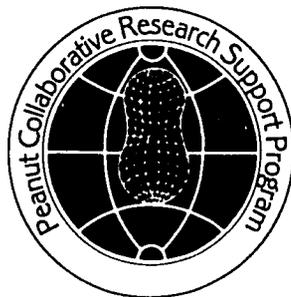


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**PEANUT  
COLLABORATIVE RESEARCH  
SUPPORT PROGRAM**

**GLOBAL PLAN  
and  
EXTENSION PROPOSAL  
for  
1990 - 1995**



Supported by USAID Grant:  
DAN-4048-G-SS-2065-00

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## PREFACE

The Peanut CRSP is funded through "Title XII-Famine Prevention and Freedom from Hunger" under the "International Development and Food Assistance Act of 1975." It is implemented by the United States Agency for International Development, (USAID) and the participating U.S. and host country institutions. The Board for International Food and Agricultural Development (BIFAD) provides an advisory role to these groups in implementation of the CRSP.

In the late 1970's USAID missions around the world in consultation with host country institutions identified peanut as a priority crop for improving the well being of farmers and consumers, but the crop was beset with constraints that could be solved through a collaborative research program. The collaborative nature of the program allows the capabilities of the U.S. agricultural research and education system to be used to enhance research systems in host countries to allow them to achieve similar levels of success and at the same time provide benefits to the U.S. research system, producers, and consumers.

An 18 month planning process began in 1980 that resulted in global goals being set, constraints and problems identified, research projects developed aimed at solving the problems and relieving the constraints, and participating U.S. and host country institutions identified. A five year research program was initiated in 1982 and extended for three years in 1987. Supported by achievements from these eight years of research and the continuing need for improved technology, this document is the basis of a proposal to extend the CRSP for an additional five years, until 1995.

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## EXECUTIVE SUMMARY

### RATIONALE

The Peanut CRSP Extension Proposal and Global Plan presents the rationale to justify a 5-year extension of the program from 1990 to 1995. The Peanut CRSP was funded in 1982, because peanut is an important crop in sustainable agriculture and food systems worldwide, is an important U.S. crop, and has critical constraints to production and utilization common to many developing countries and the U.S. that can best be resolved through collaborative research. Significant progress has been made in the first eight years, but many problems remain unresolved, which are the basis of this request for a 5-year extension.

The goals of the Peanut CRSP are to enhance the research capability of both developing countries and the U.S. and focus this capability on the alleviation of major researchable constraints limiting sustainable peanut production and food delivery in an environmentally sound system.

### ACCOMPLISHMENTS

Major accomplishments and benefits made by the Peanut CRSP during its first eight years follow.

#### Benefits to the host countries:

- Development and release of seven peanut cultivars with a potential to increase incomes over U.S. \$20,000,000 per year.
- Integrated pest management (IPM) strategies were developed to reduce insect damage. Reduction in insect damage reduced aflatoxin development caused by Aspergillus sp. invasion through insect damaged pods. Also, IPM strategies decreased losses to rosette virus in West Africa with subsequent annual yield increases up to 25%.
- A highly adsorbant clay identified to bind and remove aflatoxin from village processed peanut oil and peanut meal fed to animals (with potential as a food additive) has incalculable potential benefits in control of this carcinogenic compound.
- Nutritionally enriched "kisra" (thin bread) produced by blending sorghum and peanut flour in Sudan can reduce the sorghum induced niacin and protein deficiency and result in a ten-fold increase in the value of peanut oil meal compared to its use as a fertilizer.

- Peanut based cheese spread in the Philippines and peanut enriched noodles in Thailand were developed and are being pilot tested with potential to increase protein intake and economic benefits of U.S. \$4,000,000 annually.
- Better understanding of food needs and role of peanut to provide these needs through food consumption surveys in Africa, Southeast Asia and the Caribbean.
- Trained 15 M.S. and 12 Ph.D. students in U.S. universities, 17 M.S. students in host country universities, and 74 host country staff by short-term activities.
- Research equipment valued at U.S. \$269,000.

#### Benefits to the United States.

- Development and release of six peanut cultivars that will reduce chemical use in North Carolina through disease resistance and an initial annual return of U.S. \$1,000,000 to Texas farmers.
- IPM strategies introduced in North Carolina can save U.S. \$1,500,000 annually in chemical and application costs.
- Peanut stripe virus research in the U.S. thwarted a potential virus epidemic and resulted in the elimination of restrictions on interstate movement of peanut seed and increasing annual seed sales U.S. \$100,000.
- Highly adsorbent clay has potential of reducing aflatoxin problems in contaminated feeds with a reduction in carcinogenic effects of aflatoxin.
- A new peanut line scheduled for 1990 release in Texas has resistance to aflatoxin accumulation in the seed which results in 15% lower aflatoxin levels and could increase gross returns by U.S. \$1,000,000 per year through increased quality.
- Peanut based cheese spread has potential of providing U.S. consumers an alternative, high protein, cholesterol free product.
- Trained 19 M.S. and 17 Ph.D. students and broadened perspective of U.S. scientists.
- Provided U.S. \$176,600 in equipment.

## Technology transfer was stimulated through

- o Numerous publications
- o Over 35 workshops and conferences and in annual in-country planning sessions
- o Publication of International Arachis Newsletter
- o On-farm pilot programs.

### GLOBAL PLAN

The Peanut CRSP will continue implementation guided by strategy of the Global Plan that follows.

#### Research Thrust

##### Sustainable Agriculture Production and Food Delivery Systems.

##### Constraints:

- o Low yields because cultivars are not adapted to the short rainy periods and the cultivars lack resistance to diseases, insects, and droughts.
- o Yield losses due to infestation of weeds, insects, diseases, and nematodes.
- o Mycotoxin hazards to health due to fungal invasion of the peanut.
- o Inadequate food supplies and a lack of appropriate food technologies to exploit a relatively well adapted peanut crop that is not generally considered a primary source of food.
- o Resource management (agronomic, economic, engineering and sociological) situations preventing efficient production and utilization.

#### Research Actions:

##### West Africa

The Peanut CRSP is concentrating the Africa program on the Sahel region of West Africa.

Senegal - Research is underway to develop cultivars that are disease and stress resistant and adapted to the short season environment. Management of aflatoxin through breeding for resistance, detection, and removal by adsorptive clays is

another research action. Leadership is provided by Texas A&M University, the Senegalese Institute for Agricultural Research (ISRA), and the Senegalese Institute of Food Technology (ITA).

Burkina Faso - The cultivar improvement program in Senegal is linked to improvement efforts in Burkina Faso to infuse superior germplasm. Integrated Pest Management (IPM) research is solving problems caused by damage from insect pests. Food technology research is directed toward development of better use of peanut as a primary food and its delivery to the population. Leadership is provided by Texas A&M University, the University of Georgia, Alabama A&M University, and the University of Ouagadougou, Burkina Faso.

Mali - The cultivar improvement program in Senegal is linked to germplasm improvement in Mali, with leadership provided by Texas A&M University and the Institute of Economic Research (IER), Mali.

Niger - The cultivar improvement program in Senegal is linked to germplasm improvement in Niger with leadership provided by Texas A&M University and the Nigerien National Institute for Agricultural Research (INRAN).

Nigeria - Research to control rosette virus through development of resistant cultivars is led by the University of Georgia and Amadou Bello University, Institute of Agricultural Research with linkages to the cultivar improvement programs in Senegal and Burkina Faso.

Networks - The research program is enhanced by networks involving the interaction or linkages between the prime sites described above; cooperation with the ICRISAT Sahelian Center in research planning, implementation (cultivar program to add eight additional West Africa countries in a testing network), and workshops; and cooperative research support with IRHO (French Oilseed Research Institute) in Senegal.

#### **Southeast Asia**

The Peanut CRSP is concentrating the Asia program on Southeast Asia.

Thailand - Research is underway to develop disease and stress tolerant cultivars adapted to the environment which includes multicropping following rice. Integrated pest management (IPM) research is solving problems caused by insect pests. Peanut virus research is solving important virus problems. Food technology research is directed toward development of better use of peanut as a primary food and its delivery to the population. Leadership is provided by North Carolina State University and the University of Georgia, the Thailand Department of

Agriculture, Kasetsart University, and Khon Kaen University.

Philippines - Cultivar improvement research includes pest resistance, adaptability to post-rice planting, and tolerance to shade (under coconut trees) and acid soils. IPM research is addressing major insect problems, and virus research is directed toward solving major virus problems. The research in food technology will assist in solving food and protein/calorie shortages through new and improved food products using peanut as a major ingredient. Leadership is provided by North Carolina State University, The University of Georgia, and the University of the Philippines at Los Banos.

Networks - The research program is enhanced by networks linking the institutions within each prime countries; cooperation with ICRISAT in planning and workshops; and cooperation with IDRC-Canada and ACIAR-Australia in research planning and support which links the CRSP activities to other countries including Indonesia and Malaysia.

### **Caribbean**

The Caribbean program concentrates on the English speaking islands and Belize.

CARDI - The program to solve postharvest problems to reduce costs of peanut to the consumer and increase farmer profitability is led by the University of Georgia and coordinated through CARDI (Caribbean Agricultural Research and Development Institute) in Jamaica, Belize, Antigua, and Trinidad.

### **All Regions**

#### **Resource Management**

In all three regions research will be integrated among disciplines to solve agronomic and socioeconomic problems preventing efficient production and utilization. Research will be intra-CRSP, cooperative with in-country programs, and inter-CRSP, and will involve local, regional, and international networks.

#### **Constraints**

These three constraints apply to the Peanut CRSP in all regions.

- Inadequate numbers of trained scientists and support personnel
- Lack of adequate equipment to conduct research

- Information not available to beneficiaries for support of production and utilization activities.

**Training:** Training is an integral part of all research to upgrade the skills of present researchers and provide graduate training to develop researchers to fill present and future voids.

**Infrastructure:** Key items of research equipment will be provided to support the research programs.

**Communications and Outreach:** Expanded efforts in Communications will increase the production of publications describing new technology, increase the number of workshops to communicate technology, strengthen networks with international cooperators, and support on-farm and cottage industry Pilot Programs to extend new technology to beneficiaries.

#### BUDGET

The Peanut CRSP has received (projected to June 30, 1990) \$12,557,841 from AID, the U.S. universities have provided \$2,939,909 in cost sharing funds, and the host country contributions total U.S. \$1,226,800 in direct program support.

Total AID support requested in the 5-year extension 1990-1995 is \$18,554,800 for an optimal level budget, \$9,863,250 at current levels plus 5% for inflation compounded annually, and \$8,500,000 at current funding levels. About 45% of program research funds (less management costs and U.S. indirect costs) will pass through to host countries.

The optimal budget will return research to operational levels, provide strategic training needs, and provide "new thrusts" in research on critical constraints, evaluate new technology in the context of effective Resource Management, and enhance Communication and Outreach activities to stimulate technology transfer. Current levels plus 5% inflation compounded annually will maintain programs at near current levels. Funding at current levels for the 5-year extension will place strong restrictions on research, and cause curtailment of certain research activities that could reduce the number of constraints researched and/or the number of research sites.

#### EXPECTED ACCOMPLISHMENTS

The Peanut CRSP is well established in 12 host countries with over 65 collaborators.

- At least 15 new cultivars should be developed to increase yields, provide resistance to environmental stress, and fit into various cropping systems.

- New IPM strategies will decrease chemical requirements for pest control.
- Aflatoxin will be better controlled through resistant cultivars, biochemical blockage of aflatoxin development, use of sorbent clays to decontaminate peanut products, and decontamination by bacterial fermentation.
- Food supplies will be increased through better utilization of peanut in traditional foods and development of new peanut products.
- Improved resource management systems involving peanut.
- More and better trained researchers and support personnel.
- Key items of equipment provided for research programs.
- New technology communicated to the host country and U.S. beneficiaries.

## PROGRAM DESIGN AND GOALS

The Peanut Collaborative Research Support Program (CRSP) is a long-term research effort designed to address the alleviation of major researchable constraints to worldwide sustainable production and utilization of peanut. The Peanut CRSP is a collaborative process including the United States Agency for International Development (USAID), United States (U.S.) universities, and host country institutions with linkages to appropriate international organizations.

The goals of the Peanut CRSP are to enhance the peanut research capability of developing countries and the United States, and to focus this increased capability on development of technology that will help remove constraints limiting sustainable production and utilization. The Peanut CRSP enhances the potential of peanut as a crop for human food and animal feed in host countries and the United States, while contributing to the increase of rural incomes.

### CONSTRAINT DRIVEN

The Peanut CRSP was designed around a set of constraints to sustainable production and utilization identified during the 1980-1982 Planning process. Based on the numerous advancements achieved by the Peanut CRSP during the 1982 to 1989 period, the External Evaluation Panel (EEP) in 1989 evaluated the continuing validity of the following constraints and found them to be valid as a basic framework for the Peanut CRSP for the near future.

- Low yields because of unadapted cultivars and lack of cultivar resistance to diseases, insects, and drought;
- Yield losses due to infestations of weeds, insects, diseases, and nematodes;
- Health hazards and economic losses due to mycotoxin contamination;
- Food supplies inadequate and lack of appropriate food technologies to exploit a relatively well adapted peanut crop that is not generally considered a primary food source;
- Physiological and soil microbiological barriers to higher yields;
- Resource management (agronomic, engineering, economic and sociological) situations preventing efficient production and utilization;
- Inadequate numbers of trained researchers and support personnel.

- Lack of adequate equipment to conduct research.
- Information not available to beneficiaries for support of production and utilization efforts.

Due to budget reductions at the beginning of the first extension in 1987, research in soil microbiology was discontinued because of the expectation of more immediate returns from other research. Extensive socioeconomic research planned at the origin of the CRSP was not implemented because of guidance from the Joint Research Committee of BIFAD due to funding limitations. However, critical baseline socioeconomic activities were conducted within the resources of the Peanut CRSP. The food technology projects conducted surveys to determine food needs that could be appropriately supplied by peanut. A contract study defined the socioeconomic status of peanut in West Africa.

## GLOBAL PLAN

### RATIONALE

The peanut has a global nature as a result of:

- Worldwide distribution of the crop,
- Importance of the crop in both developing and developed countries,
- Marked similarity of production and utilization constraints worldwide,
- Potential for research to relieve production and utilization constraints and better realize its potential to contribute to an increased food supply in countries where total food and protein supply is marginal, and
- Synergistic effect of international cooperation among groups such as ICRISAT, ISC, IRHO, IDRC, and ACIAR.

### GLOBAL THRUSTS

Sustainability of production and delivery of food to the human population is a primary problem in the developing world. Based on the importance of peanut in contributing to sustainable production of food, and the problems facing optimization of the crop, the Peanut CRSP has three global thrusts to relieve the identified constraints to peanut production and utilization.

1. Sustainable agriculture production and food delivery systems that are environmentally sound is the the major global research thrust of the Peanut CRSP to relieve the identified constraints to peanut production and utilization.

2. Resource management research to relieve situations that restrict efficient management of production and utilization systems.

3. Communication of research outputs to clientele.

An integral part of the research actions is an enhancement of research capability for both the U.S. and the host countries through collaborative research, the provision of equipment, and the training of research and support personnel.

Since its inception, the Peanut CRSP has enhanced research and technology transfer activities through synergistic relationships with other international organizations. Cooperative planning, support for research, and conduct of workshops and other outreach activities characterize these global relationships. Organizations include International Crops Research Institute for the Semi-Arid Tropics, (ICRISAT), ICRISAT Sahelian Center (ISC), French Institute for Oilseeds Research (IRHO), International Development Research Centre-Canada (IDRC), and Australian Centre for International Agricultural Research (ACIAR). The External Evaluation Panel and the Administrative Review Team both recognized the benefits of cooperation with these organizations.

Paramount in the goals of the Peanut CRSP is providing information of value to its beneficiaries. The collaborative nature of the CRSP results in two-way benefits with:

- Focus on solving constraints and improving the well-being of people in host countries,
- Results of value to the constituents of the participating U.S. institutions.

Host country beneficiaries are small farmers, which include rural women, as well as food processors and both rural and urban consumers. Benefits come in the form of adequate quantities of more nutritious and safe food, and increased incomes.

United States beneficiaries are farmers, processors, and both rural and urban consumers.

The Peanut CRSP Global Plan (Figure 1) is a framework for the implementation of the program, and is a template against which progress toward reaching goals can be measured. Research is a dynamic process, not an event; consequently, Peanut CRSP management will revisit the Global Plan on a continuing basis to keep the CRSP abreast of changes in the international peanut research environment while keeping in mind the contribution of advancements in research and maturation of technologies for transfer to beneficiaries on the continued development of the program.

## ACCOMPLISHMENTS AND BENEFITS

During the first eight years of the Peanut CRSP substantial progress has been made toward relieving constraints to sustainable peanut production and utilization. Two major applications have clearly evolved. First, improved technology that lends to sustainable production and utilization can and is being transferred to target clientele through coordination with in-country programs, publications, and workshops. Second, accomplishments guide future research that will move toward further resolution of these constraints. The Peanut CRSP has a dual goal in this research effort, namely, to generate solutions to relieve constraints to sustainable peanut production and utilization, and to improve research capabilities in terms of human capital and infrastructure development, which will enhance the probability of effectively addressing these constraints in the future. A brief summary of some major accomplishments, benefits, and estimated economic returns to research investments follows. For more details refer to the EEP report, including appendices.

### RESEARCH

Constraint: Low yields because of unadapted cultivars and lack of cultivar resistance to diseases, insects, and drought.

- Thirteen peanut cultivars were developed and released for grower cultivation and consumer use (seven overseas and six in the United States).

#### Benefits:

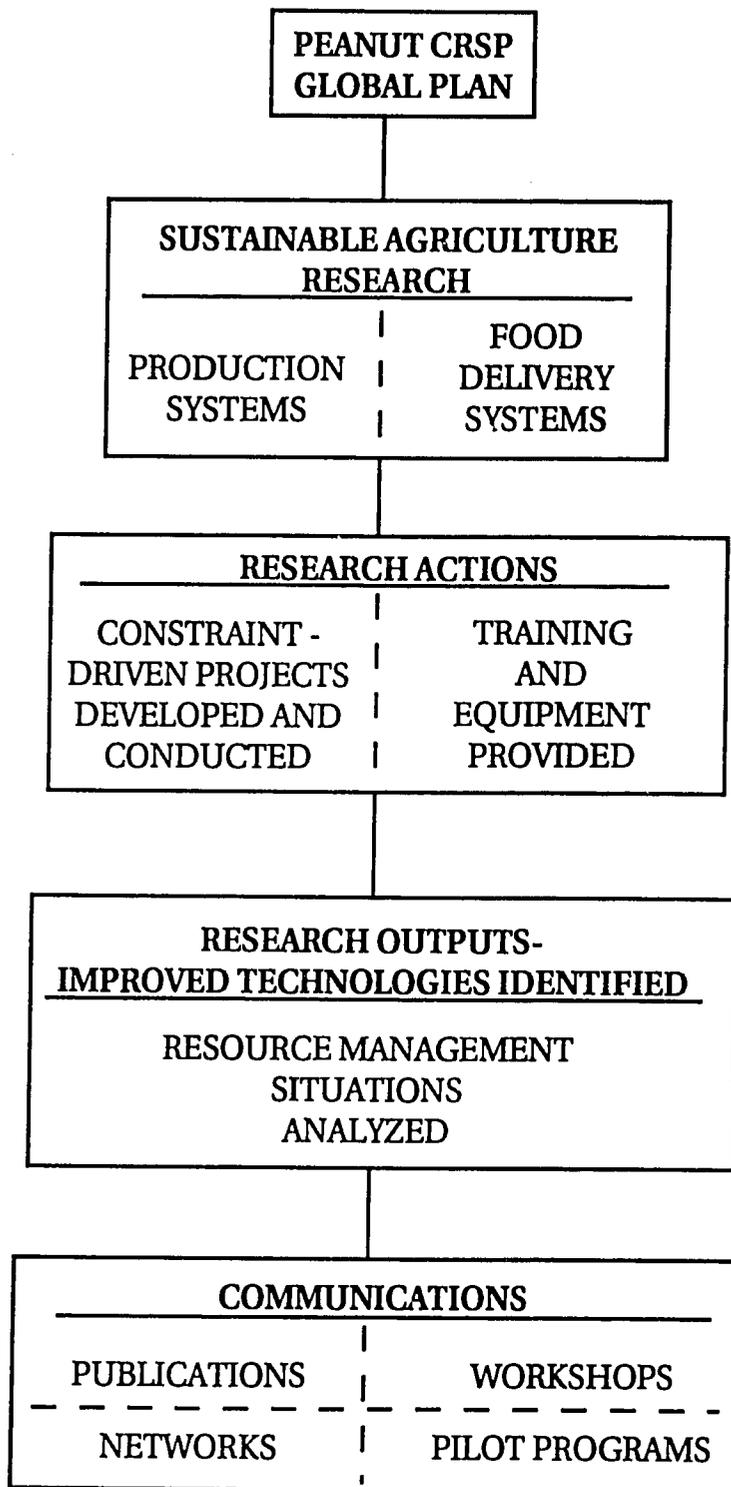
Potential increase of 42,000 metric tons of peanut valued at U.S. \$20,000,000 per year to producers in Thailand, hence increased food supplies.

Potential increased production value of U.S. \$3,500,000 in the Philippines.

Use of cylindrocladium black rot resistant cultivar allows North Carolina growers to manage the disease.

Estimated U.S. \$1,000,000 initial returns to Texas farmers from two newly developed cultivars.

Peanut CRSP release of a higher yielding, disease-resistant cultivar in Jamaica has prompted the local extension service to establish a seed increase and agronomic demonstration program with goals to triple production from the presently less than 5000 acres and double yields on the acreage in five years. A substantial increase in farmer profitability would result.



*Beneficiaries: Developing country small farmers including rural women, food processors, rural and urban consumers.*

*United States farmers, processors, rural and urban consumers.*

**Figure 1. Peanut CRSP Global Plan.**

**Constraint:** Yield losses due to pests:

- Termite resistant cultivar identified in Burkina Faso reduces pod damage and subsequent aflatoxin development.

Benefit: Could increase farm profits by U.S. \$50,000 per year.

- Peanut stripe virus research in the U.S. thwarted a potential virus epidemic and resulted in the elimination of restrictions on the interstate movement of peanut seed.

Benefit: Annual sales of U.S. \$100,000 and prevention of extensive yield losses to a potential virus epidemic.

- Reselection and distribution of two rosette virus resistant peanut cultivars in Nigeria can reduce losses to rosette; rosette losses average 20-25% per year and often cause a total crop loss.

Benefit: 25% increase in average production.

- Insect management strategies introduced in North Carolina can decrease insect damage.

Benefit: Savings in chemicals and application costs of U.S. \$1,500,000 annually.

**Constraint:** Health hazards and economic losses due to mycotoxin contamination.

- Highly adsorbant clay identified that will bind and remove aflatoxin from crude peanut oil and prevent aflatoxin in poultry feed from accumulating in poultry livers.

Benefit: Incalculable worldwide health benefits by control of this carcinogenic compound.

- New peanut line scheduled for 1990 release in Texas that has resistance to aflatoxin accumulation in the seed resulting in 15% lower aflatoxin levels.

Benefit: Could increase gross returns in the United States \$1,000,000 per year through increased quality.

**Constraint:** Inadequate Food Supplies

- Nutritionally enriched "kisra" (thin bread) by blending sorghum and peanut flours.

Benefits: Increased protein intake to reduce the sorghum-induced niacin and protein deficiency. Edible peanut flour when processed into bread in Sudan is valued as high as U.S. \$10 per pound compared to feed or fertilizer use at U.S. \$0.10 per pound.

- Peanut based cheese spread in the Philippines and the U.S. and peanut enriched noodles in Thailand were developed and are being pilot tested.

Benefits: Increased protein intake and potential direct economic benefits of U.S. \$4,000,000 per year initially.

## RESOURCE MANAGEMENT SITUATIONS ANALYZED

Constraint: Resource management situations (agronomic, engineering, economic, and sociological) preventing efficient production and utilization.

- Food consumption surveys conducted in Sudan, Thailand, Philippines and the Caribbean.

Benefits: Research in development and improvement of food products directed to fit local tastes, consumption patterns, and expressed needs for new processes or products.

- Production survey conducted in Philippines.

Benefits: Research better directed to relieve present constraints.

- Socioeconomic situation of peanut in West Africa described through a contract study.

Benefit: Research based on sound socioeconomic strategies.

## HUMAN CAPITAL DEVELOPMENT

Constraint: Inadequate numbers of trained researchers and support personnel.

Host countries:

- 15 M.S. and 12 Ph.D. students trained.
- 17 M.S. students trained in the host countries.
- 74 host country scientists and support personnel received short term training at U.S. institutions totaling over 200 man-months.

### United States:

- 19 M.S. and 17 Ph.D. students trained.
- 46 scientists provided 97 man-months of technical assistance on site visits to host countries.
- Broadened perspective of U. S. scientists.

### Non-Host Countries:

- 15 M.S. and 10 Ph.D. students trained.

The extent of training of M.S. and Ph.D. students was possible only because of leverage of support funds. Full CRSP support was provided for 20 of 28 host country students trained in the U.S., 0 of 17 host country students trained in their own country, 3 of 25 non-host country students, and 13 of 36 U.S. students, or a total 36 of 89 students received full CRSP support.

### **INFRASTRUCTURE DEVELOPMENT**

Constraint: Inadequate research equipment.

- Provided U.S. \$269,900 in equipment for host country institutions.
- Provided U.S. \$176,600 in equipment for U.S. institutions.

### **COMMUNICATIONS AND OUTREACH**

Constraint: Information not available to beneficiaries for support of production and utilization efforts.

- Over 148 scientific journal articles, 9 book chapters, 142 miscellaneous articles, and 178 abstracts published summarizing CRSP accomplishments.
- Over 35 workshops and conferences sponsored or co-sponsored by the Peanut CRSP.
- International Arachis Newsletter co-sponsored with ICRISAT.
- Annual meetings to plan and report research developed in Thailand and the Philippines.
- Peanut CRSP developed cultivar and insect management strategies extended in on-farm pilot program in Philippines; financed by Philippines.

- Peanut CRSP developed cultivar extended in on-farm pilot trials in Jamaica; financed by Jamaica and CARDI.

#### INTERNATIONAL COOPERATION

- The research and communications efforts are enhanced by cooperation with other donors such as:

ICRISAT and ISC - coplanning and coordination of research, and cosponsorship of workshops,

IRHO - Joint support of research in Senegal,

IDRC - Joint support of research in Thailand,

ACIAR - Peanut stripe virus research jointly planned; CRSP supports projects in Thailand and Philippines, ACIAR in Indonesia.

#### JUSTIFICATION FOR EXTENSION

##### RATIONALE

The basic goal of the Peanut CRSP continues: "to enhance the peanut research capability of both developing countries and the United States and focus this increased capability on developing technology that will help relieve constraints to production and utilization, thereby enhancing the potential peanut has as a food and cash crop in both host countries and the United States." Progress has been made toward reaching that goal, but there is much more that needs to be done. The Accomplishments and Benefits section (page 3) highlights some of the progress to date.

The CRSP concept envisioned a long-term program possibly extending 20-25 years in order to develop a strong, indigenous research program in the host countries with collaborative linkages to U.S. programs to develop technologies to relieve constraints to production and utilization thereby improving the well being of the beneficiaries. A 5-year extension will allow further progress toward these goals under the long-term concept.

Based on the accomplishments of the first eight years, the EEP recommends extension of the Peanut CRSP for continued development of sustainable agriculture systems that are environmentally sound. Included are crop production systems, postharvest and utilization technology that will produce sustained levels of quality food, improved technologies adapted to resource management systems, and a bridge of the communication gap between the researcher and the enduser. Also, graduate and short-term training is an important component of the research program along with the provision of key items of equipment. The diets, economy, and production systems in the

focal regions of the Peanut CRSP are improving, but hardly keep pace with the growing populations. Peanut is a legume that is adapted to areas of the world where food problems are greatest, provides nitrogen for itself and for a positive soil nitrogen balance for other crops, fits into many mono- and multicropping systems, and provides a source of high protein and energy food and cash income for rural and urban people. Therefore, the Peanut CRSP should be extended so that it can continue its role in enhancing the well-being of people in developing countries as well as the United States.

#### **EXPECTED ACCOMPLISHMENTS**

The Peanut CRSP is well established in 12 host countries with over 65 collaborators. The CRSP is poised for an accelerated rate of accomplishments.

##### **Low yielding cultivars**

At least 15 new cultivars should be released that will increase yields, provide resistance to rosette virus, leafspot, aflatoxin accumulation and insects, and be tolerant to shade, acid soils, and drought. The cultivar releases will also combine agronomic attributes (such as early maturity) to fit into sustainable cropping systems. Farm yields per unit area should double with lower production costs and higher profits.

##### **Yield losses due to pests**

Improved IPM strategies will be developed that will decrease chemical requirements for pest control. Pest resistant cultivars will contribute significantly to the IPM strategy developments in biological control agents (microbial, parasitic, pathological, and naturally occurring compounds) will eliminate chemical use in some cases. Farm production costs should decrease and profitability increase.

##### **Health hazards due to mycotoxins**

Historically, breakthroughs in mycotoxin management have been few. Improved drying and storage methods for detection and removal of contaminated peanuts from the food chain have been the major ways for reducing aflatoxin consumption. However, the Peanut CRSP has developed some exciting new technology ready for transfer. Significant progress during the next 5-years can be expected in the Peanut CRSP in at least four areas.

1. More highly resistant cultivars should be developed in addition to the one ready for release in Texas that has reduced aflatoxin production in the seed by 15%.

2. Biochemical research underway will determine how to block the metabolic production of aflatoxin by Aspergillus flavus and speed up improvements in cultivar resistance.
3. Optimizing the use of sorbent clays to remove aflatoxin from peanut products will be a major contribution to aflatoxin management.
4. Major breakthroughs are imminent in utilizing bacteria to decontaminate peanut products during fermentation and has great utility in decontaminating fermented food products.

#### **Food supplies inadequate**

Peanut has generally been recognized as an oil crop or for snack and confectionery use. The Peanut CRSP has been successful in developing or modifying existing products to incorporate peanut into staple food items and will continue. Pilot programs for production and distribution of these products should establish peanut as a major food source in areas with critical food shortages, especially protein. Examples are:

1. Peanut based cheese flavored spread in the Philippines,
2. Peanut flour enriched noodles in Thailand,
3. Peanut flour enriched "kisra" in Sudan.

Additional new products should nearly double peanut consumption in the host countries.

#### **Resource management**

The Peanut CRSP has not had financial resources to do very much in the area of Resource Management, especially in the areas of agronomic and socioeconomic evaluations. An important factor in the socioeconomic evaluations will be to ensure that new technology will fit into the sociological framework of target farmers and consumers. The additional funds requested in the optimal budget should allow for development and transfer to beneficiaries more efficient means of production and utilization. Increased production, greater profitability, and increased utilization of nutritious peanut products should result.

#### **Inadequate numbers of trained researchers**

During the first eight years of the Peanut CRSP, only one-third of the students trained in the CRSP were fully supported by CRSP funds. Leverage funding allowed the additional training with peanut research done on problems identified by the CRSP.

Additional funds requested in the Optimal Budget should double the number of scientists trained.

#### **Information not available**

The Peanut CRSP has matured to the point of having valuable technology to disseminate and to a point where the development of new technology will multiply rapidly. One of the more critical needs in our funding request is support for the enhancement of the Communications and Outreach component; the cost of which is extremely modest compared to potential returns to utilizers of the technology. We expect an increased rate of flow of information with the skills and time of a communications specialist.

#### **STRATEGIES FOR 5-YEAR EXTENSION**

The basic strategy for the Peanut CRSP continues to emphasize a collaborative mode, maximize inputs into research and communication programs, utilize an efficient management system, and concentrate on outputs that will improve the well-being of its clientele. These strategies follow.

#### **GLOBAL PLAN**

Sustainable agriculture and food delivery systems that are environmentally sound will be the major thrust of the research program. Production research will provide technology for higher and more efficient yields with minimal use of chemicals. Research will find ways to reduce health hazards associated with aflatoxin and other antiquality factors. Postharvest and food technology research will seek to develop technology to utilize the high protein and energy attributes of peanut in acceptable traditional and new types of food.

Research outputs will be identified that have potential value for the beneficiaries. The outputs will be evaluated for applicability to efficient resource management systems including agronomic and socioeconomic soundness. This effort will be led by CRSP investigators interacting with appropriate personnel involved in research and outreach activities.

Communication of published research outputs to the clientele will receive increased emphasis through publications designed for policy makers and extension workers, networks, workshops, and pilot and demonstration programs.

#### **GEOGRAPHIC COVERAGE**

The Peanut CRSP will continue in three major world regions; Semi-Arid Tropical Africa with emphasis on West Africa, Southeast Asia, and the Caribbean (Figure 2).

The EEP recommends that the Peanut CRSP continue to work in the same host countries: Senegal, Burkina Faso, Niger, Mali, and Nigeria in West Africa; the Philippines and Thailand in Southeast Asia; and the CARDI countries in the Caribbean (primary research sites in Jamaica, Belize, Trinidad, St. Vincent, and Antigua).

During the 5-year extension, linkages in West Africa will be developed with Chad, Togo, Benin, Cameroon, Gambia, Ghana, and Guinea in cooperation with ISC, and in Southeast Asia with Indonesia and Malaysia in cooperation with ACIAR.

Regional impacts will be enhanced through networks, linkages to non-host countries, conferences, workshops, USAID Mission "buy-ins", and inter-CRSP activities. These activities will be further enhanced through cooperation with international groups including ICRISAT, ISC, IRHO, IDRC, and ACIAR.

The EEP recommends that the present participating United States universities continue: Alabama A&M University, The University of Georgia, North Carolina State University, and Texas A&M University.

#### **MANAGEMENT STRUCTURE**

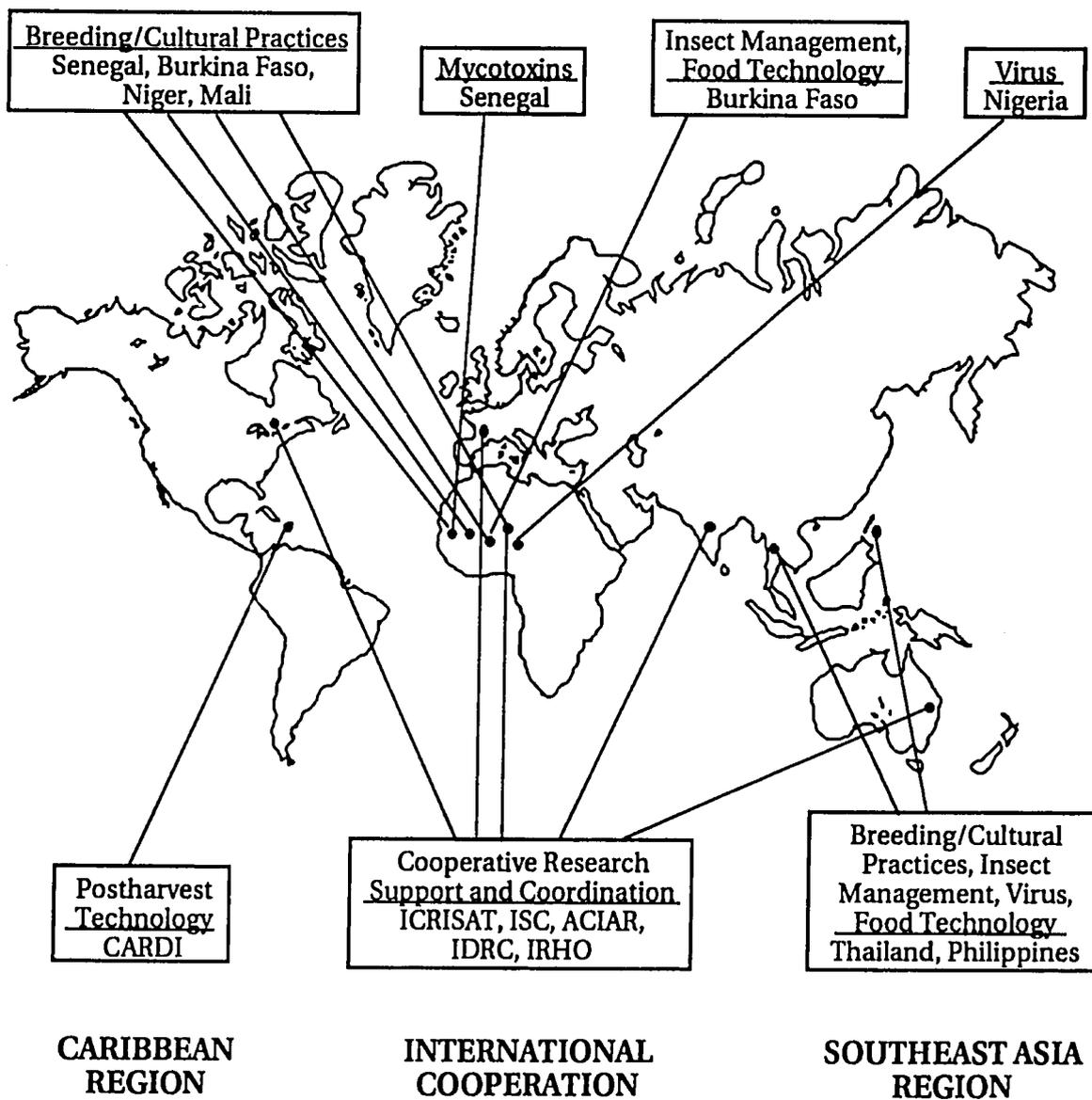
The Peanut CRSP will continue to utilize the same basic management structure. As recommended by the Administrative Management Review Team and the EEP, refinement will be made in more fully defining policies and operating procedures that have been and will be used in the future, especially for the Board of Directors and Technical Committee.

The University of Georgia is the Management Entity (ME) and the prime grant recipient, and the coordinator of activities involving USAID, the participating U. S. universities, and the host country institutions. The ME is responsible for all programmatic and fiscal affairs, including evaluations, with certain responsibilities delegated to subgrantees by Memoranda of Understanding and Plans of Work.

The Board of Directors is the policy making component of the CRSP, and is made up of a representative from each participating U.S. university and a representative from ICRISAT. The ME Program Director and AID Project Manager serve as ex-officio members. The Board advises the ME in its activities, establishes necessary policies and operating guidelines, and approves research plans and budgets as recommended by the Technical Committee.

The Technical Committee is responsible for developing the programmatic and fiscal structure of the CRSP, and is made up of one Principal Investigator from each participating U. S.

**SEMI-ARID TROPICAL AFRICA REGION**



*Figure 2. Geographic Coverage of the Peanut CRSP.*

university. The ME Program Director and AID Project Manager serve as ex-officio members. Also as recommended by the Administrative Review Team, a plan will be developed to include host country participation on the Technical Committee. The Technical Committee develops the general framework for the total program, reviews projects developed by principal investigators, and recommends the program structure to the Board. Subsequently, the Technical Committee is responsible for annual review of progress, annual work plans, and budgets as the project progresses.

The U. S. Principal Investigators, co-Principal Investigators, Cooperators, Host Country Collaborators, and Host Country Cooperators are the key individuals in the CRSP. They are responsible for developing projects based on constraints and problems, conducting research, evaluating progress, managing the finances, making necessary reports, and identifying significant results and guiding them into user channels. Observations made by the researchers are important criteria for future program directions and adjustments.

The External Evaluation Panel is presently made up of four individuals. Their role is to monitor and evaluate program direction and accomplishments, evaluate future research needs, and make appropriate recommendations for future program plans or adjustments. The Panel makes extensive and intensive evaluations subsequent to program extensions, and general evaluations on an annual basis. The need for representation of more disciplines on the EEP, such as socioeconomics, will be evaluated as recommended by the Administrative Review Team.

The USAID Project Manager is the CRSP liaison to USAID for advice in program direction and development, securing travel approval, clearances for equipment purchases, coordination with mission programs, and submittal and approval of various reports. The Project Manager is an ex-officio member of the Board of Directors and Technical Committee as stated earlier.

The BIFAD liaison to the CRSPs provides advice in various areas of concern in program development and management.

## **MANAGEMENT STRATEGIES**

The central management strategies of the Peanut CRSP are designed to maintain focus on the goals outlined in the Global Plan. The individuals described in the Management Structure will:

- Establish priorities for research
- Develop research projects and allocate resources for their support

- Implement, monitor, and evaluate programs, and make incourse adjustments
- Evaluate outputs, report progress and communicate technology to the users.

The Peanut CRSP is organized and managed for efficient balance of program and management of funds.

#### **IMPACT OF BUDGET LEVELS ON STRATEGY**

The level of available funding has a marked impact on expected accomplishments and benefits realized from the Peanut CRSP.

##### **Impact of Budget Reductions**

During the 1986-1987 period all the CRSPs underwent budget reductions. The Peanut CRSP was reduced by about 30% which left the support at a maximum \$1,700,000 per year rather than the planned \$2,400,000. Some of the major effects of the reduction follow.

- Three of the twelve projects were discontinued.
- Research on one constraint, soil microbiology, was discontinued in the termination of two of the projects.
- The scope of research in the nine remaining projects was reduced.
- The number of graduate students supported by the CRSP was minimal.
- Travel by U.S. investigators for research collaboration with host country counterparts was reduced.
- The amount of agronomic and socioeconomic research has been marginal.
- Communication of results through special publications, workshops, networks and pilot programs sorely lacks support.

##### **Impact of straightline budgets on future activities**

Funding for the Peanut CRSP at straight line or current levels for the 1990-1995 period will impose strong restrictions on project activities.

- Increases in costs of supplies, salary for technical support staff, and indirect cost by U.S. universities will necessitate a reduction in staff and material support for research. Critical areas of research will be curtailed.

- Training of graduate students and short-term training for host country personnel will not be adequate to maintain research staff due to normal attrition, much less strengthen research capability, especially in the host countries.
- Limited travel funds will restrict collaboration and on-site technical assistance visits by U.S. scientists to host country research sites.
- Midway into the five-year extension at least one project would likely be terminated to maintain "operational level" research funds in critical constraint areas.

Support at the current level plus 5% for inflation will allow continuation of the program near its current level.

- Marginal support for research personnel and supplies can be maintained with most critical research areas continuing.
- Training will still be inadequate to maintain current numbers of research staff.
- Travel will remain marginal for adequate collaboration.
- Termination of a project may still be necessary to maintain operational level funds in critical constraint areas.

#### Need for more support

The optimal budget level will strengthen the Peanut CRSP in two major ways: (1) return programs to operational levels that were eroded by inflation, increased indirect costs rates, and a 30% reduction in anticipated A.I.D. funds; and (2) allow for "new thrusts" in critical areas of research.

Return to operational levels: The Technical Committee developed through long deliberations recommendations for reasonable operational level funds for each project. The levels approved are the optimal budgets for each project minus "new thrust" funds for that project (Table 3).

- Provides adequate research support personnel and supplies for continued attention to critical constraints to peanut production and utilization.
- Allows for graduate training to maintain present staff levels and increase staff in presently weak areas.
- Provides for short-term training for present host country research staff, a most critical need to include travel needs of U.S. and host country scientists.

- Expand and accelerate research on objectives presently underway to solve problems constraining production and utilization, such as breeding for resistance to pests, improved aflatoxin management, enhancing integrated pest management, improving postharvest handling operations, and expanding food utility of peanut.

**New Thrusts:** "New thrusts" provide for expansion of critical research areas in the projects. These activities were selected from proposals developed by Principal Investigators. The EEP reviewed and prioritized the proposals. The Technical Committee further reviewed and prioritized the proposals considering the advice of the EEP, and recommended to the Board for approval the "new thrusts" that follow.

- Introgression of genes for leafspot and nematode resistance and early maturity from wild peanut species into cultivated species, Texas A&M/West Africa (TX/BCP).

Sources of resistance for pests are primarily in wild species that are incompatible with cultivated species. Introgression research utilizing advanced biotechnology is critical to accelerate cultivar improvement. Expertise is present in the TX/BCP project, but critical funds are needed to accelerate the improvement program and involve a host country trainee to enhance the utilization of this germplasm in West Africa. Populations generated in this program can be tested and re-selected in all the collaborating countries.

- Enhancement of drought research, Texas A&M and West Africa (TX/BCP).

Increased cultivar resistance to drought is a most critical need for the Sahelian Region, as well as the U.S. Present funding levels have evaluated drought response in a number of cultivars. The current approach lacks support for more basic research, integration and interpretation of results, timely communication between the drought physiology collaborators in Texas and Senegal, testing of more rapid greenhouse and laboratory procedures, and redesign of program based on these results to accelerate drought resistance breeding.

- Molecular approaches to regulation of aflatoxin biosynthesis in Aspergillus flavus, North Carolina State, (NCS/BCP).

The overall goal of this research is to clone genes coding for aflatoxin and to determine the factors that regulate its biosynthesis which could ultimately lead to genetic transformation of genes able to block aflatoxin production.

Cloned gene probes will be used to study regulation of the pathway without isolation of pathway enzymes. Information should lead to efficient selection of resistant genotypes and to the identification of genes that can be expressed in plants to totally block aflatoxin production.

- Interspecific hybridization and transfer of desirable germplasm into the Arachis hypogaea genome, North Carolina State and the Philippines, NCS/BCP.

Genetic transfers of genes for pest resistance from wild species to cultivated germplasm are nearly impossible because of resulting sterility following hybridization. The goal of the proposed research is to utilize genetic markers to enhance germplasm introgression to the cultivated species and at the same time utilize two Arachis species which together have high levels of disease and insect resistance. Research will be conducted in collaboration between Philippine and North Carolina State cytologists on problems common to both countries.

- Increasing seed viability and quality in the Philippines and Thailand, North Carolina State and Southeast Asia, (NCS/BCP).

Low germination and low seedling vigor have led to the poor stands and poor quality of seed of new cultivars released in the Philippines and Thailand. More research is needed to determine causes of the low germination and low seedling vigor and allow for production of higher quality seed. Impact will affect all sectors of the industry.

- Enhanced research for integrated pest management emphasizing millipede problems and aphid vector for rosette virus, Georgia and Burkina Faso (GA/IM/BF).

Rosette continues to be a major problem in West Africa and aphids are the vector. Millipede damage allows Aspergillus sp. invasion and subsequent aflatoxin buildup, a major health problem. Enhanced research is needed to assist breeders in the TX/BCP project to identify rosette resistant germplasm for developing resistant cultivars. The millipede research will accelerate IPM research to minimize damage that has implications in reducing aflatoxin contamination of peanuts.

- Uniform testing of insect tolerant peanut lines, North Carolina State and Southeast Asia, (NCS/IM/TP).

Peanut CRSP research has shown that lines have multi-resistance to pests that holds up across locations and regions. Many of the insect genera occur in both

Southeast Asia and the United States. Resistant germplasm will be tested in both regions and the best material supplied to the breeders for cultivar improvement. Collaboration with the GA/IM/BF project will be developed to extend the information to West Africa.

- Aflatoxin Chemisorption, Texas A&M and West Africa, (TX/MM/S).

Peanut CRSP research has identified absorptive clays as a viable and cheap means to detoxify aflatoxin contamination in peanut oil, feed, and possibly food. Research on this new approach to aflatoxin decontamination must be accelerated to make it available to users. Health benefits are incalculable, since aflatoxin has been strongly implicated as chemical progenitors of disease in man and animal. The research proposed will determine modes of action for the clays, assess the safety and efficacy of the clays, and evaluate chemical stability of the clays in feeds. Results will accelerate use of this new method for detoxifying aflatoxin contaminated peanut products.

- Post-doctoral Support for Caribbean food scientist, Alabama A&M, and Georgia and the Caribbean, (AAM/FT and GA/PH).

The University of the West Indies, Trinidad is without a food scientist since the death of the Peanut CRSP collaborator there. A Ph.D. student is near completion that could assume the role with budget support and additional training. This will insure that a trained scientist is in place for food technology research on peanut and other food products, at present a near void in the Caribbean Region.

## RESOURCE MANAGEMENT

Resource Management research is needed to evaluate new technology in the context of sound and efficient resource management systems.

Priority research areas have been identified and projects proposed.

- Intra-CRSP activities will evaluate consumer acceptability of new cultivars and peanut food products. Also, the Peanut CRSP breeding, mycotoxin, insect management, and virus projects will cooperate to develop pest resistant cultivars and IPM systems.
- Inter-CRSP activities will link Peanut CRSP to Tropsoils for soil surveys; Peanut, Bean/Cowpea, and Sorghum/Millet CRSPs are planning integrated food research for West Africa (an

additional \$40,000 is budgeted in the optimal level for this activity for the Peanut CRSP portion to be led by Alabama A&M).

## TRAINING

The training effort has been restricted in the first eight years due to budget limitations. Leverage funds have supplemented the amount of training possible. The optimal budget allows for about twice the support for training, which will provide for graduate and short-term training in critical areas.

## COMMUNICATIONS AND OUTREACH

The Peanut CRSP has matured to the point of having many new and improved technologies for dissemination. An expanded Communication and Outreach thrust will assure better dissemination of these results. The optimal budget request will increase funding in the thrust from \$56,265 to \$115,600.

- A Communications Specialist will be added to produce brochures, publications, leaflets, videos, slides, etc. to improve dissemination of results.
- Increased number of Workshops will be supported.
- International cooperator networks will be enhanced.
- On-farm and cottage-industry pilot programs will be expanded.
- International Arachis Newsletter will continue to be published in cooperation with ICRISAT.

## IMPLEMENTATION OF THE GLOBAL PLAN

## RATIONALE

The Peanut CRSP contribution to sustainable agriculture meets the criteria stated in a recent BIFAD report: "to contribute to sustainable agriculture a program must meet evolving human needs for food, fiber, and forest products and provide for a better life without damaging the natural resource base on which continuing productivity depends." (Task Force Report. Environment and Natural Resources: Strategies for Sustainable Agriculture. Agency for International Development. February 1988. p.7.)

- Peanut seed provides a readily consumable source of protein and energy for human food and animal feed. Also peanut forage is a high quality animal feed.

- Peanut and peanut products provide expandable capital for small resource farmer and aids in the sustainability through capital for farm implements, fertilizer, and labor.
- Peanut contributes significantly to meet the requirements of world vegetable oil needs.
- As a legume, peanut fixes nitrogen for its own use and leaves a positive N balance in the soil for other crops.
- Short-season peanut cultivars fit into various cropping systems of semiarid tropical environments; mono-crop, intercropping with grain crops, and late planting in case of stand loss or low stands of the primary food crop, and under-story planting in tree crops.
- Peanut has inherent drought tolerance and also escapes drought due to its relatively short production season.
- The near closed canopy of the peanut crop protects soil from erosion during heavy rains.
- Late rainy season planting with maturity into the dry season in certain areas, such as post-rice planting in Southeast Asia, utilizes available moisture for food and feed production and extends soil cover to prevent wind erosion.
- Intercropped peanut with grain crops suppresses weeds, thereby reduces labor-intensive weeding activities and converts production to a valuable crop.

Factors or problems have been identified that cause these constraints to peanut in sustainable agriculture and are being addressed in three major world regions, West (Semi-Arid Tropical) Africa, Southeast Asia, and the Caribbean.

## **WEST AFRICA**

### **Rationale**

The Peanut CRSP is concentrating its Africa program on the Sahelian Region of West Africa. The region has severe constraints to crop production dominated by a short rainy season that is broken by intermittent periods of drought. The drought problems are compounded by disease and insect pressures, mold and aflatoxin contamination. These constraints and problems make sustainable production difficult, which creates problems in maintaining a sustainable and adequate supply of food for a growing population.

Constraints to production and food delivery in West Africa that have been determined to be researchable under the collaborative mode of the Peanut CRSP are:

- Low yields because cultivars are not adapted to the short rainy seasons and the cultivars lack resistance to diseases, insects, and droughts.
- Yield losses due to infestation of weeds, insects, diseases, and nematodes .
- Mycotoxin hazards to health due to fungal invasion of the peanut.
- Inadequate food supplies and lack of appropriate food technologies to exploit a relatively well adapted peanut crop that is not generally considered a primary source of food.
- Resource management (agronomic, economic, and sociological situations preventing efficient production and utilization.

## Research

The Peanut CRSP is addressing these constraints through research resources directly available to the Peanut CRSP and through coordination with other programs, particularly ISC and IRHO. Improved technologies such as new cultivars, IPM practices, and acceptable food products, will be introduced into in-country programs to determine their adaptability into feasible Resource Management Systems.

The constraints are similar in the different countries across the Sahelian Region of West Africa, which increases the impact of research developed in the host countries and through the infusion of new technologies into the linkage countries. There are five Peanut CRSP projects operative in West Africa designed to help solve these constraints.

Project: Peanut Cultivar Improvement for Semi-Arid West Africa, Texas A & M University, University of Ouagadougou, Burkina Faso; Institute of Economic Research, Mali; National Institute of Agronomic Research, Niger; and Senegalese Institute for Agronomic Research, Senegal (Code: TX/BCP/B, M, N, S).

The ultimate solution to many of the environmentally related biotic and abiotic stresses to production is resistant cultivars; therefore, strong emphasis is given to cultivar improvement as a medium- and long-term solution to the constraints.

Presently available cultivars in West Africa produce low and unstable yields because of lack of general adaptation to the environment; susceptibility to leafspot, rust, rosette virus, Aspergillus flavus (aflatoxin), and soil-borne fungal pathogens; susceptibility to foliage and soil insects that damage leaves, stems, pods, and roots, and provide entry points for Aspergillus flavus and subsequent aflatoxin production; too late season to mature before the rains end, limiting their fit into cropping patterns; and do not have enough inherent drought tolerance to perform adequately during intermittent droughts prevalent during the growing season.

The research goals of the breeding project are to develop peanut cultivars and identify breeding lines adapted to important ecological areas of Sahelian West Africa that are resistant to pathogens, such as leafspot, rust, rosette, and aflatoxin, and to insects that cause economic loss, and that have sufficient drought tolerance to efficiently utilize the scarce supply of water. These desirable traits must be incorporated into short season cultivars that can be planted and harvested in seasons 90 days or less in duration from the first to last rain.

**Project:** IPM Strategies for Peanut Insects in SAT Africa, University of Georgia and University of Ouagadougou, Burkina Faso (Code: GA/IM/BF).

Insects classed as arthropods including termites, millipedes, aphids, jassids, and thrips cause an often unquantified economic damage to peanut. Chemical control of these pests is expensive and has potential for detrimental effects on the environment. Aphids are the vectors for virus diseases such as rosette, and termite damage to pods allows easier entry of Aspergillus flavus which produces aflatoxin in peanut. Improved integrated pest management (IPM) strategies are not available to solve these problems which include cultivar resistance to pests, cultural control measures such as timely seeding and harvest, and use of naturally occurring pesticides.

Research goals of this project are to develop technology that will reduce losses due to arthropod damage, reduce virus diseases transmitted by arthropods, and reduce invasion of Aspergillus flavus into damaged pods and subsequent aflatoxin production through the development of resistant cultivars and IPM procedures applicable to West Africa.

**Project:** Peanut Viruses: Etiology, Epidemiology and Nature of Resistance, University of Georgia; Institute of Agricultural Research, Ahmadu Beilo University, Nigeria (Code: GA/PV/N, TP).

Peanut rosette virus frequently occurs in epidemic proportions

in West Africa in areas of slightly higher rainfall (northern Nigeria, southern Niger, southwestern Burkina Faso). The Peanut CRSP project in Nigeria has developed detection methods, identified resistant lines, and initiated the increase of resistant lines for distribution to growers. The major problem confronting the growers is the unavailability of resistant cultivars with early maturity and drought tolerance (present resistance is in medium maturity cultivars).

Research goals are to support the Peanut CRSP trained peanut breeder in Nigeria who also has rosette virus training in the development of short season, drought tolerant, rosette virus resistant cultivars. The breeding effort will be coordinated with ISC and the Peanut CRSP West Africa breeding project (TX/BCP). In addition, support will be provided to the TX/BCP rosette resistance breeding effort in Senegal, Burkina Faso, and Niger (particularly Burkina Faso) and to the peanut insect management project (GA/IM/BF) in screening lines for rosette resistance.

**Project:** Mycotoxin Management in Peanut by Prevention of Contamination and Monitoring, Texas A&M University; Senegalese Institute for Agricultural Research and Institute of Food Technology, Senegal (Code: TX/MM/S).

Mycotoxin, especially aflatoxin, contamination of peanut poses a serious health hazard to consumers of peanut products throughout the world, despite the research and control efforts that have been made since the discovery of aflatoxin in 1961. Aflatoxin contamination often occurs due to the invasion of Aspergillus flavus during the production season, prior to harvest. A major problem facing researchers is how to prevent preharvest contamination.

In addition to preharvest contamination, peanut can be invaded by Aspergillus flavus after harvest because of poor harvesting, drying, and storage practices that favor fungal growth. Also, fungi present at harvest can multiply under favorable post-harvest conditions. Most countries where monitoring programs exist remove peanut from the food chain that have 20 ppb or higher aflatoxin levels. Unfortunately, people in many developing countries often consume excessive aflatoxin either unknowingly or unadvisedly.

Research goals are to develop and apply techniques which reduce the severity of the mycotoxin problems. Prevention will be through the development of aflatoxin resistant cultivars and improved management practices to reduce the levels of preharvest contamination. Improved detection and diversion procedures, and cleanup and detoxification procedures will be developed to reduce aflatoxin to acceptable levels. Expanded efforts will be made to determine the applicability of sorbents

such as "high-affinity" clays to bind and render ineffective aflatoxin in peanut products consumed by animals and man. These experiments must consider any harmful effects the sorbents may have on health.

**Project:** An Interdisciplinary Approach to Optimum Food Utility in SAT Africa (Semi-Arid Tropical) Africa, Alabama A&M University; University of Ouagadougou, Burkina Faso (Code: AAM/FT/BF).

Protein and calorie intake in Sahelian West Africa is often marginal or below recognized minimum levels. Meat consumption is generally low with protein coming from plant sources. Peanut is a well adapted grain legume for the region and is a good protein and energy source. Much of the direct consumption is in confectionery type products, such as roasted peanut. Peanut oil is also an important product. If the value of peanut as a food source is to be realized, it must become a regular part of the diet.

Aflatoxin is a concern of the food technologists. Cooperation with the breeding, aflatoxin, and insect management projects will provide for aflatoxin analyses and development of methods to remove contaminated peanut during processing. Aflatoxin buildup in storage is another concern.

Research goals are to optimize the food utility of peanut through promoting the role of peanut as food items in diets, improvement of existing food products (especially fortification of cereal based foods with peanut), and the development of new peanut food products. There will be cooperation with the breeders in quality analyses of breeding lines to insure that new cultivars will be acceptable both as food and agronomically. Research will also determine levels of aflatoxin in peanut and peanut products and seek ways to minimize the levels. The cooperation will exist with breeders, entomologists, and the mycotoxin researchers in developing better aflatoxin control through breeding, management, and decontamination.

### **Resource Management**

The Peanut CRSP has adopted the model used by ICRISAT for Resource Management, which includes agronomy (soil fertility, cultural practices such as seed rate or row spacing, agroclimatology, farming systems, entomology and pathology), agricultural engineering, and socioeconomics. The Peanut CRSP will also integrate aflatoxin and food technology efforts into the agronomic system.

New or improved technologies that have promise for general transfer to beneficiaries should first be evaluated in Resource

Management context. The research in West Africa will be primarily in agronomy and socioeconomics.

The Resource Management thrust is in its early stages of development and is presently perceived as follows.

**Agronomy:** Technology that has an agronomic or biological nature will be evaluated in the resource management context. The thrust is presently perceived with three components.

- Intra-Peanut CRSP research activities including breeding and food technology; breeding and mycotoxin, insect management and virus, and breeding and insect management.
- Cooperative efforts with other in-country, regional, or international programs; and
- Inter-CRSP activities involving multidisciplinary research (i.e. crop science, soil science, animal science and food technology).

A component in the optimum level budget will earmark funds for this purpose. Additionally, some activities will be funded through normal research funds in various Peanut CRSP projects. The leadership structure for this thrust has not been decided. Description of activities presently being planned follow.

**Intra-Peanut CRSP Activities:** The Peanut CRSP breeding and food technology projects in West Africa and Southeast Asia are cooperating to determine the quality of promising peanut lines that will assure consumer acceptability of new cultivars.

The Peanut CRSP breeding, mycotoxin, insect management, and virus projects are cooperating to develop pest resistant cultivars and integrated pest management systems.

**Cooperative activities:** The ICRISAT Sahelian Center (ISC) has a contract with USAID/Mali to conduct a large scale resource management research project. The Peanut CRSP will seek to cooperate with the project to input and evaluate new CRSP peanut lines, integrated pest management practices, and other technology in a Resource Management System. There is some indication that this project could become a Multi-CRSP and ISC effort when renewed in 1991 (Peanut, Sorghum-Millet, and Tropsoils are all present in Mali). A bilateral project could access the CRSPs through the Basic Ordering Agreement.

The Peanut CRSP and the ICRISAT Sahelian Center (ISC) have tentative plans for a Regional Germplasm Testing program to begin in 1990 (seed increase) and extend into about 12 West African countries in 1991. We will cooperatively plan, support and implement the program to test improved cultivar

and selected management production practices in the cooperating countries.

Inter-CRSP activities: A number of inter-CRSP activities are planned.

Burkina Faso. Peanut CRSP and Tropsoil scientists at Texas A&M University and scientists at the University of Ouagadougou will team up to survey the major peanut soils in Burkina Faso and relate these to the soils on which research is conducted. Results should help transfer production technology to the farmer. Financial support will be provided by the Peanut CRSP through the TX/BCP/WA project.

Burkina Faso, Mali, Nigeria. A cooperative effort is being planned with the Peanut CRSP, the Bean and Cowpea CRSP, and the Sorghum and Millet CRSP to develop systems to better utilize food resources in Burkina Faso, Mali, and Nigeria. The project will involve collaborators in these three countries and at Alabama A&M University, The University of Georgia, and Texas A&M University. Enhancement of utilization of the two grains and two grain legumes will be sought by proper blending, processing, and preparation. Funds to support the Peanut CRSP portion of this effort are included in the optimum level budget.

Socioeconomics: New technology must not only be acceptable agronomically or biologically, but must also be sound socioeconomically. The structure of this program is still being planned, but it may be led by a working group of social scientists, economists, and food scientists from the present participating U.S. universities with host country collaboration. Four components of the program are now perceived:

- The social implications of new technologies would be evaluated, such as changing labor requirements and influence on women's role when adopting a technology.
- The economic benefits of new technologies would be studied, such as the increased income derived from a higher yielding cultivar or the decrease in inputs required by adoption of a new pest management practice.
- The food technology projects have outlined protocols for surveys to be conducted to determine the need and acceptability of new or improved food products, and to determine the socioeconomic acceptability of a newly introduced product.
- Problems exist in market development and government policies that affect peanut will be studied.

A component in the optimum level budget will earmark funds for this thrust. Also, some activities will be supported through normal research funds in various Peanut CRSP projects. Description of activities presently being planned or considered follow.

**Food technology surveys:** Technologies to improve traditional peanut products and to develop new products are in various stages of completion. Considerable time and effort have been devoted to conducting surveys to determine utilization and consumption patterns of peanut and peanut products to direct research in product improvement and development. Still specific improved and new peanut products need to be evaluated with regard to their socioeconomic impact and consumer acceptability in the marketplace.

**Market and policy considerations:** There are two basic types of economic systems within which the ag-food sector is a component, i.e., the near "Subsistence System" and the "Commercial Market System." There is a shift from the subsistence to the commercial market system as a country develops. A primary goal of the Peanut CRSP is to improve the food supply and economic well-being of its beneficiaries. This component provides capability in the Peanut CRSP to determine the influence of markets, market types, and government policies on the adoption of new technologies.

### **International Cooperation**

Research planning and implementation in West Africa has and will continue to be coordinated with other key international groups for maximum efficiency in utilization of research resources.

**ICRISAT Sahelian Center (ISC):** ISC and the Peanut CRSP have some special areas of complementarity in addition to planning. ISC is regional and cooperative research efforts with ISC assist the Peanut CRSP in its regional impacts with minimum outlay of resources, for example, a cooperative cultivar and advanced line testing program is planned with 12 countries. ISC would coordinate the program with ISC and CRSP germplasm and CRSP funds to supplement the country research efforts. The Peanut CRSP has a major entomology effort, while ISC has minimal effort. Also, the Peanut CRSP provides the regional leadership in food technology in the absence of an ISC food technology program. The Peanut CRSP is a donor with links to country programs and can serve as a conduit for input of selected ISC technology.

**IRHO:** The French Oilseeds Research Institute has long supported peanut research in West Africa. The Peanut CRSP and

IRHO work closely together in Senegal. The Peanut CRSP breeding collaboration in Senegal is an IHRO staff member, along with another cooperating breeder and a plant physiologist who is our collaborator in drought physiology. This collaboration has been fruitful and effective. An IRHO scientist (Pathologist) closely communicates with the CRSP program in Burkina Faso.

**CORAF:** This French supported agronomic research group is new but will support peanut research in West Africa. The Peanut CRSP will seek close collaboration with CORAF to avoid unnecessary duplication (see later network discussion for further details).

The collaboration with these international groups will be important in research efforts.

## SOUTHEAST ASIA

### Rationale

The Peanut CRSP in Asia is concentrating its efforts on Southeast Asia. The region has constraints that are dominated by a need to optimize production through growing more than one crop per year on the same land area. A cropping system may have peanut following rice to utilize residual moisture or limited rainfall during the dryer season. The region is also characterized by intermittent droughts during the rainy season, understory cropping (such as peanut under coconut), and soils with acid and saline problems. The high population in the region demands optimum production per unit area through multicropping strategies.

Constraints to production and utilization that have been determined to be researchable under the collaborative mode of the Peanut CRSP are:

- Low yields because cultivars are not adapted to cropping systems that include peanut as a primary crop or a second crop following rice or in shade under trees, lack of resistance to disease, insects, drought, acid soils, and saline soils.
- Yield losses due to infestation of weeds, insects, diseases, and nematodes.
- Mycotoxin hazards to health due to fungal invasion of peanut.
- Inadequate food supplies and lack of appropriate food technologies to exploit a relatively well adapted peanut crop that is not generally considered a primary food source.

- Resource management (agronomic, economic, and sociological) situations preventing efficient production and utilization.

## Research

The Peanut CRSP is addressing these constraints through resources directly available to the Peanut CRSP and through coordination with other programs, especially ICRISAT, IDRC, and ACIAR. Improved technologies such as new cultivars, IPM practices, and acceptable food products, will be introduced into in-country programs to determine their adaptability into feasible Resource Management Systems.

Constraints are similar in many countries of Southeast Asia. Research collaboration is with Thailand and the Philippines with linkage into Indonesia and Malaysia through our cooperation with ACIAR. There are four Peanut CRSP projects operative in Southeast Asia designed to help solve these constraints.

**Project:** Peanut Cultivar Improvement for Thailand and the Philippines; North Carolina State University; Department of Agriculture, Kasetsart University, and Khon Kaen University, Thailand; and the University of the Philippines at Los Banos, Philippines (Code: NCS/BCP/TP).

Again, strong emphasis is given to the breeding program since cultivar improvement is the medium- to long-term solution to biotic and abiotic stresses to production.

Presently available cultivars in Southeast Asia produce low yields because of general unadaptability, lack of adaptability as second season crops and under shade, and a lack of resistance to diseases, insects, acid soils, and saline soils. Susceptibility to aflatoxin production by Aspergillus flavus also presents a quality problem, as well as does the lack of tolerance to intermittent drought periods. Emphasis in cultivar development is necessary to meet end-use requirements such as boiling-type peanuts for the Thailand market.

Research goals are to develop peanut cultivars and identify lines with increased yield potential and desired quality adapted to Southeast Asia while decreasing the dependency on chemical inputs. These cultivars and lines will have resistance to pathogens and insects causing economic loss, tolerance to shade and adverse soil problems, and tolerance to drought.

**Project:** Management of Arthropods on Peanut in Southeast Asia; North Carolina State University; Department of Agriculture and Khon Kaen University, Thailand; and the University of the Philippines at Los Banos, Philippines (code: NCS/IM/TP).

Progress has been made to determine economic losses in the host countries due to insects and to effect control through improved IPM strategies. Insect control is still too chemically dependent in the context of an environmentally sound, sustainable system. The IPM program must be refined to bring in cultivar resistance, improve biological control, and alter management practices.

Research goals are to identify increased levels of genetic resistance to insects in peanut germplasm and work with breeders in the NCS/BCP/TP project to incorporate the resistance into adapted cultivars. Increased effort will be made on developing biological controls, including parasitical, microbial, and botanical pesticides. These measures will be incorporated into existing IPM strategies to increase control of insects with the goal of eliminating chemical inputs.

**Project:** Peanut Viruses: Etiology, Epidemiology, and Nature of Resistance; The University of Georgia; Khon Kaen University, Thailand; and the University of the Philippines at Los Banos, Philippines (Code: GA/PV/N/TP).

Preliminary surveys in Southeast Asia have identified peanut stripe virus (PStV) as a major disease of peanut. Symptoms are much more severe than those observed in the United States. Another virus of increasing importance in Southeast Asia, especially Thailand, is the tomato spotted wilt virus (TSWV). TSMV is of particular concern because of its wide range of host plants. Potential yield losses are great due to the incidence of PStV and TSWV.

Research goals are to continue to determine the extent of PStV and TSWV in Southeast Asia. A second goal will be to establish the level of yield loss from these two viruses. Control measures will be developed if necessary. Peanut germplasm will be screened in cooperation with breeders and entomologists (NCS/BCP/TP and NCS/IM/TP) for PStV and TSWV resistance, along with development of cultural control measures. Resistance to PStV and TSWV infection in cultivated peanut species has not been found at this point.

**Project:** Appropriate Technology for Storage/Utilization of Peanut; The University of Georgia; Kasetsart University, Thailand; and the University of the Philippines at Los Banos, Philippines (Code: GA/FT/TP).

Although the intake of protein and calories in Southeast Asia is often marginal or low, peanut is normally used as a snack or confectionery item and not as a major food source. In order for peanut to become a major food item, its value must be recognized by the consumer and a sufficient array of food products must be made available to attract the consumer and

promote the food utility of peanut.

The aflatoxin problems are similar to those described for West Africa. The post-harvest buildup of aflatoxin in Southeast Asia can be severe because peanut produced during the rainy season is often harvested before the rains stop; hence, drying of the crop is slow, promoting growth of Aspergillus flavus. Much of the peanut produced and consumed has aflatoxin at higher than acceptable levels.

Research goals are to develop and adapt new technologies and processes to utilize peanut and peanut products in traditional and new food products. The choice of such products will be based largely on socioeconomic studies and consumer demand surveys. Methods to reduce or remove aflatoxin from peanut use biological, physical and/or chemical technologies. Work will be done to optimize previously tested chemical methods for aflatoxin removal, such as ammonia and sodium bi-sulfite. Peanut CRSP research has shown that a bacterium, Flavobacterium aurantiacum, removed up to 74% of the aflatoxin in partially defatted peanut milk within a 24-hour period. The process will be further optimized.

There will be close cooperation with the breeding project (NCS/BCP/TP) to determine quality and acceptability of new peanut lines or cultivars. Cooperation with the entomology project (NCS/IM/TP) will help solve storage insect problems. Some of these activities will extend into the Resource Management area.

### **Resource Management**

The concept of Resource Management in the Peanut CRSP was discussed under West Africa.

The Resource Management thrust, as presently conceived, has components for Southeast Asia as follows.

**Agronomy:** Technology that has an agronomic or biological nature will be evaluated in the Resource Management context.

**Intra-CRSP Activities:** The Peanut CRSP food technology and breeding projects in Southeast Asia are cooperating to determine the quality of promising peanut lines that will assure consumer acceptability of new cultivars. Technologies developed in production and technology in Southeast Asia will be evaluated for applicability in West Africa through formal and informal exchanges of information.

The Peanut CRSP breeding, insect management, and virus projects are cooperating to develop pest resistant cultivars and IPM systems.

**Cooperative Activities:** The Peanut CRSP and ICRISAT cooperate in planning and to share germplasm during cultivar development and selection for disease and insect resistance.

**Inter-CRSP Activities:** The Peanut CRSP will cooperate with a Thai soils researcher and a Tropsoils cooperator at North Carolina State University to survey the soils where peanut is grown and relate this to soils on which research is conducted to facilitate the transfer of technology.

**Rice-Based Systems:** A proposal has been prepared to develop farmer-acceptable management practices for utilizing peanuts in the rice-based cropping system with the goal of increasing efficient uses of resources to maximize food production and income.

**Socioeconomics:** Technology that has a socioeconomic nature will be evaluated in the Resource Management context.

**Socioeconomic Impact of Cropping Systems:** The socioeconomic impact of peanut in current cropping systems will be studied in Thailand and the Philippines to understand the impact of released peanut cultivars on the social, cultural, and economic systems. Research will monitor practices from planting to marketing. A project proposal has been developed that will be cooperative between North Carolina State University and Khon Kaen University in Thailand and funded through NCS/BCP/TP.

**Food Technology Surveys:** Technologies to improve traditional peanut products and to develop new products are in various stages of completion. Considerable time and effort have been devoted to conducting surveys to determine utilization and consumption patterns of peanut and peanut products to direct research in product improvement and development. Still, specific improved and new peanut products need to be evaluated with regard to their socioeconomic impact and consumer acceptability in the marketplace. The research will be conducted in Thailand and the Philippines through the GA/FT/TP project.

**Market and Policy Considerations:** The rationale for this research was discussed under the West Africa section. The Peanut CRSP will determine the influence of markets, market types, and government policies on the adoption of new technologies as problems are defined and projects are developed.

## CARIBBEAN

### Rationale

The Peanut CRSP has had a program in the Caribbean since its inception. Initially, the research was with the introduction and testing of superior germplasm, which resulted in the release of a new cultivar now under farmer increase for wider distribution. The project evolved into an agronomic-physiology program, then on recommendation of the project leader and with the concurrence of the EEP based on the perceived needs, it was changed to the present post-harvest project.

The peanut crop is small in area compared to the target regions of West Africa and Southeast Asia, but is characterized by small farmers with their inherent problems.

A major constraint to production and utilization in the Caribbean is:

- Food supplies inadequate and lack of appropriate food technologies to exploit a relatively well adapted peanut crop that is not generally considered a primary food source.

The analysis that led to the change of the Caribbean program to post-harvest concerns concluded that high labor costs in post-harvest (threshing, shelling) operations overshadowed constraints to production. The high post-harvest labor costs (some 60% of the total production costs) made production unprofitable to farmers with the existing market prices for peanut.

**Project:** Post-harvest Handling Systems for the Small Peanut Producer; The University of Georgia; and Jamaica, Trinidad, Belize, St. Vincent and Antigua through the Caribbean Agricultural Research and Development Institute (Code: GA/PH/CAR).

The price of locally produced peanuts are high primarily due to the high post-harvest labor costs leading to limited use of peanut, even though they are highly acceptable to the consumer. There would be more production, higher farm incomes, and greater availability of peanut to the consumer with lower production costs.

The goal of the research is to identify and adapt appropriate technology for mechanization of post-harvest operations and to evaluate these on a systems approach to determine their socioeconomic acceptability. An integrated system of harvest, threshing, shelling, drying, handling, and transporting will be designed to increase the availability of low cost, high quality, and nutritious peanut to the processor and consumer. A primary concern in the quality aspect will be the evaluation

of the extent of control of aflatoxin through proper post-harvest handling techniques. There will be cooperation with the Alabama A & M food technology project in the employment of the post-doctoral food scientist proposed in the optimal budget for the University of the West Indies, Trinidad.

#### **ALL REGIONS**

There are three constraints that are global in nature and extend to all the regions, namely:

- Inadequate numbers of trained scientists and support personnel
- Lack of adequate equipment to conduct research
- Information not available to beneficiaries for support of production and utilization activities.

#### **Constraint: Training**

The Peanut CRSP has recognized training to be of paramount importance and has integrated both long-term degree training and short-term, non-degree training into the research program. Research and training are inseparable. The EEP in the 1989 evaluation stated: "Training of young agricultural scientists as the stockpiling of Human capital will probably be the longest lasting, most effective accomplishment of the Peanut CRSP."

Host country trainees are selected in collaboration with administrators and researchers to ensure that the right people are selected for training and that they are trained in disciplines most needed in the country or in the region. Selected non-host country trainees expand the impact of the Peanut CRSP regionally and globally.

United States graduate students are trained with CRSP support and with multiple goals: maintaining a volume of research above that the principal investigators can handle, providing advanced degrees to students with an introduction to the problems and challenges facing international agriculture.

A plan is being considered for an indepth evaluation of training needs for peanut scientists on a country and possibly regional basis as recommended by the Administrative Review Team. The International Service for National Agricultural Research (ISNAR) will be requested to assist in this effort.

#### **Constraint: Equipment**

During the first eight years of the Peanut CRSP, key research

equipment has been provided to collaborators. The need for equipment is less for the proposed 5-year extension and only very essential equipment will be provided, with the recognition that proper equipment is necessary to conduct good research.

**Constraint: Information not available**

An expanded thrust in Communications and Outreach will be a feature of the optimum budget programs of the Peanut CRSP in response to the constraint of information on production and utilization not being available to the beneficiaries. The Peanut CRSP has matured to the point of having produced many new or improved technologies that should be valuable to the beneficiaries. We will continue to encourage publication of results in recognized outlets while increasing capability to communicate results to policy makers and extension workers. Support of participation in workshops, networks, and pilot programs to stimulate technology transfer will continue. Cooperation with ICRISAT in the publication of International Arachis Newsletter will continue. With increased funds, the Peanut CRSP will:

- Expand capability by addition of a Communications Specialist to produce publications, brochures, leaflets, videos, and slides that will communicate Peanut CRSP results to a variety of audiences, including decision makers in funding agencies, state and national legislative bodies, extension workers, and the research beneficiaries in the U.S. and host-countries.
- Increase the number of workshops to communicate research results and plan future needs in-country, regionally, and internationally.
- Strengthen network relationships with international cooperators. Develop a working relationship with the French CORAF program in Africa.
- Support on-farm and cottage industry Pilot Programs to demonstrate and encourage adoption of new technologies that are of value to the beneficiaries.

**Publications:** Publications are the primary outlet for research results. The optimal level budget will reflect increased support for this effort.

Journal Papers, Bulletins, Miscellaneous Papers, and Abstracts. The Peanut CRSP will continue to encourage the researchers to publish in normal outlets for their discipline. Research presentations in meetings resulting in published proceedings and abstracts will continue to be encouraged. As emphasized by the Administrative Review Team, we will

encourage more senior authorship by host-country scientists. We will continue to encourage the host country scientists to publish in their own in-country and regional publications.

International Arachis Newsletter. The Peanut CRSP and ICRISAT have cooperatively published the International Arachis Newsletter (IAN) since 1987. IAN is published biannually and has worldwide distribution to over 3,000 recipients. Short research articles, research program descriptions, and news items of international interest are accepted. Publication is free to the contributor. ICRISAT and the Peanut CRSP share publications costs equally, and is reflected in the communications and outreach budget.

Special Publications. The Peanut CRSP will strengthen the capability to publish special materials for distribution to funding agencies, legislatures, and linkage or network participants, and extension workers. Also, support will be provided to U.S. and host country researchers in the production of promotional material on research findings. Communication material will include but not be restricted to bulletins, brochures, leaflets, videos, and slide sets. Information will be released to public media services as appropriate.

Workshops. The Peanut CRSP will continue to support in-country, regional, and international Workshops designed to communicate research results, and plan future activities. Some examples follow.

Plans are underway for a Breeding/Entomology Workshop in Southeast Asia in 1990 to emphasize breeding for acid-soil and shade tolerance, and to explore the extent of insect problems in the region and plan research to address the insect problems. Peanut CRSP will sponsor regional workshops in West Africa and Southeast Asia in cooperation with ICRISAT, ISC, IRHO, ACIAR, IDRC, and CORAF.

Peanut CRSP will be a co-sponsor of an International Peanut Workshop to be held in 1991. ICRISAT will be the coordinator of the Workshop.

Networks. The Peanut CRSP has been actively involved in networks to better plan research, conduct research, and disseminate research results.

Peanut CRSP and ICRISAT (International Crops Research ~~Instt~~ Semi-Arid Tropics).

The Peanut CRSP and ICRISAT have coordinated their programs since the inception of the CRSP and will continue to do so. The ICRISAT peanut (groundnut) program began in 1976. CRSP

planning activities began in 1980 with research implementation in 1982. Key peanut researchers around the world had professional interaction prior to 1976 which provided the embryo for a network enhanced by present CRSP, ICRISAT, and host-country programs involving many of the same individuals.

Dr. Ron Gibbons, a member of the Peanut CRSP Planning Grant Advisory Panel and a member of the CRSP Board of Directors since 1982, has been invaluable in helping maintain proper global focus to the CRSP. In his present position as Director of the ICRISAT Sahelian Center (ISC) in Niamey, Niger, Dr. Gibbons will continue on the Board and provide special insights to the CRSP West Africa program.

Strength through diversity provides a commonality between the CRSP and ICRISAT. ICRISAT goals and objectives are based on broad, regional or zonal constraints with minimal donor type resources to support national programs. The CRSP, although global or zonal in nature, is based on linkages with and direct donor type support to national programs. In addition to CRSP developed technology, the CRSP serves as a conduit for ICRISAT generated technology, resulting in a synergistic effect of the network.

The Peanut CRSP supports host-country researchers in appropriate ICRISAT training programs. Joint workshops and seminars have been held on such subjects as rosette virus, aflatoxins, and comprehensive regional meetings of groundnut workers.

We cooperate to publish the International Arachis Newsletter, which is accessible to scientists worldwide for communicating research results.

The CRSP and ICRISAT are directly complementary in research programs. For example, in West Africa the CRSP has a comprehensive program in entomology, while ISC has only ten percent of the time of one entomologist on peanut.

A Germplasm Evaluation Network involving some 12 West African countries is being planned by the Peanut CRSP and ISC.

Peanut CRSP and IRHO (Institut de Recherches pour les Huiles et Oleagineux).

The French support peanut research in West Africa through IRHO (or Institute for Oilseeds Research). Dr. Pierre Gillier, former IRHO Director, was a member of the External Evaluation Panel and earlier a member of the Peanut CRSP Planning Grant Advisory Panel.

IRHO staffs three scientists in Senegal that also receive CRSP support in a cooperative effort to enhance the Senegal research program. Cooperation exists with an IRHO scientist in Burkina Faso.

Frequent contact is made with IRHO staff in Paris by U.S. collaborators traveling to West Africa.

IRHO publishes the journal Oleagineux, the French language journal for peanut, and the primary journal for reporting peanut research results in West Africa.

#### Peanut CRSP and CARDI (Caribbean Agricultural Research and Development Institute).

CRSP and CARDI interaction began with the Planning Grant, 1980-1982 when Dr. St. Clair Forde, Director of Research was a member of the Advisory Panel. A Caribbean research program was developed in the CRSP. Primary collaboration was through a linkage with CARDI. The CARDI network of some 13 English speaking countries has fostered research and dissemination of information in the Region.

#### Rosette Virus

An informal network of interested researchers in peanut virus research has greatly facilitated CRSP research in this area. The CRSP has been instrumental in linking research on rosette virus with CRSP researchers at the University of Georgia and Ahmadu Bello University in Nigeria, ICRISAT researchers in India and Malawi, Scottish Crops Research Institute, and the West German Virus Institute.

The collaboration in Scotland and Germany has been especially beneficial in that these countries do not produce peanuts, and researchers can take plant samples containing live virus to the laboratories for detailed analyses.

#### Aflatoxin Network

Aflatoxin research has been fostered through informal networks involving CRSP, ICRISAT and host-country scientists. Consultative groups have met to discuss and plan research. An ICRISAT scientist spent a sabbatical in Senegal working on mutual problems with mutual collaborators.

#### Peanut CRSP - IDRC (International Development Research Centre-Canada).

The Peanut CRSP and IDRC have jointly supported peanut research in Thailand for several years. The Thai program is an inte-grated effort involving the Department of Agriculture

(DOA), Kasetsart University (KU) and Khon Kaen University (KKU). The CRSP has supported DOA, KU, and KKU. IDRC supports mainly KU and KKU. A coordinated, efficient, and productive program has developed.

Peanut CRSP - ACIAR (Australian Centre for International Agricultural Research).

A linkage between ACIAR has developed during the past year relative to the peanut stripe virus program. The CRSP is developing a new initiative in Thailand and the Philippines, while ACIAR supports a program in Indonesia. Planning meetings have involved the five groups.

Recent discussions at the Regional Groundnut Scientists Meeting held in November 1988 in Malang, Indonesia should lead to cooperation between the CRSP, ACIAR, Philippines, and Indonesia. The CRSP breeding program in the Philippines is developing acid tolerant peanut lines that should be used in the acid soil program supported by ACIAR in Indonesia and Malaysia.

Peanut CRSP - CORAF (Conference des Responsables Africains et Francais de la Recherche Agronomique).

CORAF is a recently organized group to coordinate French and African cooperative research on peanut, maize, rice and manioc. Common countries and researchers will necessitate close coordination between the Peanut CRSP and CORAF. The Peanut CRSP principal investigator for the mycotoxin project in Senegal is the African coordinator for CORAF. We will seek a formal agreement for cooperation with CORAF.

Peanut CRSP - ISNAR (International Service for National Agricultural Research).

ISNAR is an IARC devoted to strengthening the management of national research systems. Cooperation with ISNAR will be sought in determining training needs for peanut scientists nationally and regionally. The ME Program Ddirector has visited ISNAR to establish areas of mutual interest.

Pilot Programs.

The Peanut CRSP will continue its involvement in Pilot or demonstration programs. The goal of these programs is to foster transfer of technology to the beneficiaries. Although there may be some overlap with the adaptation programs discussed earlier in section 8.1 Resource Management Systems, the Pilot Programs will usually be conducted in cooperation with an end-user of the technology (on-farm, cottage industry food processor, etc.) whereas the Resource Management Systems

efforts will generally remain at the station or research level. Examples of activities follow; others will develop as appropriate. CRSP financial support would normally come from individual project funds or from host institutions.

**Philippines.** A recently released peanut cultivar and integrated pest management practices developed through support of the Peanut CRSP are presently being evaluated in an on-farm Pilot Production Program in Quirno Province in Northeast Luzon. Quirno is the major peanut producing province of the Philippines. This activity should stimulate farmer adoption of the results. A major goal of the effort is on-farm multiplication of the seed of the new cultivar. Funds for this cooperative effort are provided by the Philippine Government.

**Philippines.** The Peanut CRSP food technology project (GA/FT/TP) developed a peanut based cheese flavor spread, with peanut paste substituting for the milk product base. Preliminary acceptability tests were very favorable in the Philippines. A large scale pilot project is beginning which will continue into the extension phase to cooperate with private industry to produce and test market the product to determine the socioeconomic feasibility of the product.

**Thailand.** The Peanut CRSP food technology project (GA/FT/TP) developed a peanut flour-enriched noodle that has in preliminary tests shown acceptance in Thailand. A larger scale pilot project will be conducted in cooperation with a noodle processor to further evaluate the socioeconomic feasibility of the product. The project will continue into the extension phase of the CRSP.

**Caribbean.** The Extension Service in St. Elizabeth's Province in Jamaica, which produces 95% of Jamaica's peanut crop, has a major effort underway to promote the seed multiplication and production of the new CRSP developed cultivar CARDI-Payne. Better production, harvest, handling, and storage practices are being promoted. The GA/PH/CAR project is cooperating in the postharvest component. Support for the program is from CARDI-Jamaica, the Jamaican Ministry of Agriculture, and Peanut CRSP.

**Burkina Faso.** The Peanut CRSP breeding and entomology projects have improved cultivars and pest management practices that will be evaluated on-farm in cooperation with the national research and extension program.

**Burkina Faso.** The Peanut CRSP food technology project will cooperate with the extension nutrition program to evaluate peanut flour enriched foods through targeted villages or school lunch programs.

Senegal. Village level pilots will evaluate the feasibility of removal of aflatoxin from crude peanut oil with the use of absorptive clays.

#### "BUY-INS" FOR PROGRAM SUPPORT

The Peanut CRSP has not had any "buy-ins" under the Basic Ordering Agreement. However, there has been a significant amount of "leverage" funding that has enhanced overall research efforts. Notable examples follow.

IDRC and the Peanut CRSP have supported peanut research in Thailand since inception of the CRSP. Both groups were contemplating supporting Thai research. The Thai counterparts convened meetings to determine the research support needs and how these potentially available resources could be used efficiently. A proposal was developed to divide the resources among three institutions, Kasetsart University, Khon Kaen University, and the Department of Agriculture with responsibilities delineated which was accepted by the Peanut CRSP and IDRC. This "leverage" funding allowed for a much expanded program with commendable results. The mutual funding continued until IDRC funding ended during the past year.

An important outgrowth of the initial planning meeting was a Thailand Coordinated Peanut Research Planning Conference that has been held annually since 1981, which has had great impacts on the quality of the research program. Excellent conference proceedings are published.

IRHO and the Peanut CRSP have cooperated in support of research in Senegal since the inception of the CRSP. The breeding and drought physiology collaborators in Senegal are employed by IRHO; the Peanut CRSP provides support for the conduct of the research. This cooperative arrangement has been successful in enhancement of the Senegal research program.

The Peanut CRSP Food Technology investigators at the University of Georgia also have a grant from USDA-OICD to support research, including a graduate student, to develop food products made from peanut spread and fermented peanuts. The Peanut CRSP has supplemented these funds. Subsequently, the research has produced the cheese flavored spread, highly acceptable to Philippine (and U.S.) consumers in initial tests. Expanded testing and pilot production is now underway in the Philippines.

Graduate training has been heavily supported by leverage funds. Full Peanut CRSP support was provided for 20 of 28 host country students trained in the U.S., 0 of 17 host country students trained in their own country, 3 of 25 non-host country students, and 13 and 36 U.S. students, or a total of 89 students received full CRSP support. The graduate research was on Peanut CRSP

related problems. Leverage funds to support this training was near \$500,000.

## BUDGET

Source of Funds, Table 1.

The Peanut CRSP has received (projected to June 30, 1990) \$12,557,841 from AID. The U.S. universities have provided \$2,939,909 in cost sharing funds, and the host country contributions in direct programs support total U.S. \$1,226,800.

Total A.I.D. support requested in the 5-year extension 1990-1995 is \$18,554,805 at an optimal funding level, \$9,863,250 at current levels plus 5% for inflation compounded annually, and \$8,500,000 at the current level budget.

Expenditure of Funds, Table 2.

Table 9.2 shows total AID funds expended from July 1, 1982 to June 30, 1989 broken down to U.S. program, U.S. indirect costs (IDC), host country program, U.S. university contributions, and Management Entity costs. Expenditures for the life of the grant are: U.S. program, \$4,689,411; U.S. IDC, \$1,329,846; Host Country program, \$2,562,392; U.S. contribution; \$4,249,213, and Management Entity, \$1,644,703 for a total support of \$14,475,565.

Over 35% of total program funds were expended by the host country institutions.

Summary of Proposed Budget, Table 3.

A summary of proposed A.I.D. funds for the 1990-95 extension period is shown expanded for 1990-91 and totals for the following four years at optimal, current plus 5% for inflation compounded annually, and current levels. Sub-totals are shown for global thrusts.

Strengths and weaknesses of each funding level have been discussed in more detail earlier. The optimal budget includes \$956,578 of "new thrust" funds, which are included in the adjacent optimal budget items but are listed separately to show areas of increased emphasis. New thrusts provide specific research within the projects, Resource Management to include Agronomy, Socioeconomic and Inter-CRSP activities, and a strengthened Communications and Outreach Component. The optimal level budget will return to more operational levels support for research in terms of personnel and supplies, provide for critical training, and allow for more adequate travel for collaboration with counterpart scientists.

An analysis of the 1990-91 proposed budget is given by various components in Table 4. Percentages of total budget for components are shown in parentheses. The Global Thrust section reflects total budget, while the other components are program funds not including Management Entity funds. Host Country vs. U.S. program funds are compared excluding U.S. indirect costs.

Proposed Budget by category and discussion of strengths and weaknesses of different budget levels.

Overall, a comparison of the categories shows a substantial increase in support in salaries for research support personnel and for research materials and supplies. Almost twice the support is provided for graduate students and short-term training and travel for researchers to visit host country collaborators. Projected equipment needs are minimal. The large increase in "Other Direct Costs" in the optimal budget reflect the funds requested for Resource Management which have not been allocated into categories. As Resource Management research projects are refined, these funds will be largely assigned to the appropriate project with subsequent allocation by categories. Detailed budgets follow the projects in the Detailed Project Plans for the 1990-1995 document.

Table 5. presents a summary of the three budget levels by category and year.

Table 1. Source of Funds for the Peanut CRSP

Year	USAID	University Cost Share	Host Country Contribution	Total
82/83	900,000	98,011	36,800	1,034,811
83/84	1,500,000	352,811	132,600	1,985,411
84/85	1,979,365	453,334	142,600	2,575,299
85/86	1,659,000	495,496	170,600	2,325,096
86/87	1,414,835	470,857	177,400	2,063,092
87/88	1,700,000	377,980	186,800	2,264,780
88/89	1,700,000	337,936	190,000	2,227,936
89/90	1,704,641*	353,484	190,000	2,248,125
Total	12,557,841	2,939,909	1,226,800	16,724,550

\* Projected from Feb. to June, 1990

Proposed for 1990-95

Optimal Level

(Estimated)

90/91	3,357,953	595,691	250,000	4,203,644
91/92	3,525,849	625,380	260,000	4,411,229
92/93	3,702,143	656,649	270,000	4,628,792
93/94	3,887,250	689,480	280,000	4,856,730
94/95	4,081,605	723,953	290,000	5,095,558
Total	18,554,800	3,291,153	1,350,000	23,870,953

Current Plus 5% Inflation

(Estimated)

90/91	1,785,000	347,778	200,000	2,332,778
91/92	1,874,250	363,617	210,000	2,447,867
92/93	1,967,962	375,926	220,000	2,563,888
93/94	2,066,360	391,847	230,000	2,688,207
94/95	2,169,678	407,940	240,000	2,817,618
Total	9,863,250	1,887,108	1,100,000	12,850,358

Current Level

(Estimated)

90/91	1,700,000	335,140	190,000	2,225,140
91/92	1,700,000	335,477	190,000	2,225,477
92/93	1,700,000	333,070	190,000	2,223,070
93/94	1,700,000	333,390	190,000	2,223,390
94/95	1,700,000	332,870	190,000	2,222,870
Total	8,500,000	1,669,947	970,000	11,119,947

Table 2.

CUMULATIVE EXPENDITURES FOR THE PEANUT CRSP FROM INCEPTION  
(JULY 1, 1982) TO JUNE 30, 1989

	TX/BCP	NCS/BCP	GA/IM	NCS/IM	GA/PV	TX/MM	AAM/FT	GA/FT
U.S. Programs	752,671	646,679	253,949	280,462	329,467	540,321	355,056	232,494
U.S. IDC	238,799	151,878	93,303	69,736	115,694	172,102	88,447	90,598
U.S. Total	991,470	798,557	347,252	350,198	445,161	712,423	443,503	323,092
Host Country	276,287	672,335	110,283	161,437	121,743	183,512	186,330	306,869
AID Total	1,267,757	1,470,892	457,535	511,635	566,904	895,935	629,833	629,961
U.S. Cont.	410,774	1,758,600	240,463	118,607	288,073	256,941	104,774	234,922
TOTAL	1,678,531	3,229,492	697,998	630,242	854,977	1,152,876	734,607	864,883

	GA/PH	GA/INPEP GA/BCP	TX/SM	NCS/SM	AAM/FT
U.S. Programs	83,887	206,075	346,055	390,859	270,536
U.S. IDC	34,521	76,024	105,088	80,541	13,115
U.S. Total	118,408	282,099	452,043	471,400	283,651
Host Country	66,415	131,573	0	253,560	92,048
AID Total	184,823	413,672	452,043	724,960	375,699
U.S. Cont.	33,951	310,223	211,111	202,135	78,639
TOTAL	218,774	723,895	663,154	927,095	454,338

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	Proj. Totals	ME	GRAND TOTAL
U.S. Programs	\$4,689,411	0	\$4,689,411
U.S. IDC	1,329,846	0	1,329,846
U.S. Total	6,019,257	1,644,703	7,663,960
Host Country	2,562,392	0	2,562,392
AID Total	8,581,649	1,644,703	10,226,352
U.S. Cont.	4,249,213	0	4,249,213
TOTAL	\$12,830,862	0	\$14,475,565

**Table 3. Summary of Proposed Budget, 1990/91 and Totals for 5-Years, 1990-1995**

Global Thrust--Project--		Optimal	Current plus Current 5% Inflation	Current	(New Thrusts)
<b>Sustainable Agriculture Research</b>					
Production Systems	TX/BCP	523,773	293,092	278,850	105,498
	NCS/BCP	533,632	297,990	283,800	107,932
	GA/IM	165,350	91,245	86,900	35,000
	NCS/IM	162,840	98,175	93,500	22,590
	GA/PV	138,000	96,600	92,000	---
	TX/MM	133,879	76,230	72,600	24,979
Sub-Total		1,657,474	953,332	907,650	295,999
Food Delivery Systems	TX/MM	133,879	76,230	72,600	24,979
	AAM/FT	245,000	136,169	130,000	50,000
	GA/FT	208,500	145,950	139,000	---
	GA/PH	157,000	131,250	125,000	---
Sub-Total		744,379	489,599	466,600	74,979
Total		\$2,401,853	\$1,442,931	\$1,374,250	\$370,978
<b>Resource Management</b>					
Agronomy	West Africa**	100,000	---	---	100,000
	InterCRSP/FT	40,000	---	---	40,000
	Southeast Asia	100,000	---	---	100,000
	Inter-CRSP	15,000	---	---	100,000
	(2 regions)				
Sub-Total		255,000			255,000
Socio-economics	West Africa	100,000	---	---	100,000
	S.E. Asia	100,000	---	---	100,000
	Inter-CRSP	15,000	---	---	15,000
	(2 regions)				
Sub-Total		215,000			215,000
Comm. & Outreach	All	115,600	59,078	56,265	115,600
Management Entity		370,500	282,991	269,485	----
Total 1990/91		\$3,357,953	\$1,785,000	\$1,700,000	\$956,578
1991/92		3,525,849	1,874,250	1,700,000	
1992/93		3,702,143	1,967,962	1,700,000	
1993/94		3,887,250	2,066,360	1,700,000	
1994/95		4,081,605	2,169,678	1,700,000	
Total, 5-Years		\$18,554,800	\$9,863,250	\$8,500,000	

Table 4. Budget Allocation by Various Components, 1990-91.

<u>Component</u>	<u>Optimal</u>	<u>Current 5%</u>	<u>Current</u>
	<u>By Global Thrust</u>		
Sustainable Agriculture Research			
Production Systems	1,657,474 (49%)	953,032 (53%)	907,650 (53%)
Food Delivery Systems	744,379 (22%)	489,599 (28%)	466,600 (22%)
Resource Management			
Agronomy	255,000 (8%)	---	---
Socioeconomics	215,000 (6%)	---	---
Communications & Outreach	115,600 (4%)	59,078 (3%)	56,265 (3%)
Management Entity	370,250 (11%)	282,991 (16%)	269,485 (11%)
Total	\$3,357,953	\$1,785,000	\$1,700,000
<u>Region</u>	<u>By Region (Program Funds, 9 projects)</u>		
West Africa	1,270,881 (53%)	721,297 (50%)	686,950 (50%)
Southeast Asia	973,972 (40%)	590,415 (41%)	562,300 (41%)
Caribbean	156,250 (7%)	131,250 (9%)	125,000 (9%)
Total	\$2,401,853	\$1,442,962	\$1,374,250
<u>Country</u>	<u>By Country (Program Funds, 9 Projects)</u>		
Burkina Faso	190,332	114,220	110,075
Mali	42,914	11,000	7,535
Niger	15,660	6,115	6,054
Nigeria	10,500	7,350	7,000
Senegal	134,794	61,084	59,068
Philippines	188,848	120,983	116,558
Thailand	224,607	153,047	146,997
Caribbean	126,374	53,025	50,500

Table 4., cont'd

By Host Country vs. U.S. (Program Funds, 9 projects)  
less U.S. indirect costs

Total H.C.	923,529 (46%)	526,824 (44%)	503,787 (44%)
Total U.S.	1,072,106 (54%)	669,721 (56%)	636,715 (56%)
Total Direct Costs	\$1,995,635	\$1,196,546	\$1,140,502

By Constraint (Program Funds, 9 Projects)

Constraint

Low yielding cultivars	1,057,405 (31%)	590,782 (33%)	562,650 (33%)
Mycotoxins (Aflatoxin)	267,758 (8%)	152,460 (9%)	145,200 (9%)
Yield losses-pests	466,070 (14%)	286,020 (16%)	272,400 (16%)
Inadequate food supplies	610,500 (18%)	413,700 (23%)	394,000 (23%)

By University (Program Funds, 9 Projects)

University (9 projects)

Alabama A&M	245,000 (10%)	136,500 (10%)	130,000 (10%)
Georgia	668,850 (28%)	465,045 (32%)	442,900 (32%)
North Carolina State	696,472 (29%)	396,165 (27%)	377,300 (27%)
Texas A&M	791,531 (33%)	445,252 (31%)	424,050 (31%)

Table 5. PROPOSED PEANUT CRSP BUDGET SUMMARY BY CATEGORY FOR 5-YEARS

Category	1990/91	1991/92	1992/93	1993/94	1994/95	Total
<u>OPTIMAL BUDGET</u>						
1. Salaries, Wages, Fringe Benefits	981,547	1,030,624	1,082,154	1,136,262	1,193,075	5,423,662
2. Graduate Students, Training	421,539	442,616	464,745	487,983	512,381	2,329,264
3. Equipment	34,886	36,630	38,462	40,385	42,405	192,768
4. Travel	197,821	207,712	218,098	229,000	240,452	1,093,083
5. Materials & Supplies	554,194	581,904	611,000	641,547	673,621	3,062,266
6. Other Direct Costs	555,719	583,506	612,684	643,327	675,488	3,070,724
7. Indirect Costs	612,247	642,857	675,000	708,746	744,183	3,383,033
Total	\$3,357,953	3,525,849	3,702,143	3,887,250	4,081,605	\$18,554,800
<u>CURRENT 5% INFLATION BUDGET LEVEL</u>						
1. Salaries, Wages, Fringe Benefits	634,467	664,222	701,487	739,377	770,869	3,510,422
2. Graduate Students, Training	269,773	285,487	300,716	324,120	334,881	1,514,977
3. Equipment	26,486	26,217	16,315	16,431	16,553	102,002
4. Travel	130,387	121,761	136,431	138,960	144,456	671,995
5. Materials & Supplies	317,331	334,357	355,400	378,950	400,812	1,786,850
6. Other Direct Costs	19,769	33,093	25,258	24,864	30,574	133,558
7. Indirect Costs	386,787	409,113	432,355	443,658	471,533	2,143,446
Total	\$1,785,000	1,874,250	1,967,962	2,066,360	2,169,678	9,863,250
<u>CURRENT BUDGET LEVEL</u>						
1. Salaries, Wages, Fringe Benefits	612,396	619,039	629,947	641,911	652,179	3,156,363
2. Graduate Students, Training	258,170	269,263	273,336	281,300	276,467	1,358,536
3. Equipment	24,386	20,014	7,000	7,000	7,000	65,400
4. Travel	119,451	107,544	114,192	108,351	101,781	551,319
5. Materials & Supplies	297,647	289,534	284,720	280,867	276,103	1,428,871
6. Other Direct Costs	20,011	23,965	16,765	15,187	14,934	90,862
7. Indirect Costs	367,939	369,750	374,040	365,384	371,536	1,848,649
Total	\$1,700,000	1,700,000	1,700,000	1,700,000	1,700,000	8,500,000