A&M University and their collaborators from the Institut National de Recherches Agronomique du Niger (INRAN) have integrated baseline data on climate, vegetation, soils and indigenous technologies into a geographic information system (GIS), a useful tool for developing management strategies. The team has also delineated five distinct "land management units" in the watershed:

- Tondobon, a hardened, laterite plateau that sheds rainfall quickly and provides fuel, medicines and grazing;
- Tondo Kakasia, comprised of steep slopes and eroded, crusted soils, supplying medicinal herbs and construction material;
- Fondu, gentle slopes with dry, low-fertility sands, used mostly for millet and cowpea;
- Gangani Kirey, shallow, crusted soils where grasses and shrubs are harvested for construction material;
- Gorou, gullies and washes that carry water and some nutrients from the plateau into productive fields.

Because these units recur throughout the Sahel, management systems that prove successful in the watershed project will be easily transferred to a large number of sites with similar characteristics. And, by involving an entire watershed and the people who use it, the project takes an ambitious first step toward sustainable agriculture--the necessary basis for conserving natural resources and meeting human needs. ★



With A.I.D. support, an integrated, comprehensive management system in a watershed in Niger is helping farmers conserve resources as they increase and sustain food production.

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Crop Modelling Computer Programs Help Scientists Predict Rice Yields

Scientists are developing computer programs to help them predict how much certain annual crops, such as rice, will yield when grown in different soil types, climates, or crop combinations.

Crop modelling is a relatively rapid and inexpensive way to predict crop behavior because it reduces the need for experimentation. Scientists can simulate production and water use in models to evaluate new sites, crops, or management techniques. Simulation models can establish the impact of year-to-year weather variability on a crop much faster than conventional methods. They are also useful in helping scientists guide research.

"Yield predictions cannot be perfectly precise because no one knows what the weather, which has a great influence on yield, will be like next months," says Dr. F. Penning de Vries, a scientist at the International Rice Research Institute (IRRI) in the Philippines.

"Useful predictions of crop behavior can only be made if the crop is well understood," adds Penning de Vries. "So part of our work is to better understand the crops we are developing models for."

A.I.D. is assisting in IRRI's efforts and provides approximately 20 percent of the core funding to the Institute.

For relevant predictions through crop modelling, a scientist must feed into the computer program data on the crop, historic weather patterns, the presence of crop pests, and availability of water and nutrients.

"Modelling is most useful for predicting crop responses to new situations, such as when opening new land areas," Penning de Vries says. "A farmer knows from experience how his rice crop will probably behave when he manages it in a certain way. But he may not know what to expect in a new situation, such as on newly cultivated land, or when planting a new variety or a new crop combination. Crop modelling predictions can help extension workers inform farmers about expected crop performance.

Knowledge about crops is increasing, more data bases are becoming available, and computers are rapidly being introduced into almost all countries, Penning de Vries says. This means that crop simulation can be used more readily by research stations in developing countries.

Availability of skilled people is the limiting factor for crop modelling. Training is, therefore, an important component of the Simulation and Systems Analysis for Rice Production (SARP) Project. Some 90 scientists from nine Asian countries have already been trained in SARP.

The SARP project at IRRI works in association with other institutes and universities, especially the Agricultural University at Wageningen in the Netherlands and the University of Hawaii in the United States. Scientists share the generated knowledge with colleagues in developing countries through training programs and other collaborative activities.

Scientists studying global climate change use simulation models to predict sea level rise with a temperature increase. Crop modelling can also help breeders design new plant types. With the expected increase in the carbon dioxide content of the air, for example, what changes should be made in the structure of the rice plant to enable it to capture the extra carbon dioxide for increased growth?

Predictions about crop behavior are being made not only for rice, but also for other annual crops such as wheat, maize, peanut, soybean, cowpea and mungbean.

"We thought we fully understood the growth rate of rice, but experiments showed that it can be 30 percent more than expected under certain conditions," says Dr. M. Dingkuhn, IRRI crop physiologist. "This could be because rice plants use carbon dioxide from the soil, as well as from the air. If so, this makes rice an unusual plant and we will have to investigate how we can exploit this process further." ★

Predictions about crop behavior are made for rice (shown here) and other annual crops such as wheat, maize, peanut, soybean, cowpea and mungbean.

This article is based on a recent news release by the International Rice Research Institute, Manila, Philippines.

Supplying Essential Plant Biodiversity

by Dr. George A. White, Plant Introduction Officer, U.S. Department of Agriculture and Vicki M. Binstock, Botanist, University of Maryland

Date offshoots to Jordan and Pakistan, naked barley to Nepal, sweet potatoes to Taiwan, forage legumes to Madagascar, fast-growing trees and strawberries to Haiti and flowers to India are but a few examples of plant diversity sent around the world. Movement of such plant materials occurs through the Plant and Seed Materials Project. This joint U.S. Department of Agriculture (USDA)-A.I.D. project started in 1955 and is implemented by the USDA's Plant Introduction Office (PIO). The project's long life reflects the continuous need for plant biodiversity to develop improved crops, new crops and innovative cropping systems that maximize yield, to conserve soil and other natural resources, and to improve the environment.

As part of the National Plant Germplasm System (NPGS), the PIO provides national coordination of the exchange of plant germplasm. Since this activity encompasses almost all crops, the PIO is in a unique position with its national and international contacts to provide a wide range of plant materials through the A.I.D.-funded project.

Dr. Jim Hooper of the Madagascar-International Rice Research Institute (IRRI) Rice Research Project, for example, is utilizingthe Plant and Seed Materials Project to obtain various legumes for planting after wetland rice.

The Plant and Seed Materials Project has also provided trial quantities of a series of cultivars for several promising species for the Save the Soil Project, an A.I.D. supported effort in Haiti which seeks to protect the diminishing soil resources of the country and to provide small farmers with increased revenues. Leguminous plants are an integral aspect of the techniques extended by the project as they provide ground cover, fix nitrogen and produce nutritious feed for livestock.

Crotalaria (a legume used for fiber and green manure in some countries) seed of a cultivar developed by the Soil Conservation Service of the USDA was first obtained from commercial producers in Hawaii. Initial observations indicated a high biomass production within two-three months. Crotalaria, therefore, appeared amenable to the brief fallow periods between multiple cropping seasons. The Plant and Seed Materials Project was able to provide two additional cultivars and a second species of Crotalaria. This enabled the project to conduct more intensive screening tests in an effort to find the most adapted form of this new introduction to Haiti.

The Plant and Seed Materials Project was especially useful in providing trial quantities of a series of cultivars for several other promising species the project in Haiti.

If you wish to request plant materials and associated information through the Plant and Seed Materials Project, you can access these services through the local USAID Mission Office, the Office of Agriculture, Bureau for Science and Technology, A.I.D. Washington, D.C. 20523-1809 or directly through the Plant Introduction Office, USDA Agricultural Research Center, Building 001, Room 322, 10300 Baltimore Avenue, Beltsville, Maryland 20705-2350.

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USDA's Plant Introduction Office provides national coordination for plant germplasm exchange.

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Using the Services of the Plant Introduction Office

When using PIO services some tips to remember are:

• Be specific as to the crop species and amount of seed and other propagative materials needed, desired cultivars if known, and date needed for planting.

• If familiar with a source of desired materials, provide the full address.

• When unfamiliar with cultivars or their availability, indicate the most important traits needed. Describe environmental conditions such as elevation, annual precipitation, dryland or irrigated cropping, soil type and pH, latitude and others as relevant. PIO staff will consult with crop specialists and collection curators to select the most appropriate materials.

• PIO staff honor the import regulations of every country. Requestors are advised to check quarantine requirements and, if necessary, obtain an import permit which should accompany the request. All shipments of plant materials include phytosanitary certificates.

• Seed sample size will vary roughly from 100 to 1,000 grams each depending on seed size, availability, and cost. Grafted fruit trees and other perishable vegetative materials can be provided in quantities of two to 10 each depending on availability, cost of purchase, and shipping arrangements.

• Allow three to five weeks for most seed shipments to be processed and additional time for delivery.

• Services are provided free of charge. When quantities requested exceed PIO limitations, addresses of reliable commercial sources will be supplied.

• Be sure to include complete mailing addresses and any special shipping arrangements with your request. Most seed shipments will be sent either by USAID pouch or by air parcel post. For valuable, highly perishable materials, shipment may be by air express, air freight or hand carried. ★

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scale rice farmers can use the applicator profitably for nitrogen application at af fordable rates and still achieve the same high agronomic efficiency as that achieved with the conventional hand deep placement of USG.

The applicator is affordable, lightweight, simple to construct, easy to use, requires low draft power (about 4 kilograms), and can save up to 40 percent of the labor normally required for the hand placement of USG. It also reduces the drudgery of hand placing USG after transplanting.

If USG is widely adopted in the developing world, it can help increase food production in an environmentally sound manner.

Results of recent field research in Maharashtra State, India, showed that when USG deep placement technology was used, small farmers received an additional income benefit of US $40 per hectare with a benefit: cost ratio of about five or more (anything above two is considered profitable) at a rate of 38 kilograms nitrogen per hectare when compared with traditional farmers' methods of applying prilled urea.

In future research at IFDC, the potential of fertilizers to reduce environmental problems will receive greater emphasis. Application of fertilizer to the most productive farmlands may help reduce the encroachment of farming into marginal, erodible, or fragile areas in developing countries. It may also help reduce the amount of slash-and-burn and shifting agricultural practices, which are used in developing countries to replenish nutrients on very infertile soils. Supergranule fertilizers may also play a key role in the establishment of trees and shrubs in very nutrientl—deficient areas where revegetation is critically needed to reduce soil erosion and desertification. ★

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Agricultural Biodiversity and International Conservation Efforts

By Joel I. Cohen, Project Officer, Office of Agriculture, Bureau for Science and Technology, U.S. Agency for International Development

Conservation of plant genetic resources is achieved by protection of populations in nature (*in situ*) or by preserving samples in genebanks (*ex situ*). The latter are essential for users of germplasm who need ready access. *Ex situ* conservation acts as a back-up for certain segments of diversity which might otherwise be lost in nature and in human-dominated ecosystems. The two methods are complementary. Yet, better understanding both of their interrelation and the role of *ex situ* conservation in global environmental considerations is urgently needed. Increased international attention is required to safeguard *ex situ* conservation efforts and to include them in the development of environmental policies to conserve global diversity.

In recent years, support has increased more for *in situ* than for *ex situ* conservation. For example, of the $37.5 million expended by the United States in 1987 for conservation of biodiversity just over 1 percent was used for *ex situ* projects, excluding contributions to the international system of genebanks.

In 1990, Congress requested that the U.S. Agency for International Development (A.I.D.) study the need for *ex situ* conservation of biological diversity and programs requiring support through Agency assistance. The project was originally envisioned by Congress as an "international rescue mission for the thousands of animal and plant species faced with the prospect of eminent extinction." It was given the name "Project Noah" in reference to the biblical story of Noah who put two of every species on the ark to save them for use at a future time — the earliest recorded *ex situ* conservation effort.

The Agency's Bureau for Science and Technology responded to the Congressional request by preparing a report to Congress titled "*Ex Situ* Conservation: Present Status and Future Priorities," authored by J. Cohen, T. Williams and M. Horne. Based upon recommendations in this report, Congress authorized A.I.D. to initiate preservation activities obligating $750,000 in FY 1991.

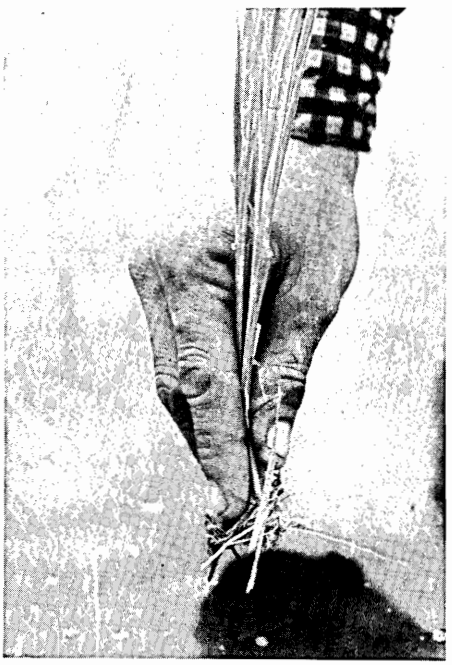
The goal of the project is:

- to stimulate urgent concern for the loss of the world's diversity;
- to promote the science and technologies necessary to advance the *ex situ* preservation of genetic material; and,
- to foster within the foreign aid community a recognition that a healthy natural environment is an indispensable requirement for successful human development.

A number of new initiatives have already resulted. In response to legislation calling for "the inauguration of a program to regenerate old stocks," A.I.D. provided a grant to CIMMYT (the International Maize and Wheat Improvement Center) to begin the first-ever coordinated, multi-national effort to regenerate and save the ancestral, primitive and landrace genetic stocks of maize. This program will involve collaborative efforts with 13 Latin American and Caribbean countries and serve as a model for future efforts to coordinate regeneration in other crops and animals

CIMMYT, based in Mexico, will serve as the central organizational body and will coordinate with other Latin American genebanks and with the National Seed Storage Laboratory of the U.S. National Plant Germplasm System. A priority listing of accessions to regenerate has already been developed.

In response to legislation requesting A.I.D. "to establish training programs and courses in *ex situ* management and preservation for developing country



A.I.D. initiatives contribute to conserving agricultural biodiversity.

scientists," a grant was made to the Genetic Resources Conservation Program at the University of California. This group is developing the first-ever course which combines plant and animal *ex situ* conservation areas such as strategies, technologies, policies, case examples, and laboratory workshops. The course will have a minimum of 26 participants sponsored by A.I.D. from developing countries. The faculty will be drawn from the San Diego Zoo, the U.S. National Plant Germplasm System, University of California and other U.S. universities.

Among other new initiatives is a project which responds to the legislation stating the need to "establish a mechanism for global information sharing on *ex situ* preservation, including the creation of an international reporting system for *ex situ* documentation and technical support." To accomplish this task, a project has been developed with Diversity magazine, a publication of Genetic Resources Information System. The grant will enhance the ability of Diversity's staff to work both with A.I.D.'s country-level and centrally-funded conservation projects.

These new initiatives will take advantage of pre-existing institutional expertise as they begin to coordinate activities to establish the foundation for an integrated, comprehensive program in *ex situ* conservation. Information will be disseminated to participating institutions. Research-oriented projects supported through the Program in Science and Technology Cooperation sponsored by A.I.D.'s Office of the Science Advisor will be highlighted as will projects supported through A.I.D. regional Bureaus and Missions. Each of the Collaborative Research Support Programs (CRSPs) will be contacted to develop articles featuring *ex situ* conservation activities within their projects. In this way, an Agency-wide program will begin to emerge over the next few years.

Future activities planned include the assessment of the degree to which genetic diversity parameters are being safeguarded by these efforts and how these relate to *ex situ* and *in situ* activities. This study will be undertaken by an American Association for the Advancement of Science (AAAS) Science and Diplomacy fellow joining the Office of Agriculture in October, 1991.

It is hoped these initiatives will help contribute to the costs of conserving the world's agricultural biodiversity. Project Noah provides the starting point to begin efforts to strengthen national and international programs conserving diversity while providing new means of interaction between U.S. and developing country scientists. ★

A.I.D. Mandate for Project Noah

The U.S. Senate Appropriations Committee requested that A.I.D. undertake the following steps in Fiscal Year 1991:

- To establish the Noah project as a component within existing biodiversity efforts, with its own budget and advisory panel;
- To establish an A.I.D. policy and a strategic plan for *ex situ* conservation, including national *ex situ* action plans integrating collection, storage, and data base documentation of crop plants, threatened wild plants, domesticated and wild animals and useful but unexploited wild plant species and forest species;
- To obligate and execute funds in Fiscal Year 1991 for specific country projects and as a demonstration of the viability of national *ex situ* action plans;
- To seek to establish a regular international biodiversity forum for channeling U.S. support for *ex situ* preservation efforts, coordinating and charting international support through official, international and non-governmental organizations as well as assisting priority national programs in *ex situ* collection, conservation, documentation and research;
- To establish an A.I.D. research module to coordinate and fund technologies to advance *ex situ* animal, plant and tree conservation including the inauguration of a program to regenerate old stocks, perform characterization and document existing holdings of significant biodiversity collections;
- To establish training programs and courses in *ex situ* management and preservation for developing country scientists, including the naming of an international coordinator within the U.S. National Plant Germplasm System (NPGS) to facilitate training research;
- To establish initiatives, through A.I.D.'s private sector program, for the commercial application of *ex situ* technologies to development;
- To establish *ex situ* preservation as a component of A.I.D.'s Mission environmental strategies and the development of national promotion campaigns to encourage host country citizens to assist in the extension of *in situ* and *ex situ* biodiversity efforts;
- To establish a mechanism for global information sharing on *ex situ* preservation, including the creation of an international reporting system for documentation and technical support.

CICP: Twenty Years of Pest and Pesticide Management Assistance

By Dr. Allen Steinhauer, Project Director CICP and Chairman of the Department of Entymology, University of Maryland

The Consortium for International Crop Protection (CICP), has been one of the primary resources for the advancement of economically efficient and environmentally sound crop protection in developing countries since 1971.

CICP's roots can be traced to an original project which resulted from recommendations by a National Academy of Sciences panel that reviewed pesticide procurement and pest management activities in developing countries. The project brought together the expertise of nine U.S. universities and the U.S. Department of Agriculture.

In 1979, the Consortium was formed. In addition to the U.S. Department of Agriculture, four more universities were added to comprise the present Consortium membership of: Cornell; North Carolina State; Oregon State; Purdue; Texas A&M; and the Universities of California, Florida, Hawaii, Illinois, Maryland, Miami, Minnesota and Puerto Rico.

In 1985, the weed management project at Oregon State's Integrated Plant Protection Center, was folded into the CICP Project followed, in 1988, by the incorporation into CICP of the nematode project at North Carolina State University.

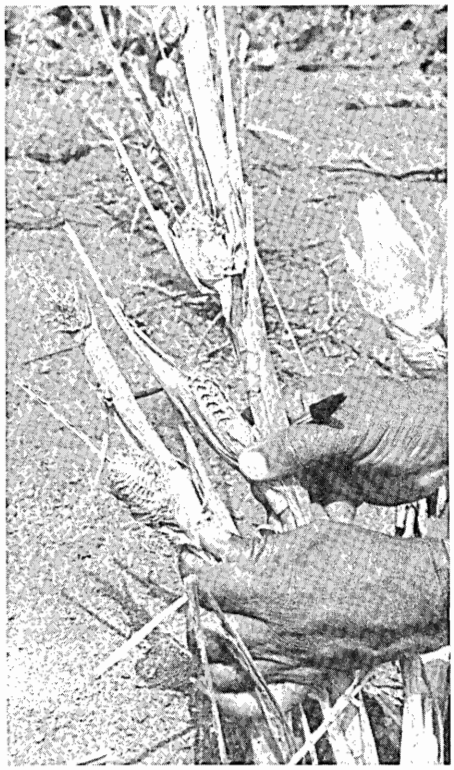
The Consortium has made a significant contribution in the area of pest and pesticide management in the developing world.

A Pioneering Approach

Early on, CICP multi-disciplinary teams sent to the developing world found that pesticide abuse was a serious problem in most countries, and that pesticide laws and training programs were inadequate.

The situation in El Salvador was typical. Heavy use of organophosphates on cotton resulted in many cases of poisoning of field workers and nearby residents every year. Salvadoran beef exports were rejected due to high chlorinated hydrocarbon residues from contaminated corn and cotton products fed to cattle. Also, the anopheline mosquito vector of malaria was already resistant to organophosphates in the coastal cotton belt, and there was a danger of acquiring resistance to carbamate insecticides and DDT.

To address these problems, CICP joined the Pan American Health Organization and the Government of El Salvador in conducting a workshop in San Salvador in 1973. The agromedical approach to pesticide management was emphasized, combining the skills and knowledge of agriculture, applied chemistry, and medicine. The workshop developed recommendations for solving El Salvador's problems. Intensive training in pesticide residue analysis for Salvadoran chemists as well as training for pest management team members at U.S. universities were key to resolving the problems.



CICP has made a major contribution to addressing pest and pesticide management issues in the developing world.

CICP was the first to propose the agromedical approach to pest management and to promote cooperation between crop pest and disease vector integrated pest management (IPM) as a means of forestalling the development of pesticide resistance.

Subsequently, CICP has helped conduct similar workshops in Indonesia, the Philippines, Guatemala, Egypt, Colombia, Senegal, the Caribbean, Panama, Bolivia, Kenya, and Thailand. These workshops have had a significant impact on the implementation of IPM and sounder pesticide policies in developing countries. **An Agromedical Approach to Pesticide Management: Some Health and Environmental Considerations**, a 1982 CICP publication, is still considered to be the classic in its field.

As part of the CICP project, the University of Miami conducted pesticide analytical training for developing country personnel and maintained a quality control program that now encompasses 57 laboratories in 30 countries. More than 578 technicians from 27 countries have been trained in pesticide residue analysis and diagnosis as well as in the treatment of pesticide poisonings. This effort has enabled developing countries to better monitor pesticide problems and implement necessary programs.

Meeting Environmental Safety Concerns

CICP produced an Environmental Impact Statement (EIS) on the use of

pesticides in A.I.D. projects in 1978 and helped develop the Agency's regulation that requires a risk-benefit evaluation of pesticides used in A.I.D. projects. The regulation also prohibits financing application of pestcides unregistered, banned or highly restricted in the U.S. and commits the Agency to safely use pesticides and in an IPM context.

Since 1978, CICP has conducted over 80 initial environmental examinations or environmental assessments. These have recommended relatively safe and effective pesticides as well as research, training, and appropriate safety measures to safeguard human health and the environment. They have also encouraged the development of pest management systems that rely on nonchemical techniques and greatly reduced pesticide use in A.I.D. projects.

Training in Pest and Pesticide Management

CICP sponsored training programs and courses have made valuable contributions to agricultural development and environmental safety. Over 5,400 participants from 46 developing countries have received training through the course of the project in topics such as: crop loss assessment; microcomputer use in plant protection; modeling pest-crop interactions; integrated pest management; plant resistance breeding; weed management; plant disease identification and management; and, diagnosis and treatment of pesticide poisoning.

Integrated Pest Management Research

CICP has also made significant contributions to research. Since 1980, CICP has performed, through its member institutions and in collaboration with numerous international agencies, over 20 separate research initiatives in areas such as: cholinesterase testing; millet crop loss assessment; Asian corn borer control; the use of living mulches; herbicide evaluations; and the fate of pesticides used for locust control. CICP recently completed the development of eight collaborative research projects with the Egyptian National Agricultural Research Project, 11 U.S. universities and the U.S. Department of Agriculture.

Networking

CICP has provided international specialists with valuable current information through a wide range of publications

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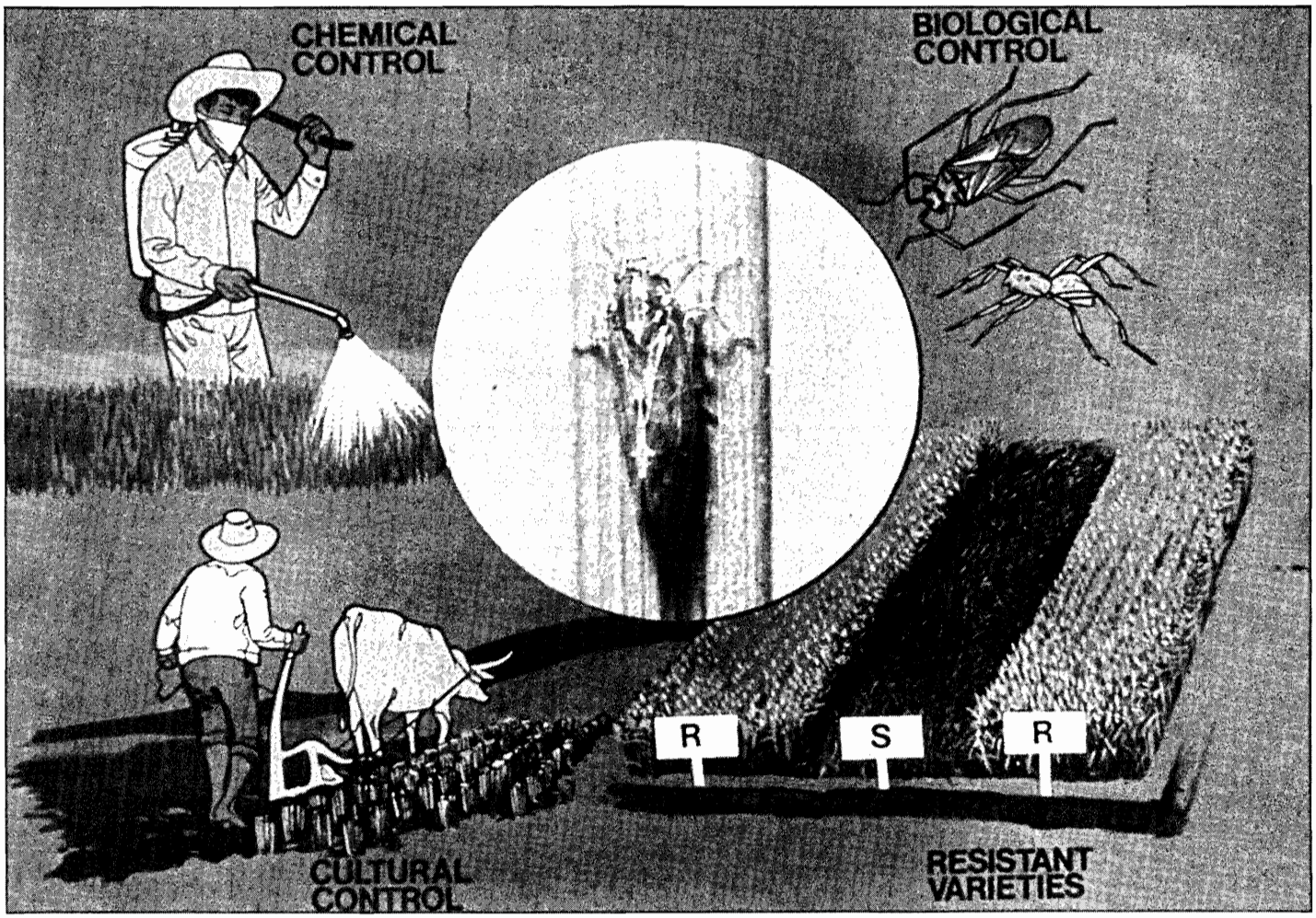

CICP has helped promote integrated pest management and environmentally sound crop protection practices on a worldwide scale.

APAP Approaches to Agricultural Policy Analysis and Sustainable Development

By Chris Brown, APAP II Project Officer, Office of Agriculture, Bureau for Science and Technology, U.S. Agency for International Development

The Agricultural Policy Analysis Project (APAP), initiated in 1983, is one of the longest-term efforts on economic policy reform of the U.S. Agency for International Development (A.I.D.). The project has evolved — from a sector specific price and subsidy focus to a sustainable natural resource management perspective and a commitment to address policy constraints affecting production as well as processing, storage, distribution and marketing of agricultural commodities.

One of the project's objectives has been to address topical agricultural policy issues faced by developing countries. The Bureau for Science and Technology, Office of Agriculture (S&T/AGR) funded project was created to: identify, inventory and analyze agricultural policies in developing countries; examine price policy reforms; study the policy environment to expand the role of the private sector; analyze the role of food aid and economic policy reform; and, build institutional capacity in developing countries to carry out policy analysis. This mandate is carried out through technical assistance and training.

APAP is now midway through its second phase (APAP II) with emphasis placed on strengthening guidelines and methods as well as on research including: the impact of economic adjustment programs on the agricultural policies upon the natural resource base; and the political dynamics of agricultural policy formation.

APAP II and Sustainable Agriculture

Under APAP II, analysis of policy issues affecting the interaction of the agricultural sector with natural resource use and environmental concerns is an area of emphasis that is important for a variety of reasons.

Improved agricultural and natural resource management policies affect: prices received by producers and exporters; input prices including land; natural resource management objectives and practices; domestic and foreign capital flows; return on rural infrastructure investments; and, the well-being of rural populations.

An improved policy environment can provide incentives to stimulate sustainable development and growth of agribusiness and the value added aspect of agriculture. Through increased value added, sustainable agricultural growth takes place helping to increase employment as well as local and national government revenues. In turn, environmental degradation is minimized as is the loss of environmental goods and services necessary for its sustainable growth.

The Policy Analysis Process

In each research category: macroeconomic structural adjustment; agribusiness policy; natural resource policy; and, capacity building, different approaches were designed for analyzing policy problems. The first step is policy reconnaissance followed by analysis and recommendations, concluding with policy dialogue.

Policy reconnaissance identifies issues, focuses on major constraints, makes policy reform recommendations when appropriate, and identifies areas of future research. Two examples of APAP's techniques for policy reconnaissance are policy inventories and village-level analysis.

A policy inventory lists all the policies affecting agriculture in a particular country and identifies areas where more research is needed. Policy inventories have been conducted in Guatemala, Honduras, Belize, El Salvador and Costa Rica. For example, low taxation rates for timber resources in these countries have lead to "high grading" for valuable

APAP has addressed topical agricultural policy issues faced by developing countries.

timber species such as mahogany and poor management and harvesting of timber and non-timber resources in general. This has contributed to dramatic rates of deforestation along with expansion of the agricultural frontier and increased fuelwood collection.

A village-level analysis identifies policies affecting local level production and their impact on other levels of the political spectrum. This approach provides guidelines for program design and policy intervention. This fall, APAP II will launch village-level analyses in Senegal and Gambia, including a study of rural land tenure systems and their effect on agricultural incentives and natural resource use.

Policy analysis includes a wide range of applied methods such as the Policy Analysis Matrix or PAM, developed

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Simulating Solutions to Agricultural Problems

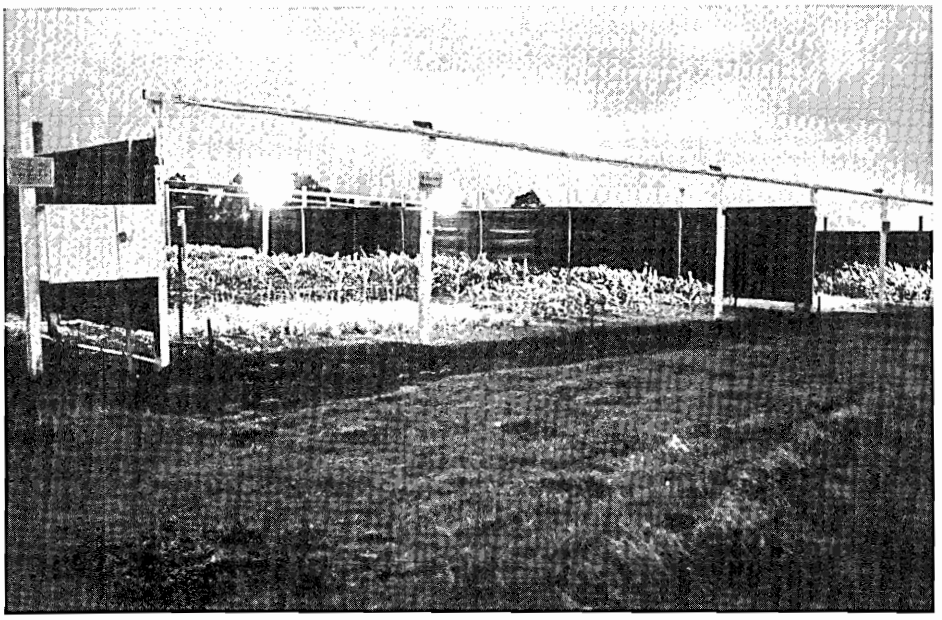
By Renee Moulun, Project Editor, International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT), University of Hawaii

In America, coins read "in God we trust." Fijians, however, take a more pragmatic view of the cosmos; their coins read "grow more food." This matter-of-fact viewpoint not only seems to hit the nail on the head as far as offering a solution to the problems of a hungry world, it also defines one of the central goals of the International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT) Project. Behind this acronym is an international network of scientists working to improve and sustain crop yield in a range of agroecosystems by using the newest and most sophisticated technology. Or as the Fijians put it, we are looking for better ways to "grow more food."

The IBSNAT Project set the following goal: to improve farm performance and increase family income of resource-poor farmers by enabling them to choose and integrate new crops, products, and practices, with existing farming systems without sacrificing stability and sustainability of production. This can be done by using systems tools to accelerate the flow of agrotechnology and increase the success rate of technology transfer from agricultural research centers to farmers' fields.

The IBSNAT Project, which is funded by the U.S. Agency for International Development's Office of Agriculture, Bureau for Science and Technology (S&T/AGR) in a Cooperative Agreement with the University of Hawaii, was initiated in 1983 at an International Symposium on Minimum Data Sets, at ICRISAT Center, Hyderabad, India.

IBSNAT was a logical next step to the Benchmark Soils Project which tested the viability of an analogue approach to the transfer of agrotechnology in the tropics, based on soil classification. The IBSNAT approach involves matching crop requirements to land characteristics through the use of crop simulation models and data bases. At the Minimum Data Sets Symposium, twelve major food crops were defined as essential for modeling. Since then, IBSNAT has developed six, and is continuing to develop the remaining six. A minimum data set (MDS) was chosen to ensure standardized data collection, and structured so that users in developing countries can create national data bases with minimum effort. The aim is to encourage investment in research based on systems analysis and to, demonstrate the capability of a decision support system to simulate agricultural processes and outcomes in a cost effective and timely way.



IBSNAT models are tested on Mount Haleakala in Maui when the mountain's diverse climate can mimic any summer condition. Twenty two mini farms around the base and up the mountain's 1,000 foot flank offer a range of climates from desert to tropical rain forest. Electric lights artificially change the day length at some test sites.

Instead of using the time consuming trial-and-error experiment approach as a method of testing cultivars and predicting yields, IBSNAT researchers use computers to test new technologies. Systems simulation helps to examine the variability in output associated with selected strategies, and to identify those strategies that maximize returns and minimize risk. This helps strengthen the decision making capacity of farmers and extension agents.

IBSNAT reached a major milestone in 1989 with the release of its Decision Support System for Agrotechnology Transfer (DSSAT) software. DSSAT is comprised of three parts: the Data Base Management System (DBMS), the Crop Models, and the Application Programs.

The Data Base Management System (DBMS) allows users to store the minimum data set (MDS) and retrieve data files. These files are used to validate the applicability of IBSNAT crop models in a user's location by allowing comparison between predicted and observed results.

The DBMS provides easy access to several data bases covering weather, soil and crop management. A users' Input Data Base allows soil and data collected by national soil survey organizations to be entered and an Experimental Data Base includes phenological crop data

required for validating crop models.

The data bases are used to run crop models for wheat, maize, rice, soybean, drybean and peanut. Compatible models for sorghum, millet, barley, aroid, and potato are at various stages of development. The models simulate the effects of weather, soil water, genotype, and soil and crop nitrogen dynamics, on crop growth and development in minutes. By rapidly simulating the growth of crops over a number of seasons under different environmental conditions, using different cultivars, users can eliminate cultivars or management combinations that do poorly. Data can be calibrated and validated until a satisfactory model is created.

Crop models can be coupled to the Strategy Evaluation program in DSSAT which allows users to evaluate the merits of simulated strategies and identify the one most suitable. The program helps users determine the effectiveness of crop management strategies, the economic return of a new cultivar, or the suitability of a site for a specific crop.

Using its weather generator programs which produce coefficients from historical weather data, DSSAT can simulate the growth and development of a crop for up to 50 consecutive years. This facilitates long-term evaluation of crop performance. DSSAT currently allows up to 15 combinations of options to be simulated in a single experiment, and thus can generate in a few hours, amounts of data that have traditionally required an agronomist's lifetime of work.

Although DSSAT was designed primarily for user groups in agriculture, it has already been adopted by others for assessing future conditions. For example, the Environmental Protection Agency (EPA) uses DSSAT to research the impacts of greenhouse warming on the production and trade of the major food staples throughout the world. Using DSSAT, EPA can simulate crop growth under increased temperature and carbon dioxide concentrations and predict yield changes.

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Small Ruminant Production: Systems for Sustainability Workshop

By Joyce Turk, Office of Agriculture, Bureau for Science and Technology, U.S. Agency for International Development

Small ruminants (sheep, goats, and camelids) play crucial roles in sustaining agricultural production in developing countries in areas such as: income and employment generation; income savings; and biological control of undesirable plants. Small ruminants are also sources of fertilizer and nutrition for subsistence producers.

To heighten awareness of the role played by small ruminants in development, the Office of Agriculture, Bureau for Science and Technology (S&T/AGR), U.S. Agency for International Development (A.I.D.) organized and chaired a two-day workshop June 20-21 at the University of Maryland College Conference Center.

The Small Ruminant Production: Systems for Sustainability workshop brought together some 48 representatives of private voluntary organizations (PVOs), land grant universities and Historically Black Colleges and Universities (HBCUs), private industry, the U.S. Department of Agriculture's Office of International Cooperation and Development (USDA/OICD), and A.I.D..

Discussion covered a wide range of subjects including: biological and sociological criteria of small ruminant production; technology transfer of research results generated on agricultural stations and farms; and, data and collection methods needed by planners to evaluate such production systems.

Copies of workshop proceedings are available from S&T/AGR. Please call Harvey Blackburn (703-875 6414) or Joyce Turk (703-875-4081). ★

Peterson New Office of Agriculture Director

Dr. Pat Peterson, the new Director of the Office of Agriculture, Bureau for Science and Technology (S&T/AGR), assumed his duties in July. Dr. Peterson received his B.A. in History and International Affairs in 1964 from Florida State University. He holds an M.S. in Agriculture from the University of Florida and an M.A. and Ph.D. in Agricultural Economics from the University of Wisconsin, Madison.

Dr. Peterson joined the U.S. Agency for International Development (A.I.D.) in 1974. He worked in the Africa Bureau and in the Bureau for Program and Policy Coordination. He served as the senior Agriculture Officer in Jamaica (1978-80), Yemen Arab Republic (1980-84), Bangladesh (1984-1987) and Pakistan (1987-1991).

Before joining A.I.D., Dr. Peterson was a Peace Corps volunteer in Liberia. He served as a World Bank consultant in Jamaica and was an Assistant Professor at the University of Wisconsin.

As Director of the Office of Agriculture, Dr. Peterson's priorities will be: to examine ways the Office can improve its services to A.I.D.'s field operations; to better articulate the important role agriculture has to play in the Agency's development process; and, to develop a professional career structure for agriculture professionals in the Agency.

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including the Integrated Plant Protection Center's INFOLETTER, and Haustorium, the newsletter of the International Parasitic Plants Working Group. The North Carolina State University Nematode project published the International Nematode Network Newsletter.

CICP collaborated with a wide-range of organizations including the agencies of the United Nations, international organizations and development aid agencies, U.S. government agencies, environmental or other non-governmental organizations, and numerous counterpart government institutions. This collaboration has enabled CICP to extend its impact and influence in the promotion of integrated pest management and environmentally sound crop protection practices on a worldwide scale. The CICP has been funded by the Office of Agriculture, Bureau for Science Technology (S&T/AGR) at the U.S. Agency for International Development. ★

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under APAP, and concludes with recommendations for future action.

Once critical policies are identified and analyzed, and policy alternatives defined, APAP II contributes to policy dialogue through senior advisory visits, long-term expert technical assistance, and policy workshops. The project is currently engaged in such efforts in Pakistan where a dialogue was initiated on cereals subsidy policy; in the Philippines where a policy workshop on structural adjustment was recently held; and, in Niger where assistance is provided to a government sub-committee in developing a comprehensive rural development plan.

After APAP

Although APAP will conclude in 1993, it will have developed innovative approaches to help make agricultural policy dialogue sustainable. To follow up on APAP, S&T/AGR is in the initial stages of developing the Economic Policy Analysis for Sustainable Development (EPASA) project. This effort, to be initiated in 1993, will combine the expertise of natural resource, environmental and agricultural economists with that of agribusiness interests. EPASA will develop innovative and environmentally sound policy agendas and analytical techniques for sustainable agricultural growth in developing countries and will provide training in analytical methods and policy reform strategy.

EPASA is expected to serve as a ground breaking vehicle in bridging the mutual concerns of natural resources management in the environment, agricultural economics and agribusiness. ★

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Improvements to the DSSAT software are currently being made. A whole-farm model is being developed to help assess specific technologies in a whole-farm context. The modeling concept will take into accout factors such as management changes, the impact of new technology as well as socioeconomic factors that constrain or impinge upon agricultural production and decision making. Other research efforts are focused on intercropping and the development of a pest and disease module that will be coupled with the crop models to simulate the effects of pests and diseases on crops.

DSSAT is applied in many countries. In Guatemala, the BEANGRO model is being tested and used. In Malawi, efforts are underway to apply the CERES-maize model to specific problems. In India, DSSAT was used to test fertilizer strategies for sorghum, and in Thailand, CERES-rice is being validated for local rice cultivars.

The IBSNAT network has expanded to include a large users network. With the continuing cooperation of a body of international researchers, and the development of new modules and applications, IBSNAT may help solve some of the agricultural and environmental problems faced by the world's resource-poor farmers. ★

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Hans P. Peterson
Director
Office of Agriculture (S&T/AGR)

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Assisting the New Independent States in Food and Agriculture: A Technical Assistance Strategy

By Vincent Cusumano, Chief, Economic Policy and Planning Division, Office of Agriculture, Bureau for Research and Development, U.S. Agency for International Development

The U.S. government is playing a significant role in the efforts of the ex-Soviet Union States (NIS) to move from a command economy to market led economic systems. Critical to this effort is the overall support for the macro-economic reform packages being proposed by the International Monetary Fund, the World Bank and other donors. At the heart of the reform program are price liberalization, elimination of subsidies, fiscal corrections, institutional reform, as well as efforts to address inflation and tight monetary policies.

After decades of state control, the period of transition for the people of the NIS will not be easy. The road ahead is a difficult one and potentially dangerous for world wide stability. The next 12-36 months will be especially critical as consumers and workers struggle with shortages while learning to respond to market signals. Although the ultimate success or failure of economic reforms are in the hands of the leaders and people of the NIS, it is in the interest of the U.S. government to assist in this transition.

According to a joint strategy paper produced by the U.S. Agency for International Development (A.I.D.) and the U.S. Department of State, the United States must "ensure that economic and political reforms not fail because human needs are not met." In the area of food aid and related technical assistance, the immediate food needs of populations at risk and including people living in large cities and those living on fixed incomes must be addressed. Technical assistance must be provided to improve food distribution, transportation, storage and to increase the overall efficiency of the marketing system. This assistance should, in the short-term, help avert severe food shortages and raise the efficiency of the NIS' food system.

A short and intermediate technical assistance package has been proposed by the Office of Agriculture in the Bureau for Research and Development (R&D/AGR) in support of agriculture and food systems development in the NIS. This effort recognizes that the short-term objective of restoring food security in the NIS and the longer term goal of agricultural sector development are paramount for not only meeting immediate food and fiber needs but also are critical to the success of democratization.

Sector Problems

There are a number of sector problems that need to be addressed.

Weak Agricultural Distribution System:

Lack of investment in agricultural processing, marketing and overall infrastructure limits the ability of farm products to find their way to urban consumers. In the past, food crises were often resolved by increased investments on the farm at the expense of investments in distribution systems.

Waste and post-harvest inefficiencies in the NIS are high and estimated to exceed the 30-40 percent range. Losses of grain alone run as high as 20 percent of the annual harvest. A city as important as Moscow, for example, does not have a wholesale market. Farm produce being moved by rail can take as much as 15-18 days to reach delivery points. Refrigerated and ventilated rail cars and trucks are in short supply, and use of chemical preservatives is prohibited. Product losses are also present in the provision of farm inputs (agrochemicals, machinery, and spare

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BNF Technology in Thailand 11

Due to reorganization and management changes in the Office of Agriculture, Bureau for Research and Development, the Fall 1991 issue of STAR was not published.

parts). To aggravate the situation, with the collapse of the rouble, people hoard food in anticipation of higher prices in the future. Trade is conducted on a barter basis. Relatively little food is channeled through the formal distribution system.

Lack of Managerial Expertise:

After decades of heavy state involvement in economic decision making and three generations of collective agriculture, it is extremely difficult for individual farmers as well as agribusiness and government leaders to break out on their own using open market principles. Many lack the management skills to run farm enterprises and supporting agro-industries effectively. And while producers welcome the opportunity to have more control over their own destiny, many still do not appreciate that they, and no one else, shall be responsible for dealing with the corresponding risks.

Reduced Agricultural Capacity:

The ability of the sector to provide food, feed, fiber and income for NIS populations is threatened. Price liberalization, especially on the input side, reduced subsidies, restrictive monetary policy and continued effort of the government to keep food prices low significantly impact on agricultural productivity. As input prices rise and credit markets become limiting, production is reduced. This can exacerbate the current food shortages, and lead to higher unemployment, reduced farm income as well as political instability in both rural and urban areas.

Importance of Agriculture

Agriculture will continue to play a central role in the economic growth and development of the NIS. For example, it employs 30 percent of the direct labor force involved in farm production and significantly more when supporting agro-industries are included and

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Expanded Role for Office of Agriculture

The Bureau for Science and Technology at the U.S. Agency for International Development (A.I.D.) was renamed the Bureau for Research and Development (R&D) and given expanded responsibilities in providing technical leadership and support to the Agency's overseas Missions as part of the 1991 Agency reorganization. The Office of Agriculture (R&D/AGR), is, as a result, making changes in its portfolio.

In addition to fulfilling its global and legislative mandates, the Office of Agriculture is now more directly involved in field support activities. "Because of the reduction of technical expertise in the Agency's regional Bureaus, the Agriculture Office is expected to take on an increasing role to provide that support," says Alan Hurdus, Deputy Director of the Office of Agriculture. Hurdus, formerly Chief Agriculture Officer with the Agency's Bureau for Asia, joined the Office of Agriculture in January, 1992 to help catalyze this effort and to institute systems that will directly link the office to the overseas Missions.

"We're also including the Agency's regional Bureaus and Missions at the earliest possible stage in the project development process," adds Agriculture Office Director Pat Peterson. "Their perspective on whether or not a proposed project meets their needs influences our decision as to whether or not we go forward with a concept."

In order to provide more effective field support with limited resources, the Office plans to consolidate and restructure its current portfolio of projects. For example, the Office has recently taken all of its post-harvest activities and combined them into a single post-harvest program.

The Office is also taking a closer look at its research programs to both see how responsive they are to Mission goals as well as to accelerate the utilization of research through private sector linkages.

"Our focus must be on research efforts that respond to commercial needs such as hybrid seed production that is commercially viable," says Peterson. The Nitrogen Fixation in Tropical Legumes (NifTAL) project is an example. "NifTAL research has been on-going for a while," explains Peterson. "Our emphasis is on getting this technology out to farmers by linking up with agribusiness, with a private sector company that sells seeds and other products to farmers."

"We will build upon our existing programs and expand those where we can be more responsible to Mission needs without abandoning the excellent research efforts that we have helped generate," says Peterson.

Intellectual Property Rights and World Agriculture

by Joel I. Cohen, Biotechnology and Genetic Resource Specialist and Judith A. Chambers, Biotechnology Specialist, Office of Agriculture, Bureau for Research and Development, U.S. Agency for International Development

Integrating biotechnology with conventional agronomic research provides technologies to address productivity constraints in crops, animals and microbes. Many of these new technologies and products have been developed using some form of intellectual property protection and have altered the ways in which agriculturalists view research developments.

Intellectual property describes property that is not directly tangible, but which originates through the creative effort of the inventor. Such property can typically be further characterized as a trademark, a copyright, a trade secret or a patent.

Establishing public patent policies and systems advances technology by requiring public disclosure of each invention filed. This innovation is encouraged by assigning rights to the inventor for exclusive commercial use and by encouraging competitors to design around the invention. The inventor's knowledge is preserved for the benefit of society and future generations.

Over the past decades, the application of intellectual property rights (IPR) to biological advances from agricultural research has been limited. However, this is changing as agricultural scientists explore new technologies and reconsider whether or not IPR could hasten product delivery to consumers and farmers. The impact on agriculture will become more critical as public advocacy and consumer demand for the products of technology increase and as the economic, environmental and social benefits of products developed from initial investments in agricultural biotechnology are realized. The capacity of new technological tools to shorten the time between basic biological discoveries and product development has also motivated the trend towards privatization.

The institutional structure of agricultural research has undergone significant change in the United States.

The application of intellectual property rights to biological advances has been limited. This is changing as agricultural scientists explore new technologies and explore how intellectual property rights could hasten product delivery to consumers and farmers.

Publicly-supported institutions, such as the land-grant universities, respond to this institutional shift in support and location for biotechnology research by increasing staff and programs. They are, however, less able to generate greater unilateral participation due to lack of budgetary control and overall decreased public support for basic agricultural research. This changing institutional base, when coupled to the obvious commercial potential of the technology, has been a catalyst for greater collaboration between public institutions and private biotechnology companies.

Several legislative enactments and court decisions, which underscore the responsiveness of U.S. patent policy to technological innovation, have also contributed to an evolving partnership between the public and private sectors. This partnership has particular relevance for future international agricultural research centers (IARC) and developing country activities in biotechnology with publicly-supported U.S. institutions. The 1930 Plant Patent Act (PPA) and the 1970 Plant Variety Protection Act (PVPA) permitted the protection of most asexually produced plants and provided protection of seed-produced varieties, respectively. For example, private sector soybean breeding programs have increased from 5 percent to 30 percent after the PVPA ruling. Similarly, private investment in plant research in the U.S. from 1970 to 1980 increased at a ratio of 2 to 3 with no accompanying increase in market cost of products.

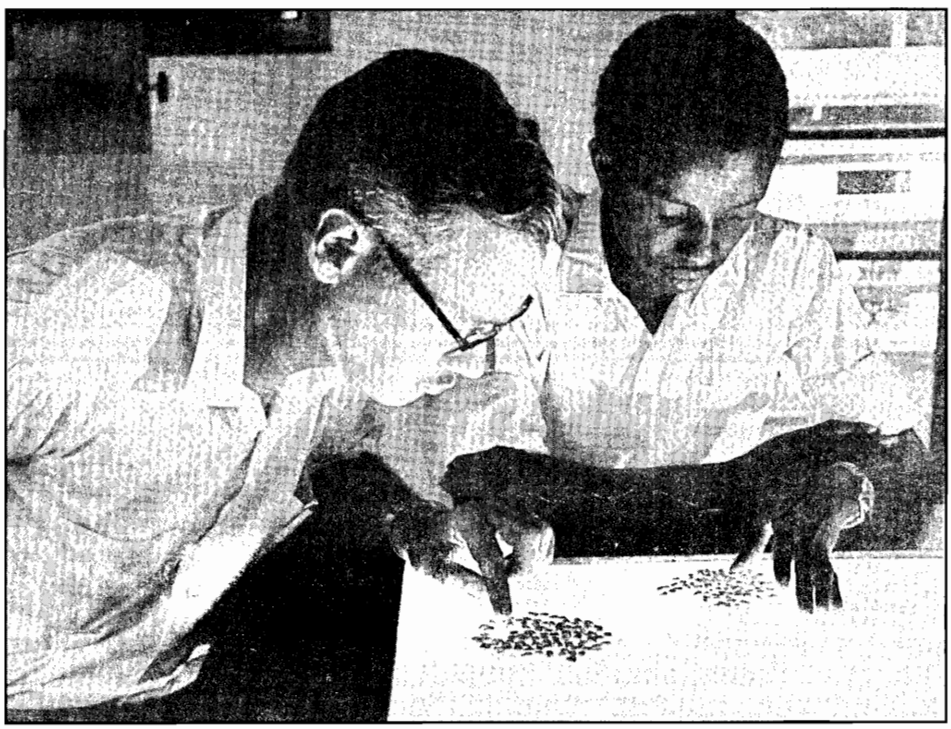
Agricultural research initiatives at land-grant universities and other publicly-supported institutions have been directly affected by the 1986 Federal Technology Transfer Law. This legislation responded to the perception that Federally-supported research results were not being readily adopted by the private sector for development of new products for consumers and farmers. This act authorized government-supported agencies and institutions to enter into cooperative research agreements with U.S. private companies and was developed to bridge the gap between the fundamental research undertaken by

public institutions and the more downstream, applied research performed by the private sector. It provides the ability to grant an exclusive license to one company to practice an invention arising from federal funds and has transformed publicly-supported institutions into more desirable industrial partners. As a result, collaboration between public and private research groups in the United States has markedly increased and is now influencing the current trend towards privatization of biotechnology research.

Universities are filing for patents as an effective means to transfer technology to companies in a manner which offers greatest utility. Patents can also protect university-based research practiced abroad. For example, publication of information critical for product development and commercialization, prior to filing for foreign patents, could result in the loss of foreign patent rights and additional revenues. This, in turn, could jeopardize future collaborative possibilities between universities and private companies.

Patent protection of university-sponsored research can assure that benefits to the public are ultimately obtained through commercial product development. A recent example involves the agreement between Iowa State University Research Foundation and Pioneer Hi-Bred International regarding low palmitic acid soybean germplasm. This material was developed by scientists at Iowa State University and exclusive rights have recently been assigned to Pioneer. The soybeans have reduced fatty acids, making them more desirable for food processing. By granting exclusive rights, Iowa State University has enhanced the time required to reach commercialization, now estimated at 1993 by Pioneer.

Historically, IARCs and national programs in developing countries have relied on public sector institutions in developed countries for advances in basic research which are then adapted for application. What does the trend towards privatization and patenting in agricultural biotechnology mean for international agricultural research? The traditional route of donor, IARC and developing country access to biotechnology through U.S. public institutions, once a timely and responsible way of conducting agricultural research geared towards developing country problems and constraints, is being altered by increasing domestic trends towards privatization of research and the emergence of new sources of expertise in the application of biotechnology to agricultural constraints.



Research by the emerging private seed industry in developing countries would be strongly encouraged if legislation on breeders rights is more widely enacted.

Recognizing this, the Office of Agriculture, Bureau for Research and Development at the U.S. Agency for International Development, recently initiated the new Agricultural Biotechnology for Sustainable Productivity (ABSP) project aimed at mutually benefiting developing countries and U.S. agricultural biotechnology initiatives. The project includes U.S. public and private sector technical and managerial resources. ABSP will increase human capacity in agricultural biotechnology in developing countries and will stimulate the local, indigenous biotechnology private sector in these countries through collaborative research with U.S. partners. A major component of the project is the pursuit of equitable patent protection and distribution in regard to inventions arising from its research and commercialization activities.

As new research initiative such as ABSP begin, negotiations regarding IPR protection may be initially necessary, particularly for "inventorship" where U.S. and developing country or IARC scientists have jointly participated in research. In the United States, a patent must be filed under the name(s) of the original and authentic inventor or inventors. Exceptions to this requirement occur if one inventor has assigned his rights to another institution, such as a university. Also, a person who either

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Collaborative Research: Benefits for U.S. Agriculture

by Robert Schaffert, Office of Agriculture, Bureau for Science and Technology, U.S. Agency for International Development

"The greatest service which can be rendered by any country is to add a useful plant to its culture."

Thomas Jefferson, 1821

A decade ago, the Collaborative Research Support Programs (CRSPs) were the beginning of a new idea in scientific cooperation. Created by the U.S. Agency for International Development (A.I.D.) to carry out research under Title XII of the Foreign Assistance Act of 1961 (as amended in 1975), the CRSPs are now widely recognized for the successful long-term partnerships they have forged. The CRSPs are jointly planned, managed, and financed by A.I.D., U. S. universities and institutions in developing countries. They mobilize the research capabilities of U.S. higher education to work collaboratively with the agricultural research institutions in developing nations and in coordination with international agricultural research centers.

Mobilizing and fostering the talent of U.S. researchers in high-payoff, problem-oriented research programs on key food, nutrition, and rural development problems that confront the developing world, the CRSPs effectively interact with and complement national, bi-national, and multi-national agricultural development programs in developing countries.

Today, new technologies developed by CRSP scientists help developing country farmers to produce enough food for their families and a marketable surplus to improve their incomes and quality of life. Though less well-known, the results of CRSP research also benefit American farmers. Some CRSP innovations use methods as new as modern biotechnology and computer simulation. Others are based on techniques such as plant and animal breeding which have been in use since crops were first cultivated and animals were domesticated more than 10,000 years ago.

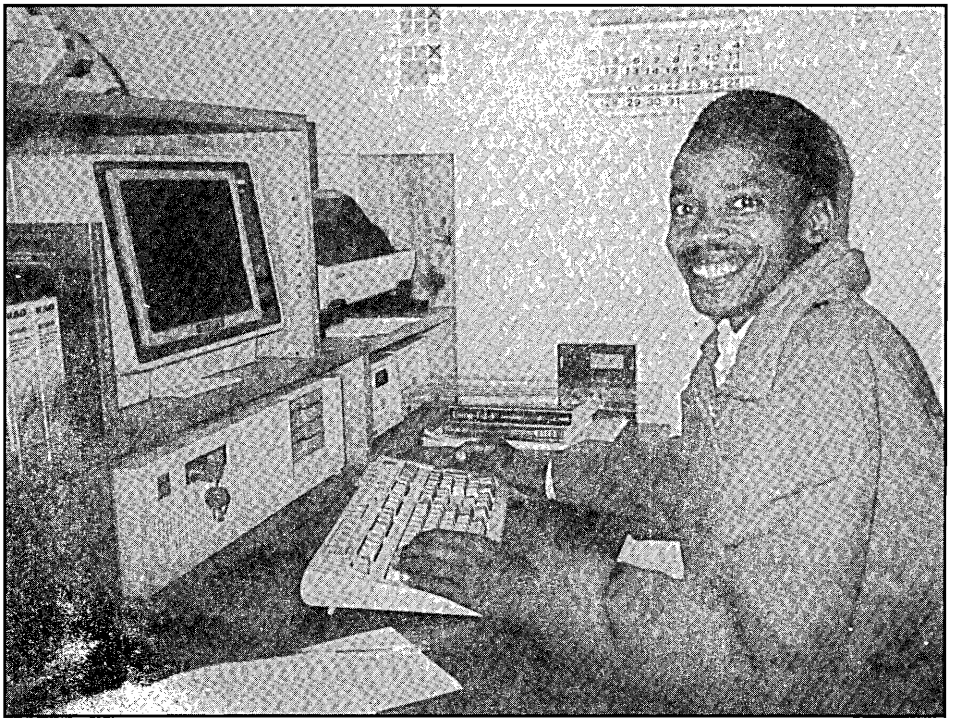
CRSP research has benefitted American farmers in a number of ways.

Improved Varieties from Available Genetic Resources

Farmers have been improving crop varieties since the dawn of agriculture. Early plant selection and breeding depended primarily on local genetic resources. Today, with a wide selection of germplasm available from around the world, plant scientists can more easily develop varieties that improve yield, hardiness and food quality.

Through collaborative research, Peanut CRSP scientists are increasing peanut yields by developing cultivars that resist diseases, insects and drought and adapt to the short rainy periods prevalent in tropical regions. U.S. and developing country researchers have collaboratively developed several improved cultivars which also meet local standards for taste and appearance.

Germplasm exchange and joint research have brought direct benefits to U.S. peanut growers. Six new cultivars with higher yield potential and disease resistance, developed by CRSP scien-



The Pond Dynamics/Aquaculture CRSP maintains the world's largest data base on tropical aquaculture that can be accessed from anywhere in the world.

tists from North Carolina State and Texas A&M Universities, are available to U.S. growers.

A cultivar released in North Carolina, for example, is resistant to cylindrocladium black rot, a disease prevalent in the North Carolina/ Virginia production area, and is a better market grade than the cultivar it would replace.

A cultivar with increased tolerance to three other diseases -- pythium rot, sclerotinia blight and aflatoxin infection -- is scheduled for release by Texas A&M University. A Spanish-type peanut grown primarily in Texas and Oklahoma, this cultivar has the potential to increase crop yields and cash value while reducing the need for disease-controlling chemicals. This increased disease tolerance, especially peanut seed tolerance to aflatoxin, has national and global implications.

In 1980, the Sorghum/Millet CRSP (INTSORMIL) launched a major effort to improve sorghum production in Sudan. A very important cereal crop and food source in that country, sorghum production is constrained by extended and brief periods of drought that occur throughout the growing season.

Scientists from the Sudan Agricultural Research Corporation (ARC) worked collaboratively with CRSP researchers from Texas A&M and Purdue Universities on the development of drought-screening techniques to identify genetic material resistant to droughts at different stages in the growing cycle. The drought-screening techniques, first developed by the ARC in Sudan, were refined at Texas A&M and used in the Texas breeding program. The refined techniques were then reintroduced into the Sudanese breeding program where they were used to identify several Sudanese sorghum varieties with excellent tolerance to drought both before and after flowering. These lines then became the basis of Sudan's breeding program.

The new lines were introduced into Texas, combined with local germplasm, and tested as potential parents of sorghum hybrids for Texas farmers. The U.S. drought of 1988 and 1989 provided Texas A&M scientists with an excellent opportunity to evaluate the experimental hybrids and varieties, which proved to have an outstanding level of drought resistance. In the most severe drought case -- southern Texas in 1989 -- the only plants worth harvesting, out of over 5,000 different varieties and hybrids, were the ones containing the new Sudanese germplasm. Ten lines developed through this project will be released to private U.S. seed companies and are expected to have a far-reaching, positive impact on sorghum productivity in the drought-prone regions of Texas, Kansas and Nebraska.

Small Ruminant CRSP researchers developed sheep and goat simulation models that help address two critical concerns of the American sheep industry: how to reduce the fat content of slaughter lambs and how to increase profitability.

Virtually every U.S. bean research program, whether public or private, is being helped by the research efforts of the Bean/Cowpea CRSP. These benefits include new germplasm resources that improve disease and insect resistance, biological nitrogen-fixing ability, and nutritional value of U.S. cultivars. Extensive germplasm collection and preservation by CRSP researchers increases genetic resources worldwide and helps offset past bean and cowpea genetic erosion in the United States.

CRSP researchers at Cornell University developed and recently released a new red kidney bean cultivar. Planted on 2,000 acres in New York State, the new cultivar yields 20 percent more than the old variety and increases the probable return to New York growers by $150,000 per year.

Over 100,000 acres in Michigan are planted with new bean cultivars into which CRSP researchers have incorporated germplasm from several developing countries. The new cultivars, released by Michigan State University, increase yields by 30 to 35 percent and will increase income to Michigan bean growers by several million extra dollars per year.

Reduced Rate of Global Climate Change

Many of the improved technologies generated by the CRSPs can help reduce pollution and slow the progress of global warming, a process that poses a serious threat to the productivity of American agriculture. Significant warming of the northern hemisphere's temperate zone could turn the enormous midwestern breadbasket of the United States into an arid wasteland.

According to recent estimates by the Environmental Protection Agency, 15 to 25 percent of global warming is caused by the clearing of tropical forests for agriculture, among other purposes. Improved food crops that increase yields on existing farmland help reduce the need to expand the acreage under cultivation. Soil management technologies help to further rebuild the depleted soil of already cleared lands, stabilize acreage devoted to agriculture, and boost yields. The

development of sustainable soil management technologies by the TropSoils CRSP, for example, when adopted on previously cleared lands, can save 10 hectares of rainforest for each hectare of adoption.

Another way to slow the pace of global warming is to reduce the use of fossil fuel and chemical fertilizer. The reduction of energy use will serve several purposes as energy resources become more scarce and expensive.

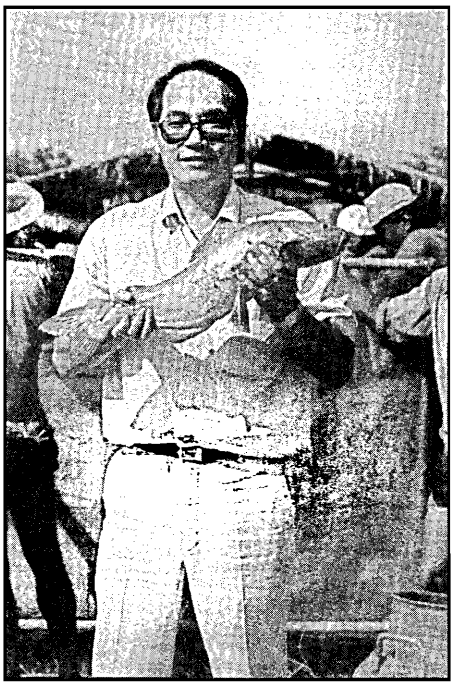
To help reduce energy consumption in aquaculture ponds, Pond Dynamics CRSP researchers substituted composted on-farm waste products for higher cost, more energy-intensive materials. The results were more and bigger fish, reduced use of chemical fertilizer and fuel to transport it as well as reduced risk of water pollution from chemical fertilizer.

The CRSP also studied the effect of different combinations of continuous and intermittent artificial aeration and circulation on water quality and pond productivity for tilapia. Research showed that the best water quality and least energy consumption resulted from a combination of nighttime aeration (if needed) and daytime circulation. The extensive pond production of channel catfish and baitfish in southeastern areas of the United States could benefit from this cost-effective technology.

New snap-beans, bred by Bean/Cowpea CRSP researchers at the University of Wisconsin with germplasm from Brazil and other developing countries, fix 50 pounds of nitrogen per acre as compared to only 10 to 30 pounds from other varieties. Farmers who plant the new variety save $10 to $15 per acre by reducing their use of chemical nitrogen fertilizer which can pollute groundwater and add to global warming.

INTSORMIL researchers determined that by rotating sorghum and soybean crops on the same land, sorghum yields equalled those usually obtained by applying significant amounts of nitrogen fertilizer when only sorghum was grown. Again, U.S. farmers can reduce both economic and environmental costs by lessening their reliance on chemical fertilizer.

The Peanut CRSP is also contributing to these efforts. Integrated pest management programs in North Carolina and Georgia will reduce the need for chemical pesticides. Other CRSP research has identified ways to increase the nitrogen fixing ability of selected peanut cultivars by 25 percent, thus increasing their value as a rotation crop.



Aquaculture is a multi-million dollar business in the United States. Catfish are the most important aquacultural product. CRSP studies of catfish have focused on polyculture with other species and on hatchery techniques for fry prooduction.

Other Benefits

Providing access to germplasm resources and reducing global pollution and climate change are only two of the many positive results of CRSP research.

Household studies conducted by the Human Nutrition CRSP are yielding universally useful information. Working in rural and semi-rural communities in Egypt, Kenya and Mexico from 1982 to 1987, CRSP researchers examined the effects of mild to moderate malnutrition in children. Findings from all three countries showed that reduced quantity and quality of food, particularly micronutrient intake, was associated with impaired growth, cognitive development and school performance. The CRSP is now analyzing these results in order to recommend specific diets that better assure optimal child growth and development. This information could prove useful in U.S. nutrition programs, particularly those serving children from disadvantaged homes.

Innovative techniques developed by the Fisheries Stock Assessment CRSP will help the United States to assess and manage its own fish stocks for maximum sustainable yields. This is an important step toward reducing the major U.S. annual trade deficit in fish and fishery products, which is over $7 billion.

Research by Small Ruminant CRSP scientists demonstrated that caprine arthritis encephalitis (CAE) virus infection was more prevalent in dairy goats in industrialized countries than in goats indigenous to developing nations. The studies led to the development of management methods to control and perhaps eradicate the virus in U.S. herds.

Peanut CRSP researchers recently developed a method in which clay is used to absorb and control aflatoxin, a carcinogenic compound found in swine and poultry feed. Since U.S. peanut growers must often control aflatoxin infections in their crops, this new technology could help solve a major problem for them and for their customers. Earlier Peanut CRSP research developed a rapid aflatoxin assessment technique that helps American peanut growers and processors identify contaminated peanuts.

New Opportunities

In recent years, scientific research received a significant boost from breakthroughs such as computer

technology and biotechnology. These new tools open doors to previously unimagined possibilities by speeding up research processes and overcoming barriers that were once insurmountable.

In many instances, computer simulation can solve one of the major problems of traditional agricultural research -- the time it takes to develop useable information. An accurate simulation model can provide, in days or weeks, answers to research questions that could otherwise take years of plant cultivation or animal reproduction and extensive data collection and testing.

The software known as GAPS (General Purpose Simulation model of the soil-plant atmosphere system) is an excellent example of computer application. Developed by TropSoils researchers at Cornell University's Department of Agronomy, GAPS is already in wide use in the United States. The model simulates the flow of water through and around plants. Researchers can use it to determine the optimal amount and movement of water for field experiments. It can also be used to include variable water-flow factors in other kinds of simulations.

Cornell has distributed more than 100 copies of the software, many to U.S. laboratories and universities. The National Aeronautics and Space Administration (NASA) has added GAPS to the group of programs it uses to simulate environmental processes. U.S. agricultural extension specialists are using GAPS at the farm level. The U.S. Department of Agriculture (USDA) will use GAPS to help predict the effects of global climate change on U.S. grain-crop yields.

The North Carolina State University TropSoils program developed the Fertility Capacity Classification (FCC) system to production constraint identification of soils in the humid tropics. Thirty-five states in the U.S. have adopted this system. The Washington, D.C. based World Resources Institute utilizes this system to characterize constraints on soils on a global scale.

In the early 1980s, Small Ruminant CRSP researchers at Texas A&M University developed sheep and goat simulation models which simulate the interaction between breed of animal, type of feed and body composition. The model was first used in the United States in 1989 to study two critical concerns of the American sheep industry: how to reduce the fat content of slaughter lambs and how to increase profitability.

Simulating the interplay of the three factors, researchers identified a combination that would achieve a 6 to 9 percent reduction of fat in slaughter

Germplasm collected by CRSP scientists has been incorporated into several improved bean varieties. The new bean varieties will increase income to Michigan growers by several million dollars per year.

lambs. They also determined that a pricing system, which discounted overly fat lambs, could encourage better management of nutrition practices, thus increasing producers' net returns by 3 to 6 dollars per head.

The American Sheep Industry Association may use computer simulation to further analyze lean-lamb production and to help plan marketing strategies based on variable sale prices and production costs. This contribution by the Small Ruminant CRSP is particularly valuable to the U.S. domestic sheep industry because limited research on small ruminants is done in the United States.

Using data collected from diverse locations around the world, Pond Dynamics/Aquaculture CRSP researchers developed and standardized several different models of pond dynamics. The models simulate the process of aquatic production, taking into account such variables as pond soil composition, nutrient and lime additions, water alkalinity, hardness and clarity as well as oxygen and nitrogen available to fish. The simulations help scientists to understand the processes occurring in ponds and to predict the potential effect of altering key variables.

These dynamic models are now combined with information from other sources to help fish farmers make informed management decisions about their ponds. In the United States, models can be directly applied to channel catfish and baitfish production systems in the southeast and to recently developed catfish and tilapia farming enterprises in California and Idaho.

The Fisheries Stock Assessment CRSP is developing simulation models and associated manuals which will help assess potential catch levels in tropical multispecies fisheries. Because such fisheries may contain up to several hundred species, accurate assessment and understanding of the inherent relationships can be very difficult. Models developed by CRSP researchers at the Universities of Maryland, Washington and Rhode Island will be welcomed by U.S. fisheries scientists as they attempt to determine maximum sustainable yields for the U.S. domestic fishery industry.

New methods of biotechnology also may help find new solutions to old problems. The Bean/Cowpea CRSP University of Wisconsin-Dominican Republic project has concentrated on the study of fungal, bacterial and viral pathogens of beans. Current efforts include the identification of various types of viruses associated with bean golden mosaid virus, a particularly vigorous plant virus sweeping through Latin America. Researchers have successfully determined the DNA codes of the various types of bean golden mosaid virus and developed a biotechnological tool to easily identify these viruses in the field. Using a particle gun to inject isolated DNA particles into the infected plant cell, scientists hope to develop new virus-resistant bean plants.

This research is extremely important to U.S. agriculture as the methods can be applied to many other crop plants. Further research is being conducted with the collaboration of Agracetus, a Wisconsin-based private agricultural research unit of J.R. Grace, Inc.

A.I.D.'s Collaborative Research Support Programs are developing agricultural technologies that can improve food production in all regions of the world. American farmers and consumers are among the "big winners" as the use of these new agricultural technologies helps reduce the risk, expense and environmental damage associated with food production, while increasing productivity and profits. ★

Pest Management Documents Available

Two documents on pest management, compiled by the Office of Agriculture in the Bureau for Research and Development (R&D/AGR) at the U.S. Agency for International Development (A.I.D.) are now available upon request. **A Report to the U.S. Congress by the Agency for International Development: Integrated Pest Management and Pesticide Management**, July 1991 (15 pp. plus appendix), describes A.I.D. activities in pest and pesticide management. **Pest Management Guidelines for the Agency for International Development** (40 pp. plus appendices) summarizes the Agency's policy on pest management issues, strategies and tactics. Also covered are A.I.D. environmental regulations and procedures, information on pesticides, safe use and disposal of pesticides, pesticide toxicity, and pest management operations during emergencies and disasters.

To obtain a copy of these documents, please write to:
Dr. Allan T. Showler, Office of Agriculture, Bureau for Research and Development, U.S. Agency for International Development, Washington, D.C. 20523.

(continued from page 2)
consumes over 40 percent of the petroleum products. Diesel consumption by this sector alone is estimated in the 40-45 percent range, gasoline at the 30-35 percent range and motor oils at 50 percent. Agriculture not only provides food and raw material for domestic consumption but needed foreign exchange as well. Agriculture and related activities are important sources of employment, income and services for the rural population. In the near term, as unemployment increases, agriculture will become an important employer of last resort -- permitting people to purchase more food and other goods, including manufactured inputs, from the non-agricultural sector. In those republics where a high proportion of consumer income is devoted to food, the performance of the agricultural sector is critical to maintaining and expanding the levels of real wages and savings necessary for longer term growth.

Strategy

The goal of any short or medium term assistance package must be to maintain the capacity of the agriculture sector to continue to provide for peoples needs. This will require:

- an economic policy environment that promotes investments in human and physical capital;
- access to technology and financial markets;
- new institutions that permit the emerging private sector to respond to free markets and incentives;
- stabilizing the natural resource base by more accurately attributing its real costs to users and devising more efficient production systems; and,
- efficient distribution systems.

Accomplishing these objectives will not be easy. It is anticipated that the stabilization program being promoted by the International Monetary Fund, the World Bank and other donors will address the problems associated with the rouble and other macroeconomic adjustments.

The Office of Agriculture can also assist in this effort. Over the years, it has demonstrated a capacity to address problems in the following areas:

- how to reduce waste and improve efficiency in post-harvest handling, marketing and utilization of crop, livestock and fisheries products;
- how to undertake economic analysis which improves the understanding of agricultural policy issues and strengthens local institutional capacities; and
- how to develop technology which increases income by reducing risk and lowering unit costs of production associated with losses from pests, diseases, drought, water logging and salinity, soil nutrient imbalances, and other biological and physical stresses.

Enhancing human capacity and promoting institutional development by improving the skills of individuals working in agriculture is at the core of all activities in the Office portfolio.

The R&D/AGR technical assistance strategy for the NIS must be based on an understanding of the Office's comparative advantage and the need to address the short-term and intermediate problems of agriculture in the republics.

Specifically, the breakdown in the food pricing and distribution system must be addressed. Knowledge and information are needed to identify and remove bottlenecks. The new decision makers of the NIS must learn the rules that make free market economies successful. The program strategy should provide targeted technical assistance and training. Within the next 12-36 months, special attention must be given to addressing problems of:

- reducing post-harvest losses and damage in basic food and feed grains;
- improving obsolete processing systems;
- identifying and correcting inefficiently managed and inadequate transport and distribution systems; and
- addressing problems of badly organized and unresponsive wholesale and retail markets.

In the longer term, inefficiencies in agricultural production which damage the environment must also form part of the technical assistance package.

A strategy built on the concept of targeting pockets of opportunities, initially in the post-harvest and marketing areas and eventually in other aspects of agricultural development, while at the same time building on the Office's comparative advantage must find a way to expose the portfolio to the reality of agricultural development in the Republics. R&D/AGR's demonstrated capacity in policy analysis, and technology development both in post-harvest and production areas will not be tapped unless there is a mechanism for bringing the two sides together. A rolling design is, therefore, recommended in order to develop these initial linkages and longer-term development activities.

High priority subsectors to be targeted are likely to include food and feed grains, livestock and fruits and vegetables. The program must also target key commodity systems in selected areas of the NIS and demonstrate the effectiveness of these systems through the use of free market principles. Developing long-term linkages and opportunities between the Office portfolio, NIS collaborators and the private sector must be an expected result of this targeted effort.

In the long-run, the goal of this assistance package must be to promote economic and political stability in the NIS as the republics move from a command economy to a market-led system. As a result, the efficiencies and overall capacity of the agricultural sector in NIS to continue to provide for the food, feed, employment and income needs of its people will be improved.★

A.I.D. Supports Adoption of BNF Technology in Thailand; Cooperation is the Key to Success

by Patty Nakao, Head of Communications
NiFTAL Project, University of Hawaii

The U.S. Agency for International Development (A.I.D.) helped to introduce biological nitrogen fixation (BNF) technology to Thailand some 15 years ago. Today, as a result of effective promotion of the technology through government extension services, the private sector has capitalized on the market demands created. A number of new commercial enterprises have resulted.

A.I.D. has worked with the Thai Ministry of Agriculture and Cooperatives to expand the development of BNF technology which has increased legume productivity and profits for farmers. The technology involves the practice of inoculating grain and forage legume seeds at planting with soil bacteria called rhizobia. The Thai farmers who use inexpensive high quality legume inoculant products ensure that their legumes become self-sufficient for nitrogen. This practice is important in the tropics where most soils lack nitrogen and effective rhizobia. In addition, BNF technology is environmentally sound and is the foundation for sustainable agricultural production.

The Thai Department of Agriculture (DOA) in Bangkok produced inoculants which were distributed by the Thai Department of Agricultural Extension (DOAE) and vendors in the private sector. They have been so effective in raising farmers' demand for the product that several private Thai firms have now gone into the inoculant manufacturing business and a number of ancillary businesses have been launched. The U.S. inoculant manufacturers are interested in this new market.

BNF technology in Thailand received strong leadership when Dr. Nantakorn Boonkerd of the Thai Department of Agriculture received his doctorate degree in the United States under a scholarship program supported by A.I.D.. When he returned to Bangkok, Dr. Boonkerd used A.I.D. loans to establish an inoculant production facility at the DOA. Under his leadership, DOA inoculant production for legumes like mungbean, peanut and soybean went from a total of 5 metric tons in 1979 to 126 tons in 1990. A.I.D. sponsored the training of other key DOA and DOAE personnel involved in inoculant production, quality control and extension projects. The Agency also helped translate a resource manual on legume inoculation into Thai -- an effort that proved invaluable to the technology transfer program.

Another key component in the success of the Thai effort was A.I.D. Bureau for Research and Development, Office of Agriculture support for NifTAL (Nitrogen Fixation by Tropical Agricultural Legumes), a University of Hawaii project dedicated to promoting BNF for sustainable agricultural development in the tropics. In 1983, NifTAL and the Thai DOA jointly established the BNF Resource Center (BNFRC) for South and Southeast Asia in Bangkok. Dr. Boonkerd is director of the regional BNF Resource Center.

The BNFRC trained DOAE extension agents in applied BNF technology. Farmer demonstration trials were conducted in which the use of inoculants resulted in yield increases of up to 1,000 kg per hectare for some legume crops. This increase translated into a net return of 8,780 baht (US$350.00) per hectare. Other extension activities included mobile units which visited farmers' fields and mass media advertising. The DOAE also used various cost incentives to promote both inoculants and improved seed varieties. Cooperation with commercial distributors of agricultural materials helped bring inoculants to remote areas of the country. Currently, national income increases are estimated to be $100,000,000 per year from increased inoculant use.

A.I.D. - introduced BNF technology has created a number of new commercial enterprises in Thailand.

Since 1989, grants from the Thai government and technical assistance from the BNFRC helped stimulate private sector production and distribution of legume inoculants. The Bangkok Seed Company of the Chareon Pokphand Group of Companies, for example, is now in the market with a projected annual production of 200 metric tons of inoculant (worth

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about US$500,000). Through a grant from the Thailand Science and Technology Board, the BNFRC helped the Bangkok Seed Company in the design of inoculant production facilities, providing rhizobial cultures, training and quality assurance standards.

The strong development of the private sector inoculant industry has prompted the government to reassess its operation. The DOA is no longer expanding its own production. Even the DOAE now purchases inoculants from the Chareon Pokphand Group.

Other spin-off Thai enterprises have thrived as a result of the boom in private sector inoculant production including harvesters and distributors of indigenous peat carrier material used in the inoculant industry and the Bangkok manufacturer of NifTAL designed fermentors used both locally and by inoculant facilities around the world.

The impact of work of the BNFRC has been felt throughout South and Southeast Asia. NifTAL and the BNFRC supply technical assistance, material support and training for the region. BNFRC helped establish a commercial inoculant manufacturing facility in Indonesia. NifTAL and the BNFRC also trained a core of Indonesian extension specialists who will educate other agents and farmers in the benefits of the product. NifTAL, building on its experience in Thailand, has developed an integrated package of services for agriculture and agribusiness which is available to other countries.

The adoption of BNF technology in Thailand shows that cooperation between A.I.D., government agencies and the private sector is mutually beneficial to all concerned. The BNF technology project in Thailand has now become a model for other countries to follow. ★

(continued from page 4)
discovers or copies an invention of another, anywhere in the world, cannot obtain a patent for it.

In the case of joint inventorship, which may become essential elements of collaborative research, each inventor must contribute to the conception of the invention. Conception, as defined here, refers to the mental formulation of an idea so complete as to enable one of ordinary skill in the art to reduce the concept to practice without undue experimentation. If IPR arises from collaborative development projects, then such projects should also consider terms and conditions of the IPR, potential mechanisms of enforcement and means by which inventions will reach farmers and consumers in the developing world.

Research by the emerging private seed industry in developing countries, as companions to that undertaken by IARCS and national programs, would be strongly encouraged if legislation on breeders' rights, as one form of IPR, is more widely enacted. With this in mind, and in combination with the changes taking place regarding IPR in industrialized countries, it is essential that clear policies on IPR are communicated and used to build the trust and confidence required to derive success from mutually beneficial research collaboration in international agriculture. ★

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Hans P. Peterson
Director
Office of Agriculture (R&D/AGR)

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SANREM CRSP Emphasizes Landscape/Lifescape Interrelationships

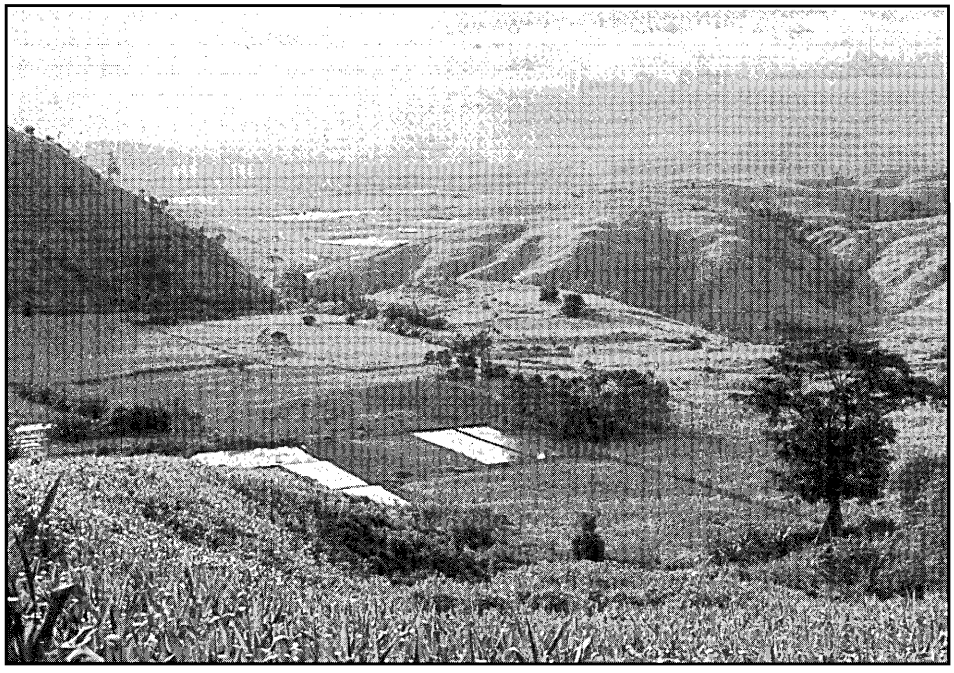
by Dr. Jim Bonner,
Office of Agriculture, Bureau for Research and Development, A.I.D.

The Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program (SANREM CRSP), set to begin in Fall 1992, will focus on food production and natural resource management within an ecological framework. Emphasis will be placed on the relationship of end-users — such as farmers, fishermen, processors and their families — to the environment and the natural resource base. The five-year program is funded by the Office of Agriculture, Bureau for Research and Development at the U.S. Agency for International Development (A.I.D.).

The CRSP will unite national programs, international research centers as well as a broad spectrum of scientific disciplines including agriculture, ecology, and the social sciences. Its unique integration of individual ecosystems within the larger ecological and human perspective will enable the CRSP to address key issues related to economic and social development and the environment.

Program goals are to:

- preserve biodiversity in the landscape and reduce the rate of loss of biological and genetic diversity;
- reduce the rates of deforestation and/or desertification resulting from agricultural activities;
- reduce soil erosion and soil nutrient depletion;
- improve information exchange on natural resource management and environmental issues;
- strengthen research capabilities in developing countries, especially in landscape approaches; and



Among SANREM CRSP goals is the preservation of biodiversity in the landscape.

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SANREM research will incorporate a gender perspective in understanding the dynamics of the relationship of people to the environment and the environment to people.

- improve monitoring and evaluation of changes in the natural resource base.

SANREM CRSP activities will focus on three countries — the Philippines, Honduras, and Burkina Faso — which provide particularly outstanding opportunities for research related to sustainable agriculture and natural resource management in a landscape setting. In the Philippines, for example, the Pulangi watershed, where one meter of sediment was collected one year after the completion of the National Power Company Dam, offers a unique chance to research high rates of soil loss and sedimentation. The Philippines also provide an opportunity to study protected forest bioreserves at high altitudes in a watershed. Honduras' Choluteca area, where pesticide contamination and sedimentation are damaging coastal mangrove ecosystems and the shrimp industry, provides a potential case study of significant downstream impacts. In Burkina Faso, the focus will be on research in human migration. Migration from the Sudano-Sahelian zone of Burkina Faso, is increasing pressure on more humid zones to the south.

The SANREM CRSP will be implemented by a nine-member consortium led by the University of Georgia. Consortium members include: Auburn University; Colorado State University; Heifer Project International; Tuskegee University; Virginia Polytechnic Institute and State University; Washington State University; the University of Wisconsin, Center for PVO/University Collaboration in Development and the United States Department of Agriculture-Agriculture Research Service (USDA-ARS).

On-site research activities will be planned and conducted by interdisciplinary teams responsible for workplans, site research and dissemination of results. Team members will be trained in landscape ecology, gender sensitivity, and farmer-first methodology. The scientific expertise assembled to address these issues represents "an unprecedented array of social, ecological and agricultural sciences" according to Dr. Ron Carroll, Associate Director of The University of Georgia's Institute of Ecology.

Among SANREM research goals are:

- identification and collation of existing biophysical and socioeconomic baseline data, including relevant indigenous knowledge. Determination of the need for additional baseline data collection leading to ecosystem boundary definition and hierarchical relationships;
- collection and integration of additional physical, biological, and socioeconomic baseline data;
- improvement of the understanding of important ecosystem processes and critical ecosystem linkages in a landscape setting (i.e. water quality issues associated with upstream activities causing negative "downstream" impacts);
- recognition and understanding of the cultural, socioeconomic, political, and institutional framework which can be used to overcome constraints to sustainability in agricultural and natural ecosystems; and
- promotion of education, training, and information exchange in sustainability issues.

SANREM research will also incorporate a gender perspective in understanding the dynamics of the relationship of people to the environment and the environment to people (i.e. the lifescape upon the landscape). In many societies, women have been traditionally entrusted with important tasks associated with cropping systems and natural resource management. "Gender analysis, when an integrated part of research design and implementation, can help identify key sustainability issues and problems and the technical solutions most likely to solve them," says Dr. Cornelia Flora, Virginia Polytechnic and State University sociologist.

Research activities will be supported by a number of state-of-the-art tools such as the Geographical Information System (GIS) which provides a means of collecting, storing, retrieving, transforming and displaying spatial data. Simulation modeling and systems analysis will be employed in the research process to analyze and integrate results, identify gaps and recommend further experimentation.

"There will be exciting results coming out of this research. So it is imperative

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Integrated Pest Management: Progress and Trends

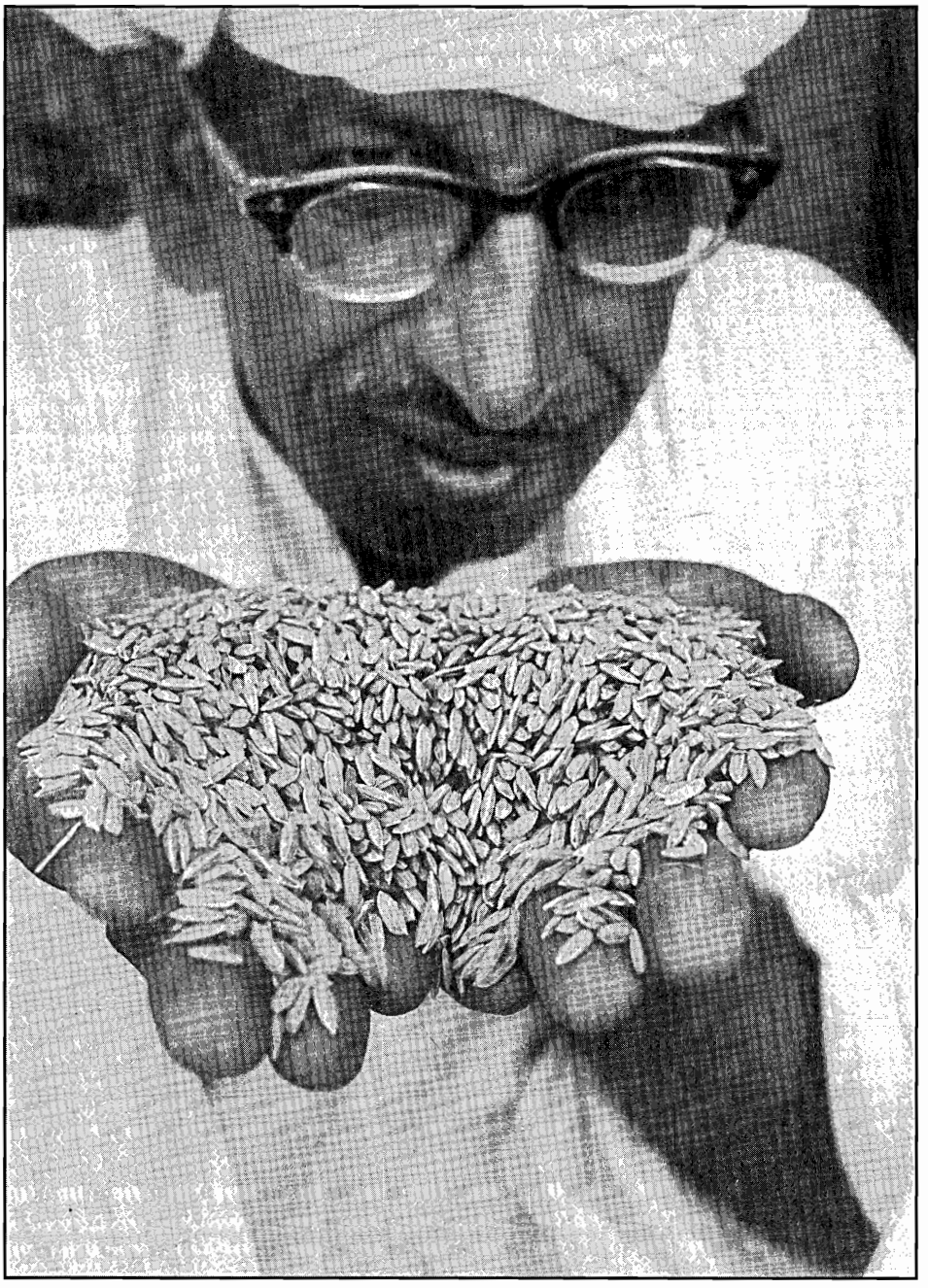
by Robert Hedlund,
Office of Agriculture, Bureau for Science and Technology,
U.S. Agency for International Development

A new program focusing on Integrated Pest Management (IPM) will soon be announced by A.I.D.'s Office of Agriculture, Bureau for Research and Development. The program will focus on overriding constraints to IPM such as training, technology development, interdisciplinary collaborative research, socioeconomic factors, outreach and extension services and policy issues. A systems approach will be used and is expected to provide benefits both to the U.S. farmer as well as to farmers in developing countries.

Synthetic pesticides were used since the 1940s as a means of controlling pests such as insects, weeds, plant diseases, nematodes and even vertebrates that caused large losses to agricultural crops. Even though pests became resistant to these chemicals, the development of newer and more effective pesticides allowed producers to continue to rely on their use. This use became so common that chemicals were often applied according to a schedule rather than when the populations of pests actually warranted their use.

By the mid 1950s, scientists became aware of some of the dangers such as environmental hazards and development of resistance that resulted from continued reliance on pesticides to sustain yields. They began to develop alternative means of controlling pests. The use of these techniques in various combinations led to practices now referred to as Integrated Pest Management.

IPM was defined by a U.S. Congressional Office of technology assessment in 1990 as, "the optimization of pest control measures in an economically and ecologically sound manner, accomplished by the coordinated use of multiple tactics to assure stable crop production and to maintain pest damage



Integrated Pest Management helps assure stable crop production while minimizing hazards to humans, animals, plants and the environment.

Integrated Pest Management .....*continued from page 3*

below the economic injury level while minimizing hazards to humans, animals, plants and the environment." The basic concept behind IPM is the use of ecologically neutral measures for pest control whenever they are available and effective. This minimizes the costs and environmental dangers which accompany the use of synthetic chemicals.

The most common recommendation and practice in IPM is to use chemicals only when the level of pest infestation is high enough that its control would cost less than the damage it would cause to the crop. This concept is known as the economic threshold.

In addition to the economic threshold concept, techniques used in IPM include but are not limited to:

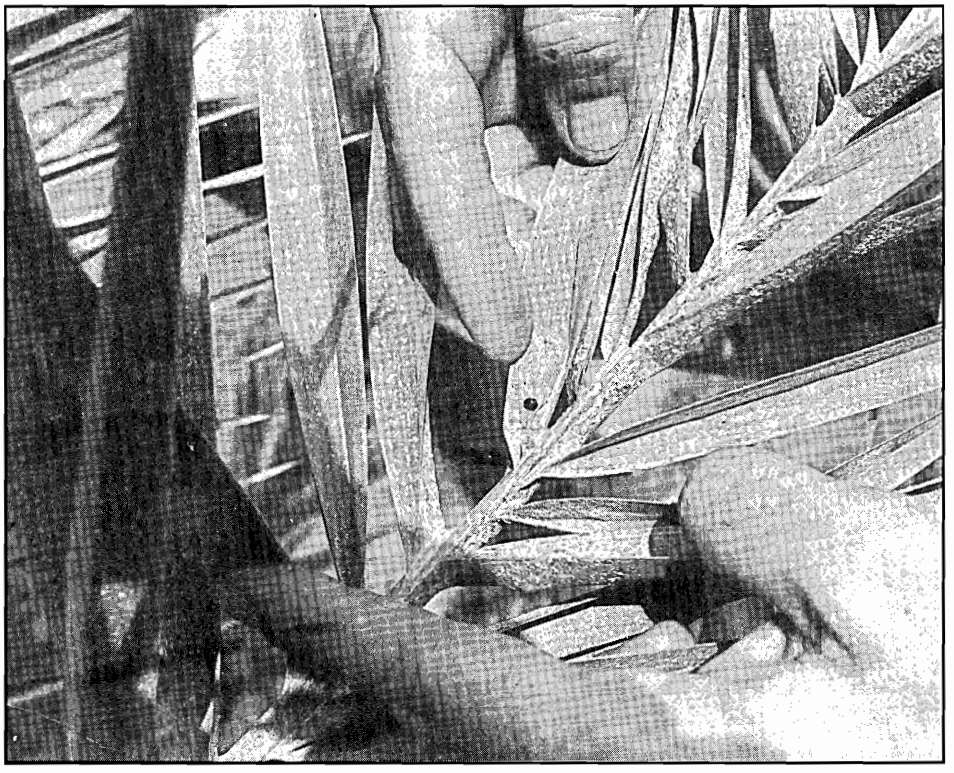
- biological control — which should include the protection and preservation of natural enemies;
- cultural methods such as planting times, tillage practices and crop rotation;
- use of pest resistant varieties of crops — especially effective against plant disease;
- chemical controls — used only when necessary and in such a manner as to minimize environmental hazard.

With the accidental introduction of the New World screwworm fly into North Africa in 1988, A.I.D. actively supported the eradication program implemented by the U.N. Food and Agriculture Organization's Screwworm Eradication Center for North Africa (SECNA). The program involved the release of sterile male screwworm flies into wild, fertile fly populations. Enough sterile males were released in relation to the wild population to cause a decline in reproduction. Eventually, the pest was eradicated. This autocidal control technique has been used in IPM programs with at least ten different insect species. And, it was used to eradicate the screwworm from the entire North American continent.

The IPM approach has also been successful against Take-All Decline; a serious fungal disease of wheat, barley and many grasses. This case illustrates the use of agricultural practices to favor resident antagonists of the pathogen in soils, use of closely-related avirulent fungi as a form of cross-protection to displace the pathogen, and enhanced disease resistance of the host through breeding and proper nutrition. Using this integrated approach to disease control, Take-All Decline has been nearly eliminated from some of the major grain producing regions of the world such as the midwestern United States and Central Europe.

Use of these and other techniques are inhibited by many factors. Often, technical research may not have been conducted or may have been conducted in disciplinary isolation rather than through a systems approach. An economic threshold may vary according to each growing area, the intended use of the crop, the farmer's willingness to assume risk or the availability and effectiveness of alternative control methods. Grading standards and consumer demands may favor cosmetically perfect produce. This encourages the use of pesticides which do not necessarily increase yield. Growers may not be aware of alternative pest control techniques or may not be convinced of their economic benefit. Sociological factors may also impede adoption of IPM in some cultures.

For further information on Integrated Pest Management, contact Dr. Robert C. Hedlund, Agricultural Production Division, Office of Agriculture, Bureau for Research and Development. ★



IPM uses ecologically neutral measures for pest control. Here a ladybug feasts on white scale infecting palm leaves. The use of insects has helped save the trees.

Incorporating Gender Issues into the Bean/Cowpea CRSP

By Anne Ferguson,
Women and Development Program, Bean/Cowpea CRSP.

Beans and cowpeas are major sources of protein and vitamins for families in many developing countries. In these areas, they are often grown by small-scale producers under rain-fed, limited-input farming conditions. In Africa, especially, women and children are involved in bean and cowpea production, while women the world over store, harvest, process and market these important food crops.

To improve the health and economic well-being of women, their families, and other farmers and consumers, A.I.D.'s Office of Research and Development supports the Bean/Cowpea Collaborative Research Support Program—a program of twelve research projects addressing major production and utilization constraints associated with these legumes.

Project research focuses on a wide range of production, utilization and consumption issues. Control of pests and diseases through integrated pest management strategies, increasing capacities for biological nitrogen fixation, and developing cultivars with multiple disease resistance and heat and drought tolerance are some of the production-related issues under study. Storage, nutrition and utilization constraints also receive attention, including research on bean and cowpea storage technologies, the hard-to-cook phenomena in beans, and bean protein digestibility. All directly address concerns voiced by women farmers and consumers in developing countries. A mix of research techniques, including biotechnology and appropriate technology, are used to address the problems.

Headquartered at Michigan State University, the CRSP includes collaborative research projects with 12 U.S. universities and 11 developing-country Ministries of Agriculture, universities or research institutes. In Africa, projects are currently underway in Cameroon, Senegal, Tanzania, Malawi, and two new projects have recently been initiated in Ghana. In Latin America, on-going projects are located in Ecuador, Honduras, the Dominican Republic, and Mexico and new projects have been established in Costa Rica and Jamaica.

Women play a major role in agriculture in developing countries.

From its inception, the CRSP has emphasized the importance of gender sensitive research because of the important role women play in many aspects of bean production and use in developing countries. A Women and Development (WID) program provides support to the projects by working toward integrating gender variables into research problem identification and agenda setting, technology development and dissemination efforts and toward gender parity in CRSP research and training programs. Each year, the WID program identifies a number of

Incorporating Gender Issues into the Bean/Cowpea CRSP .....*continued from page 5*

Bean/Cowpea CRSP projects to work with on an intensive basis. U.S. and developing country researchers are assisted to:

- devise gender-sensitive research strategies which take into account existing differences among men and women farmers and among women farmers themselves related to the projects' research objectives;
- develop methods to include women and other farmers and consumers in the research process to better assure that the resulting new varieties, techniques and technologies will meet their needs and be adopted by them;
- monitor the social and gender-related impacts of project-developed technologies so researchers can act on this information in their on-going research process; and
- identify researchers in the U.S. and in developing country institutions who can perform these project functions on an on-going basis.

Women throughout the developing world plant, store, harvest, process important food crops including beans and cowpeas.

A number of CRSP projects include significant WID-related agricultural research. For example, the collaborative project between Washington State University and Sokoine University in Tanzania, now headed by U.S. anthropologist Dr. Lorna Butler, focuses on developing participatory research techniques to integrate women and other farmers into the bean improvement program. Researchers at Sokoine University are bringing farmers to experiment stations to help in evaluating early generation bean breeding materials.

The CRSP project in Malawi, involving researchers at Bunda College of Agriculture, University of California, Davis and Michigan State University, initially carried out studies to explain the great phenotypic diversity found in Malawian beans. Dr. M. Wayne Adams, Dr. Todo Edje, Dr. Pat Barnes McConnell, and Dr. Anne Ferguson found that farmers in the Northern and Central Regions often planted more than ten different landraces of farmer-developed bean varieties on their farms.

CRSP investigators discovered that biological, socio-economic and cultural factors interact to account for this diversity. Outcrossing and adaptation to specific environmental niches are important in shaping the diversity present in these landraces. Farmers and consumers also exert powerful influences by their selection practices. Women are especially important in this regard. In many parts of Malawi, they play major roles in bean planting, weeding, harvesting and storage

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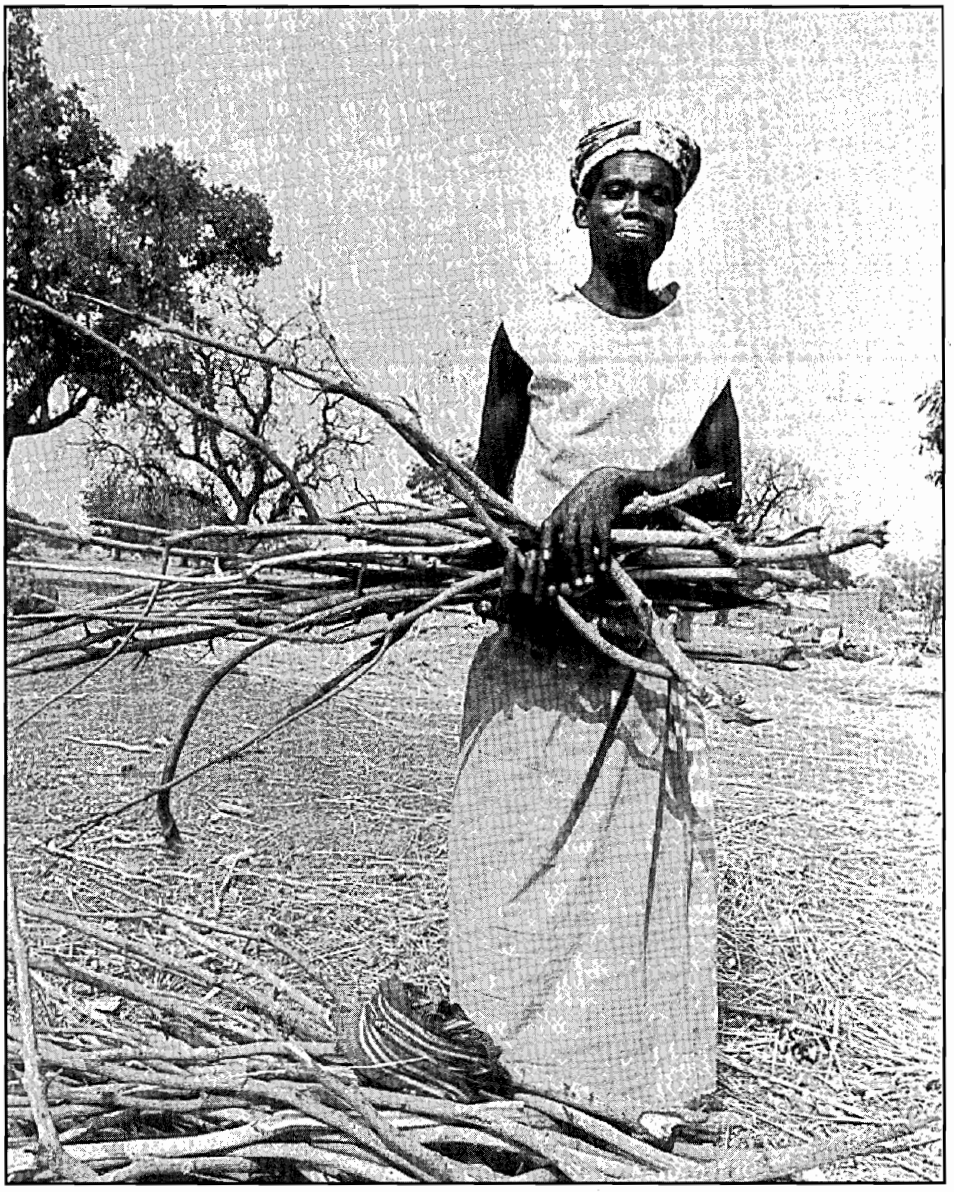


Reducing the rate of desertification is among the goals of the SANREM CRSP.

that communications and networking be a high priority," notes Dr. Constance Neely, Assistant Program Director. Although only three field sites have been initially planned, the information and lessons learned will be transferred to other countries and regions of the world.

Innovative approaches are needed to utilize the vast storehouse of end-user knowledge and skills in problem solving.

"SANREM will use a diverse toolkit of participatory methods, such as community meetings, end-user group interviews, key informants, group treks, village preference rankings and other methods," notes Dr. Bob Rhoades, anthropologist at the University of Georgia. "Scientists, public officials, community leaders, PVO/NGO representatives, extension agents, end-users, resource managers, and others will regularly and systematically come together in the landscape context to identify goals, problems and potential solutions."

The SANREM CRSP will help create a new paradigm for sustainable agricultural research.

Training, education and information exchange will be fully integrated into the program. New approaches will be designed and tested for training and information exchange, including community-based education in environmental and ecological awareness, farmer-to-farmer information exchange, and formal training at the undergraduate, graduate, and visiting scientist levels, emphasizing holistic, interdisciplinary approaches, farmer-first methodologies, and creative approaches to technology design.

The SANREM CRSP will identify a group of parameters that will serve as quantifiable indicators of sustainability. They will include on-farm biophysical markers (soil properties and biotic factors), off-farm biophysical markers (hydrologic measurements, water quality measurements, changes in biodiversity and land use), and socio-economic markers (demographic variables, descriptive economic indicators, and social and economic cost/benefit analysis of alternative strategies).

The SANREM CRSP will help create a new paradigm for sustainable agricultural research that includes an integrated, interdisciplinary approach centered around end-users and an improved understanding of the landscape. ★

Regenerating West African Soils

by Timothy McBride,
Editor, Soil Management CRSP,
North Carolina State University

In the United States, "collecting dust" means doing something useless or unproductive. In Sahelian Africa, the opposite is true. Harvesting wind-borne sediments may be a key to restoring degraded lands. This is the conclusion reached by a collaborative effort between the Soil Management CRSP (TROPSOILS), the International Center for Crop Improvement in the Semi-arid Tropics (ICRISAT), International Fertilizer Development Center (IFDC), and the Niger National Institute for Agronomic Research (INRAN). The program is supported by the A.I.D. Mission in Niger (USAID/Niger).

"Today, we're trying to find out how we can gather dust more effectively," says Roger Hanson, TROPSOILS Management Director. "In windy areas of the Sahel, mulching strategies can simultaneously increase production and improve the environment."

Millet-producing soils of semi-arid West Africa are sandy, infertile, and low in organic matter. Animal manure is not plentiful enough to overcome these constraints. Millet residue, however, is extremely effective — and readily available. When applied as a surface mulch on plots at the ICRISAT Sahelian Center at Sadore, Niger, it increased biomass yields by as much as 400% after five years. Used with fertilizers, millet residue increased yields by as much as 1,200%.

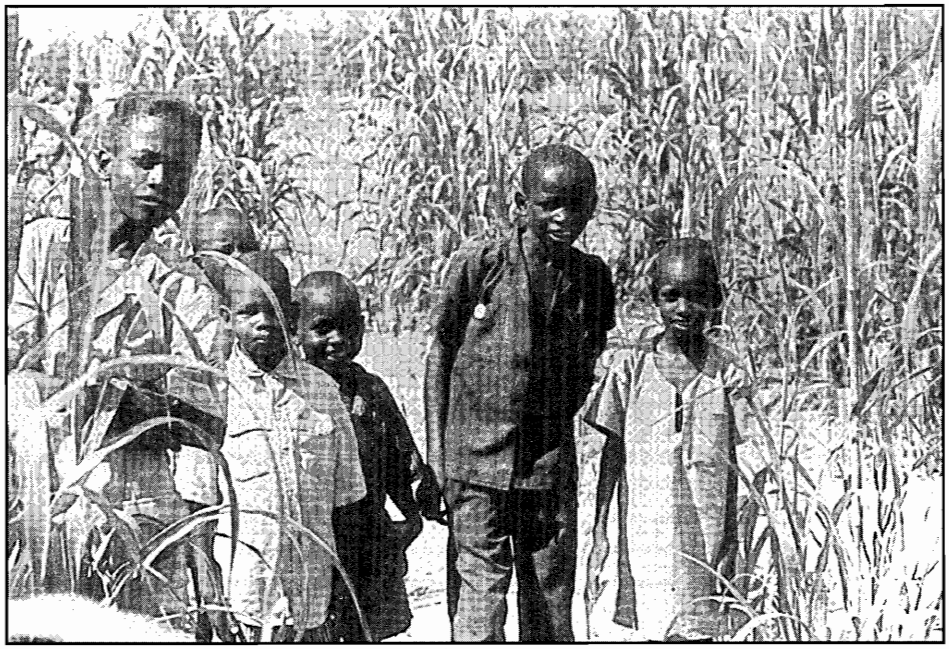
Research also suggests that millet residue can reduce soil acidity, eliminate exchangeable aluminum from the soil's top 10 cm, increase plant-available phosphorus and improve the soil's exchangeable-base content.

One way that residues may increase crop production is by recycling nutrients. Termites and micro-organisms break down millet residues, thus returning nutrients to the soil. One study indicated that three years of mulching can increase stover yields 268%, nitrogen content by 288%, phosphorus content by 240%, calcium content by 212%, magnesium content by 260%, and potassium content by 311%.

Researchers have concluded that residues may enhance millet growth, in part, by increasing nitrogen-fixing bacteria, which, in turn increases root surface area and nitrogen content. These changes help increase a plant's ability to use phosphorus, the most limiting nutrient to millet growth in the Sahel.

Even more striking, perhaps, are the findings on topography, which provide evidence that mulch reduces erosion and traps wind-borne dust. Over a five-year period, mulched soils showed a 15 cm increase in surface elevation when compared with control plots. This finding is especially encouraging considering that trapped soil generally has proven more fertile than surface soil on control plots. Consequently, natural revegetation can occur in the nutrient-rich wind borne materials.

Soil Management CRSP researchers at Texas A&M University indicate that nutrient enrichment and recycling are critical to millet growth on the infertile sandy soils of Niger and elsewhere in the semiarid regions of West Africa. Hanson says that these findings "would not have been possible without the project support provided by USAID/Niger and the collaborative efforts of ICRISAT, INRAN, and IFDC." ★



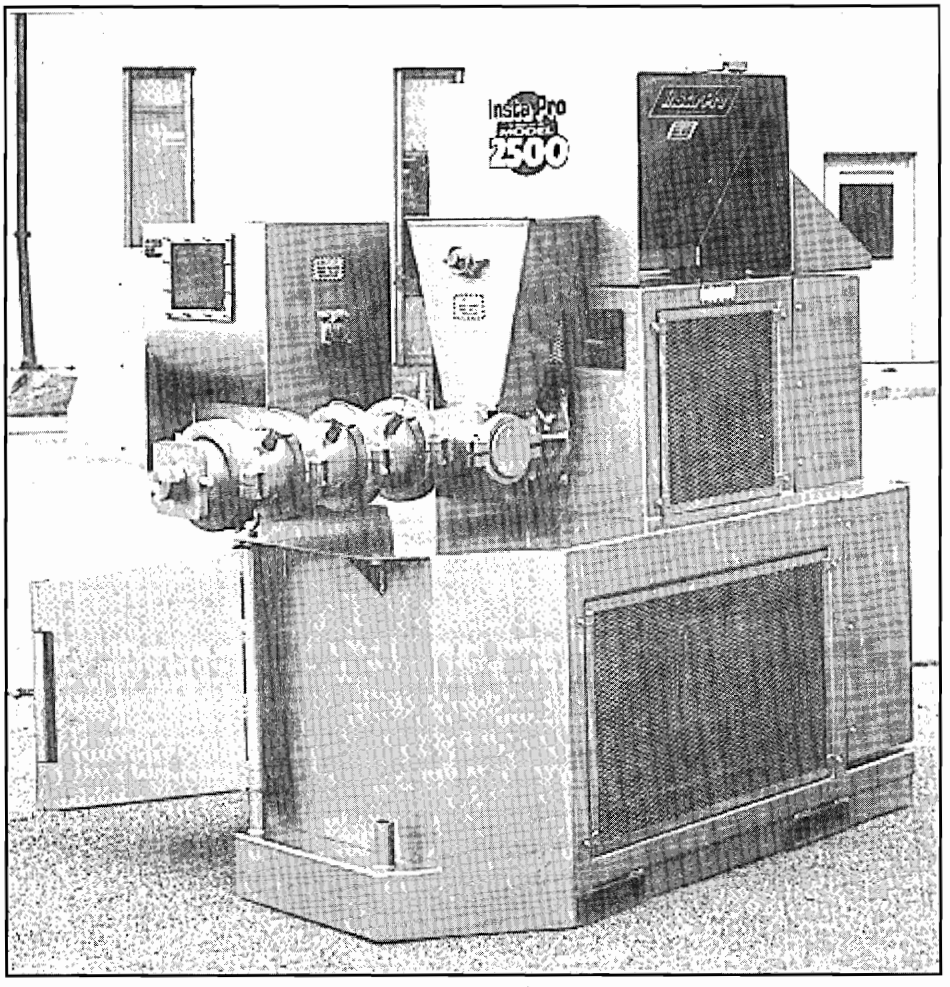
Incorporating crop residue has increased yields along the Hamdallaye watershed in Niger.

A Technology for Extruding and Expelling Soybeans

by Dr. Leroy Hanson,
President Triple F, Inc., Des Moines, Iowa.

"Think globally; act locally," is the catchphrase of the 1990s. It's also an accurate description of the philosophy behind a small-scale, mechanical soybean processing operation in central Illinois which had its origin in the developing world. At the Triple "F" Extrude 'n Mix Center in Congerville, Illinois, farmers are turning locally grown soybeans into a high-protein, medium-oil animal feed and a stable vegetable oil for food or feed use. Triple F, Inc. is an international agribusiness company specializing in nutrition, microbiology and extrusion and conducting business in 72 countries worldwide.

The Dry Extrusion Process, pioneered by Triple F and INSTA-PRO (a Triple F wholly owned subsidiary in Des Moines, Iowa), uses mechanical friction to produce the optimum heat and pressure to process whole soybeans. This high temperature, 280 degrees F; high pressure, 400 psi; short cooking-time, 26 seconds; produces a product that is high in digestibility and Omega-3 fatty acids and has had the trypsin inhibitor destroyed, as well as an oil that is all-natural, clean and stable.



The INSTA-PRO Model 2500 Extruder is currently being used to produce 15,000 tons of a fortified corn/soy mixture for feeding a million people in a refugee camp in Africa.

Triple F's unique combination of an INSTA-PRO extruder and a Continuous Horizontal Press adds value to a soybean crop and provides a superior protein and energy source for livestock.

An INSTA-PRO Model 2500 Extruder is currently being used to produce 15,000 tons of a fortified corn/soy mixture for feeding a million people in a refugee camp in Africa. Similar food and feed operations, using INSTA-PRO technology, are operating in Eastern Europe, Mexico, South America and Asia.

This Midwestern project resulted from a public-private partnership which included Triple F, the College of Agriculture at the University of Illinois in Champaign-Urbana; and support from the U.S. Agency for International Development (A.I.D.) through the INTSOY program at the University of Illinois. The cooperators include food scientists, specialists from developing countries, small business consultants and animal nutritionists.

Triple F looks for markets where its products can help customers enhance their positions or improve their conditions. Several years ago, a global study showed that the Triple F system had the potential to feed people in countries with low levels of technology and little infrastrucutre. The food scientists and INTSOY staff at the University of Illinois were interested.

Professor Al Nelson, food science emeritus member and INTSOY Soybean

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Incorporating Gender Issues into the Bean/Cowpea CRSP .....*continued from page 6*

activities. In addition, they are usually responsible for selecting and preserving bean seed for the next growing season.

Women in the different regions of Malawi and among different socio-economic strata often favor different bean varieties. Some varieties are prized because they are fast cooking or early maturing. Others have superior taste characteristics, while yet others are high-yielding or easy to sell at the market.

The project has also carried out agronomic and socio-economic surveys of major bean production constraints in the three regions of the country. Biological researchers — Dr. Paul Gepts, Dr. Steve Temple and Dr. Bob Gilbertson, from the University of California, Davis — together with long-time researchers at Bunda College and Michigan State University —are now using survey and diversity study results to develop bean breeding strategies. These plant improvement strategies maintain genetic diversity in the bean crop at the same time that they address women's and other farmers' identified constraints.

In northern Cameroon, where storage pests have been identified as major constraints, the CRSP is conducting research on cowpea storage technologies. Project investigators from Purdue University — Dr. Larry Murdock, Dr. Laurie Kitch and Dr. Jane Wolfson — together with the Institute of Agricultural Research's Mr. Georges Ntoukam and Mr. Z. Boli, began by surveying the storage techniques currently used at the household level by women and other farmers. Researchers examined how a number of techniques currently used, such as storage in ash, could be made more effective. In addition, new, low-input storage techniques, including solar heating and triple bagging have been developed to supplement methods already in use in northern Cameroon. Meanwhile, researchers are also using plant breeding techniques and biotechnology to introduce seed and pod resistance into preferred local cultivars.

In Malawi, plant improvement strategies maintain genetic diversity in the bean crop while addressing women's constraints.

WID-related research has also been carried out in Bean/Cowpea CRSP projects in Nigeria, Senegal, and Brazil and is currently underway in projects located in Ecuador and the Dominican Republic. In Ecuador, the new local Principal Investigator, Ms. Consuelo Estevez, is a woman.

The results of these gender-sensitive research projects, including participatory research strategies, new breeding schemes to preserve diversity and new storage technologies, have application well beyond the countries where they were developed. Many are directly transferable to the region and some may have even wider applicability.

Integrating women into Bean/Cowpea CRSP training programs is also an important function of the WID program. Principal Investigators are encouraged to identify qualified women to take part in degree and non-degree training efforts sponsored by the CRSP. To date, 104 (45%) out of the 232 people receiving degrees under CRSP auspices have been women. The CRSP has also supported 243 (27%) women out of 899 participants in non-degree training efforts.

Additionally, discussions of the relevance of gender issues to agricultural research are routinely integrated into Bean/Cowpea CRSP workshops held for students and researchers in the program. ★

A woman harvesting beans in Malawi.

Expanding Electronic Communications for Agricultural Technical Services

by James Beebe,
Chief, Agricultural Policy and Planning Division, Office of Agriculture,
Bureau for Research and Development, U.S. Agency for International Development

Three recent initiatives using computer based electronic communications will help A.I.D.'s Agricultural Policy and Planning Division improve communications between agricultural professionals in A.I.D./Washington and the field.

A.I.D. Agriculture and Environment Network or AIDAENET is a bi-weekly electronic newsletter that will provide timely information in a cost effective way to the Agency's agricultural, environmental and natural resource officers. The newsletter will include information about position vacancies, opportunities for training, book reviews, publications and reports by A.I.D. contractors and other donors, deadlines and schedules for contracts as well as project information. Contents will primarily consist of material submitted by readers in electronic form. AIDAENET will be distributed by E-mail or by FAX. AIDAENET will help promote greater use of technical expertise among professionals in the field and develop an increased sense of community among professionals.

The second initiative, the Agriculture and Environment Network Directory (AENETDIR), is an electronic database listing the Agency's agriculture, environment and natural resource development officers in Washington and the field. The system was designed to automatically address E-mail and fax messages and to produce mailing labels. The directory includes names, positions and title information, addresses for international mail, fax, office phone and E-mail addresses. AENETDIR is used for the distribution of AIDAENET and eventually will be available as a dBASE file to others in the Agency.

The third initiative — the Agriculture and Environment Network Bulletin Board Service (AENETBBS) — uses a stand alone PC set up with a modem and software that allows individuals with access to a modem to dial into the system. Individuals can post messages for each other and can upload and download files. Initially the system includes the AENETDIR, backcopies of AIDAENET, and examples of scopes of work for A.I.D. documents. Because of the limitations of the hardware, access to the system must be limited to officers overseas at USAID Missions that do not have E-mail. If there is sufficient demand, the system will be expanded.

New computer based electronic communications will help improve information flow between A.I.D.. agricultural professionals in the United States and overseas. A bi-weekly electronic newsletter and database will provide project, personnel and other information. The Agriculture and Environment Network Bulletin Board will streamline agriculture information management. Other possibilities for expanding electronic communications are being considered.

Other ideas are currently being considered for further expansion of electronic communications. Depending upon the demand for AENETBBS, for example, the system could be moved to hardware that permits numerous phone lines. A CD-ROM system could give overseas USAID missions instant access to bibliographies, abstracts and data bases produced by U.S. government agencies such as USDA and international organizations such as FAO.

Readers who are on INTERNET are encouraged to share their ideas and suggestions in response to this article. We welcome any short articles (one or two paragraphs) that can be included in AIDAENET or any ideas for materials to be included in AIDAENET, as well as materials that should be maintained onfile in the AENETBBS. Until the A.I.D. email link with the outside is established, contact James Beebe at jbeebe@esusda.gov. If you are not on a system that can reach this address, please send your comments by FAX to (703) 875-4384. ★

A Technology for Extruding and Expelling Soybeans .....*continued from page 9*

Utilization Program Leader, conceived and worked for more than a decade with associates on the product and process development of extruded and expelled soybeans as well as other oilseed and cereal crops. In developing countries, 90 percent of human food comes from plants. In these countries, the lack of protein is a serious problem for certain groups such as pregnant women and infants.

In the United States, small-scale technologies like Extrude 'n Mix systems offer farmers and rural communities: cost savings over commercial soybean meal and oil; a superior animal feed; the ability to add value to a locally grown crop and keep that value at home; job creation; economic revitalization of a community for a relatively low capital investment.

Technologies such as mechanical soybean processing benefit farmers and rural communities both in the United States and in the developing world.

Overseas, the same technology allows users: improved human and animal nutrition; economic development without huge capital investment in multi-million dollar extraction plants, construction of infrastrucutre or costly high-tech training; flexibility in the variety and volume of food and feedstuffs processed.

Although U.S. food markets are not the projected short-term target, Nelson notes that the future is very promising for processes which do not add to or take away from the qualities of the raw material. The natural approach is here to stay. The use of chemicals for oilseed extraction may come under more stringent regulations. This process offers a local, viable option, for soybean and other oilseed processing. ★

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Hans P. Peterson
Director
Office of Agriculture (R&D/AGR)

STAR responds to a demand for regular communications between A.I.D.'s Office of Agriculture and a worldwide audience. It provides current information on research and development programs sponsored by A.I.D./R&D/AGR. STAR's objective is to share information and facilitate the transfer of agricultural technology.

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