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# **Global Research for Sustainable Development**

**Bean/Cowpea CRSP**

**Broadening Access and Strengthening  
Input Market Systems CRSP**

**Integrated Pest Management CRSP**

**Peanut CRSP**

**Pond Dynamics/Aquaculture CRSP**

**Postharvest Collaborative Agribusiness  
Support Program CASP**

**Small Ruminant CRSP**

**Soil Management CRSP**

**Sorghum/Millet CRSP**

**Sustainable Agriculture and Natural  
Resources Management CRSP**

**West Africa Natural Resource  
Management (NRM) InterCRSP**

**United States Agency  
for International Development**

**Center for Economic Growth and  
Agricultural Development**

**Board for International Food and  
Agricultural Development**

**CRSP Council  
1997**

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*This publication describes the CRSPs' collective strengths and accomplishments in order to encourage the maximum application of our resources to international development challenges.*

## **Preface**

The Collaborative Research Support Programs (CRSPs) were developed in response to Title XII of the Foreign Assistance Act legislated in 1975. The main thrust of Title XII was to strengthen the capacities of Land Grant and other U.S. universities to participate in programs of sustainable agriculture and natural resource management; the programs were to help developing countries to produce adequate food, fiber, fuel and shelter materials.

The United States Congress funds the CRSPs through the Title XII program. Participating U.S. and Host Country institutions provide support for the programs as well. The CRSPs are implemented by the U.S. Agency for International Development.

The CRSP Model has received widespread commendation and is recognized for its success in developing mutually beneficial collaborative research between U.S. and Host Country institutions. The CRSP programs have been able to attract the most capable U.S. faculty into their collaborative research because of the unique scientific challenge, mutual interests and global benefits derived through this model.

The CRSPs are prepared to enter the 21st century with a history of two decades of long-term research and development services. This publication describes the CRSPs' collective strengths and accomplishments in order to encourage the maximum application of our resources to international development challenges.

We invite you to call upon the CRSP programs to initiate collaboration in areas of common interest in our quest for sustainable development.

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## Introduction

Innovative technologies have been important keys to world development. This is especially true for the developing world. When technological advances result from collaborative activities between U.S. and developing-country scientists, institutional growth and improved human resource capacity also occur.

Collaborative research of this kind is carried out by the U.S. Agency for International Development (USAID) in many of the scientific disciplines that contribute to development. The most important efforts are those which improve the sustainability of food production systems in developing countries with an emphasis on enhancing the quality of life for small-scale crop, animal and fish farmers and their families. The Agency's Collaborative Research Support Programs (CRSPs) are long-term, multidisciplinary research and training initiatives that capitalize on the vast U.S. Land Grant University and College of Agriculture system that works with developing-country research programs. The currently functioning CRSPs are:

**Bean/Cowpea CRSP**  
**Broadening Access and Strengthening  
Input Market Systems CRSP (BASIS CRSP)**  
**Integrated Pest Management CRSP (IPM CRSP)**  
**Peanut CRSP**  
**Pond Dynamics/Aquaculture CRSP (PD/A CRSP)**  
**Small Ruminant CRSP (SR CRSP)**  
**Soil Management CRSP**  
**Sorghum and Millet CRSP (INTSORMIL)**  
**Sustainable Agriculture and Natural Resource  
Management CRSP (SANREM CRSP)**

The productive activities of these nine programs directly support USAID's Strategic Plan by helping small-holders in developing

*The Agency's Collaborative Research Support Programs (CRSPs) are long-term, multidisciplinary research and training initiatives that capitalize on the vast U.S. Land Grant University and College of Agriculture system that works with developing-country research programs.*

*All of the CRSPs carry out research that leads to the development of ecologically and environmentally sound technologies. The knowledge they share and the innovations they devise help developing-country farmers manage their food-producing resources for sustainable yields and economic growth.*

countries to improve their incomes, alleviate hunger, and maintain and improve the natural resource base upon which they depend for food, fuel, fiber, and shelter.

The various CRSPs use similar methods to pursue this goal. All of the CRSPs carry out research that leads to the development of ecologically and environmentally sound technologies. The knowledge they share and the innovations they devise help developing-country farmers manage their food-producing resources for sustainable yields and economic growth.

Each CRSP has created collaborative linkages between the U.S. and developing-country research communities. These linkages foster institutional growth and encourage the education and training of scientists and technicians.

In addition to individual operational activity, the CRSPs have entered into a Memorandum of Understanding among themselves which provides a vehicle, the CRSP Council, for collaboration among the functioning CRSPs and the authority for them to operate as a group.

CRSP innovations are being shared with international agricultural research centers, private industry, private voluntary organizations and other nations beyond the developing countries and regions directly involved in the original research, including the agricultural community of the United States.

Over 70 Missions and Regional Offices and Regional Bureaus through which USAID directly assists developing countries are vital partners in the generation and distribution of these CRSP technologies. By means of cooperative agreements, grants, contracts and other collaborative arrangements, the USAID Missions

and Regional Offices and Regional Bureaus involve themselves in the research, technical assistance and educational activities of the CRSPs. These collaborations enhance the CRSP impacts and provide a broader base from which to share findings and technical expertise.

Through the CRSP Council, the CRSPs have renewed their dedication to providing services and backstopping to USAID Missions. The CRSPs are striving to integrate programs that enhance collaborative activities which serve the clientele in developing countries.

The following sections delineate the Purpose, Program and Accomplishments of the individual CRSPs. A list of each program's leadership appears at the end of each CRSP section. Information on how to reach key individuals is given at the beginning of each section.

USAID Missions and Regional Offices are encouraged to expand their CRSP contacts as they envision and plan their agricultural programs.

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## **Bean/Cowpea CRSP**

### **Purpose**

To overcome constraints to the production, distribution, storage, utilization, and marketing of beans and cowpeas, important sources of dietary protein and other essential nutrients.

### **Program**

The Bean/Cowpea CRSP brings together scientists from developing countries and the U.S. for research and training in three comprehensive regional projects: West Africa, East Africa and Latin America/Caribbean Basin.

Working across ecological zones, CRSP scientists integrate traditional resources with biotechnology in ways that are mutually reinforcing of developing country and U.S. agriculture.

Focusing on the needs of small-scale farmers, especially women, this CRSP addresses limitations caused by insects and diseases and by plant response to environmental stress, e.g., heat and drought. CRSP researchers also study farming systems, socio-cultural constraints, the economics of the production-consumption cycle, food storage, nutrition and health.

Short-term and degree training. To date, 369 graduate degrees were earned through the CRSP and nearly 1,000 scientists received short-term training in such areas as on-farm testing, research management, pest control and computer technology.

### **Accomplishments**

Overall, bean yields in the U.S. have increased approximately 20 percent, in large measure due to the CRSP.

Average cowpea yields in California have increased since the late 1980's from 2,000 kg/ha to 2,900 kg/ha due in part to CRSP technologies.

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**Year of Inception**  
1980

*In 1996, an estimated 35,000 acres of a new CRSP pinto variety (Chase), which is high yielding and disease and fungus resistant, were grown in Nebraska and Colorado. With less protection needed, production costs are lower, the environment is protected and yields are greatly improved.*

Use of germplasm from developing countries reduced U.S. bean vulnerability through increased genetic diversity.

Disease resistance in new, CRSP-developed bean varieties in the U.S. reduces the need for chemicals, thus enhancing profitability and reducing environmental pollution.

CRSP scientists in California completed genetic mapping within the cultivated cowpea gene pool. The maps are valuable in selecting for hard-to-breed-for traits.

A CRSP scientist in Minnesota identified a new nitrogen-fixing rhizobium with tolerance to acid soils, temperature, and pesticides, now used commercially in the U.S. and Canada.

Without the CRSP, damage to the U.S. bean industry would have been hundreds of million of dollars, far more than the total cost of the CRSP over its life span. Virus monoclonal antibodies (MCABs) from Washington State University detected a critical virus in seed lots of an Idaho cultivar grown in six states. With the MCABs, the virus was eradicated from all domestic seedlots within three years, preventing the complete quarantine of U.S.-grown bean seed on the international market.

Studies of the bean genome resulted in an antiviral strategy that led to a patent application for tomato protection jointly submitted by Wisconsin, California and a private seed company.

In 1996, an estimated 35,000 acres of a new CRSP pinto variety (Chase), which is high yielding and disease and fungus resistant, were grown in Nebraska and Colorado. With less protection needed, production costs are lower, the environment is protected and yields are greatly improved.

CRSP researchers from Wisconsin released two snap bean lines with enhanced BNF capacity, reducing nitrogen application requirements and thus groundwater nitrate run-off. Farmers' costs are decreased \$15-20 per acre by the reduced fertilizer need.

In Michigan, new cultivars developed by CRSP scientists are being planted on over 40,000 acres per year. These new cultivars give a 20-25 percent increase in yield. In a normal year the increase means over \$3.7 million extra dollars for Michigan growers.

Asgrow Seed Company and Rogers Seed Company use linked molecular (RAPD) markers developed by the CRSP for snap and dry bean disease resistance and drought research.

When a multiple-year drought decimated seed stocks in Senegal, variety CB #5 from California increased production from 16,000 tons to 70,000 tons and averted mass starvation, feeding over a million hungry Senegalese. A Rate-of-Return Study reported a 63 percent return on the CB #5 dollar investment.

More recently, two new CRSP cultivars contributed to a cowpea production increase 2.4 times the 20-year average in Senegal.

CRSP solar storage technology in Cameroon kills 100 percent of cowpea weevil eggs, larvae and adults without affecting germination or cookability. It is already used by about 10 percent of cowpea farmers in the country.

A steam treatment for cowpeas was developed in Ghana which kills the eggs, larvae and adults of weevils in storage and prevents their re-infestation. Commercial processing using continuous belt feed is under discussion.

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*The CRSP institution in Honduras produces 40-50,000 pounds of seed of CRSP disease resistant varieties, which is sold to other seed producers and Honduran farmers. Drought and heat tolerance in these varieties is making low-elevation regions more productive.*

At Princess Maria Louise Hospital for Children in Ghana, CRSP cowpea flakes (a potato-chip-like product) were introduced for protein malnutrition management. The children made excellent recovery rates.

NGOs and the Women in Agricultural Development of the Ministry of Food and Agriculture in Ghana are promoting nutrition in impoverished communities through CRSP cowpea-fortified, protein-improved traditional foods.

In Senegal, a multi-village women's association is producing processed cowpea products in 1 kg sealed plastic bags. They generated an \$80 profit the first year, over \$1,000 the second and continue to grow.

In the Dominican Republic, in cooperation with the DR Government and others CRSP crop management recommendations and improved varieties resulted in a 95 percent yield increase over the past ten-year average. The recommendations were developed through extensive surveys of weeds for bean-infecting geminiviruses using new molecular methods. Disease losses were reduced by 40-50 percent. These recommendations/varieties are being tested in Haiti through an NGO.

Bean yields in Honduras have increased almost 20 percent, with the most significant change being the adoption of CRSP-developed disease resistant varieties.

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The Tanzania project illuminated the life cycle of bean weevils and discovered that a brief, twice-daily tumbling of the beans reduced weevil populations by 97 percent.

A bean-based weaning food is being developed for Costa Rica by CRSP scientists, assisted by Gerber Companies Foundations, that will supply 50 percent of the daily iron required for children 1-3 years old, be 30-35 percent more digestible than regular cooked beans and produce less flatulence.

#### **Collaborating U.S. Institutions**

Auburn University  
Clemson University  
Michigan State University  
Oregon State University  
Purdue University  
University of California-Davis  
University of California-Riverside  
University of Georgia  
University of Minnesota  
University of Nebraska  
University of Puerto Rico  
University of Wisconsin  
Washington State University

*Average cowpea yields in California have increased since the late 1980's from 2,000 kg/ha to 2,900 kg/ha due mostly to CRSP technologies and joint work with another U.S. cowpea program.*

## **The Broadening Access and Strengthening Input Market Systems (BASIS) CRSP**

### **Purpose**

To strengthen both US and host-country research capacity through jointly developed and collaborative programs of research and training on land, water, labor, and finance markets and their interactions. The mission is to help governments, donor agencies, the private sector, and NGOs design, evaluate, and propose policies that enable factor markets to mediate broadly based, integrated, and environmentally sustainable rural economic growth in response to the following fundamental policy problems:

- 1) liberalization without growth,
- 2) exclusionary growth accompanied by concentration of wealth and income and asset inequality,
- 3) gender-biased growth leading to poverty that affects nutrition and well-being,
- 4) ethnically-biased and socially unstable growth,
- 5) environmentally destructive growth,
- 6) growth that is constrained by poor management, and
- 7) growth that is constrained by unsustainable policy and slow institutional innovation.

### **Program**

In general, the BASIS CRSP works to:

Target and sequence market liberalization and development;

Help develop market organization and support under privatization and agrarian reform;

Aid natural resource management, environmental protection, and common property; and

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### **Year of Inception**

1996

*"The Consortium will study how land, labor and finance markets function in the farm sectors of less developed countries and determine what can be done to improve their performance," says Program Director William C. Thiesenhusen.*

Address water rights and social conflict.

Three cross-cutting research themes help to integrate work on all factor markets. They include:

market integration,  
gender, and  
household resource strategies under risk.

The objectives of the Consortium for Applied Research on Market Access (CARMA) are to:

Analyze the performance, interactions, and synergies of land, labor, and financial markets and translate research results into policy recommendations. Emphasis will be on access for women, the poor, and economically disenfranchised ethnic groups.

Translate the lessons from developing and transitional economies to others in similar stages of development.

Find solutions to wasteful resource use and suggest policies that utilize and price resources so they are used efficiently and sustainably.

Determine key performance factors in non-market institutions that allocate resources (such as households, financial organizations, common property holders, and members of irrigation water associations) to bolster their efficiency and equity.

Communicate research in a timely and usable manner to allow for establishment and implementation of suitable policy changes.

Identify and monitor indicators of economic and social welfare that measure improvements in factor market performance, food security, employment, and equity.

**Collaborating U.S. Institutions**

The Consortium for Applied Research on Market Access (CARMA) includes the following members:

Department of Agricultural and Applied  
Economics, University of Wisconsin-Madison  
Harvard Institute for International Development  
Institute for Development Anthropology  
Institutional Reform and the Informal Sector,  
University of Maryland at College Park  
International Center for Research on Women  
International Resources Group  
Land Tenure Center, University of Wisconsin-  
Madison  
Land Tenure Service, Food and Agricultural  
Organization  
Lincoln Institute of Land Policy  
Michigan State University  
Rural Development Institute  
Rural Finance Program, the Ohio State  
University  
Tuskegee University  
Wirrock Associates  
Workshop in Political Theory and Policy  
Analysis, Indiana University  
World Council of Credit Unions

*The research and training program  
will center on Central America, Horn  
of Africa, Southern Africa, Central Asia  
and Southeast Asia.*

## **Integrated Pest Management (IPM) CRSP**

### **Purpose**

To foster IPM through collaborative research between U.S. and LDC institutions for their mutual benefit by improving their abilities to develop and implement economically and environmentally sound crop protection methods.

### **Program**

In general, the IPM CRSP works:

To reduce pesticide residue on horticultural crops produced for export. With widespread adoption of IPM practices in production systems for export and associated crops, the health of farm families will be less endangered by unsafe pesticide use, and the safety of food products consumed in host countries and the United States will be better assured.

To research IPM in transitional production systems. A major challenge to agricultural production is to minimize production losses when the local environment is in a state of transition. This transition often is accompanied by higher use of chemical inputs including pesticides and an increase in losses to pests. Under good management, including proper IPM practices, such increases can be avoided or minimized and the systems more rapidly stabilized.

To develop innovative IPM practices. Studies that incorporate the entire production system - from food crops to livestock to cash crops to fruits and medicinal herbs that are produced for on-farm consumption - can design effective, appropriate IPM strategies that are readily accepted, and provide a blueprint for research around the world.

The IPM CRSP uses a participatory approach to

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### **Year of Inception**

1993

*The IPM CRSP in the Philippines found that pesticide misuse on vegetables was increased by membership in agricultural organizations, by use of credit, by contacts with Department of Agriculture technicians and with chemical company representatives, and by lack of knowledge about natural enemies.*

solving pest problems. Among other things, this approach means the people who will use the new knowledge generated by the IPM CRSP have a say in setting the research agenda.

Program goals will be met by:

- Identifying and describing the technical factors affecting pest management;

- Identifying and describing the social, economic, political, and institutional factors affecting pest management;

- Working with participating groups to design, test, and evaluate appropriate IPM strategies;

- Working with participating groups to promote training and information exchange on participatory IPM; and

- Working with participating groups to foster policy and institutional changes.

#### **Accomplishments**

In the Philippines, the presence of root-knot nematodes, *Meloidogyne graminicola*, significantly changed the CRSP's view of the pest situation on onions in the San Jose region. Preliminary assessment of the onion farmers' fields revealed that most fields were infested with various degrees of root-knot nematode. Significant efforts are now underway to develop IPM for nematodes.

In eggplant, the most significant pest is the eggplant fruit and shootborer (EFSB). In worst case situations this pest is sprayed 30-50 times in a single season. Pheromone tests, similar to those used for Spodoptera, are being carried out to develop suitable IPM measures.

The IPM CRSP in the Philippines found that pesticide misuse on vegetables was increased by membership in agricultural organizations, by use of credit, by contacts with Department of Agriculture technicians and with chemical company representatives, and by lack of knowledge about natural enemies.

The net effects of tariff and exchange rate policies in the Philippines are to subsidize pesticide use, but the subsidy is only six to eight percent and hence should not provide a major barrier to IPM adoption.

In Jamaica, Lepidoptera larvae/spider mites on callaloo (amaranthus), viruses on peppers, and sweet potato weevils on sweet potatoes were found to be the main pests and the primary sources of crop loss. IPM efforts are focussing on these crop pests.

Preliminary analyses of the cropping systems revealed a number of points in the production cycle where potential IPM interventions would be possible. These include improved timing of field sanitation and harvest; use of different traps and trap cropping.

The existence of high levels of root-knot nematode resistance in three accessions of Scotch Bonnet type *Capsicum chinensis* germplasm was confirmed. The resistance to root-knot nematodes exhibited by the *Capsicum annuum* cultivar Carolina Cayenne was demonstrated to be exceptional.

In Guatemala, determination of the best commercial Bt products for control of specific insect pests in non-traditional vegetables was established.

Broccoli intercropping experiment in Guatemala showed that the main lepidopteran insect pests affecting broccoli were *Plutella xylostella*, *Leptophobia aripa* and *Trichoplusiani*. Use of strip cropping (black bean/broccoli) resulted in up to 51% greater yields than broccoli monocultures.

IPM and identification of market window opportunities and IPM for selected non-traditional

*Since leaf miner has been the cause for major Guatemalan snowpea shipment rejection, the CRSP has worked with the concerned Guatemalan organizations and developed strategies for minimizing the rejection problem.*

*The existence of high levels of root-knot nematode resistance in three accessions of Scotch Bonnet type Capsicum chinensis germplasm was confirmed.*

crops in US markets are receiving a major attention of the CRSP and its Guatemalan collaborators.

Since leaf miner has been the cause for major Guatemalan snowpea shipment rejection, as a response to a Technical Assistance, the CRSP has worked with the concerned Guatemalan organizations to develop strategies for minimizing the rejection problem.

In Mali, IPM CRSP found that the neem extract Azatin EC resulted in a 53% increase in early and main season millet yields. The increase in millet yield obtained in these trials has significant potential to improve village food supplies, especially in drier areas more dependent on millet.

Striga IPM research on millet in Mali involving integrations of millet/cowpea intercropping, cultural practices combined with the use of organic and mineral fertilizers on local Souna millet, and improved Striga resistant IT89KD45 cowpea variety from IITA have given promising results for developing locally suitable IPM tactics.

In Uganda, the CRSP has facilitated the establishment of National IPM network under the leadership of Makerere University, the IPM CRSP partner institution.

The IPM CRSP is aware that strong USAID Mission support is critical to success, and has involved the local Missions in all that they have done. Strong host country support has resulted in the signing of Memoranda of Understanding (MOUs) by national institutions in seven countries (Guatemala, Jamaica, Mali, Philippines, Uganda, Eritrea, Ethiopia) officially allowing the CRSP to work in those countries.

**IPM CRSP Resources****Collaborating U.S. Institutions.**

Consortium for International Crop Protection  
(CICP)

Virginia Tech (Lead Institution)

Lincoln University

Montana State University

Ohio State University

Pennsylvania State University

Purdue University

Rodale Institute Research Center

University of California/Berkeley

University of Georgia

USDA Vegetable Laboratory

**Collaborating Host-Country Institutions**

Agrilab, Guatemala

ALTERTEC

CARE, Guatemala

Institute de Ciencia y Tecnologia Agricola (ICTA),  
Guatemala

Escuela Agricola Panamericana (Zamorano),  
Honduras

Ministry of Agriculture, Jamaica

Caribbean Agricultural Research Institute  
(CARDI), Jamaica

Rural Agricultural Development Authority  
(RADA), Jamaica

Institut d'Economie Rurale (IER), Mali

Philippine Rice Research Institute (PhilRice),  
Philippines

National Crop Protection Center/University of  
the Philippines

Los Banos (NCPC/UPLB), Philippines

Department of Agriculture, Thailand

Makerere University, Uganda

Ministry of Agriculture, Eritrea

Institute of Agricultural Research (IAR),  
Ethiopia

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**Collaborating International Institutions**

Centro Internacional de Agricultura Tropical (CIAT), Colombia

International Rice Research Institute (IRRI), Philippines

Centro internacional de la Papa (CIP), Peru

Asian Vegetable Research and Development Center (AVRDC), Taiwan

International Center for Insect Physiology and Ecology (ICIPE), Kenya

## The Peanut CRSP

### Purpose

To develop cultivars, cultural and pest management practices, and utilization processes that have sound economic and sociological bases to lower costs and stimulate peanut use as a primary food resource.

### Program

The Peanut CRSP research focuses specifically on developing alternatives to low-yield cultivars that lack stress tolerance, ameliorating yield losses due to pests, reducing aflatoxin hazards, overcoming inadequate food supplies, and alleviating socio-economic forces that prevent efficient production and utilization. Transfer of technology to the user is point of focus.

### Accomplishments

Senegal released peanut variety Fleur 11 which yields 25% more than presently grown varieties. Distribution to farmers in areas of adaptation is underway, and can increase the gross value of peanut produced by \$18 million per year.

North Carolina released cultivar NC10c, the only *Cylindrocladium* black rot resistant cultivar available to farmers. In 1992 and 1993, NC10c occupied about 20% of North Carolina's peanut area, with a net value of about \$4.5 million annually.

The new cultivar, Tamspan 90, released by the Texas Agricultural Experiment Station and the USDA, yields 11% more than Starr, the previously most popular variety. Tamspan 90 has partial resistance to important soil-borne diseases, including *Sclerotinia* blight and *Pythium* pod rot. Tamspan 90 was grown on about 40,000 acres in Texas and Oklahoma in 1995 with a net value of about \$12 million per year based on expected

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### Year of Inception

1982

*Peanuts are important to the development of sustainable stable societies since they are grown for both home consumption and sale. They have a wide range of value added products, and provide women with income generating opportunities.*

yield increase of the disease resistant variety over the non-resistant variety that would have been planted.

In Georgia, *Pseudomonas aeruginosa*, genetically engineered with the delta endotoxin gene from *Bacillus thuringiensis*, plus Sunspray Oil was as effective as the chemical Lannate in controlling both corn earworm and the velvetbean caterpillar. This new technology, when implemented, can reduce the use of potentially polluting chemicals presently needed for insect control.

In Thailand, four new varieties with greater potential yield and higher market value than farmers' varieties have been released in cooperation with Khon Kaen University and the Thai Department of Agriculture.

The Jamaica Department of Agriculture released CARDI-Payne, which yields 42% more than traditional Virginia types. Farmers grow CARDI-Payne on about 10% of Jamaica's peanut area with \$60,000 yearly added value to producers.

The peanut line, NCAc343, was identified in Philippine-Peanut CRSP research as having broad resistance to insects. Experiments in the United States and West Africa confirmed this observation. Breeders around the world are crossing NCAc33 with locally-adapted germplasm to produce insect resistant varieties and to reduce the need for chemical pesticides.

As a result of Peanut CRSP insect management work, Philippine researchers began an annual IPM planning workshop in 1993 for research and extension staff.

Based on monitoring by Filipino Peanut CSP scientists, the Philippine Bureau of Food and drugs condemned several brands of peanut

butter because they contained high concentrations of aflatoxin. Retailers had to withdraw contaminated brands from market shelves, with resultant decreased aflatoxin exposure of consumers.

A technology was developed using adsorptive clay to remove aflatoxin from peanut oil and meal in Senegal. Economic projections estimate that the technology can contribute \$5 million annually to the economy of Senegal.

In Burkina Faso, Peanut CRSP collaborators have worked with a private company to improve the processing and packaging of peanut paste. This effort has led to cost-effective and sanitary marketing of peanut paste, which is widely used in soups and other dishes.

Peanut-based cheese-flavored spreads developed and found acceptable to consumers through market tests in the Philippines can substitute for the popular spreads made from imported milk. A significant advantage of the peanut-based spread is that it does not require refrigeration.

#### **Peanut CRSP Resources**

##### **Participating U.S. Institutions**

Alabama A&M University  
Auburn University  
University of Connecticut  
University of Florida  
University of Georgia  
Purdue University  
North Carolina State University  
North Carolina A&T University  
Virginia Polytechnic Institute and State University  
Texas A&M University

*The Peanut CRSP has contributed to the basic research needed to exploit the natural resistances to production constraints in the wild relatives of peanut. This will help maintain economic production of peanut while helping to preserve the environment.*

*Based on listed accomplishments, the Peanut CRSP can demonstrate a return to the peanut industry of about \$10 for every one invested in the Peanut CRSP. All peanut producing states are benefitting from these technologies.*

#### **Collaborating Host-Country Institutions**

Institut National Recherches Agricoles, Benin (INRAB)

Asociacion de Productores de Oleaginosas Y Trigo, Bolivia (ANAPO)

Centro de Investigacion Agricola Tropica, Bolivia (CIAT)

EMBRAPA-CFC Project, Brazil

Canning Research Institute, Bulgaria

Institute for Introduction and Plant Genetic Resources, Bulgaria

Crops Research Institute, Ghana

Food Research Institute, Ghana

Savana Research Institute, Ghana

University of Ghana

University of Science and Technology, Ghana

Quisqueya University, Haiti

Department of Agriculture, Chitedze Research Station, Malawi

Bunda College, Malawi

University of Ouagadougou, Burkina Faso

Institut National E R A, Burkina Faso (INERA)

Institut d'Economie Rurale (IER), Mali

Institut Senegalais de Recherches Agricoles (ISRA), Senegal

Institut de Technologie Alimentaire (ITA), Senegal

Ecole National d'Economie Appliquee (ENEA), Senegal

FUNDACIONPERU, Peru

Caribbean Agricultural Research and Development Institute, CARDI (Jamaica and Belize)

University of Zambia

Visayas State College of Agriculture, Philippines

University of the Philippines, Dilliman

Philippine Council for Agriculture and Resources Research and Development (PCARRD)

Institut National de Recherches Agronomiques du Niger, (INRAN)

Kasetsart University, Thailand

Khon Kaen University, Thailand

**International Collaborators/Networks**

International Crops Research Institute for the  
Semi-Arid Tropics (ICRISAT)

International Institute for Tropical Agriculture  
(IITA)

Centre de Cooperation Internationale en  
Recherche Agronomique Pour le  
Developpement Department des Cultures  
Annuelles (CIRAD-CA), France

Conference des Responsables Africains et  
Francais de la Recherche Agronomique (CORAF)

International Virus Working Group

International Aflatoxin Working Group

Semi-Arid Food Grains Research and  
Development (SAFGRAD)

*Both U.S. and host country peanut industries benefit from the collaboration with peanut scientists in other countries. Virus disease management strategies being adapted in the U.S. were pioneered by collaborating institutions. Biotechnologies for viruses developed in the U.S. are being adopted by these collaborators.*

## **Pond Dynamics/Aquaculture CRSP**

### **Purpose**

To enhance the development and sustainability of aquaculture production systems for improving food supply and human nutrition on a long-term basis.

### **Program**

The Pond Dynamics/Aquaculture Collaborative Research Support Program (PD/A CRSP) is an international effort to develop aquaculture technology as a means of confronting food security problems in developing countries. This CRSP was originally structured around a single, main theme - that of a common set of experiments to be implemented globally, following a standard experimental protocol at a number of research sites around the world. The Global Experiment was intended to facilitate comparative studies of aquaculture pond dynamics.

As CRSP research progressed, it became apparent that important additional research needs remained. New components were added and the main core of the program has expanded to include Special Topics Research in Host Countries, and Data Analysis and Synthesis.

Later the main core of CRSP activities was augmented by research in socioeconomics, soil-water interactions, the development of new techniques for the evaluation of pond conditions, and fish reproduction. Recently, a new research support branch - composed of Information Management and Networking, Education Development, and Database Management - greatly expands the program's ability to provide accessible information and data to both the aquaculture and development communities.

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### **Year of Inception**

1982

*Research is focused on production optimization as well as on the environmental effects and social and economic aspects of aquaculture.*

#### **Accomplishments**

Under recent work plans researchers have investigated the effects of pond management practices on water quality and on the broader environment. Researchers are also interested in the effects of aquacultural practices on the environment.

The CRSP makes full use of Internet opportunities. Program information, reports, technical abstracts, and CRSP publications catalogs are available at the PMOs homepage located at: <http://www.orst.edu/dept/crsp/homepage.html>.

PD/A CRSP data, collected during 15 years of standardized experiments in tropical pond aquaculture, are housed in the PD/A CRSP Central Database, the world's largest standardized aquaculture database. In an effort to improve accessibility of these data to the world aquaculture community, the PD/A CRSP and the Consortium for International Earth Science Information Network (CIESIN) are jointly developing a user interface and the underlying computer software components needed to provide access to the CRSP Central Database via the WWW.

The decision support system POND©, a software developed by CRSP researchers, is widely used throughout the world. POND© also attracted the attention of the Food and Agriculture Organization (FAO) of the United Nations. This has resulted in collaborative work using the POND© fish growth model to assess aquaculture production potential in Latin America.

In Honduras, a CRSP-led public-private joint venture continues to produce economic benefits while increasing the understanding of water quality issues associated with the shrimp industry in the southern part of the country.

The CRSP works with the Ministry of Agriculture and Livestock, the National Association of Honduran Aquaculturists (ANDAH), and the Panamerican Agriculture School (EAP). CRSP researchers also serve as advisors to Peace Corps volunteers, who in turn have assisted with logistical arrangements for the program.

Program researchers have been active in conducting informal training activities whenever possible. They conduct short courses and workshops, teach courses at host country institutions, and advise and mentor graduate students. Since the beginning of the program, upwards of 450 individuals have participated in some form of CRSP education and training activities. Over 150 degrees (B.S., M.S., and Ph.D.) have been awarded, and 37 are in progress. Financial support ranges from the CRSP providing graduate research assistantships for Ph.D. students to wages for undergraduate work-study students.

Summarizing and synthesizing recent achievements in aquaculture studies, CRSP researchers and other members of the aquaculture community have collaborated on a new book entitled, "Dynamics of Pond Aquaculture." Publication of this new reference for aquaculture students and practitioners is expected in 1997.

Under the program's current five-year grant, awarded in 1996, PD/A CRSP international research activities are taking place in Latin America (Honduras and Peru), Africa (Kenya), and Southeast Asia (Thailand and the Philippines), with potential research efforts in Indo-China. In addition to specific research in areas such as production optimization, environmental effects, and social and economic aspects, researchers associated with host country projects will be working to increase

*A new reference for aquaculture students and practitioners entitled "Dynamics of Pond Aquaculture" has been co-authored by CRSP researchers and other members of the aquaculture community, and will be published in 1997.*

*Current research sites include Honduras, Peru, Kenya, Thailand, and the Philippines.*

networking opportunities with existing regional aquaculture and development organizations. The goal of the regional planning initiative is to gain an understanding of current regional aquaculture research strengths and constraints in order to identify areas where CRSP activities can be most effective and relevant to the larger research community. US-based research includes Data Analysis and Synthesis as well as other projects that have global application and relevance.

#### **CRSP Resources (1996-97)**

##### **Collaborating US Institutions**

Auburn University  
Oregon State University  
Southern Illinois State University  
The University of Michigan  
University of Arizona  
University of Arkansas, Pine Bluff  
University of California, Davis  
University of Hawaii  
University of Oklahoma  
University of Texas

##### **Collaborating Host Country Institutions**

Asian Institute of Technology, Thailand  
Central Luzon State University, Freshwater  
Aquaculture Center (FAC/CLSU), Philippines  
Ministry of Agriculture and Livestock  
(DIGEPESCA), Honduras  
Ministry of Tourism & Wildlife/Department of  
Fisheries, Kenya  
National Inland Fisheries Institute, Royal Thai  
Department of Fisheries, Thailand  
National University of the Peruvian Amazon,  
Peru  
Institute for the Investigation of the Peruvian  
Amazon, Peru

In addition to the CRSPs formal connections with host country institutions through Memo-

randa of Understanding, the CRSP maintains ties with numerous other organizations. A partial list of informal CRSP linkages follows:

American Tilapia Association, Arizona  
Aquaculture for Local Community Development Programme (ALCOM), FAO, Italy  
CARE, Honduras  
Consortium for International Earth Science Information Network (CIESIN), Washington, DC  
Escuela Agricola Panamericana (Zamorano), Honduras  
International Center for Aquaculture (ICA), Auburn University, Alabama  
International Center for Living Aquatic Resources Management (ICLARM), Philippines  
National Agricultural Library, Washington, DC  
National Association of Honduran Aquaculturists (ANDAH), Honduras  
Network of Aquaculture Centers in Asia-Pacific, Thailand  
North Central Regional Aquaculture Center (NCRAC), Michigan  
Programa Regional de Apoyo al Desarrollo de la Pesca en el Istmo Centroamericano (PRADEPESCA), Honduras  
Peace Corps, Honduras  
South East Asian Fisheries Development (SEAFDEC), Philippines  
US Department of Agriculture, Washington, DC  
World Aquaculture Society (WAS), Louisiana  
Western Regional Aquaculture Consortium (WRAC), Washington

*Regional planning initiatives at all the research sites will result in CRSP activities that are closely tied to the existing strengths and constraints in aquaculture research and its use on the ground.*

## **Postharvest Collaborative Agribusiness Support Program (CASP)**

### **Purpose**

To develop indigenous capability and to increase standards of living by creating employment opportunities and potential for income generation through provision of support and services needed to reduce postharvest losses and accelerate the development of value-added agribusiness.

### **Program**

In general, the Postharvest CASP works:

To communicate, demonstrate and replicate postharvest and value-added science and technology in four commodities: (1) food and feed grains; (2) soybean and other grain legumes; (3) fruits and vegetables; and (4) seeds through:

Four U.S. Centers of Excellence [Food and Feed Grains Institute (FFGI); the International Soybean Program (INTSOY); the Postharvest Institute for Perishables (PIP); and the Seed Improvement Program (STL)] that work with the U.S. and international private sectors and with international research and technology-transfer institutions to develop, evaluate and disseminate appropriate postharvest technologies.

Regional overseas Postharvest Agribusiness Development Centers (PADCs) that use a task-force approach to assist postharvest agribusinesses. PADC specializations include management, industrial engineering, economics, food technology, product development, packaging, market analysis and marketing, distribution, and business analysis. PADC services include training, technical support, and linkages to U.S. agribusinesses and to research and technology-transfer institutions.

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### **Year of Inception**

1993

*"The primary CASP institutions have more than 100 collective years of development assistance experience in adding value to agricultural production and in reducing postharvest losses."*

The CASP promotes and supports improved practices for the storage, processing, distribution and marketing of food and feed grains, soybeans and other grains, legumes, fruits and vegetables and seeds through a structure and integrated program of:

Mission (field) support;  
Applied research;  
Training; and,  
Technical Information Transfer.

#### **Support and Services**

The CASP strengthens both public and private institutions concerned with postharvest agribusiness by:

Assessing and recommending facilities and equipment needs, training programs, research planning and management, emergency storage plans, food reserve programs, new product processes, and technical assistance.

Conducting client-driven applied research programs.

Linking PACDs to small and medium-sized agribusinesses so that PACD activities address their postharvest constraints and problems.

Conducting economic and technical studies in agribusiness design, development and management, and in process improvement.

Conducting loss-assessment studies and recommending cost-effective and environmentally-friendly postharvest conditioning, storing, processing, marketing, and distribution processes and technologies.

Examining the effects of policy change and technology insertion on marketing, food security and agribusiness development, and delin-

eating the procedures involved in changing a policy or technology.

Designing training courses and internships for private agribusiness people in food storage and marketing, food-management processes and business development and management.

### **Accomplishments**

#### *Africa*

The FFGI developed a country-by-country profile of the main objectives of national security stocks; e.g., target levels of national security stocks, public-sector storage capacity, trigger mechanisms for security stocks, capability of managing organization(s) responsible for food security stocks, the sustainability of food security policies, and the funding sources for the maintenance and replenishment of security stocks.

INTSOY is assisting the Kenyan Ministry of Agriculture to design a project to promote the utilization of soybeans. INTSOY designed the utilization activities in areas relating to processing of food and feed, soybean marketing and promotion. Subsequently, INTSOY conducted an investigation of the Kenya soybean processing industry. Information and recommendations from the study will be used in project design.

#### *Asia and the Middle and Near East*

The FFGI conducted a 6-year technical assistance program for the design and development of equipment and facilities for the Southeast Asia Cooperative Postharvest Research & Development Program, including feasibility studies for development projects and continuous assistance to 17 development projects.

*"The CASP cooperating institutions have managed and implemented projects, responded to requests for short-term assistance, and provided training in 65 countries in Africa, Asia, the Caribbean, Central and South America, the Near East, and Europe/NIS."*

*"The CASP provides educational and development services, and technical support through multidisciplinary task forces."*

The STL through a 6-year technical assistance program assisted the Government of Egypt with the rationalization, development and enactment of seed policies, and with the design and implementation of balanced government/private sector programs and facilities to ensure a dynamic Egyptian seed industry.

INTSOY assisted the Government of Egypt with the design, procurement and fabrication of model food processing facilities for research on new food product development, and for feasibility studies on the economics and acceptance of these products.

#### *Eastern Europe and the NIS*

PIP has fielded 18 teams of technical and marketing specialists to Russia and Ukraine to improve handling, marketing, and storage of potatoes, and has assisted USAID to construct three modern potato facilities in Russia and Ukraine that are to be used as training facilities for farm managers. In addition, 25 Russians and Ukrainians have received business management, marketing and cold storage training.

PIP and its counterparts have initiated private farmer assistance programs in Russia and Ukraine; in 1994 improved potato seeds were marketed to private Russian farmers for the first time. The program will be replicated in Ukraine in 1995 by the Ukrainian Potato Institute with PIP assistance - Farmer Centers are planned in strategic areas for distribution of information and provision of technical assistance.

#### *Latin America*

The FFGI recently completed a 4-year technical assistance and training program for the EL

Salvador Ministry of Agriculture transition team for divestiture of government-owned grain facilities - 18 of 20 grain storage and handling facilities available for sale are now under private-sector ownership.

The STL completed a 2-year technical assistance and training program for the Honduran Ministry of Agriculture for divestiture of government-owned seed production, storage and processing facilities.

PIP developed a manual on systems approach to identifying/solving pre/postharvest problems associated with various commodities. The Commodity Systems Assessment Methodology (CSAM) is now published in English, French and Spanish and has been utilized for a diagnostic tool for a variety of commodity systems in countries such as India, Malaysia, Nepal, Guatemala, Romania and Mali.

INTSOY is assisting the Brazilian National Soybean Research Institute (CNPSo) in the development of strategy for incorporation of soybeans into the Brazilian food system. INTSOY and CNPSo are developing a sustainable and replicative model for food use of soybean at the rural level. The technical and economic feasibility of processing soy-based food at the cooperative level and marketing in rural communities is being investigated as a possible concept.

#### **Collaborating U.S. Institutions**

Kansas State University, Food and Feed Grains Institute (FFGI)

Mississippi State University, Management Entity  
Mississippi State University, Seed Improvement Program (STL)

The University of Idaho, Postharvest Institute for Perishables (PIP)

The University of Illinois, International Soybean Program (INTSOY)

*"All technical assistance and training are conducted in partnership with host country personnel to transfer information and skills at all projects."*

## The Small Ruminant CRSP

### Purpose

To improve food security and quality of life in less developed countries through collaborative partnerships with US land-grant institutions and national and international agencies (government, NGO, private sector) for research leading to sustainable improvements in animal agriculture.

### Program

In general, the Small Ruminant Livestock CRSP works:

To strengthen ability of institutions to identify problems and constraints and develop appropriate solutions in production systems in which livestock play a role.

To support decision makers in developing more effective policies and technologies to improve livestock production, marketing, processing, and natural resource conservation and management.

To enhance the nutritional status of targeted populations through consumption of livestock products.

To increase employment and incomes among livestock producers and associated value-added agribusinesses.

The Small Ruminant Livestock Collaborative Research Support Program (SR-Livestock CRSP) has embarked upon a new phase of livestock research.

The redesign of the Livestock CRSP program has been based on the reengineering guidelines established by USAID. The program is innovative in a number of key areas: 1) collaboration with regional partners in the early stages of program development; 2) extensive networking with national and international agencies (government entities, nongovernmental organizations, and representatives of the private

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### Year of Inception

1978

*The systems approach and research results in Bolivia have application to livestock production in the US high plains inter-mountain states and have benefited a project funded by the Utah Agricultural Experiment Station.*

sector); 3) regionalization and extensive application of research results; and 4) management reforms to reduce transaction costs and to enhance research quality through competitive funding mechanisms.

The Livestock CRSP Advisory Panel is composed of US university, IARC, other donors, World Bank, NGO, private sector and USAID representatives. Each Panel representative is experienced in international private and public sector livestock development at the global, regional, smallholder, and commercial levels, thus bringing extensive expertise and broad perspective to the CRSP's reorganization.

Regional priorities were defined through the development of "problem models" within the three areas of research identified for CRSP activities: 1) the role of livestock in economic growth; 2) the role of livestock in human nutrition, and 3) the impact of livestock on the environment.

In October 1996, ten assessment teams were selected to begin a year-long process of "problem redefinition" and "regional team building." Teams are working to solidify regional relationships while refining problem models and developing long-term proposals, thus engaging regional partners at every step.

### **Accomplishments**

#### *Bolivia (1991-1996)*

The systems approach and research results in Bolivia have application to livestock production in the US high plains inter-mountain states and have benefited a project funded by the Utah Agricultural Experiment Station. The Bolivian program has also developed forage seed markets for US exports.

A unifying data management system for all economic and sociological data was established. Data include gender specific analyses of production strategies and studies of Livestock commercialization on the altiplano.

*Indonesia (1980-1996)*

The Livestock CRSP has collaborated on the evaluation of forage tree species with the Nitrogen Fixing Tree Association (NFTA), the International Centre for Research in Agroforestry (ICRAF), the Indonesian Biotechnology Research Institute, International Centre for Tropical Agriculture (CIAT), and the Australian Center for International Agricultural Research (ACIAR).

The Sei Putih Hair Sheep was developed with superior genetic potential for resistance or tolerance to internal parasites. The crossbred ewes produce about 47% greater weight of lambs weaned (22.4 kg/yr) than Sumatran ewes (15.2 kg/yr). Productivity per unit weight of ewe and productivity per unit metabolic weight of ewe were 13% and 20% higher than for Sumatran ewes, respectively.

Small farmers raising sheep on rubber plantations average 33% higher profit and their return for labor is almost three times higher than those who do not raise sheep. The increase of small holder incomes reduces pressure for over-tapping of rubber trees and subsequent tree destruction.

Four women's groups with 30 members per group were formed by the Livestock CRSP. Every five members own six sheep and are responsible for passing along two female lambs to other members of the group over a three-year period.

*The Livestock CRSP has collaborated on the evaluation of forage tree species with the Nitrogen Fixing Tree Association (NFTA), the International Centre for Research in Agroforestry (ICRAF), the Indonesian Biotechnology Research Institute, International Centre for Tropical Agriculture (CIAT), and the Australian Center for International Agricultural Research (ACIAR).*

*The viral transmission of caprine arthritis encephalitis through colostrum and milk was determined, and methods were developed to prevent its spread. These control methods are important for the United States where about 80% of dairy goats are affected. The control of this disease represents a US \$20,000,000 savings for goat producers worldwide.*

Sociological studies indicated that women play a central role in the farm enterprise. Women substantially contribute to the raising of small ruminants and benefit directly from their economic value.

*Kenya (1980-Present)*

A new breed of Kenyan dual-purpose goat (KDPG), composed of equal proportions of two local goats and two exotic dairy breeds, was developed by the SR-CRSP to meet the requirements of small-scale farm families.

Introduction of KDPGs and improved forage production practices has resulted in a 66% increase in food yield from goats for small holder families. Each DPG generates an average of US \$52 additional income per hectare. If 10% of the humid and subhumid zone in Kenya were available for food crops and fallow, the potential annual benefits to farmers would amount to \$2,500,000.

Disease detection techniques have been developed for animals infected with contagious caprine pleuropneumonia (CCPP), heartwater, and anaplasmosis. A number of these products have the potential for use in many parts of the world, including the US.

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**Collaborating U.S. Institutions:**

University of California, Davis

University of California, Los Angeles

Colorado State University

Cornell University  
University of Kentucky  
University of Missouri, Columbia  
Texas A&M University  
University of Wisconsin, Madison  
Utah State University  
Washington State University  
Winrock International Institute for Agricultural  
Development

**Collaborating Overseas Institutions:**

Association for Strengthening Agricultural  
Research in Eastern and Central Africa  
(ASARECA)  
Consortium for Sustainable Development of the  
Andean Ecoregion (CONDESAN)  
Kenya Agricultural Research Institute (KARI),  
Kenya  
Latin American Research Network for Animal  
Production Systems/IICA (RISPAL)  
Instituto de Investigacion Nutricional (IIN), Peru  
Inter-American Institute for Cooperation on  
Agriculture (IICA)  
International Center for Agricultural Research  
in the Dry Areas (ICARDA)  
International Livestock Research Institute (ILRI)  
International Potato Center (CIP)  
Uzbekistan Academy of Agricultural Sciences

**Networks:**

*Asia*

The Indonesian Small Ruminant Network,  
established in 1988, has participated in a Small  
Ruminant Production Systems Network for Asia  
initiated in 1980.

*Latin America*

The Andean Small Ruminant Network was  
formed in 1990 with La Paz, Bolivia as the  
headquarters.

*Each DPG generates an average  
of US \$52 additional income per  
hectare. If 10% of the humid and  
subhumid zone in Kenya were  
available for food crops and fallow,  
the potential annual benefits to  
farmers would amount to \$2,500,000.*

## **The Soil Management CRSP**

### **Purpose**

To improve the management of soil, water, and associated natural resources in ways that enhance the economic, nutritional, and social well-being of people in developing countries; and to integrate sustainable land-management practices and indigenous technologies through research, training, and related activities in order to increase productivity, profits, diversity of outputs, and intergenerational equity.

### **Program**

The Soil Management CRSP was restructured in 1996 to focus on five critical food security constraints related to: nitrogen management, especially technologies that improve nitrogen use efficiency; phosphorus management, especially decision aids to promote enlightened fertilization policies and technologies that increase efficiency for use of phosphorus amendments; acidity management, especially decision aids that help apply current knowledge to soil management; management of water deficiencies, especially through better understanding of the interactions between nutrient management and water use efficiency; and erosion and land degradation.

### **Accomplishments**

Research on high -input systems in Indonesia and Peru has shown that yields can be sustained indefinitely while also conserving the soil and enhancing its fertility.

Agroforestry systems and perennial crops have improved soil management and enhanced natural resources in both the humid and semiarid tropics. Tree crops provide mulch and recycle nutrients; they also protect erodible soils in wet areas and conserve moisture in dry areas.

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### **Year of Inception**

1981

*One legume, mucuna, can fix up to 170 kg of nitrogen per hectare, enough for an excellent corn crop.*

Trees also provide food, oil, lumber and firewood.

Soil Management CRSP programs have identified readily available plant species that are well suited to low-input sustainable land-management systems.

Pastures based on acid-tolerant legumes and compatible grasses increase per unit cattle-production area in the humid tropics, thus raising income and food quality while reducing the need to destroy more rainforests.

A four-year experiment in Mali demonstrated that fertilization combined with various ridged tilling practices can increase sorghum and cowpea grain yields by 157% and 123%, respectively.

Rapid screening techniques have been developed to test the release pattern of nitrogen-fixing legumes. One legume, mucuna, can fix up to 170 kg of nitrogen per hectare, enough for an excellent corn crop.

Researchers have identified drought-resistant legumes that can become an important part of savanna cropping systems. Without displacing food or cash crops, such legumes would increase the N in the agricultural system through biological nitrogen fixation. They will also help prevent the progressive land degradation that occurs when neither legumes nor crops stabilize the dry-season landscape.

Soil acidity and active aluminum have been identified as primary constraints to crop production at Niamey, Niger. Evidence suggests that this is a serious problem throughout the country, as well as in much of the Sahel. New techniques are being devised to assess the extent of the problem and measure the impact

on farm and national food production.

Researchers have developed an acidity decision support system (ADSS) that turns raw information into useful knowledge. Part of a new generation of computer programs called expert systems, ADSS let extension agents and other technology-adoption personnel solve problems that would previously have required a specialist. Thus, valuable information need no longer be confined to the research site or circumscribed by the movement of a specialist. Expert systems also expose knowledge gaps and guide research priorities in ways that encourage the efficient use of funds: they help us avoid doing what has already been done and rediscovering what we already know.

The value of mulching has been demonstrated in natural forest reseeded, weed control and plant nutrient conservation. The return of plant residues can be equivalent to a generous application of fertilizer. In agroforestry systems, nutrients in hedgerow residues can greatly increase the productivity of primary food crops.

Soil Management CRSP researchers workshops, on-site instruction programs, and a variety of training publications, the Soil Management CRSP has helped more than 55 countries improve their soil resource inventories, monitor resource degradation and rejuvenation, and apply consistent soil taxonomy criteria to their soil resource inventory.

Researchers are developing multi-disciplinary analytical methodologies that integrate soil data and agronomic, agroclimatic and economic data as they relate to the long-term productive capacity of the resource base. Researchers are also clarifying the way that national policies on such variables as land use, agricultural

*Part of a new generation of computer programs called expert systems, ADSS let extension agents and other technology-adoption personnel solve problems that would previously have required a specialist.*

*The Soil Management CRSP has enabled the U.S. Soil Taxonomy to become the de facto international system of soil classification, thereby allowing its users to transfer agricultural technology from its site of origin to new locations where it is most likely to succeed.*

prices, and private enterprise influence soil management and environment quality.

The Soil Management CRSP has enabled the U.S. Soil Taxonomy to become the de facto international system of soil classification, thereby allowing its users to transfer agricultural technology from its site of origin to new locations where it is most likely to succeed.

More than 100 individuals from host countries have received graduate and undergraduate degrees from institutions involved in the Soil Management CRSP, Non-degree formal training has been provided to over 1,500 people, approximately half of whom have been woman. Two graduates are now Director Generals of their respective country institutions.

#### **Soil Management CRSP Resources**

##### **Participating U.S. Institutions and Organizations**

Cornell University  
Montana State University  
North Carolina State University  
Texas A&M University  
University of Florida  
University of Hawaii/NifTAL Center (Nitrogen Fixation by Tropical Agricultural Legumes)

##### **Collaborating International Institutions**

Centro Internacional de la Papa (CIP)  
Centro Internacional de Agricultura Tropical (CIAT)  
Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT)  
International Fertilizer Development Center (IFDC)  
International Board for Soil Research and Management (IBSRAM)  
International Rice Research Institute (IRRI)  
International Crops Research Institute for the Semi-arid Tropics (ICRISAT)

International Centre for Research in  
Agroforestry (ICRAF)  
Tropical Soil Biology and Fertility, Kenya (TSBF)  
Bean/Cowpea CRSP  
Peanut CRSP  
SANREM CRSP  
Sorghum Millet CRSP (INTSORMIL)  
Integrated Pest Management (IPM CRSP)  
Pond Dynamics/Aquaculture CRSP  
Small Ruminant CRSP

**Networks**

Red de Investigacion en Suelos Tropicales  
(RISTROP), a tropical soil management research  
network of scientists from 12 Central and  
South American countries.

*Non-degree formal training has  
been provided to over 1,500 people,  
approximately half of whom have  
been woman.*

## **Sorghum/Millet CRSP (INTSORMIL)**

### **Purpose**

To improve the production, marketing, and utilization of grain sorghum and pearl millet in less-developed countries, and to strengthen the capabilities of LDC institutions to generate, adapt, and apply improved technology to local conditions.

### **Program**

In general, INTSORMIL works:

To address universal constraints to the production, availability, and improved utilization of sorghum and pearl millet. Environmentally sustainable agroecosystem constraints addressed by the program fall within disciplinary areas of germplasm improvement/conservation, integrated pest management (pathology and entomology), adaptation of plants to stress soils (pathology and entomology), adaptation of plants to stress soils (physiology, ecologically sound production practices, utilization, economics and sociology.

To improve research capability through collaboration between U.S. and host-country counterparts, through exchange of professional visits between the U.S. and the host country scientists, and by supporting LDC national research programs in terms of equipment, supplies, travel, and personnel.

To provide both short-term and degree training programs for host-country staff at U.S. institutions. On-site technical assistance and training are provided by U.S. scientists.

To disseminate the technologies developed by the INTSORMIL program through host-country organizations, NGOs and PVOs to the farmer information chain. These technologies can be shared with all USAID missions and countries where sorghum and millet are important food crops.

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### **Year of Inception**

1979

*The sorghum hybrid "Hageen Dura - 1" was planted on 12% of the sorghum area of the Sudan Gezira Scheme in 1992. In 1996, the Sudanese Government called for production of enough Hageen Dura-1 seed to plant all of the area normally planted to sorghum (approximately 500,000 acres). Impact studies show internal rates of return to this technology of 31% with fertilizer use.*

In order to overcome constraints that continue to thwart the development of sound sorghum and millet systems, environmentally sustainable agroeco production systems are categorized by the CRSP under five global technical thrusts. These thrusts, oriented toward natural resource conservation and development, environmental protection, and sustainable agroeco production systems, are as follows:

- Germplasm Enhancement & Conservation—5 projects
- Bio-Intensive Plant Protection Systems—7 projects
- Sustainable Production Systems—3 projects
- Crop Utilization and Marketing—3 projects
- Host-Country Program Enhancement—8 projects

#### **Accomplishments**

Germplasm exchange, movement of seeds in both directions between the U.S. and host countries, has involved populations, cultivars, and breeding lines carrying resistance to insects, diseases, Striga, drought, and soil acidity, as well as elite materials with high yield potential which can be used as cultivars per se or used as parents in breeding programs.

The hybrid sorghum success story in Sudan traces to ICRISAT/INTSORMIL/ARC collaboration in which they developed, produced seed, and popularized the first hybrid sorghum, Hageen Dura-1 (Tx623 x K1567), for this country. In 1996 the Sudanese Government called for the production of enough Hageen Dura-1 seed to plant all of the Sudan Gezira Scheme area normally planted to sorghum (approximately 500,000 acres). Impact studies show that the internal rates of return to this research without further extension of the production area in Hageen Dura-1 were 23% for low fertilizer levels, and 31% for high fertilizer use levels.

In Honduras, three food-type high yielding sorghum maicillo cultivars have been tested and released. These are Tortillero, Catracho, and Sureño. Sureño, in particular, has widespread acceptance by Honduran farmers because of its superior grain quality, high yield potential, disease resistance, and dual purpose use for both forage and grain. INTSORMIL's socioeconomic research has also shown that in Honduras the internal rate of return to the development of the two new sorghum cultivars, Sureño and Catrcho, which are in diffusion, is estimated at 32% or, on annuity basis, \$0.7 million annually for the next 30 years. These new sorghum cultivars have economically benefited small farmers dependent on small-acreage hillside farms, the poorest farmer segment in Honduras.

A new drought tolerant sorghum hybrid designated NAD-1 has proven to be highly productive and well adapted in Niger. The grain quality is acceptable for local food preparations and the yields reported from on-farm demonstration plots in 1992-1996 were approximately twice the yields of local varieties. Farmer interest has been very high since this is the first sorghum hybrid that has actually reached farmer fields, and both the head size and grain yield have been impressive.

The INTSORMIL PIs at Purdue University have studied each stage of the Striga life cycle separately. They are characterizing the host-parasite interaction at each stage, particularly the chemical signals exchanged. For each stage, simple ways to detect ineffective interactions are sought such as an agar gel assay for germination stimulant production. These screening methods are being used to identify crop genotypes bearing the resistance-conferring traits, and to map the traits on the sorghum genome.

*Two food type sorghum cultivars released in Honduras, Sureño and Catracho have been widely accepted by Honduran farmers. Impact studies show an internal rate of return to development of these two cultivars of 32% or on an annuity basis, \$700,000 annually for the next 30 years.*

*Each stage of the life cycle of the parasitic weed **Striga** has been studied. The host plant-parasite interaction has been characterized at each stage, particularly where the chemical signals are exchanged. Simple screening methods have been developed and are being used to identify sorghum genotypes bearing resistance-conferring traits and to map those traits on the sorghum genome genetic map.*

In Honduras and Niger, INTSORMIL/ Mississippi State University and Texas A&M University collaboration has resulted in the development of sustainable biological control strategies for stem borers, and information on pest and natural enemy biologies has contributed improved approaches to IPM. For enemies, for stem borers in Honduras, an efficient natural enemy was imported, released in Honduras and established; for stem borers in Niger, natural enemies were demonstrated to occur in greater densities in natural vegetation than in millet, a suggestion that the substantial changes in pearl millet production practices is interfering with biological controls.

Pearl millet head miner (*Heliocheilus albipunctella*) is a serious insect pest of west Africa, and has been found to be an excellent candidate for biological control since it has a predictable habitat, consistent annual habits, produces one generation per year, and has several natural enemies. Two major predators and two commonly encountered parasites have been identified, and are being studied. It is reasonable to expect that with an adequate knowledge-base about this insect pest, it will be possible to develop a regional biological control research program with NARS entomologists participating in the ROCAFREMI network.

Food quality laboratories have been established and equipped in Mali and Niger. Both are conducting sorghum and pearl millet food technology research to develop or improve food products, and assist breeding programs. These laboratories developed a Sorghum Quality Laboratory Manual which has been widely distributed in West Africa.

An inexpensive children weaning food (MILEG) consisting of a blend of three parts millet flour and one part of cowpea flour was developed

and introduced in Mali.

Parboiling research trials showed the importance of grain with tan plant color to produce improved highly acceptable food products. This has led to current breeding objectives to produce an improved local photosensitive sorghum with tan plant color specifically for use in value added processing. A product of this research is a new sorghum product called SORI which was developed in Mali. The basic process is similar to rice parboiling. Partially cooked, steeped sorghum was dried and decorticated to produce endosperm pieces that can be cooked like rice. When cooked, the decorticated kernels remain intact, retaining their individual integrity. The process is fairly simple, and does not require sophisticated equipment. The SORI process looks promising.

The process of implementing collaborative research with host country institutions has annually increased and improve the cadre of LDC scientists and technicians available to conduct research on these two priority crops. As of mid-1996, the CRSP has trained 611 non-U.S. and 254 U.S. students from USAID grant funds and non-USAID sources. Since the CRSPs inception, 875 students have been educated and have received Graduate degrees. An additional 104 short term, post-doctoral/visiting scientist recipients have been benefited from the program.

#### **INTSORMIL CRSP Resources**

##### **Collaborating U.S. Institutions**

Kansas State University  
Mississippi State University  
University of Nebraska  
Purdue University  
Texas A&M University

*IPM control research is developing sustainable biological control strategies for stem borers, whorl worms and pearl millet head miner in sorghum and millet.*

*A new parboiled sorghum product called "SORI" has been developed in Mali. The process is similar to rice parboiling. Partially cooked steeped sorghum was dried and decorticated to produce endosperm pieces that can be cooked like rice. When cooked, the decorticated kernels remain intact, retaining their individual integrity. The process is fairly simple, and does not require sophisticated equipment. The "SORI" process looks promising.*

**Collaborating Host-Country Institutions**

Department of Agricultural Research (DAR),  
Botswana

Ministerio de Recursos Naturales (MRN),  
Honduras

Institut Economie Rurale (IER), Mali

Institut National de Recherches Agronomiques  
du Niger (INRAN), Niger

Agriculture Research Corporation (ARC), Sudan

Kenya Agricultural Research Institute (KARI),  
Kenya

Ethiopia Institute of Agricultural Research,  
Ethiopia

Eritrea Department of Research and Extension,  
Eritrea

**Networks**

Consejo Latin Americana de Investigadores in  
Sorgo (CLAIS)

SADC/ICRISAT, Southern Africa

ROCAFREMI, West Africa

WCASRN, West Africa

ASARECA, East Africa

## **Sustainable Agriculture and Natural Resource Management CRSP (SANREM)**

### **Purpose**

To elucidate and establish the principles of sustainable agriculture and natural resource management on a landscape scale through a research strategy built on the respective comparative advantages of farmers, scientists, NGOs and GOs.

### **Program**

In general, the SANREM CRSP is a research and information exchange program that strives:

To improve the understanding of important ecosystem processes and identify critical ecosystem linkages in a landscape/lifescape setting.

To identify and measure key indicators of sustainability that integrate appropriate physical, biological, and/or socioeconomic data that describe the changes in sustainability.

To delineate the global to local forces, as understood and acted upon by diverse stakeholder groups, which either facilitate or constrain sustainability on a landscape scale.

To develop and evaluate strategies to improve natural resource management, inform policy, and strengthen institutions to positively impact sustainability.

To test and/or demonstrate the applicability of the approach, methodologies, indicators, management strategies and/or improved policies to other environments.

To promote institutionalization of sustainable approaches through education, training, and information dissemination and exchange.

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### **Year of Inception**

1992

*The key to sustainability is enhanced human capacity to manage natural resources in a way that will improve quality of life and ecosystem integrity.*

The core sites for SANREM CRSP are the Philippines, Burkina Faso, and Ecuador. Other project sites include Cost Rica, Honduras, Cape Verde and Morocco. All sites have several characteristics that make them of keen interest in studying sustainable agriculture and natural resource management in a landscape setting. These include 1) reserves of plant genetic diversity; 2) centers of both cultural and biological diversity; 3) high rates of soil loss and sedimentation; 4) significant downstream impacts; 5) zones of human migration; and 6) significant loss of forest resources.

#### **Accomplishments**

Participatory constraints analysis conducted at each site.

Development of demand driven research agenda.

Improved agroforestry systems that include indigenous tree species and contour hedgerow systems.

Improved vegetable production systems that control erosion.

Development of a hydrologic watershed model that links the biophysical and social aspects of natural resources management.

Development of a landuse GIS for the Philippines site and assessed land use change over a 19 year period.

Heightened community awareness of local sustainability issues and development of new partnerships between researchers, development professionals, and community members.

Enhanced capacity of community members, non-government organizations, and local

government workers by active involvement in research design, data collection, and subsequent information exchange.

Utilization of participatory research methodologies in institutions at all sites.

Implementation of training programs and curriculum development for graduate, undergraduate, primary and secondary students as well as community training activities and regional training programs.

Utilization of participatory research results in policy and decision making related to economic and environmental sustainability.

**CRSP Resources:**

The SANREM CRSP consortium members include the following institutions as well as many site-local Non Government organizations, Local Government Units, Farmer Groups, User Groups, and Tribal Councils.

**Collaborating U.S. Universities**

Auburn University  
 Colorado State University  
 Iowa State University  
 Center for PVO/University Collaboration in Development  
 Tuskegee University  
 University of Georgia  
 University of Wisconsin  
 Virginia Polytechnic Institute and University  
 Washington State University  
 USDA-ARS

**Collaborating International Non-Government Organizations**

CARE  
 Heifer Project International  
 Plan International  
 Center for Holistic Management

*The uniqueness of the SANREM CRSP rests in its four cornerstones: landscape/lifescape interactions, interdisciplinary teamwork, institutional partnerships, and participatory methodologies.*

*"This is a great opportunity to have world level scientists in our community. With their very well detailed explanations based on their experience in other countries, it helps us to reflect and realize the gifts our Nature gives us and also the risks we face if we do not take good care of Her."*

*- Resident Chullaje Community*

**Collaborating International Research Centers**

International Potato Center (UPWARD)

International Center for Research in

Agroforestry

International Rice Research Institute

**Collaborating Host Country Institutions**

*Philippines*

Philippines Council for Agriculture, Forestry,

and Natural Resources Research and

Development

*Burkina Faso*

Institute of Environment and Agricultural

Research

Institute for Rural Development, University of

Ouagadougou

General Delegation for Scientific Research

*Ecuador*

COMUNDEC

Center for Data Conservation

Terra Nueva

University of Quito, San Francisco

Central University of Ecuador

EcoCiencia

NEFAN

*Honduras*

Escuela Agrícola Panamericana (Zamorano)

*Costa Rica*

EARTH University

*Cape Verde*

National Institute for Agricultural Research and

Development

## West Africa Natural Resource Management (NRM) InterCRSP

### Purpose

To build upon the expertise and experience of the individual CRSPs in order to address regional priority Natural Resource Management (NRM) technology development and transfer problems in West Africa.

### Program

USAID has supported NRM-related activities in West Africa through the CRSPs for many years. Currently, six CRSPs (Bean/Cowpea, IPM, INTSORMIL, Peanut, SANREM, Soil Management) are active in West Africa, some building on programs more than 15 years old. During this time, the CRSPs have been very successful and influential in their core areas. They have succeeded in helping national agricultural research systems (NARS) increase crop yields, develop disease and pest resistant varieties, implement sustainable agricultural practices, develop appropriate marketing policies, and increase human and institutional capacities.

The realization that effective responses to the severe NRM problems in West Africa required regional and integrated solutions has led the Africa Bureau of USAID and the individual CRSPs to develop the NRM InterCRSP. The NRM InterCRSP is composed of the original six CRSPs plus the Pond Dynamics/Aquaculture CRSP.

### Accomplishments

The InterCRSP has succeeded in creating an effective framework for collaboration among partners on both sides of the Atlantic. This prerequisite for building an effective regional technology development and transfer (TDT) program has been accomplished by InterCRSP teams composed of U.S. and West African scientists who have visited participating countries and stakeholders and have lead, participated in, and supported other NRM

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Virginia Polytechnic Institute and State University (Virginia Tech)

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### Year of Inception

1995

*The InterCRSP has succeeded in creating an effective framework for collaboration among partners on both sides of the Atlantic.*

workshops throughout the region.

Based on extensive consultations with West African and American partners through a series of workshops and meetings, collaborative multi-CRSP and multi-country TDT proposals on priority NRM problems were prepared, evaluated, and funded. Two projects in the highest priority area of soil and water management have been funded: A West project centered in Senegal with participation of Mali, Cape Verde, and The Gambia involving the Soil Management, INTORSMIL, Pond Dynamics, IPM, and SANREM CRSPs; and an East project centered in Niger with the participation of Cameroon, Chad, and Burkina Faso involving the Peanut, Bean/Cowpea, SANREM, and Soil Management CRSPs. A small pilot project to inventory biodiversity projects and programs in Senegal and a regional technology transfer project linking the CRSPs to a regional NGO (World Vision International) to facilitate technology transfer have also been funded. Field work on the projects began in May 1997.

To reinforce mechanisms for regional collaboration in NRM TDT, both regional and national institutions in the region have been targeted for strengthening by the InterCRSP. The InterCRSP's principal West African regional partner, the Institut du Sahel (INSAH) has benefitted from technical assistance in strategic planning and from other InterCRSP activities designed to support its regional coordinating role in NRM. The collaborative regional InterCRSP projects currently underway in the different participating countries are designed to help strengthen the individual NARS and build human capacity in NRM TDT programs.

**InterCRSP Resources**

The pool of resources available to the NRM InterCRSP extends to the 38 U.S. university members of the participating CRSPs as well as their U.S. and international CRSP partners.

**Principal InterCRSP Partners in West Africa  
INSAH and The NARS:**

Burkina Faso  
Cameroon  
Cape Verde  
Chad  
The Gambia  
Ghana  
Guinea Bissau  
Mali  
Mauritania  
Niger  
Senegal

*The pool of resources available to the NRM InterCRSP extends to the 38 U.S. university members of the participating CRSPs as well as their U.S. and international CRSP partners.*