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COLLABORATIVE RESEARCH
SUPPORT PROGRAM

EXTERNAL EVALUATION REPORT

1989

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ACRONYMS

AAM/FT/CAR	Alabama/Food Technology/Caribbean (Peanut CRSP project code)
AAM/FT/BF	Alabama/Food Technology/Burkina Faso (Peanut CRSP project code)
AAMU	Alabama A&M University
ACIAR	Australian Centre for International Agricultural Research
ADO	Agricultural Development Officer (USAID/Mission)
AGLN	Asian Grain Legumes Network
AID-Winrock	USAID supported project in Indonesia
APRES	American Peanut Research and Education Society
ASEAN	Association of Southeast Asian Nations
ATA	Agricultural Technology Cooperation - Netherlands (cooperation with ATA project in Indonesia).
BD	Board of Directors
BIFAD	Board of International Food and Agricultural Development
BNF	Biological Nitrogen Fixation
CGIAR	Consultative Group on International Agricultural Research
CMU	Chieng Mai University
CIMMYT	International Research Institute for Maize and Wheat (English definition)
CORAF	Conference des Responsables Africans et Francais de la Recherche Agronomique
CRSP	Collaborative Research Support Program
DOA	Department of Agriculture
EEP	External Evaluation Panel
ELISA	Enzyme-Linked Immunosorbent Assay

FAO	Food and Agricultural Organization of the United Nations
GA/FT/TP	Georgia/Food Technology/Thailand, Philippines (Peanut CRSP project code)
GA/IM/BF	Georgia/Insect Management/Burkina Faso (Peanut CRSP project code)
GA/PH/CAR	Georgia/Postharvest/Caribbean (Peanut CRSP project code)
GA/PV/N, TP	Georgia/Peanut Viruses/Nigeria, Thailand, Philippines (Peanut CRSP project code)
GNP	Gross National Product
GRAV	Groundnut rosette assistor virus
GRV	Groundnut rosette virus
HC	Host-Country
HPLC	High pressure liquid chromotography
IAR	Institute of Agricultural Research (Ahmado Bello University, Nigeria)
ICRISAT	International Crops Research Institute for the Semiarid Tropics
IDR	Institut Development Rural
IDRC	International Development Research Centre- Canada
IITA	International Institute for Tropical Agriculture
INERA	National Institute for Agricultural Research
INPEP	International Peanut Evaluation Program (Earlier CRSP project)
INRAN	National Institute for Agricultural Research-Niger
IPB	Institute of Plant Breeding
IPM	Integrated Pest Management
IRHO	Oilseeds Research Institute (French)
IRRI	International Rice Research Institute

ISC	ICRISAT Sahelian Center, Niamey, Niger
ISN	Institut Scientific Natural
ISP	Institut Superior Polytechnique
ISRA	Senegalese Institute for Agricultural Research
ITA	Food Technology Institute (Senegal)
IVSCAF	in vitro seed colonization by *Aspergillus flavus*
JRC	Joint Research Council
JCARD	Joint Council for Agriculture Research and Development
KKU	Khon Kaen University
KU	Kasetsart University
ME	Management Entity
M.S.	Master of Science
NCPC	National Crop Protection Center
NCS/BCP/TP	North Carolina/Breeding/Cultural Practices/Thailand, Philippines (Peanut CRSP project code)
NCS/IM/TP	North Carolina/Insect Management/Thailand, Philippines (Peanut CRSP project code)
NCS/SM/TP	North Carolina/Soil Microbiology/Thailand, Philippines (Peanut CRSP project code)
NCSU	North Carolina State University
NPGS	(U.S.) National Germplasm System
ORSTOM	French Organisation for Oversea Scientific Research
PCARRD	Philippine Council for Agriculture, Forestry, and Natural Resources Research and Development
Ph.D.	Doctor of Philosophy
PI	Principal Investigator
PI 1174	PI when with a number means Plant Introduction

P.L. 480	Public Law 480 (U.S. Congress)
PMV	Peanut mottle virus
PP	Pathogenesis-related proteins
PStV	Peanut stripe virus
PYSV	Peanut yellow spot virus
RPIS	(U.S.) Regional Plant Introduction Station
RNA	Ribo-nucleic acid
SAFGRAD	Semi-Arid Food Grams Research and Development
SAM	Selectively adsorb mycotoxins
SASS	Statistical Analyses Support System
SAT	Semi-arid Tropics
S.E.	South East
SECID	Southeastern Consortium for International Development
TAMU	Texas A&M University
TC	Technical Committee
TSWV	Tomato spotted wilt virus
TX/BCP/S,BF, N,	Texas/Breeding/Cultural Practices/Senegal, Burkina Faso, Niger (Peanut CRSP project code)
TX/MM/S	Texas/Mycotoxin Management/Senegal (Peanut CRSP project code)
TX/SM/TP	Texas/Soil Microbiology/Thailand, Philippines (Peanut CRSP project code)
UGA	University of Georgia
UPLB	University of the Philippines at Los Banos
U.S.	United States
USAID	United States Agency for International Development
USDA/ARS	United States Department of Agriculture/Agricultural Research Service
WAPEP	West Africa Peanut Evaluation Program (Cultivar Evaluation network under CRSP project, TX/BCP/S,BF,N)

EXECUTIVE SUMMARY

1. INTRODUCTION

This is the second Triennial Review of the Peanut Collaborative Research Support Program by an External Evaluation Panel (EEP).

EEP membership was approved by BIFAD and AID in 1988 and subsequently evaluated the Peanut CRSP during the first six months of 1989. All four U.S. Universities were visited and all host country institutions in Asia, Africa and the Caribbean. The members were:

Dr. John P. Cherry, Director, USDA/ARS Eastern Regional Research Center, Philadelphia, Pennsylvania.

Dr. Ray O. Hammons, Special Consultant, Geneticist, and formerly USDA/ARS Peanut Research Program Leader, Tifton, Georgia.

Dr. Allan J. Norden, Emeritus Professor of Agronomy, University of Florida, Gainesville, Florida.

Dr. Johnny W. Pendleton, Emeritus Professor of Agronomy, University of Wisconsin, Madison, Wisconsin, Chairman.

The directions for external evaluations in the Guidelines for the Collaborative Research Support Programs under Title XII of the International Development and Food Assistance Act of 1975 (June 1985) were followed in developing the Scope-of-Work. Our assessment of individual projects included: 1. Achievements, 2. Implementation and Management, 3. Institutional Development, 4. Adequacy of Science, 5. Applicability of Research, 6. Observations - Strengths and Weaknesses, 7. Recommendations.

The previous Triennial Review was held in 1985 when the individual research projects were relatively new and often still in the establishment stages. The EEP reviewed the 1985 Report, to identify previous concerns and assure that earlier recommendations were considered. In the 1989 review most CRSP projects had completed six years so our evaluation concentrated primarily on *accomplishments*, with observations on present strengths and weaknesses plus recommendations for the future.

2. IMPACTS

2.1 Human Capital or resources for peanut research has been dramatically increased in the host countries and the U.S. A total of 54 graduate degrees (37 M.S. and 17 Ph.D.) were awarded under Peanut CRSP auspices. Forty-eight additional students are presently pursuing advanced degrees. Individuals from 32 foreign countries (95% LDC) received academic and/or research training at U.S. Universities.

Non-degree specialized training was provided to numerous foreign collaborators and peanut scientists, with over 200 person-months spent in the U.S. to improve their expertise, competence and confidence. A significant number of both degree and non-degree trainees were women.

2.2 Research Enhancement. Research capability was improved in host countries by providing funds, research equipment and periodic visits by the U.S. collaborators. Great strides were taken toward the attainment of a sustainable agriculture in the host countries.

3. SELECTED NOTEWORTHY ACHIEVEMENTS

Excellent management and collaborative, high quality research were observed in Peanut CRSP. With the help of the Principal Investigators the estimated potential "pay-offs" from a few of the research projects follow:

3.1. Yield constraint. Thirteen peanut cultivars were developed and released for grower cultivation and consumer in Peanut CRSP supported research focused toward the constraint use of low-yields: three each in Thailand, Philippines and North Carolina, two in Texas, and one each in Belize and Jamaica. In addition, two cultivars resistant to rosette disease were reselected, seed multiplied, and distributed to farmers in Nigeria.

- In the poverty-stricken area of Northeast Thailand, the new cultivars yield 10 to 20 percent above the standard check in their market class. Their use with the available low input management practices gave an average 24 percent advantage in farmer's fields for a potential to return an additional 42,000 metric tons with a current market value of $20 million. The three new cultivars increase supplies of food for each of the normal ways peanut is consumed in Thailand: boiled, roasted, snacks, as food ingredients, and as peanut butter. The Thai Department of Agriculture recognized the Khon Kaen 60-3 cultivar as the Outstanding Research Accomplishment of 1988.

- In the Philippines, UPL Pn6, with an average 14 percent increase over the standard cultivar, has the potential of increasing the value to Filipino farm families by more than $3.5 million. Shade tolerant genotypes, identified in the Peanut CRSP program at Los Banos, have potential for even greater impact for food security by expanding production to new areas through intercropping the extensive coconut groves of Southeast Asia.

- Rust and leafspot pathogenic fungi limit peanut productivity in Jamaica (and several other Caribbean nations). After evaluation of a number of CRSP-supplied genotypes under

farmer's management regimes and with end-product commercial processing, one line with resistance to the fungi and high yields was released as cultivar CARDI-Payne in Jamaica where rapid small farmer acceptance was observed.

- Expanded research capabilities at North Carolina State University aided the development of three cultivars valuable to U.S. producers where the virginia market type is prominent. One of these NC 10C, is expected to become a key component in the program to control cylindrocladium black rot disease by genetic resistance and reduce chemical outlay and minimize environment effect.

- The development and release of the Langley and Tamrun-88 cultivars in Texas should have impact in the Southwestern U.S. production area and in West Africa. Langley, a short duration bunch cultivar of the spanish market type, and Tamrun-88, a runner, both have higher shelling grade and yield. The "first sale" increase in gross return with normal penetration of Tamrun-88 in Texas agriculture can be estimated at 1.0 to 1.2 million dollars annually.

- Seed of a spanish type breeding line (TX 87-36-1) have been multiplied in Texas for release in 1990. This genotype should reduce the risk of loss from pythium pod rot and sclerotinia blight. More importantly, under heavy Aspergillus flavus pressure, the aflatoxin content of seed produced by this genotype averaged 15 percent lower. Coupled with its 6.5 percent higher yield, the projected annual gross increase in Texas could exceed $1 million/year. Where sclerotina blight limits Florunner, substituting the new genotype should contribute another million dollars annually.

3.2. Yield losses from pests. Five Peanut CRSP projects have primary thrusts within this constraint: One on peanut viruses, two concerned with insect management strategies, and the two focusing on low-yielding cultivars. Examples of progress:

- In much of West Africa, rosette disease is a critical constraint. Rosette normally infects 5-10 percent of plants on an annual basis and can cause total crop loss in epidemic years. Two rosette-resistant cultivars were re-selected and distributed to Nigerian farmers. The most promising, RMP-12 requires too long a growing season for much of the Northern SAT Africa area, but is a useful source of resistant germplasm for breeding already in progress to stem the downward slide in peanut production in West Africa which has adversely affected food nutrition and farm income.

- Reduction in termite damage with resistant genotypes suited to the maturity and drought-stress constraints in Burkina Faso gave higher percentages of undamaged pods which by using

conventional baseline data could attain benefits estimated at $50,000 per annum by adoption of the cultivar by the nations's growers. Since aflatoxin contamination is directly related to damaged pods and to delayed harvesting, changing cultivars and digging the crop at normal maturity should reduce aflatoxin levels by a significant degree and contribute to food safety and environmental quality.

- Peanut stripe virus (PStV) of Southeast Asia was found to be in the same plant virus group as peanut mottle virus (PMV), is vectored by the same aphids, and is seed transmitted. If PStV becomes established in commercial fields in Georgia, and spreads like PMV, a one percent loss could occur, costing Georgia's growers an estimated $5 million.

- The development of integrated insect management strategies for peanut in the North Carolina - Virginia area centers on the southern corn rootworm. Use of the tolerant NC 6 cultivar can cut in half the cost of systemic insecticides, provide even greater savings in costs of applying the chemicals, and cut the environmental impact. Under current production costs, monetary savings in the area could reach $1.5 million annually.

- Three years of cooperative research on peanut stripe virus, led by two Peanut CRSP PIs in Georgia, resulted in the elimination of State Department of Agriculture restrictions upon the interstate movement of peanut seed for an estimated sales of $100,000 annually.

3.3. Food Safety. Mycotoxin management is the primary objective of one Peanut CRSP project, but all of the other projects have it as a strong secondary objective in their design and implementation.

- A local Senegalese clay was found to be a high sorbent for aflatoxin in peanut oil and in animal feeds respectively. The clay bound over 90 percent of the aflatoxin in the oil and subsequent poultry feeding trials in Texas showed that a small percentage of the clay in an aflatoxin contaminated ration prevented accumulation of aflatoxin in poultry livers. This research has drawn worldwide attention from scientists and industry. Estimation of the value of improving human/animal health by reducing the aflatoxin hazard in food and feed are almost incalculable, but the aflatoxins are among the most potent carcinogens known.

- Research achievements on drying and storage technologies and application of aflatoxin detection methods to peanut pastes show how peanut quality can be improved and maintained after harvest to processed foods. This information is being presented to food industry personnel at universities in the

Philippines, Thailand and Burkina Faso. These efforts are creating an awareness for proper storage/handling of peanut and peanut products and the control of aspergilli/aflatoxin contamination.

3.4 Food supply (postharvest utilization). Three projects are concerned with the adaptation of postharvest field technology for local use and the development of an array of dairy products or snack foods from peanut for use in SAT Africa, Southeast Asia and Caribbean countries.

- Utilization research supported by Peanut CRSP produced a nutritionally superior quality food product, 'kisra' (a thin pancake-like leavened bread), from blends of sorghum and peanut flours for use in SAT African countries. Using peanut products in these foods improves protein levels in a protein-deficient diet. Presently, peanut cake is used as feed or fertilizer. As an edible flour, its value increases substantially. It is estimated that in Sudan, "one million lb/yr" of flour could be processed for kisra, a net processed value of U.S. $10 million. Similar estimates can be made for "toe" in Burkina Faso. Another major benefit is the reduced suffering and medical costs due to the sorghum-induced pellagragenic effect.

- Formulation of dairy-like products from peanut such as milk, yogurt, coffee whitener, and simulated cheese pastes are technological developments achieved by Peanut CRSP being tailored for Southeast Asian countries, in particular the Philippines. Similar achievements are about to be commercially realized in Thailand where Chinese noodles were fortified with peanut proteins to a level equivalent to that of meat. The direct economic benefits of peanut advances as food in Southeast Asia are estimated at about $4 million with a potential return of up to $40 million per year.

4. SUMMARY

AID is well vested, and this youngest of the commodity CRSPs is in the right places, doing the right things. The Management Entity is lean, working with a minimum staff but with effective strategies. The EEP observed Board and Technical Committee sessions on two occasions and read Minutes from prior meetings. We noted their administrative policy and technical decisions were made judiciously and soundly.

Lastly, in September 1989 the EEP carefully reviewed the new five year (1990-1995) plans, budgets and accompanying justifications. We strongly support the challenging research described therein, and the request for additional funding.

2. SYNOPSIS

2.1 Program Achievements or Observations

2.1.1. Training of young agricultural scientists or the stockpiling of Human Capital will probably be the longest lasting, most effective accomplishment of Peanut CRSP. The reader is urged to scan Appendix II.

A total of 37 M.S. and 17 Ph.D. graduate degrees have been granted under the auspices of Peanut CRSP. Forty-eight additional students are presently pursuing advanced degrees, Appendix II. Both foreign and U.S. degree students were trained. The latter were often interested in international food problems, and some conducted their research in foreign countries.

Numerous undergraduate students received practical training in peanut improvement and utilization projects at Khon Kaen University, Thailand, University of Philippines, Los Banos, University of West Indies, Trinidad, and the University of Ouagadougou, Burkina Faso.

Non-degree specialized training has been provided foreign collaborators and peanut scientists. Approximately 204 months were spent in U.S. Universities (see Appendix II). The EEP encountered positive feedback on this type of training in every country visited. Very few collaborators and generally only recent staff additions, had not spent time in the U.S. institution working with project PI's.

Conversely the EEP observed and often heard U.S. Institution Administrators say how Peanut CRSP had broadened the vision and made better scientists of participating U.S. staff. Most of the U.S. scientists had never visited, or been envolved in LDC Agriculture prior to Peanut CRSP. Many admitted early reservations, but over time have become avid and appreciative participants.

2.1.2. Linkages and scientific friendships were welded that will endure long after Peanut CRSP. Appendix V lists the numerous national, regional and world organizations with which Peanut CRSP has developed cooperation to solve peanut production and utilization constraints. An example was the formation, under Peanut CRSP project leadership, of an informal international network (Consortium) of scientists interested in peanut viruses, linking researchers in Georgia, Nigeria, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) of India, Malawi, Scotland, France, Germany, Philippines, Thailand, Indonesia, Australia, China and Japan. The EEP commends this action and suggests that other Peanut CRSP disciplines should be alert to similar opportunities to

commentary within the following project evaluations will detail the specific collaborations in existence.

However, while the above is commendable, first and foremost were the research linkages formed between disciplines within Universities in the U.S. and foreign institutions. Time and again the EEP was told by host country administrations that there had been no annual peanut planning conferences including all disciplines and appropriate research institutions until Peanut CRSP started. Thus a research infrastructure has been built.

2.1.3. Conference sponsorship. Peanut CRSP sponsored or supported many conferences, workshops and symposia on peanut. These are listed in Appendix IV. The attendance of Peanut CRSP collaborators was supported. This offered educational benefits, encouragement and promoted personal friendships among scientists.

2.1.4. Publications. An impressive list of publications released or supported by Peanut CRSP are listed in Appendix III. While some observers may say that publications are not a good criteria for measuring a CRSP program, this EEP feels otherwise. The EEP believe well designed and conducted research should be made available to and reviewed by peers; or else how can science advance. For example, the science of genetics (some say biotechnology) did not commence until after Gregor Mendel published his brief paper on studies with peas.

One caution, we note that possibly through oversight Peanut CRSP is not acknowledged in some publications of research supported either directly or indirectly by CRSP funds. This should be more carefully monitored by PIs in the future.

2.1.5. The Role of Women. The scientific success of Peanut CRSP to a considerable degree is due to the many women scientists involved in the various projects.

2.1.5.1. In the U.S., Ms. Ruth Ann Tabor and Dr. Anna Resurreccion have served as Principal Investigator (PI) and Co-PI for the TX/SM/TP and GA/FT/TP projects, respectively.

2.1.5.2. In the Philippines, Dr. Remedios Abilay, Dr. Virginia Ocampo, Dr. Marina Natural, and Dr. Erlinda Paterno are the PIs for the NCS/BCP/TP, NCS/IM/TP, GA/PV/N,TP, and NCS/SM/TP projects, respectively.

2.1.5.3. In Thailand, Dr. Penkwan Chompreeda is PI, and Dr. Chintana Oupadissakoon and Dr. Yenchai Vasuvat have served as PIs, for the GA/FT/TP and NCS/SM/TP.

2.1.5.4. Dr. Dely Gapasin serves as the Deputy Executive

Director of Research for PCARRD in the Philippines and is an ardent Peanut CRSP supporter.

2.1.5.5. Dr. Janice Reed is CARDI country representative for Jamaica, and Mrs. Barbara Black is program coordinator for CARDI/Jamaica and both interact with the GA/PH/CAR project.

2.1.5.6. Numerous women are listed as supporting scientists on many projects and were observed participating in field and laboratory trials in Asia, Africa and the Caribbean.

2.1.5.7. Appendix II indicates the considerable number of women, both foreign and U.S., who were supported in either graduate degree or short term training programs supported by Peanut CRSP.

2.1.6. National Research Program. Peanut CRSP provided the thrust for National Programs for Peanut Improvement in the Philippines and Thailand under the aegis of the Philippine Council for Agriculture, Forestry and Resources Research and Development (PCARRD) and the Thailand Department of Agriculture (DOA). Annual National Peanut Planning Workshops were initiated by these agencies since Peanut CRSP started.

2.1.7. Spread of Technology. The new cultivars and promising experimental lines developed in the Peanut CRSP programs in the Philippines and Thailand have been introduced to the Asian Grain Legume Network and IRRI Farming Systems Network trials and therefore will be available for seed increase or as breeding materials in 15 countries in Asia.

2.1.8. Utilization Research on Chinese-type noodles were extended by the University of Georgia (UGA) and Kasetsart University (KU), Thailand, food scientists to include wheat flour fortified with peanut and cowpea flours. This is an example of collaborative studies of Peanut CRSP and Bean/Cowpea CRSP.

2.1.9. A primary strength noted for Peanut CRSP is the knowledge, dedication, leadership and enthusiasm of the PI, co-PI's, and the cooperating scientists to attack the constraints of peanut production and utilization.

2.2. Comments

2.2.1. Management of Peanut CRSP. As indicated in the Management Entity Review section, the EEP commends the ME of Peanut CRSP. The EEP feels Peanut CRSP has been fortunate to have had Dr. David G. Cummins as one of the original planners and then serve as the Program Director with the exception of a two-year leave of absence (1986-1988) to serve USAID in the Philippines. Even while there, he kept his involvement and

enthusiasm for Peanut CRSP. We commend the excellent leadership provided by Dr. Tommy Nakayama as Acting Program Director during Dr. Cummins' leave.

The superb guidance and policy advice provided to the Program Director by the Board of Directors and Technical Committee has been noteworthy. All CRSP Boards had extremely difficult decisions to make when USAID funds were severely reduced about midway of the program. The tough decisions, insofar as Peanut CRSP, were made judiciously and soundly in the judgment of the EEP. Rather than taking the easy way of reducing all projects proportionately, the TC and Board drastically reduced or curtailed certain projects that had either been slow evolving or that were less likely to show accomplishments or impact in a reasonable time frame.

The EEP suggests consideration be given to having a written policy on criteria to use and procedures in the event curtailment should be called for again, or when a new or substitute project is proposed by any institution. Such written policies might lessen misunderstandings.

The members of the Board of Directors (BOD), and the Technical Committee (TC) should not stay the same throughout the life of the project. Rotating members off of these administrative entities would allow for the sharing of involvements, interests, input, and professional development by PIs and Co-PIs from projects not represented. This rotation of PIs and Co-PIs would especially be beneficial where more than one project is located at an institute. Members from host countries should also have an opportunity to serve on administrative committees.

2.2.2. Policy of stationing US scientists overseas. The EEP believes one of the strengths of Peanut CRSP is the present policy of not assigning or stationing U.S. peanut scientists for extended periods of time in developing countries. Conversely the EEP urges that the U.S. Principal Investigators continue to make approximately one week annual visits to host country collaborators to exchange views, interpret results and jointly prepare future research and budget needs. The latter arrangement offers advantages to both the host country, U.S. institutions and the scientists involved. By implementing, conducting and interpreting the research a host country scientist gains confidence, experience and perhaps is more likely to carry on such research after Peanut CRSP funds cease.

Secondly, outstanding scientists within U.S. peanut institutions may be enlisted without jeopardizing their teaching, research or professional careers under a sometime "publish or perish" environment.

2.2.3. Financial support by USAID Missions. In the Guidelines for the Collaborative Research Support Programs (June 21, 1985) produced by the Board for International Food and Agricultural Development and the Agency for International Development the EEP notes on page 37 "that USAID Missions are authorized to negotiate and issue grants, cooperative agreements, and contracts with the CRSP Management Entity or to participating institutions."

On the same page is a suggested model where AID Regional Bureau or Mission funding could be directed to International Agricultural Research Centers to develop joint projects with CRSPs. The following justification for use of such funds is given. "Joint projects with IARCs have the advantage of pooling international scientific resources on a common problem where the comparative advantage of each party can be utilized to the fullest. For example, U.S. institutions can provide academic training and the more basic backup biological, genetic, and other research requiring sophisticated laboratories and staff which are more limited in most centers than in Universities."

This EEP believes that both of the above suggestions have merit, but judges that neither policy has been implemented insofar as Peanut CRSP is concerned. The EEP wonders if this is true with other CRSPs, and if so, recommend that these policies either be deleted or preferably implemented. The EEP understands that the Basic Ordering Agreement is now in place, so the ME of Peanut CRSP should more vigorously pursue such options.

In some Peanut CRSP regions and host countries, millions of U.S. dollars are going into agricultural development. This EEP was warmly greeted by local mission personnel and while encouraging views were expressed on the need for increased peanut production for food development and positive impressions of Peanut CRSP achievements, no direct monetary support was evident. For example, the judicious allocation of a few thousand dollars of local mission funds to CRSP for training, equipment or studies of specific pest problems or food applications in host countries would seem worthwhile.

2.2.4. Continue linkages. The many linkages formed with research institutions and organizations throughout the world are impressive (see Appendix V). Peanut CRSP should continue these linkages and seek others as opportunities arise. Cooperation should be particularly close with the ICRISAT research networks in Asia and Africa, the IRRI Farming Systems Network and in ACIAR in Asia, the new CORAF Peanut Network in the French speaking West African countries and with CARDI in the English speaking Caribbean Nations.

2.2.5. Sponsorship of Newsletter and Conferences. Peanut CRSP should continue to sponsor the International Arachis Newsletter

in collaboration with ICRISAT and continue to aid in the planning and sponsorship of regional and international conferences and workshops relating to the crop. Supporting the attendance of appropriate host country PIs and publication of proceedings should merit continued priority, as funds permit.

2.2.6. Uniformity in data recording and reporting. The EEP recommends that all experimental trials where yield, disease, insect, virus, other environmental factors/constraints are investigated, or where food quality factors are measured, should use commonly designed check cultivars as standards. Common rating scales for disease and insect observations should be adopted and referenced. The term "resistance" should not be confused with "tolerance".

2.2.7. Rotation of Board Meeting. The EEP recommends the Peanut CRSP Board rotate their meetings between the four participating U.S. Universities so as to become more familiar with facilities, staff and on going research. The Board chairman and/or other members of the Board should visit host country institutions as funds, time or itinerary permit.

2.2.8. An International Conference for Peanut. The EEP proposes to the Program Director and Board that Peanut CRSP enter into discussions with international agencies (ICRISAT, FAO-IBPGR, IRRI, UNDP, ACIAR, CORAF, IRHO, IRRI, CARDI, African Groundnut Council, etc.) to sponsor and plan an international peanut research (conference, workshop, congress) in a Peanut CRSP host country in 1991 or 1992.

(Eminent host country and US PIs should be convenors/section chairpersons - e.g. Sopone Wongkaew, Aran Patanothai, Penkwan Chompreeda, Virginia Ocampo, Amadou Ba, Brian Cooper, Alfred Traore, Bruno Ndunguru, et al).

2.2.9. Courtesy calls. When a US PI visits a host country sufficient time should be allocated to visit the USAID missions for briefings on the objective, progress, accomplishments, and challenges of Peanut CRSP. Secondly, the PI should attempt to pay courtesy calls on CRSP collaborators in other projects within that country.

2.2.10. U.S. Grower Relations. The EEP commends the administrators and PIs of U.S. Peanut CRSP Universities for meeting periodically with national and state Peanut Grower Associations to keep them fully informed of activities, accomplishments, and potential payoffs to U.S. growers. The EEP considers this a fundamental requirement and trusts that recognition of such educational opportunities continues. Such dialogue promotes mutual trust and benefits.

2.2.11. Collaboration with other CRSPs. The EEP recommends the Program Directors and Board Chairmen of all CRSP programs meet periodically with USAID and BIFAD to exchange philosophy, operational procedures and especially to seek opportunities for collaboration.

With the advent of Farming Systems Research in many LDCs there would appear to be opportunities for CRSP commodity "cross fertilization" and also across the animal and soil CRSPs. One example, mycotoxins on peanut pose both a serious food and feed hazard, and more so in developing countries than in the US because of poorer postharvest handling. One of the most exciting achievements from Peanut CRSP is the indication that certain clays adsorb or bind the aflatoxin in feedstuffs (TX/MM/S). This should be of great interest to the SMALL RUMINANT CRSP and particularly in Africa. Research on intercropping, crop succession and food utilization are high priority in LDCs and herein may lie opportunities for information exchange or collaboration between the COMMODITY and/or TROPSOIL CRSPS. We were pleased to learn of recent efforts by the food scientists of three CRSP projects (Peanut, Sorghum and Cowpea) to jointly plan research.

2.2.12. Relationship with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). Since ICRISAT is the International Agricultural Research Center (IARC) with the world mandate for peanut improvement the EEP was particularly interested in the relationship with Peanut CRSP. This linkage will be even more important as ICRISAT rapidly expands its peanut research in Sahelian Africa. To better evaluate this important question the entire EEP visited ICRISAT's relatively new Sahelian Center (ISC) at Sadore, near Niamey, Niger, and met with the peanut scientists for about eight hours over a two day period. The scientific caliber of the four-person peanut research team (Breeder, Agronomist, Pathologist and Physiologist) recently established there plus their new research facilities and their knowledge and plans for attacking peanut production constraints of Africa were indeed impressive. Dr. Ron W. Gibbons, present Director of the ICRISAT Sahelian Center was on the Peanut CRSP planning grant advisory panel and has been a member of the Board of Directors since 1982. They are as interested as Peanut CRSP in maintaining a complementary, as opposed to a duplicative, research relationship. The EEP sensed no duplication of efforts either now or in the future with the Peanut CRSP projects in Africa concerning Mycotoxins, Food Science and Technology, Insect Control, or Virology. Even the Peanut CRSP and French supported Senegalese breeding projects have somewhat different objectives and could complement ICRISAT's new breeding program, and Peanut CRSP might be the bridge between. The EEP also believes the U.S. Universities involved in Peanut CRSP have more basic know how and facilities to conduct biotechnology research, such as

gene transfer, than ICRISAT, and this might offer another bridge or opportunity for collaboration.

Lastly, The EEP believes that Peanut CRSP and ICRISAT have the opportunity to develop a "Model" for Training African scientists for peanut improvement. That is, graduate students would do their academic work in a U.S. CRSP University, but then conduct their thesis research either at the ICRISAT Sahelian Center or nearby farms. Advantages for the latter would be more "hands on" experience in an African environment. The Sahelian Center will have a new training facility completed in 1990, and peanut research will cover agronomy/physiology, breeding, pathology, entomology and resource management areas such as agrometeorology and agroforestry. The EEP wonders if some support for such training might come from USAID Regional or Mission funds.

2.2.13. Field plot techniques and data interpretation. The EEP observed only a limited number of field experiments because it was winter in the temperate zones and the dry season in the tropics. However, a small portion of the trials viewed under irrigation in the tropics, and a careful study of annual reports gives the EEP some concern regarding field plot techniques and data interpretation. Poor or erratic stands did not seem to bother some host country scientists, and they would quickly say "poor seed quality" or carefully explain how they could "get yield by harvesting individual plants". The EEP accepts neither explanation and recommends that more "tender loving care" be given the experiments and that education is needed. It is far better to discard an experiment, than to estimate yields. Secondly, the EEP considers basic statistical treatment to be necessary before data is presented in any table or figure. While there were statistical odds presented in most of the tabular and figure materials presented in Annual Reports, there were worrisome exceptions. In conclusion, unless proper cultural care, randomization, replication, and analysis is followed - use common sense - and destroy or don't report the data.

2.2.14. Annual Reports. These seem to have been published regularly and each contains extensive background information concerning Peanut CRSP. The advantage to this is that each one stands alone, and the reader of any one report can learn a great deal about Peanut CRSP. Contributing to a lengthy annual report are the extensive tables and verbiage included by some PIs. The EEP questions whether such extensive reports are necessary. What were the "Highlight" accomplishments, and their implications to future peanut production or utilization? The EEP recommends the ME, TC and Board put this point on a future agenda.

Elsewhere the EEP has recommended an educational brochure describing Peanut CRSP for wide distribution be considered.

Suggestions for joint publication on specific subjects with other linkage agencies may be found within Project Evaluations and in point 2.2.21 below.

2.2.15. Funding delays. The EEP sympathized with host country PIs who almost always mentioned funding delays and ensuing research difficulties. These seem to arise from different budget year dates, slow and unreliable mail service, the red tape of approval (by several persons or across several desks) for both incoming and outgoing budget items, and the frequent changes in administrative or scientific staff overseas. Both the ME Program Director and Financial Officer are aware and concerned with the many bottlenecks. A continuing educational program on procedures must be maintained both in the US and host countries. The latter must send vouchers or receipts for expenditures more frequently and well in advance of needs. When a US PI receives a budget printout - might they share appropriate sections with their overseas counterparts. The EEP gathered that no country has completely solved the red tape or significantly reduced the time needed for financial transactions from source to ultimate user. It's a fait accompli! Hopefully the new FAX machine at ME Headquarters will help.

2.2.16. Aflatoxin hazards. Peanut CRSP should promote or sponsor educational materials on aflatoxins, particularly in Africa. The EEP was told by one African scientist that liver problems in West Africa are 500 times greater than in Europe and he attributed this to aflatoxins coming from corn and peanut (in the diet).

2.2.17. Specialized discipline needs. There appears to be a shortage of trained virologists, nematologists and food scientists in Africa, given the magnitude of the problem and particularly with peanut. Such needs might be addressed as future trainees are selected.

2.2.18. Seed movement. While well aware of the need for phytosanitary regulations or requirements, the EEP deplored the sometime slow exchange of germplasm among African countries. This should perhaps be a future agenda item for IBPGR (International Board for Plant Genetics Resources). Secondly, the EEP recommends the origin, history and characteristics of a line accompany the seed. Often foreign collaborators had no such information about the lines, and scientists were simply testing a number.

2.2.19. Training. The EEP noted where a few host country M.S. or Ph.D. graduates either did not return or remained in country for only a short period of time. In a way, this defeats the training objective and suggests some type of service agreement or commitment to the government or agency be initiated. Conversely, the EEP questions the policy of some host countries

to require an M.S. recipient to work several years before being eligible to start Ph.D. studies. For example, in Niger the EEP was told this was five years.

The EEP impressions in West Africa was that the French are not offering graduate training opportunities to many native Africans. Thus there is justification for this activity to continue to receive high priority in Peanut CRSP. Well trained agricultural scientists, particularly for food crops, are sorely needed in Africa.

2.2.20. Benefits to women. In many Less Developed Countries (LDCs) men traditionally cultivate the cash crops and women tend the food crops such as peanut. Thus the development of technologies, as described herein, for improving or stabilizing yields with less labor or expense, benefits women.

2.2.21. Publications. Additional publications or ideas for consideration by the ME and Board would be:

2.2.21.1. A general informational brochure about Peanut CRSP for worldwide distribution.

2.2.21.2. A peanut insect identification booklet in collaboration with the Department of Agriculture (DOA) Thailand and perhaps International Development Research Centre (IDRC) for Asian distribution.

2.2.21.3. A simple educational brochure on Aflatoxins on peanut in collaboration with Food and Agriculture Organization (FAO) or World Health Organization (WHO) for African distribution.

2.2.21.4. A peanut virus informational publication in collaboration with ICRISAT for world distribution.

2.2.21.5. A food science brochure on improved traditional and new peanut ingredients (vegetable proteins) and products for distribution to host country and US food industries.

2.2.21.6. The ME should make certain the excellent summary of publications (Appendix III) gets into computer search files to aid peanut researchers worldwide, and to have copies of the journal articles on file at Headquarters. Documentation of publications and theses in the quarterly newsletter APRES Peanut Research is also appropriate.

2.2.22. Networking. The EEP commends the number of Linkages established by Peanut CRSP and note that many involve Networking. The latter is a proven method of testing and transfering agricultural technology across national borders, and will particularly allow the new improved cultivars, pest control

practices, and food developments to move from Peanut CRSP host countries to adjacent countries in the region, or to similar ecologies and populaces on other continents.

2.2.23. Quality standards. In some host countries, the peanut crop is sold on the basis of size, but not quality. Therefore no extra breeding efforts are made to improve quality characteristics. This economic market factor also adversely influences the post harvest handling, and especially, food processing. For example, in Senegal peanuts are stored in huge uncovered piles which often lead to quality deterioration. While Peanut CRSP is involved in postharvest research perhaps increased educational efforts are needed on quality and the development and introduction of grading standards.

2.2.24. Food science and technology. Peanut consumption surveys have been completed in host countries and have defined peanut-eating habits and identified new utilization thrusts that will increase the use of peanut in diets. Traditional and new foods, as a result of these surveys, are being improved and developed, respectively. Research on appropriate technology for storage and handling of peanut prior to processing to assure peanut quality (e.g., aspergilli aflatoxin-free peanut) has been completed. Efforts need to be strengthened to train industry personnel in these developments. Collaborative studies of production and utilization scientists also need to be strengthened to ensure continued advancement of these technologies.

2.2.25. Mechanization of on-farm machinery. The EEP had the opportunity to visit the Department of Agricultural Engineering, Faculty of Engineering, Khon Kaen University (KKU), Thailand to learn about the farm mechanization program. The program was initially funded by the International Development Research Center (IDRC, Canada) and offers excellent opportunities for development of collaborative studies with Peanut CRSP scientists from the Philippines, African and Caribbean countries. Engineers at KKU are now committing resources to developing and disseminating on-farm peanut harvesting/processing machinery including threshers, strippers, shellers, sizers and shakers in demonstration projects in Thailand. Efforts are with farmers, traders and village processors. This technology needs to be transfered to other Peanut CRSP countries.

2.2.26. Dual type peanut. Peanut CRSP breeders involved with West Africa should be aware of the ready market for peanut hay during the dry season and perhaps look for "dual purpose" genotypes. But having made the statement, the EEP shudders to think of the long term effects on soil organic matter, fertility and even erosion by removing everything from the fields. The environmental and economic impact of dual purpose peanut should be evaluated.

2.2.27. Senegal peanut growing area. Like the last EEP we wonder why peanut is not grown, or at least researched more in the southern areas of Senegal where rainfall is more abundant and less erratic. This would certainly lessen the breeding challenges for producing high yielding early cultivars with drought tolerance required in central and northern Senegal. And there seems to be no early genotypes with resistance to the sometimes devastating rosette virus, whereas tolerance has been found in later maturing lines.

2.2.28. CORAF. In West Africa the EEP encountered a relatively new (1987) agricultural research organization or network called CORAF (Conference des Responsables Africains et Francois de la Recherche Agronomique). This is made up of France and 10 former French African Colonies (Burkina Faso, Cameroon, Chad, Congo, Cote d'Ivoire, Guinea, Madagascar, Mali, Niger, and Senegal) and funded primarily by the European Economic Community (EEC) and the French government. Emphasis is on research networks involving several West African food crops including peanut. The CORAF Groundnut Network has held two organizational meetings and the coordinator is Dr. Amadou Ba who is also the Peanut CRSP PI for the TX/MM/S project. Strangely, while Associate Network members are listed as Botswana, Brazil, Burundi, Greece, Portugal, Spain and the United Kingdom-no reference is made of the U.S., or to Peanut CRSP among the "other organizations" cooperating with the Network". A CORAF information sheet entitled Groundnut Network lists five Main Research Priorities and four Joint Projects as underway. The Network Headquarters has been recommended to be at the Institut Senagalese de Recherches Agricoles (ISRA) in Bambey, Senegal, which is also the Senegal site for a Peanut CRSP Texas breeding project entitled Disease Resistant Peanut Varieties for Semi-Arid Environments. Our only comment is one of encouragement for both USAID and Peanut CRSP to become involved, if and when the opportunity arises. Politics and science sometimes make strange bedfellows.

2.3. Achievements Toward Solving the Original Designated Constraints[1]

2.3.1. Constraint 1: Low yielding cultivars.

2.3.1.1. Thirteen new cultivars with improved yield and pest tolerance have been released and other promising lines are in final testing or increase stages.

Philippines. A new cultivar 'UPL Pn 6' (Biyaya 6) was released to growers in the Philippines in 1986. It outyields presently

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[1]More detailed Achievements may be found within each project evaluation.

grown cultivars by 14 percent, has moderate resistance to Cercospora leaf spot and rust and improved seed shape and color. This new cultivar is a primary component in the government's Peanut Development Action Program (PDAP) which involves 172 farmers and 65 hectares in 1989. 'UPL Pn 2' and 'UPL Pn 4' were released for specific ecological zones and food uses.

'IPB Pn 174', with resistance to stem rot (Sclerotium rolfsii) has been seed-multiplied and is awaiting approval for release by the Philippine Seed Board. 'JL-24', 'IPB Pn 48-75', 'IPB Pn 48-90', and 'IPB Pn 42-14' are promising entries in the National Crop Testing Program (NCTP) trials.

Shade tolerant genotypes have been identified under large artificial shade structures at Los Banos, and are being field tested in coconut plantations on several Philippine islands. The potential expansion of peanut production in this intercropping system has significant implications for many areas of Southeast Asia.

Thailand. Three new cultivars have been released to Thailand growers: 'Khon Kaen 60-1', '60-2', and '60-3'. These have superior yields and are for specific needs and environments. The Thailand Department of Agriculture recognized Khon Kaen 60-3 cultivar as the Outstanding Research Accomplishment of 1988.

Jamaica. A new cultivar, 'CARDI-Payne', was released in the Caribbean in 1987 and is being accepted by both farmers and traders. This was selected from 'Georgia V-30' (Tifrust 2) sent to Jamaica in an early Peanut CRSP nursery.

Senegal. Three experimental lines with superior yield potential are in final testing and early seed increase stages: 'GC8-35' (early 75-80 day maturity), 'PI 1174' (90 day maturity) and 'Sn 79-79' (105 day maturity).

U.S.. 'NC 9', 'NC 10 C'and NC V11 were released by North Carolina State University. NC 10C is a cylindrocladium black rot resistant, large seeded virginia-type peanut. Two other lines with high yielding ability ('NC Ac 18411' and 'NC Ac 18423') have been approved and seed is being increased.

Langley and Tamrun-88 are new varieties released by Texas A&M University. Langley, a short duration bunch type cultivar of the spanish market type, and Tamrun-88 (a runner type), have higher shelling grade and yield than presently grown cultivars. Texas also is increasing seed of a line for release in 1990 which has more tolerance to pythium rot, sclerotinia blight, and aflatoxin infection than cultivars presently available to growers.

2.3.1.2. Cultivar transfer. New cultivars and promising lines have been entered in Regional and International Network Testing Programs, so other countries may evaluate and benefit.

2.3.1.3. Exchange of germplasm. More than 2,800 genotypes have been introduced in the Thai peanut improvement program supported by CRSP and 300+ crosses have been made by the breeders.

NCSU introduced 178 crosses and 210 germplasm accessions to the Philippines and 629 crosses and 1603 accessions to Thailand.

Texas A & M University sent 218 early maturing lines and populations to Senegal, 120 to Burkina Faso, and 48 to Niger for yield, pest resistant and quality evaluations.

Conversely, 310 Burkina Faso, 25 Senegal, and 10 Niger peanut lines with specific traits were sent to Texas via the USDA Plant Introduction Station, Beltsville, Maryland.

2.3.1.4. Development of host country peanut breeding programs. Large complex breeding programs where hybrid populations are made and evaluated in multi-locational, multi-year nurseries for agronomic characteristics, pest tolerance, and drought are now operating in the Philippines, Thailand, and Senegal. The most promising nursery lines go to the National Cooperative Testing Programs and from there to on-farm test sites.

2.3.1.5. Team approach. CRSP has stimulated interdisciplinary teams at all institutions. Breeders are now working closely with pathologists, entomologists, and agronomists for crop improvement. Peanut projects are now integrated within and across institutions and thereby providing a synergistic effect.

2.3.1.6. Drought tolerance. A team of two plant breeders and a crop physiologist are making progress at Bambey, Senegal on selecting genotypes for drought tolerance by use of (1) plant/water simulation models, (2) rhizotron studies of root development, and (3) physiological and above ground anatomical traits.

2.3.1.7. Breeding methodology. Senegalese breeders have commenced a long term recurrent selection program as a way of introducing greater genetic diversity. This program includes African, Chinese and U.S. lines.

2.3.1.8. Nematode resistance. Texas A & M University breeders have identified immunity to several species of nematodes in lines derived from interspecies crosses between wild and the domestic *Arachis* and are now making crosses to obtain agronomically acceptable cultivars.

2.3.1.9. Cytogenetics. Studies at NCSU have identified several linkage groups in peanut. This has been a far more difficult problem with peanut than most crop species, but very basic for long term crop improvement.

2.3.1.10. Biotechnology. A gene transfer procedure at NCSU, successful in Tobacco, appears to have promise with peanut.

2.3.2. Constraint 2: Pest damage

2.3.2.1. Control by breeding. Thailand scientists have identified genotypes with resistance to leaf spot, rust, and *Aspergillus* crown rot. Note: Many new cultivars and lines mentioned in 2.3.1.1. above carry improved pest tolerance.

2.3.2.2. Integrated pest management (IPM). Exhaustive insect research on life cycles, alternate hosts, time of appearance on the crop, population levels and subsequent damage to the plant performed in the Philippines, Thailand and the U.S. has provided the basis for IPM recommendations. Such programs provide both economic and safety benefits to farmers. Thailand entomologists are improving their IPM recommendations by systematic research on four components: biological, genetic, chemical and cultural.

2.3.2.3. Minimizing use of chemical pesticides. Economic threshold levels (plant damage/stage of development and/or insect populations) have been determined when chemical spraying would payoff for several insect pests in Thailand and Philippines. Such treatment based on need saves money and reduces health hazards.

2.3.2.4. Pest surveys. Early insect surveys indicated that many of the same peanut insect genera were present in Thailand, Philippine and the U.S. Thus control technologies or resistant genotypes may be transferable. These same surveys identified the most prevalent and destructive pests of peanuts, permitting a sharper focus on research priorities.

2.3.2.5. Benefits to host country and U.S. growers. U.S. investigators have collaborated on research concerning disease and insect problems which are not yet present in the U.S. peanut growing belt. The evaluation of U.S. genotypes to new and different insect populations and pathogens may ultimately offer the most economical control to the small farmers of the host countries, and be insurance to the U.S. grower in the event the foreign pests are inadvertantly introduced. For example, Thailand entomologists are making progress on control of the subterranean ant (*Dorylus orientalis*) a serious peanut pest in that country but not presently in the U.S.

2.3.2.6. Multiple insect resistance nursery. An international

collection of insect resistant genotypes selected for multiple pest resistance in Thailand is now being evaluated in the Philippines and also in Georgia, Florida, Alabama, Virginia and North Carolina.

2.3.2.7. Soil insects. The severity of damage by soil insects (termites, millipedes and subterranean ants) on peanut production and quality was determined in trials in Africa and Asia.

Burkina Faso entomologists determined the severity of termite and millipede damage to seed yield and quality. Aflatoxin contamination was directly related to damaged pods and also to delaying harvest beyond the normal maturity of the crop.

Peanut germplasm introduced into Burkina Faso reported as having some resistance to termites in India did indeed show more tolerance than local cultivars.

2.3.2.8. Foliar diseases. Significant advances were made in understanding the pathogenicity and epidemiology of foliar pathogens in different environments.

2.3.2.9. Virology advancements. Basic virology research has led to the discovery of the two causal agents for Peanut Rosette Virus, a devastating constraint in Africa.

A line resistant to Rosette Virus, 'RMP-12' has been identified and seed increase is taking place in Nigeria. While the 120 day maturity of RMP-12 is too long for much of the African production area, breeders are already incorporating the resistant genes into earlier lines.

Peanut stripe virus (PStV) has been painstakingly studied. The morphology of the particle, symptoms, and serological relationships with other legume potyviruses were established. Fortunately the virus has been found to be less of a threat to peanut yields in Asia and the U.S. than originally predicted.

The vector insects for various peanut viruses have been carefully documented in Thailand.

2.3.2.10. Biological control of insects. Ground leaves and seed of the neem tree (*Azadicachta indica*) significantly reduced thrip damage in Burkina Faso. This medicinal plant is native to peanut growing areas of SAT-Africa and Asia where chemical insecticides are often prohibitively expensive, scarce, and constitute a hazard to human health and the environment.

Research on biological control of peanut insects has resulted in two microbial agents and one insect predator being

commercially available in the Philippines.

2.3.2.11. Use of Biotechnology. The use of such techniques has made possible hybridization between wild and domesticated *Arachis* species for the transfer of certain pest resistant genes found only in the wild types.

Another biotechnology procedure has been used to disrupt the protein coat replication process of a major peanut virus, thereby rendering it impotent.

2.3.2.12. Program strengthening. A strong foundation for economic entomology research and teaching has been built in the host countries through CRSP collaborative research and training programs.

2.3.3. Constraint 3: Food Safety, Health Hazards - Mycotoxins.

2.3.3.1. Advances by breeding. Peanut breeding lines were identified with moderate levels of resistance to invasion by the aflatoxin - producing fungus, *Aspergillus flavus* at Texas A&M University. Seed of one line is being increased in 1989.

2.3.3.2. Detoxification by clay. The discovery that certain types of clay found in both the U.S. and Senegal can adsorb (detoxify) aflatoxins in peanut oil and animal feeds has created world wide interest among both the scientific and business community.

2.3.3.3. Simple village method for reducing aflatoxin. At the Institut de Technologie Alimentaire (ITA) in Senegal the aflatoxin content of contaminated peanut butter was reduced by approximately 80% of the original concentration after boiling for two hours in water.

2.3.3.4. New screening method for aflatoxin. A rapid, inexpensive, field-practical assay procedure for screening peanut and various other grains for aflatoxin contamination was developed.

2.3.3.5. Laboratory screening vs. field trials. Both Texas and Senegal scientists have noted correlations between laboratory in vitro colonization by *Aspergillus flavus* and field infections among genotypes, thus offering a faster, less expensive screening method.

2.3.3.6. Drying and storage, technologies. Research achievements on drying and storage technologies and application of aflatoxin detection methods to peanut pastes show how peanut quality can be improved and maintained after harvest to processed foods. This information is being presented in scheduled workshops to food industry personnel at universities

in the Philippines, Thailand and Burkina Faso. These efforts are creating an awareness for proper storage/handling of peanut and peanut products and the control of aspergilli/aflatoxin contamination. Noteworthy in the presentations is that careful monitoring and removal of off-colored, immature and damaged peanut and proper packaging can eliminate aflatoxin contamination of peanut products in Southeast Asia and SAT Africa.

2.3.4. Constraint 4: Soil Microbiology

2.3.4.1. Mycorrhizal collection. Over 200 vesicular-arbuscular endomycorrhizal fungi (VAMF) were collected in peanut soils in the Philippines, Thailand and the U.S. These were classified and evaluated on peanut plants in the greenhouse and field.

2.3.4.2. Yield results. In pot culture, seed yields were reported to be an astounding 300 percent greater in some cases with the addition of certain VAMF species as compared to check plants. Unfortunately field results were generally disappointing, with moderate or non-significant differences.

2.3.4.3. Commercial interests. Two American companies have avidly followed this research and are investigating methodologies to apply VAMF in the field.

2.3.4.4. Methods to identify. The use of monoclonal antibodies to determine or identify VAMF species has been successful.

2.3.4.5. Potential for other crops. VAMF applications sometimes were noted to increase plant biomass without increasing seed yield, which has led the researcher to wonder about their use on leafy vegetable crops.

2.3.4.6. Collection and evaluation of Rhizobium strains were an early objective of this project. Over 125 strains have been evaluated on peanut and great differences in BNF effectiveness noted.

2.3.4.7. A positive interaction for BNF was noted between cultivars and Rhizobium strains.

2.3.4.8. Methodology. An "artificial nodule" technique to determine the symbiotic regulating compounds produced by bacteroidins was successfully developed.

2.3.4.9. Biochemical effects of Rhizobium strains. Much basic research information was elucidated on free amino acid composition of root nodules, free sugars and free amino acid content of peanut seed when inoculated with different

Bradyrhizobium sp. strains.

2.3.4.10. The effect of "plant passage" or generations on symbiotic effectiveness was monitored for three strains of rhizobium with varying results.

2.3.5. Constraint 5: Inadequate Food Supplies

2.3.5.1. The impact of Peanut CRSP in food research has far exceeded its actual funding. The funds allocated over seven years has brought near term results in developing human capital (training); increased the knowledge base (research); educated the public in international dimensions of technology; and increasd sensitivity of the land grant and sister institutions to the global problems of technology. This modest investment has caused a tripling of the effort in research, extended a network of collaborators and allowed for the actualization of graduate programs at Kasetsart University, Thailand, the University of the Philippines at Los Banos and the University of Ouagadougou, Burkina Faso. In the Caribbean it has brought technology for local use through CARDI and the University of West Indies, Trinidad.

2.3.5.2. Collaborative surveys in Southeast Asian, SAT African, and Caribbean countries, and the U.S. to determine variations in environment, socioeconomics and food technologies as they constrain the utilization of peanut and peanut products were completed. These data were, or are being, published and show that peanut utilization can be considerably increased if efforts are made to convert peanut into more refined/processed forms; improve packaging of peanut and peanut products to increase shelf-life; utilize peanut meal (oil-extracted) to enhance protein value of cereal-based foods; and improve methods of storage, handling and inventory management.

2.3.5.3. Composition data on peanut are being developed by scientists through collaborative studies in Southeast Asia, SAT Africa, Caribbean countries, and U.S. in research for selection of improved cultivars and food products. These studies are showing the nutritional quality of food products made with peanut from different cultivars grown at various locations in Host Countries and the U.S. The peanut processing industries in Peanut CRSP countries are realizing the value of these studies.

2.3.5.4. Utilization research supported by Peanut CRSP has produced a nutritionally superior quality food product, 'kisra' (a thin pancake-like leavened bread), from blends of sorghum and peanut flours for use in SAT Arica. Efforts are underway to commercialize kisra and extend this technology to another of Peanut CRSP's similar products 'toe.' Important is that the use of peanut products in these foods improve protein

levels in a protein-deficient diet. Also, the ratios of selected amino acids, leucine/isoleucine and leucine/lysine, are favorably altered in the blended product so as to diminish the pellagragenic characteristics that can occur with sorghum-based foods. Presently, peanut cake from oil-crushing mills is used as feed or fertilizer with an estimated value of less than $0.10/lb. As an edible flour, its value increases to as much as $10/lb. In Sudan, it is estimated that one million lbs. of flour could be processed/yr for kisra, a net value of up to $10 million. Another major benefit is the savings of medical costs due to the sorghum-induced pellagragenic effect.

2.3.5.5. A collection of 84 samples representing 18 different peanut products and recipes manufactured in 13 regions of the Philippines, was completed at the University of Los Banos. Eight selected products were published in pamphlets entitled "Sugar Coated Peanut," "Peanut Candy," "Pastillas de Mani," "Peanut Brittle," "Peanut Butter," "Mazapan de Mani," "Polvoron de Mani," and "Peanut Bar." These publications are available to food processors and helping to expand commercialization of peanut products in the Philippines.

2.3.5.6. Formulation of dairy-like products from peanut such as milk, yogurt, coffee whitener, and simulated cheese pastes are technological developments achieved by Peanut CRSP being tailored for Southeast Asian countries, in particular, the Philippines. Similar achievements are about to be commercially realized in Thailand with a food, Chinese noodles, fortified with peanut proteins to a level equivalent to that of meat. Animal foods are expensive and peanut protein products used daily by the populace would engender a continual return on industrial investments. The direct economic benefits of peanut advances as food in Southeast Asia are estimated at about $40 million per year.

2.3.5.7. Research at Kasetsart University, Thailand, and University of Georgia has developed highly acceptable peanut foods including a peanut butter bar, fruit (banana, papaya, durian) flavored peanut spreads/pastes, chocolate-flavored peanut beverage, peanut yogurt, peanut ice cream, and chicken patties and Thai sausages extended with peanut protein ingredients. Sensory analyses and larger scale consumer tests are confirming acceptance and potential marketability of these peanut products.

2.3.5.8. Chinese-type noodles were extended by University of Georgia researchers to include wheat flour fortified with defatted peanut and cowpea flours. This is an example of collaborative studies of scientists of Peanut CRSP and Bean/Cowpea CRSP. Computer-generated analyses revealed that up to 15% peanut flour and 8% cowpea flour supplementations produced Chinese noodles with acceptable physical and sensory

qualities while improving protein content. These data show that the fortified peanut-cowpea Chinese noodles would contribute to the nutritional status of the low income populations in Thailand and other Southeast Asian countries.

2.3.5.9 A commercially available stable peanut butter product from valencia has been produced by collaborative studies in Jamaica. A problem of shelf life stability due to poor textural quality and oil separation was solved with the development of a new formula. Proximate composition, microbiological contamination and aflatoxin monitoring systems were implemented to assure nutritional quality of the peanut butter. The result was increased peanut butter production, expanded consumer availability and enhanced sales with an additional value to one industry of approximately $30,000/yr.

2.3.5.10. Peanut CRSP in Caribbean countries has stimulated the interest of farmers to improve peanut quality. These activities have brought realization among farmers that reduced cost of production and postharvest applications and increased value of peanut (due to improved quality) can increase profits. Ongoing achievements include improvements on mechanical threshing, shelling, drying and storage technologies. Successful field-testing of two refurbished old peanut "CeCoCo" threshers was an important development in these studies. The stimulus provided by Peanut CRSP on the farm is raising the economic value of peanut to the farmers. Fabrication of equipment by local manufacturers and marketing of value-added peanut should further enhance the economic status of the farm community in the Caribbean.

2.4 Comments and Recommendations Concerning Designated Constraints[2]

2.4.1. Low yielding cultivars

2.4.1.1. Need for breeding indices. The breeders of drought and aflatoxin tolerant lines need more precise and easy-to-use selection indices for progress. More basic research is needed from other disciplines to provide such tools.

2.4.1.2. Germplasm collection. U.S. breeders should make special effort to see that foreign lines are added to the U.S. National Germplasm systems, and that all seed exchanges include history and description of lines.

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[2]More detailed recommendations are found within each project evaluation.

2.4.1.3. Seed storage. There appears to be an urgent need for improved seed storage facilities for the breeding programs in Africa.

2.4.1.4. Equipment needs. Transportation vehicles for collaborating African scientists is an acute problem and one which appears to be growing worse rather than better.

2.4.1.5. Genotype names. Peanut breeders and their cooperators should agree on and use uniform names for peanut genotypes.

2.4.2. Pest damage - Comments and recommendations

2.4.2.1. Collaboration. While the past collaboration between disciplines and projects has been generally rated highly satisfactory, we believe there are further opportunities that should be pursued: virologists and entomologists should closely collaborate on insect vector/virus interactions and the three Peanut CRSP projects in Burkina Faso (GA/IM/BF, AAM/FT/BF and TX/BCP/S,BF,N) may be too independent of each other.

2.4.2.2. Nematodes. More basic and applied research on nematodes seems justified. With the severity of the problem in West Africa and the promising interspecies breeding program already at Texas A & M University, consideration should be given for increasing funds in the TX/BCP/S,BF,N project.

2.4.2.3. Virus research. The program should be continued in West Africa. If unable to do so in Nigeria then in some other West African country such as Niger or Burkina Faso where other Peanut CRSP projects are in place. We believe the TC should reconsider shifting to an area (Asia) where virus diseases are less important as a peanut constraint than in Africa. If both areas are continued more funds will be needed.

2.4.2.4. The publication of a peanut virus information resource in collaboration with ICRISAT should be considered.

2.4.3. Mycotoxin - hazards to health

2.4.3.1. We commend the basic research acomplishments of this project but recommend increased funding for more food scientists and animal physiologists and/or nutritionists to be brought into the project for adaptive research.

2.4.3.2. Because of the serious health hazard of mycotoxin in peanut, high priority should be given to follow up research on the use of certain clays for mycotoxin detoxification of peanut oil and meal.

2.4.3.3. Perhaps a special world symposium could be held

focusing on this and other potential mycotoxin control methods. We suspect the transferability of such research findings would be simple.

2.4.3.4. An <u>informational brochure</u> on "Aflatoxin" should be prepared for wide distribution in Africa (English & French).

2.4.3.5. We were pleased to learn tentative plans have been made for another 1890 University (Prairie View) to become involved in the mycotoxin project via feeding trials with their goat herd. Because of the importance of this animal in many peanut growing LDCs we would encourage such trials to be planned and adequately budgeted in the future in Africa and the U.S.

2.4.4. <u>Soil Microbiology</u>

2.4.4.1. The basic and creative biochemical and physiology research taking place at NCSU's Rhizobium project (NCS/SM/TP) has elucidated much new knowledge, ideas and questions meriting further research. However, to transfer the sometimes speculative interpretations to economic returns to a peanut grower may necessitate many more years, and be beyond the means of a CRSP program. This same general observation is offered for the TX/SM/TP mycorrhizal research.

2.4.4.2. The only exceptions might be to: (1) provide funding for a small breeding program in Thailand at Khon Kaen University to select genotypes with a high BNF capacity with the indigenous rhizobium, and (2) provide a small grant to Dr. De La Cruz at UPLB, Philippines for pelleting and field testing Mycorrhizal and Rhizobium strains in combination.

2.4.5. <u>Inadequate food supplies</u>

2.4.5.1. Food science and technology research should be closely coordinated with breeding and variety evaluation programs through collaborative studies. Moreover, breeding, agronomic, entomological and food science studies should be coordinated with post-production handling, storage and processing conditions, and marketing and consumer acceptance factors.

2.4.5.2. The advancements were impressive on manual and powered mechanized machinery (tillers, planters, weeders, strippers, threshers, shellers, cleaners, sizers and grinders) for peanut production and postharvest handling in the Department of Agricultural Engineering, Khon Kaen University, Thailand. These developments are available for technology transfer via workshops at Khon Kaen University to other Southeast Asian, African and Caribbean countries, and the U.S. It is through this type of technology transfer where Peanut

CRSP can make a strong contribution.

2.4.5.3. Food scientists with strong chemistry backgrounds are needed in Burkina Faso. The Peanut CRSP should reexamine present priorities to focus projects in the training of personnel to strengthen expertise in selected areas, e.g., food chemistry and engineering, in SAT Africa.

2.4.5.4. Peanut CRSP should strengthen its commitment with start-up funds to host country scientists returning home after study in the U.S. New funding increases to Peanut CRSP should be directed to meeting these needs. This will assist them in efforts to initiate new programs. These trained scientists with their newly learned expertise are capable of rapidly developing new programs to meet the immediate needs of the host country, if funds were available.

2.4.5.5. The close proximity of Caribbean countries to the U.S. compared to Southeast Asian and African countries offers a unique opportunity for Peanut CRSP's U.S. PIs to test selected research developments under actual field (host country) conditions. Environmental and socioeconomical similarities to Southeast Asian and African countries are likely to exist in the Caribbean. This would allow researchers to obtain additional data in support of those of the distant host countries, and therefore, enhance potential for advancing Peanut CRSP's objectives.

2.4.5.6. The observations and recommendations of an EEP-Ad Hoc Committee (formed at the request of the Peanut CRSP-Board of Directors, December 1985) still hold and are clearly being met with the postharvest/utilization programs in Southeast Asia; i.e., Peanut CRSP was extremely successful in its concepts and most objectives were being met relevant to the food needs of host countries. Peanut CRSP is staffed with competent scientists successfully working within funding constraints to design programs in food science, technology and production. One major benefit noted, and continues today, was contributions of expertise, equipment/instruments and facilities, at no cost from scientists not on the Peanut CRSP through collaborative programs. In spite of limited funding, the programs are productive, and are accomplishing more than expected. To date, a strong research foundation has been built and will serve as a springboard for a 5-year extension of Peanut CRSP. The postharvest/utilization research could proceed much more rapidly if additional funds were provided. Host country researchers are developing the expertise and facilities to provide a broad program of food science/technology and nutritional analyses, including aflatoxin detection, removal and prevention. Collaborative studies and meetings/workshops among institutions doing sustainable agriculture and postharvest/utilization research within and among host

countries and U.S. should be strengthened and regularly occur. Peanut CRSP is the vehicle through which all of these needs can be developed.

3. PREFACE

3.1. Introduction

An External Evaluation Panel (EEP) is an integral part of all Collaborative Research Support Programs (CRSP's). The external evaluation by the EEP is most important to the CRSP operations to assure objectivity in decision making on important and sometimes difficult institutional issues.

Consistent with these criteria, the Peanut CRSP grant document established an EEP consisting of three to five eminent scientists recommended by the CRSP Management Entity to AID/BIFAD for specific terms of appointment. Periodically as appropriate the EEP shall:

1. Review projects and programs of the CRSP and provide written evaluation.

2. Make recommendations for the addition, elimination, or modification of component projects and overall objectives, to include retention; elimination; or addition of new overseas sites.

The Guidelines for the CRSPs as circulated by BIFAD/AID on June 21, 1985 further defines the EEP roles. Principal purposes of the evaluation are to: maintain programmatic focus and effective scientific balance of research toward achievement of objectives; identify inadequate performances, identify activities irrelevant or marginal to CRSP objectives; consider effective balance between research and training for development of institutional research capability; assess the balance of domestic versus overseas research in terms of effectiveness of solving constraints in developing countries; evaluate the cost-effectiveness of the entire CRSP operation in terms of actual cost of doing business versus costs of alternatives that may require less funding, or may otherwise be more efficient or more effective; examine ways of dissemination of research results, and the effectiveness of utilization, a measure of the appropriateness of the research; and report its findings and recommendations annually to the ME, the Board, AID, and JCARD/BIFAD.

EEP MEMBERS

A slate of nominees for the Peanut CRSP was proposed by the Principal Investigators, Technical Committee, Board of Directors, and Program Director during mid-1987. The Board later approved a list of four nominees that were presented to AID/BIFAD. Approval of these nominees was received in June 1988.

Basic criteria used in choosing the EEP were:

a. A background in and a basic understanding of science.

b. Experience in international agricultural research and/or development and knowledge of LDC problems.

c. Specific in-depth experience in peanut research.

d. An understanding of the U.S. landgrant research system.

The EEP members selected were:

1. Dr. John P. Cherry, Director, USDA/ARS Eastern Regional Research Center Philadelphia, Pennsylvania. He is a Senior Executive, USDA/ARS, and Food Scientist/Biochemist with experiences in peanut product research in the Food Science Department of the University of Georgia Griffin Experiment Station and in crop product chemistry and utilization at the USDA/ARS Southern Regional Research Center, New Orleans, Louisiana. (Strengths: a, c, d).

2. Dr. Ray O. Hammons, Special Consultant to the EEP, and former Supervisory Research Geneticist USDA/ARS, Coastal Plain Station, Tifton, Georgia. He was formerly the USDA/ARS Peanut Research Program Leader. A highly respected scientist, writer and editor with International experience with peanut on three continents. (Strengths: a, b, c, d).

3. Dr. Allan J. Norden, Emeritus Professor of Agronomy, University of Florida, and formerly Peanut Research Program Leader for Florida. He has developed many popular peanut cultivars including Florunner which is presently the most widely grown one in the U.S. His peanut expertise has taken him to several countries in Africa and South America as a consultant on the crop. (Strengths: a, b, c, d).

4. Dr. Johnny W. Pendleton, Emeritus Professor of Agronomy, University of Wisconsin. Formerly Professor of Crop Production, University of Illinois, and Chairman of Agronomy, University of Wisconsin. International experience as Head of the Multiple Cropping Department and Leader of Farming Systems Research at the International Rice Research Institute (IRRI) in Philippines and Deputy Director General-Research of

the International Institute for Tropical Agriculture (IITA) in Nigeria. (Strengths: a, b, c, d).

The Board of Directors and Technical Committee felt that this four member EEP was manageable in size and collectively strong in the basic criteria used in the selection process.

3.2. Scope of Work

The scope-of-work plan followed by the Triennial Review by the External Evaluation Panel in 1985 was reviewed at the first organizational meeting of this EEP with the Peanut CRSP Board, the Technical Committee and the Management Entity in Griffin, Georgia, January 30-31, 1989. While the 1985 EEP's scope-of-work plan was extremely thorough, there was a concensus that the repetition which necessarily issued therefrom might be reduced by judiciously integrating some sections and shortening others, without sacrificing the overall evaluation objectives. The EEP was encouraged to consider a more concise, shorter form incorporating the primary points in the previous multiple or separate forms used for the U.S. institutions and each host country.

The evaluation format used evolved over the next four months, following extensive discussions among the EEP, the Program Manager and the Chairman of the Board at Texas A & M University on March 31, 1989. The final form (see next page) was agreed upon after several "trial writeups" by EEP members at a meeting of all the EEP and the Peanut CRSP Program Director at Niamey, Niger on April 16, 1989. Copies were mailed to the Chairman of the Board and the USAID Peanut CRSP Project Manager for comments.

A reader may now find all evaluation ratings and commentary concerning a particular project on adjacent pages. We also chose to group projects by U.S. institutions because these often were somewhat integrated.

All project ratings were coded as follows: E = Excellent; HS = Highly Satisfactory; S = Satisfactory; and NS = Not Satisfactory.

Several projects were just getting underway when the previous Triennial Review was made and thus our predecessors had some degree of difficulty in evaluating achievements. This EEP attempted to evaluate the various projects by their total output or accomplishments along with comments on present strengths and weaknesses, plus recommendations for the future. The ME was encouraged to prepare separate Appendices for Training, Publications, Linkages formed with other research organizations, and major Equipment items provided the host countries - not simply for the last three years, but over the life of the Peanut CRSP. This provided us with a better overall appraisal opportunity and we believe will aid all interested readers.

EXTERNAL EVALUATION PANEL ASSESSEMENT RATING
FORM FOR INDIVIDUAL PEANUT CRSP PROJECT[a]

1. Achievements[b] of objectives. . . . . ._____

1.1.-1.n. List

2. Implementation and Management of Projects

2.1. Administrative involvement

2.1.1. Attitude towards, support and perceived relevancy to the institution. . . . . _____

2.1.2. Fiscal/logistical assistance. . . _____

2.1.3. Resource commitment (faculty/facilities)_____

2.1.4. Comments

2.2. Researcher involvement

2.2.1. Attitude towards, support and perceived relevancy to the institution . . . . . _____

2.2.2. Fiscal/logistical assistance.. . . _____

2.2.3. Resources commitment (faculty/facilities)_____

2.2.4. Comments

3. Institutional Development

3.1. Complementarity to ongoing research efforts._____

3.2. Strengthening of scientist/equipment/facility capabilities. . . . . _____

3.3. Extent of collaborative interactions. . . . _____

3.4. Training. . . . . _____

3.5. Comments

4. Adequacy of Science

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[a]Code E = Excellent; HS = Highly Satisfactory; S = Satisfactory; NS = Not Satisfactory.

[b]Insofar as possible, put Host Country comments before U.S.

4.1. Progressiveness and innovativeness of the science/research. . . . . _____

4.2. Social science/economic impliations. . . . . _____

4.3. Appropriateness of research (basic/adaptive)_____

4.4. Comments

5. Applicability of Research

5.1. Relevancy and transferability of research to Host country/U.S. programs. . . . . _____

5.2. Relationship to other international research programs. . . . . _____

5.3. USAID host country of Peanut CRSP perceptions_____

5.3.1.-5.3.n. Comments

5.4. Comments

6. Observations

6.1. Strengths

6.1.1.-6.1.n. List

6.2. Weaknesses to improve

6.2.1.-6.2.n. List

7. Recommendations

3.3. Procedures

Procedure followed for Project Evaluation and Presentation. An organizational and planning meeting was held with the Peanut CRSP Board and Technical Committee on January 30-31, 1989 at the Management Entity (ME) Headquarters at Griffin, Georgia with all the External Evaluation Panel (EEP). At least two, and generally three or four EEP members visited all U.S. Institutions and Host Country Institutions during the period February-June, 1989. A detailed itinerary including the EEP participants, dates, institutions and individuals contacted appears in Appendix I.

Before making the visits, the EEP was provided past Annual Reports, the 1985 Triennial EEP Report, and miscellaneous other materials, including the Guidelines for the Collaborative Research Support Programs (CRSP) under Title XII of the International Development and Food Assistance Act of 1975, by the ME Program Director, Dr. David Cummins.

Principal and co-investigators, and administrators of the participating institutions were interviewed plus USAID agricultural mission officers in the host countries. A special effort was made to visit the International Crops Research Institute for the Semi Arid Tropics' (ICRISAT) new Sahelian Center at Sadore near Niamey in Niger for an appraisal of their expanded peanut research program in Africa and the past and future complementarity of the ICRISAT and Peanut CRSP programs.

Prior to our visits the ME office and AID Washington Peanut CRSP Director, Dr. Loren Schulze made arrangements with the appropriate local staff and in the case of foreign countries with the USAID Mission. An introductory and instructional letter was also dispatched which included brief biographies of the EEP members, explanation of the purpose of visits, and specific agenda items to be covered. These actions greatly facilitated the EEP's tasks and the courteous treatment received everywhere.

In addition to the oral research presentations and candid discussions centering around the predetermined format, the EEP was often provided voluminous research data and miscellaneous information about the collaborating institution or country.

This report was based on general guidance received from the Board of Directors and the General Guidelines of BIFAD and USAID and the collective observations and conclusions of the EEP members. Following the EEP's visits, a First Draft of this Triennial Review was written and presented to the Peanut CRSP Board of Directors, TC and ME at the American Peanut Research and Education Society at Winston Salem, North Carolina, July 10, 1989.

In September the EEP reviewed the new five year plans, budgets and accompanying justifications. EEP members provided individual numerical rankings for all projects and for new research thrusts to the TC.

The final draft was submitted to USAID in early mid-October and oral presentations made before the JCARRD/BIFAD Board and USAID personnel November 15-16, 1989.

3.4. Acknowledgments

Sincere appreciation is expressed to the Peanut CRSP Board of Directors, the Technical Committee, the Principal and Co-Investigators in both U.S. and host country institutions, and the staff at the Management Entity Headquarters in Griffin, Georgia, for their many courtesies, patience and professional help extended during the course of a stimulating educational experience for this External Evaluation Panel.

To Dr. David Cummins, Program Director, and Mrs. Barbara Donehoo we especially express our deepest gratitude for answering our numerous questions and supplying our every request - honestly and expeditiously.

The success of any research program depends primarily on the caliber of the personnel. In our opinion the success of Peanut CRSP as documented herein has again proven this old adage.

We trust that our observations will be constructive to all concerned.

John P. Cherry

Ray O. Hammons

Allan J. Norden

Johnny W. Pendleton

3.5. BACKGROUND INFORMATION ON PEANUT CRSP

The Peanut CRSP is global in nature (Figure 1.), because of the worldwide distribution of the crop, its importance in developing countries, and the 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. Key research locations are situated in three major world regions: SAT Africa, Southeast Asia, and the Caribbean.

3.5.1. Semiarid Tropical (SAT) Africa

SAT Africa extends across Africa South of the Sahara Desert and includes portions of Senegal, Mali, Mauritania, Burkina Faso, Niger, Benin, Nigeria, Cameroon, Chad, Central African Republic, and Sudan. Peanut is cultivated in SAT Africa for oil, direct consumption, and hay for livestock. The major use has been for oil but the changing oil market has minimized oil production except for Senegal. The high protein content of peanut makes it an important source of food where protein is inadequate in most diets, and the use in the region has shifted from an oil crop to a food crop. SAT Africa is characterized by a population beset with extreme poverty both in rural and urban areas. Peanut is one of the few crops with enough drought tolerance for the region. Also, it has a short maturity period for the short rainy season. Most of the crop is grown by peasant farmers on small holdings with usually less than one hectare of peanut. The importance of peanut in the economy, the often unrealized value of peanut as a direct food crop, and the great need for research answers to relieve constraints to increased production and utilization means placing SAT Africa in a position of high priority for research under the CRSP.

The key research sites in SAT Africa reach across the Sahel from Senegal to Niger and have a maximum of two to three projects per country. This spread was necessary to obtain expertise for projects addressing the constraints, and are representative of the region to facilitate linkage and technology transfer into other countries of the region.

Key countries are: Senegal, Burkina Faso, Niger, and Nigeria. Some pertinent points about the countries follow.

Senegal

Senegal is the western most country of the Region. It is divided by Gambia; the northern part lower rainfall, the southern part higher rainfall. Most of the peanut production area lies north of Gambia and the Gambia river. Production is generally higher than other Sahelian countries because of higher inputs of fertilizer and pesticides. Target production is set by the government at 1.2M hectares, but present area is less than 1.0M

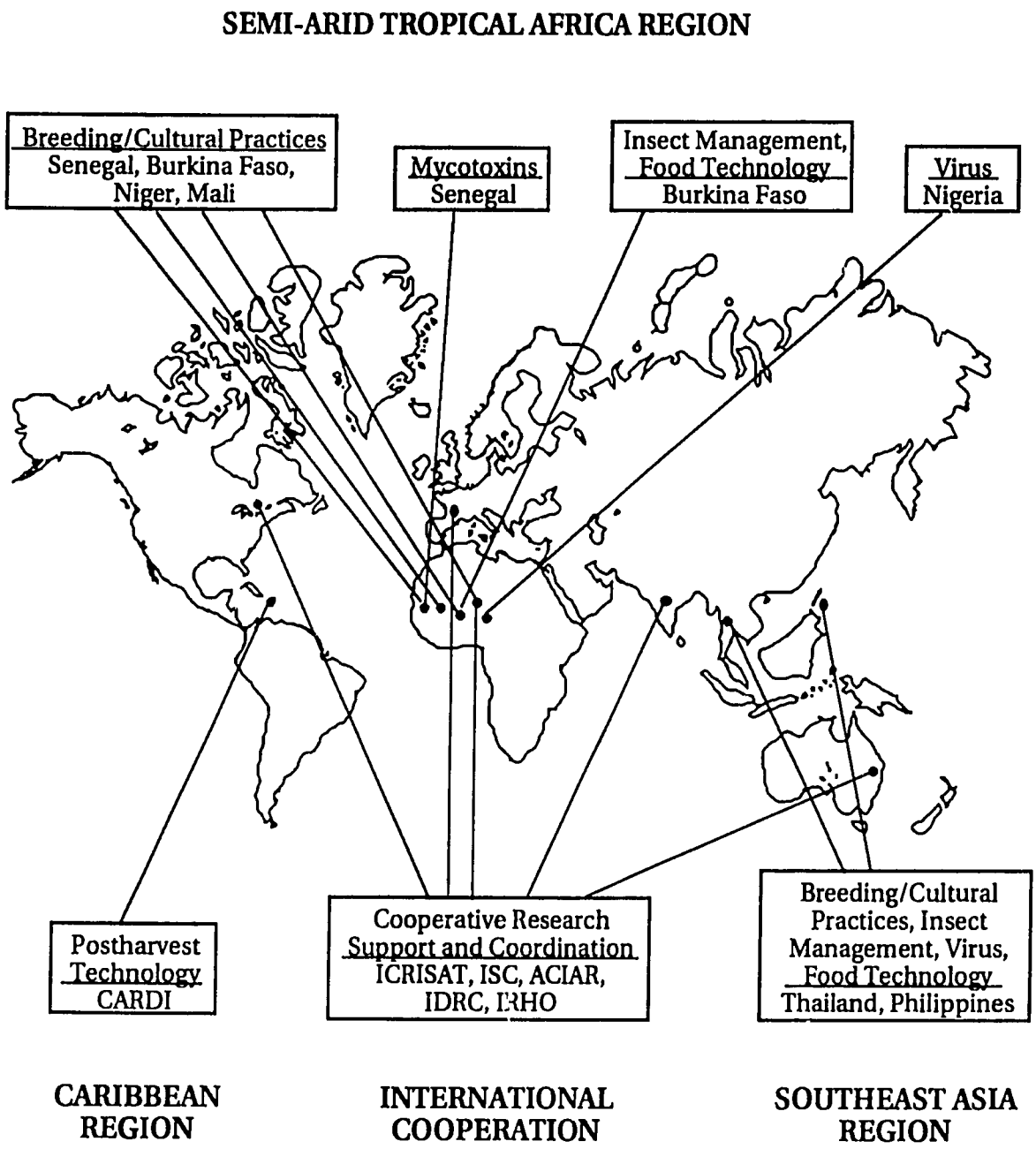

Figure 1. Geographic Coverage of the Peanut CRSP.

hectares.

Year	83/84	84/85	85/86	86/87	87/88	88/89
Area, 000 ha	937	874	607	808	846	903
Yield kg/ha	606	641	967	1011	1102	764

Peanut has been an important commercial crop for oil and oil meal production for many years. The crop was developed as an oil crop by the French, beginning in the mid-1800's. Competition from other vegetable oils for market share, drought, and aflatoxin problems are causing concerns in the Senegalese peanut industry. An increasing amount of peanut is going into domestic uses, and is a regular part of the diet in the production areas, especially. Agricultural research in Senegal is with the Senegalese Institute for Agricultural Research (ISRA). Peanut research began in Senegal in the 1920's by the French. The original station at Bambey is still the center for peanut research. Food and quality related research is the responsibility of the Food Technology Institute (ITA). The Peanut CRSP Breeding and Cultural Practices project is linked to ISRA with research located at Bambey and Nioro and at other locations as needed for a range of environments. The CRSP Mycotoxin Management project is located at Kaolack and Dakar. Both projects are led by Texas A&M University. Emphasis is placed on the local market in larger seeded cultivars for improved acceptance as an edible peanut and in lower aflatoxin content.

Burkina Faso

Burkina Faso is a land-locked country east of Mali. Peanut production was also developed there by the French. The drought years of the mid-70's caused a cessation of commercial oil production, which has not recovered and likely will not.

Year	82/83	83/84	84/85	85/86	86/87	87/88	88/89
Area, 000 ha	140	140	140	180	180	230	230
Yield kg/ha	550	571	500	711	696	635	720

Yield estimates for the latter years, are near 700 kg/ha. The near 150,000 tons produced annually are consumed domestically as a direct food source with some village level oil production. There is an increasing awareness of the food value of peanut. Early peanut research was an outreach of the French work in Senegal.

The agricultural research system comes under the Ministry of Higher and Secondary Education and Scientific Research. More basic research is done at the University of Ouagadougou and applied/demonstration research is with INERA (National Institute for Agricultural Research). Increased cooperation and technolgy flow is noted betweeen these groups. Extension is the responsibility of the Ministry of Agriculture. Because of interest

and training level of scientists, the Peanut CRSP is linked with the University. An Insect Management project is led by the University of Georgia, Breeding and Cultural Practices by Texas A&M University, and Food Technology by Alabama A&M University. Focus and local interest in the CRSP is to improve peanut for domestic use.

Niger

Niger lies east of Burkina Faso and north of Nigeria. Because of low rainfall further north, peanut production is along the Nigerian border in the East, and in the Southwest (south of Niamey). Similar to Burkina, the French-developed oil market fell with the mid-70's drought and is now a crop for domestic consumption. Early research again was an outreach from Senegal, beginning at Tarna (Southeast) in 1927.

Year	83/84	84/85	85/86	86/87	87/88	88/89
Area, 000 ha	159	140	100	100	100	130
Yield kg/ha	465	214	400	600	450	615

Rosette virus was a severe problem in the 1988 season in Eastern Niger.

The Peanut CRSP project on breeding and cultural practices is led by Texas A&M University and is located at INRAN (National Agricultural Research Institute) at the Maradi Station in Eastern Niger. Emphasis is on short season cultivars because of the short rainy period. In 1989, the cooperator from Niger spent three months in Texas. One goal was to make some crosses for Niger, which included rosette resistant germplasm along with short season material.

Nigeria

Peanut was an important commercial crop in Nigeria until drought and rosette virus devastated the crop in the early-to-mid 1970's. The crop has never recovered in importance. Mid-season maturity cultivars are adapted to the middle part of Nigeria (North to South); and cultivars have tolerance to rosette virus. Further north, rosette tolerance must be bred into the short season cultivars.

The Peanut CRSP virus project, led by the University of Georgia, has cooperated with Amadou Bello University at Zaria. Emphasis has been on basic studies of the epidemiology and causal agents of rosette virus. Progress in the research and the training of a breeder with virus research experience will enable the development of short season, virus tolerant cultivars for Northern Nigeria with impact also in Niger.

Mali

Mali lies between Senegal and Burkina Faso. Peanut production has a similar history; begun by the French in the mid-1800's. Early research was linked to Bambey, Senegal. Similarly, the production and market faded in the mid-1970's. Most of the peanut production is in the South and Southeast parts of the country, and is consumed domestically.

A newly negotiated agreement will formalize a linkage to the Texas A&M University Breeding/Cultural Practices project (Senegal, Burkina Faso, Niger). Emphasis will be on short season, disease resistant cultivars. Some informal collaboration and provision of germplasm by the CRSP has occurred earlier.

The EEP review did not include Mali.

Year	83/84	84/85	85/86	86/87	87/88	88/89
Area, 000 ha	97	97	97	97	110	115
Yield kg/ha	515	464	928	928	909	1000

3.5.2. Southeast Asia

Thailand and the Philippines were selected as the key countries for research in Southeast Asia. Environments are representative of the region for technology transfer, and there is institutional capacity for multidisciplinary research programs. In both countries peanut is grown by peasant farmers in less than one ha plots and most of the crop is consumed directly. Thailand exports some whole peanut and imports some oil and oilcake. A major research site is in Northeast Thailand at Khon Kaen, the poorest area of the country. The work will complement long range plans to increase peanut production. The Philippines are emphasizing increased production in Northern Luzon. Since both countries have needs for increased dietary intake (protein and total calories), and have a distinct poor rural and urban population, the Peanut CRSP is well suited and has a potential for short-term impact. Increased production is needed and can be accomplished by encouraging the use of peanut as a second crop in a rotation and production on farms where peanut has not been grown, and by stabilized or increased production per unit area. In addition to on-farm consumption, both countries have many small cottage scale processors where new or improved food products could be effectively promoted.

Burma and Indonesia have significant peanut production and could profit from information developed at the key country-sites in Southeast Asia. Linkage efforts can be extended to these countries as the program develops and information is available.

Key countries are: Philippines, Thailand. Additional information about the countries follow.

Philippines

The Philippines is an island nation east of Vietnam and north of Indonesia. The geography, many islands on a rather long north-south axis, leads to a diverse agricultural production system. In turn, research is spread to many locations to meet the needs of a diverse and geographically dispersed agriculture. Most agricultural products are consumed locally, with exports mainly in fruits. They are generally self-sufficient in rice production.

Peanut is grown on small plots by farmers throughout the country. The main production area is Northeast Luzon. Consumption is for snack foods. Peanut butter is produced mainly from imported peanut. Local production satisfies about two-thirds of the annual consumption.

Year	83/84	84/85	85/86	86/87	87/88	88/89
Area, 000 ha	46	47	50	45	51	50
Yield kg/ha	913	894	880	911	902	900

The agricultural research program is coordinated by the Philippine Council for Agriculture, Forestry, and Natural Resources Research and Development (PCARRD). The National Agricultural Research system includes Universities, Colleges, the Department of Agriculture, and the Department of Natural Resources, with more basic research by the colleges and universities and applied/on-farm work by the two departments. The Peanut CRSP projects are linked to the Institute of Plant Breeding (IPB) [staffed by University of Philippines at Los Banos (UPLB) scientists] and the UPLB. Projects are: NCSU/IPB for breeding cultural practices, NCSU/UPLB for insect management, NCSU/UPLB for rhizobia, TAMU/UPLB for mycorrhizae, and UGA/UPLB for food technology. Cultivar testing programs have recently expanded to Cagayan State University (Northeast Luzon) and the University of Southern Mindano. A PCARRD led Pilot program with a new CRSP developed cultivar and integrated pest management strategies is underway in Northeast Luzon with a goal to increase yields a modest 25%. Interest is high to transfer production and food technology (piloting of a cheese flavored peanut spread will begin soon) advances to the intended clientele.

Thailand

Thailand peanut production is concentrated in the North, Central, and Northeast areas of the country. The Northeast is a sandy, low fertility plateau, with rainfall levels just above the Semiarid Tropical classification. The Peanut CRSP has concentrated production related activities in the Northeast, which complemented a USAID Rainfed Development Project.

Peanut is a small farmer crop. Consumption is as roasted and boiled forms, and as additions to confectionary products. Most production is consumed domestically, although there is a small export of high quality peanut.

Year	83/84	84/85	85/86	86/87	87/88	88/89
Area, 000 ha	120	125	123	125	118	119
Yield kg/ha	1225	1376	1398	1352	1373	1429

Agricultural research is in the Universities (more basic) and the Department of Agriculture (DOA-more applied). There is generally a cooperative attitude between the two groups. The Peanut CRSP projects are collaborative with the Department of Agriculture, which coordinates the total effort and Kasetsart University (Bangkok) and Khon Kaen University. The NCSU/Thailand Breeding/Cultural Practices project links with the above three groups, the NCSU/Thailand Insect Management project with DOA and Khon Kaen University, the NCSU and TX/Thailand Soil Microbiology projects with DOA and Khon Kaen University, and the UGA/Thailand Food Technology project with Kasetsart University. Improved cultivars released due to the CRSP effort are being increased for distribution to farmers and integrated pest management practices are ready for farm testing. Peanut flour enriched noodles will be commercially tested. Thailand has a well coordinated effort aimed at moving technology to the farmer and consumer.

3.5.3. Caribbean

CARDI serves the agricultural research interests of 12 English speaking nations or islands from Belize through the lesser Antilles to Guyana. In most cases the people of this Caribbean region have low incomes and are undernourished. Peanut, although a minor crop at this time, has promise to alleviate in part these problems by supplying income to small farmers through sales in local and inter-island markets and to increase protein and caloric intake of both rural and urban poor. Presently, peanut is primarily consumed as snack foods, with some peanut butter production. There is very little oil production, and a significant amount of peanut is imported.

The countries represented by CARDI have varied climates (rainfall) and information developed could be transferable to other countries in the region and to other Central and South American Countries.

Key countries are: Trinidad, Jamaica, Belize, Antigua, St. Vincent, St. Kitts. Additional information about the Caribbean follows.

Some thirteen English speaking countries in the Caribbean are linked together economically through a group called CARICOM (Caribbean Community). The region is characterized by small

farmers and relatively low incomes, partially due to high cost of labor. Peanut is produced by small low-resource farmers, and except for Jamaica has a small area devoted to peanut. Most countries would have a maximum of 400-600 acres. Jamaica has had about 3000 acres until recently, with present acreage estimated at nearly 5000 acres. Production is either consumed locally or enters into inter-CARICOM trade. Jamaica limits imports. Consumption is largely as roasted peanut with some peanut butter and confectionary uses. The growth of the Jamaica production parallels an intense extension effort to distribute a new CRSP supported cultivar and to encourage better management practices.

Agricultural research in CARICOM is largely through the Caribbean Agricultural Research and Development Institute, headquarters in Trinidad and supported by the member countries. The Peanut CRSP collaborates through CARDI with major thrusts presently in Jamaica, Belize, Antigua, and Trinidad. CARDI is regional but works closely with local Ministries of Agriculture in research and extension efforts.

3.5.4. The Research Program

The Peanut CRSP was organized around a set of prioritized constraints to peanut production and utilization developed during the planning process from a worldwide assessment. The constraints were identified through site visits to 13 countries in Africa, South and Southeast Asia, South America, and to the Caribbean that were identified from cables sent out by USAID for expressions of interest; a worldwide survey through questionaires; and attendance to an International Workshop on Groundnut at ICRISAT where research results and production problems were discussed and also provided opportunity to interview researchers from a number of developing countries. Thirteen constraint areas were identified. The Planning Grant Team and Technical Advisory Panel selected five constraint areas as most important to include in the plan within proposed size and budgetary limitations. The constraints are:

a. low yields because of unadapted cultivars and lack of cultivar resistance to diseases, insects, and drought;
b. yield losses due to infestations of weeds, insects, diseases, and nematodes;
c. health hazards and economic losses due to mycotoxin contamination;
d. food supplies inadequate and peanut is not generally considered a primary food source;
e. physiological and soil microbiological barriers to higher yields.

Regional Research Programs

The constraints to peanut production were rather universal and served as a basis to develop projects in the various regions. Countries were located at key locations where the constraints were clearly evident and an interest and capacity to do collaborative research existed.

The relationship of research projects targeted to peanut production and utilization constraints in developing countries in the three regions is shown in the following chart.

See chart; "Summary - Peanut CRSP Projects and Constraints in Three Geographic Regions" on the following page.

Project codes identification: (Describes projects in chart)

(1)	TX/BCP/S,BF,N	- Disease-Resistant Peanut Varieties for Semi-Arid Environments.
(2)	TX/MM/S	- Mycotoxin Management in Peanut by Prevention of Contamination and Monitoring.
(3)	GA/PV/N,T,P	- Peanut viruses: Etiology, Epidemiology, and Nature of Resistance.
(4)	GA/IM/BF	- IPM Strategies for Groundnut Insects in SAT Africa.
(5)	AAM/FT/BF	- An Interdisciplinary Approach to Optimum Food Utility of the Peanut in SAT Africa.
(6)	NCS/BCP/TP	- Peanut Varietal Improvement for Thailand and the Philippines.
(7)	NCS/IM/TP	- Management of Arthropods on Peanut in Southeast Asia.
(8)	NCS/SM/TP	- Influence of Soil Microbiology on Nitrogen Fixation and Growth of Peanuts in Thailand and Philippines: A. Rhizobia.
(9)	TX/SM/TP	- Influence of Soil Microbiology on Nitrogen Fixation and Growth of Peanuts in Thailand and Philippines: B. Mycorrhiza.
(10)	GA/FT/TP	- Appropriate Technology for Storage/Utilization of Peanut.
(11)	GA/PH/CAR	- Postharvest Handling Systems for the Small Peanut Producer.
(12)	AAM/FT/CAR	- Peanut Utilization in Food Systems in Developing Countries.

SUMMARY - PEANUT CRSP PROJECTS AND CONSTRAINTS
IN THREE GEOGRAPHIC REGIONS

RESEARCH Research Projects	Primary Sites	CONSTRAINTS Low Yielding Cultivars	Health Hazards: Myco-toxins	Losses From Pests	Inadequate Food Supplies	Soil Micro-Biological Barriers
			SAT Africa			
(1) Breeding and Cultural Practices	Senegal					
	Burkina Faso	X	X	X		
	Niger					X
(2) Mycotoxin Management	Senegal		X			
(3) Peanut Viruses	Nigeria	X		X		X
	Philippines	X		X		
	Thailand	X		X		
(4) IPM Strategies	Burkina Faso	X		X		
(5) Optimum Food Utility	Burkina Faso		X		X	
			Southeast Asia			
(6) Peanut Varietal Improvement	Thailand	X	X	X		X
	Philippines					
(7) Mgt. of Arthopods	Thailand			X		
	Philippines			X		
(8) Rhizobia Influence	Thailand					X
	Philippines					X
(9) Mycorrhizal Fungi	Thailand					X
	Philippines					X
(10) Peanut Consumption	Thailand		X	X	X	
	Philippines		X	X	X	
			Caribbean			
(11) Post Harvest Concern	Caribbean			X	X	
(12) Peanut Utilization	Caribbean		X		X	

Note: Projects 8,9, and 12 are being phased out due to budgetary constraints.

3.5.5. Strategy

A strategy for accomplishing the goals of the Peanut CRSP formed the basis of the original plan, with a continued improvement in the execution of the strategy.

1. The research is located at key locations in three major regions in the developing world. The locations conduct research that is not only beneficial to the countries comprising the major locations, but provide information that will relieve production and utilization constraints in neighboring countries of the region. Key countries were selected by location, capability, and interest.

2. Develop linkages to non-CRSP countries in the region to disseminate information obtained at the primary locations, and conduct adaptive research if necessary to extend the research.

3. Plan and conduct workshops with regional participation to train researchers and disseminate research information.

4. Technical assistance is available through the program to provide on-site consultation in nonparticipating countries. Upon requests of USAID missions, appropriate U.S. scientists will be engaged to provide short-term consultation on specific problems.

5. A very important component of strategy is coordination with international centers, who by design and practice have an international capacity to conduct research and disseminate information. With proper planning and coordination, the CRSP and centers programs can be extremely complementary. The Peanut CRSP works closely with ICRISAT, which has peanut as a mandate crop. The ICRISAT peanut program leader is a member of the Peanut CRSP Board of Directors, plans are shared, and CRSP and ICRISAT researchers are in frequent contact. The breeding project in the Philippines has a cooperative linkage with IRRI through the Institute of Plant Breeding, University of the Philippines at Los Banos in the development of peanut cultivars to follow rice in a cropping system.

EEP REVIEW REPORTS FOR PROJECTS

4.1. EXTERNAL EVALUATION PANEL REVIEW

Peanut CRSP Code: TX/BCP/S,BF,N

Project Title: DISEASE-RESISTANT PEANUT VARIETIES FOR SEMI-ARID ENVIRONMENTS

Principal Investigators and Collaborating Institutions: Dr. Olin D. Smith, Texas A&M University, College Station, TX; Mr. J. C. Mortreuil, ISRA, Bambey, Senegal; Dr. Philippe Sankara, ISP, Ouagadougou, Burkina Faso; Mr. Amadou Mounkaila, INRAN, Niger.

Major constraints to peanut production in the countries of Senegal, Burkina Faso and Niger in West Africa include short seasons of annual rainfall, intermittent drought, poor soil moisture holding capacity, diseases, mycotoxin producing fungi, insects, nematodes and low soil fertility. The development of peanut cultivars with resistance or tolerance to these constraints, and that produce good yields of high quality seed and forage, would improve the quality of living, not only in these West African countries, but in the U.S. and other similar peanut production areas of the world as well.

Senegal has approximately 3.5 million hectares of tillable land. Cereals were grown on about 1.2 million hectares in 1987 and 1988 and peanut on 825,000 hectares. Rotations are practiced and very little fertilizer is used. The average fertilizer use in Senegal two years ago was 17 kg/ha because of economic and environmental reasons.

The Republic of Niger located south of Algeria and Libya, north of Nigeria, east of Mali and Burkina Faso, and west of Chad is by far the largest of the three host countries collaborating on this project. Niger has an area three times that of California with a population of seven million people of which 10% are literate. Although the official language in Niger is French, as is the case for Burkina Faso and Senegal, several native languages predominate in everyday life.

In the early 1970's, 400,000 tons of peanut were being produced annually in Niger. Now, primarily due to droughts and epidemics of groundnut rosette virus, the annual production is only 9,500 tons, all of which is used for food. This is only one fourth of the peanut quantity that could be used for food if available. The spanish-type peanut cultivar, 55-437, is the most popular cultivar grown in Senegal, Burkina Faso and Niger.

The program of the Peanut CRSP, TX/BCP/S,BF,N project, can be divided into four major sections: (1) Germplasm exchange and evaluation; (2) Disease resistance; (3) Productivity under drought stress; and (4) Training. The following project profile evaluation

resulted from visits to Texas A&M University on March 29-30, 1989 by three EEP members: Drs. R.O. Hammons, A.J. Norden and J.W. Pendleton; to Senegal on April 9-14, 1989 by Drs. A.J. Norden and J.W. Pendleton accompanied by the PI, Dr. R.E. Pettit; to Burkina Faso on April 11-14, 1989 by Drs. J.P. Cherry and R.O. Hammons accompanied by Dr. D.G. Cummins, Program Director; and to Niger on April 15-17, 1989 by all four EEP members accompanied by Dr. D.G. Cummins. While in Niger, the panel visited the ICRISAT Sahelian Center (ISC) located near Niamey and with four ICRISAT scientists; the Agronomist, Peanut Breeder, Pathologist and Physiologist that are assigned to work on peanut. The persons visited and the itineraries of the EEP for the U.S. University and host countries are given in Appendix I. In addition to the first hand discussions, the evaluation is based on visits to research laboratories, field plots, and on the Annual Reports and other written materials provided by the hosts and by Dr. D.G. Cummins.

1. ACHIEVEMENTS.....Highly Satisfactory

1.1. A significant impact of this project is the training of an M.S. degree student from Senegal (O. N'Doye) and one from Burkina Faso (M. Ouedraogo). Two other graduate students, one from Zaire and one from the U.S. also received M.S. degrees. The capabilities were improved of four non-degree scientists, one from each of the three host countries and one from Burma, through short-term (2 to 6 months) training programs at Texas A&M University and three Post Doctoral students. In addition to the on-site consultations provided by the U.S. scientists in the host countries, two workshops were conducted in Africa.

1.2. Germplasm exchange and evaluations: from the U.S. to Senegal ca. 200 lines and 18 early maturity populations; to Burkina Faso 30 lines/year for yield and quality evaluations in cooperation with ICRISAT in the West African Peanut Evaluation Program (WAPEP), and 80 entries for disease evaluations; to Niger 30 lines/year for yield and quality evaluations in WAPEP and 18 early maturity populations. The Texas program received for evaluation 310 lines from Burkina Faso, 25 from Senegal and 10 from Niger.

1.3. Two new experimental cultivars (PI 1174 with 90-day maturity and Sn 79-79 with 105-day maturity) with superior yield potential should be released in Senegal within two years. Another line, GC8-35, matures in 75-80 days and equals the yield of the standard cultivar, 55-437, which requires 90 days to mature. Thus GC8-35 would be a more dependable cultivar than 55-437 that is currently grown for edible use in northern Senegal. The first year of seed increase of GC8-35 will be in 1989.

1.4. Trials conducted with rosette virus resistant genotypes in different parts of Niger showed that the cultivar RMP 12

yields well and is suitable for the Gaya area, and KH 149B, also a good yielder, is suitable for the Maradi and Zinder areas. Rosette virus is a serious constraint in Niger.

1.5. TX798736-1, a spanish line with resistance to pythium pod rot, and sclerotinia blight, and reduced aflatoxin production with substantially higher yields than the presently grown cultivars is nearing release.

1.6. Progress on peanut breeding for drought tolerance by ISRA (Senegal) has been made possible by: (1) selection of genotypes within a given maturity range based on rainfall frequency and water balance simulation models; (2) selection based on rate of root system development which would result in maintenance of high water potential in the tissues during drought; and (3) selection for various physiological and/or anatomical characteristics. (D.J. Annerose, Oleag. 43:217-221. 1988)

1.7. A good correlation was found between the temperature of the peanut foliage and drought resistance. The test, though requiring further substantiation, would be a rapid, inexpensive method for the breeder.

1.8. Two cultivars ('Langley' and 'Tamrun 88') and four peanut germplasm lines (TXAG-1, TXAG-2, TXAG-4, and TXAG-5) were released by Texas A&M University. "Langley and Tamrun should have impact in the Southwestern U.S. production area and in West Africa. The "first sale" increase in gross return with normal penetration of Tamrun-88 in Texas agriculture can be estimated at 1.0 to 1.2 million dollars annually."

1.9. Multiple data assessments using two or more leafspot evaluation methods have been made on more than 1000 peanut introductions from South America accessed through joint efforts of IBPGR and Texas A&M University. Elite lines have been increased and included in field trials in West Africa.

1.10. Texas A&M scientists have identified immunity to several species of nematodes in a peanut line derived from interspecific crosses with two wild species of Arachis and are now making crosses to transfer the nematode resistance trait into an agronomically acceptable variety. The nematode problem is serious in Senegal between Kaolack and Bambey.

1.11. Progress is being made in breeding for tolerance to Aspergillus flavus/aflatoxin, but this is a long term program. Breeding lines were identified with moderate levels of resistance to invasion by the aflatoxin producing fungus.

1.12. Disease surveys in Niger, Burkina Faso, and Senegal reinforced the need for leafspot, rust and rosette resistant cultivars.

1.13. Scientists compared leafspot disease assessment methods and confirmed similarity of foliar disease responses in Texas and Burkina Faso.

1.14. Peanut CRSP has made possible an interaction of scientists among the West African countries, their U.S. counterparts, and other world institutions (see Appendix V). In fact, some of the scientists working in the West African countries had not met each other prior to Peanut CRSP.

2. IMPLEMENTATION AND MANAGEMENT OF PROJECTS

2.1 Administrative Involvement

2.1.1. Attitude towards, support and perceived relevancy to the institution..... HS

2.1.2. Fiscal/logistical assistance..... HS

2.1.3. Resource commitment (faculty/facilities)... S

2.1.4. Comments:

The administrative involvement in Peanut CRSP project TX/BCP/S,BF,N at Texas A&M and in the three host countries was highly satisfactory in two of the three categories. The host country collaboration in Senegal involves two government organizations (ISRA and ITA), and one in Niger (INRAN), while in Burkina Faso the collaboration is with the Institut Superieur Polytechnique (ISP) of the University of Ouagadougou.

2.1.4.1. Senegal. The panel had discussions with Dr. Mahamadou Ty (Director General of ISRA), with Dr. Ababacon N'Doye (Director General of ITA) and with the Directors of the Experiment Stations at Bambey and Kaolack. The Directors General both emphasized the importance of the training aspects of the Peanut CRSP to Senegal and hope that Peanut CRSP will continue to function in collaboration with their organizations in Senegal. Director General N'Doye sees the primary aims of peanut production in Senegal as being good quality seed for planting and consumption, drought and disease resistant cultivars, and information on fertilization.

Dr. Amadou Ba, Co-PI on the mycotoxin project (TX/MM/S), was appointed Director of the Kaolack Station in October 1988 and also is the Coordinator of the new CORAF Peanut Network which has eight projects on peanut including a project on drought stress and one on foliar diseases.

The peanut physiologist at the Bambey Station, Dr. Daniel Annerose, replaced Dr. J. Gautreau in 1983, but has been

working on the Peanut CRSP project for only the past year and without receiving any Peanut CRSP funds. Mr. Ousmane N'Doye, who recently completed the M.S. degree in plant breeding at Texas A&M University, had completed three months of his six-month trial period at Nioro, Senegal. Upon satisfactory completion of the trial period, Dr. J.C. Mortreuil, who had been conducting the breeding work at Nioro in the interim will turn over the work to Ousmane N'Doye, who will be hired by ISRA. Dr. Mortreuil will return to the Bambey Station full time. The salaries of the French scientists Drs. Mortreuil, Annerose and Khalfoui are paid by the French government organization, IRHO. At Nioro, Mr. N'Doye will be in need of a technician and perhaps more importantly a vehicle which is very difficult to obtain: the panel was told that one needs approval from the President of Senegal to purchase a vehicle.

2.1.4.2. Burkina Faso. The panel interviewed Dr. Philippe Sankara, Professor of Plant Pathology (ISP) of the University of Ouagadougou. Dr. Sankara, who is the collaborator for Burkina Faso on the project, gave a detailed presentation of the program using color slides, overlays, and handouts. Dr. Sankara has two technicians, a vehicle driver and laborers to assist with the field plot research. The major emphasis thus far has been germplasm evaluation mainly for foliar and soil borne diseases. The last two years tests have been conducted at five different locations: Gampela and Saria in the center of the country, Tenkodogo in the east, and Bobo and Niangoloko in the southwest. Because of diseases (rust, leafspots, rosette) and nematodes, especially in the west locations, it has been difficult to obtain good performance estimates.
A major constraint for Dr. Sankara is a reliable vehicle for transportation to the different locations, which he must visit every two weeks. Dr. Sankara has authorization to use the Institute of Rural Development (IDR) vehicle but the vehicle (a Jeep) is broken down and they cannot get parts to repair it. Also the Jeep uses a lot of gas, which is expensive, and the distance from Ouagadougou to Niangoloko is 500 km.

The progress with WAPEP has been good despite the problems and Dr. Sankara feels the evaluation should continue in six (rather than five) locations; and he is optimistic about using on-farm trials to compare the new cultivars with local cultivars.

2.1.4.3. Niger. In Niger, the panel interviewed the Deputy Director General of the Institut National de Recherches Agronomiques du Niger (INRAN) since the Director General, Dr. Idrissa Soumano, was out. Dr. Paul Hebert, Chief of Party of a USAID Contract in Niger involved with sorghum, millet and cowpeas, was present during the panel's interview with the Deputy Director General. INRAN is also involved with the INTSORMIL CRSP and may soon be involved in the Small Ruminant

CRSP. The main research station of Niger is at Maradi and this is the site for peanut improvement. There are eight other research stations in the country. The Deputy Director General is also Head of the Food Quality Laboratory in Niger. He remarked that INRAN is very appreciative of the Peanut CRSP program in Niger, and that without it the work probably could not be done. Currently there are no Ph.D.'s working on peanut in Niger but he is hoping that this situation can soon be remedied. Also, they want to review the breeding program that Mr. Mounkaila and Dr. Olin Smith are developing for Niger, and would like ICRISAT input before any finalizations are made. The PI Collaborator for the TX/BCP/S,BF,N project in Niger, Mr. Amadou Mounkaila, was at Texas A&M University taking a six-month training course in Plant Breeding and was interviewed by the panel during the panel's visit to Texas. Mr. Mounkaila is making crosses, attending classes in plant breeding, and planning the future peanut breeding program for Niger.

The attainment of self-sufficiency in food production is currently the main emphasis of agricultural research in Niger.

2.1.4.4. Texas. The Texas A&M University Administrators have been very successful in working with the PI, Co-PI's and Cooperators of the Peanut CRSP programs. The Breeding, Culture and Production project of Peanut CRSP meshes well with the on-going program at Texas A&M University. The administration at Texas A&M encourages faculty interchanges and foreign visitors and gave the panel a definite impression of being firmly in favor of Peanut CRSP. The CRSP concept of two-way benefits is strong at Texas A&M.

2.2. RESEARCHER INVOLVEMENT

2.2.1. Attitude towards, support and perceived relevancy to the institution..... HS

2.2.2. Fiscal/logistical assistance..... S

2.2.3. Resource commitment (faculty/facilities)... S

2.2.4. Comments:

The researcher's involvement for the U.S. PI's and host country collaborators on this project is highly satisfactory. A very extensive program involving intensive germplasm evaluation trials is being conducted in all the countries, which is important when selecting for complexly inherited traits involving multiple disease resistance, drought tolerance, and improved yield and quality. Progress will come from a program so designed. The panel received no adverse reactions concerning the logistics of travel or working in these

countries by the U.S. PI's. However, there is still some room for improvement in communication between the scientists, in fiscal matters, and in research equipment and facilities.

2.2.4.1. Senegal. In a visit to the physiology laboratory at the Bambey Station, the equipment, at least for the present, seemed adequate for carrying out the planned research. The laboratory was equipped to screen fairly large numbers of genotypes; e.g., the Rhizatron, consisting of 800 tubes, is capable of screening five replications of 160 lines at one time. Two ISRA greenhouses were renovated and temperature adjustment equipment was installed with CRSP funds.

The seed storage facility for the breeding program at the Bambey Station was not in use at the time of the panel's visit and appeared to have been inoperative for some time. Also, the pod pre-sizer needed repairs and the seed sizer more screens.

The logistic problems reported by the 1985 EEP have been corrected for the most part. There are still some problems with delays in reporting results and submitting receipts for expenditures, and the host country collaborators would like to receive budget information sooner from Peanut CRSP.

2.2.4.2. Burkina Faso. The collaborator, Dr. Philippe Sankara, conducts a large program of germplasm evaluation at five widespread locations. From these tests, he has identified a number of peanut lines with improved yielding potential, five with resistance to rust and leafspot, and a few with resistance to soil-borne diseases caused by Pythium, Rhizoctonia, and Sclerotium.

In the foliar disease screening, Dr. Sankara needs to take notes every two weeks at each location and is having problems keeping his vehicle operating. We saw the Jeep he uses during our visit to his station. The engine was pulled and it needed a head gasket, rings, etc. He shares the Entomology project pick-up truck when available, but this vehicle also was in need of repairs. They hope it will be fixed by planting time. Operating funds are received from Peanut CRSP each year and he uses some facilities of the University of Ouagadougou.

2.2.4.3. Niger. Currently, Amadou Mounkaila, the collaborator on this Peanut CRSP project, is the only one assigned to work full-time on peanut research in Niger. Prior to the severe droughts and epidemics of rosette virus disease in Niger, which reduced the peanut acreage to currently less than one-quarter million acres or about one fourth the acreage planted to peanut in the 1960's, there was an agronomist, pathologist and entomologist working on peanut in Niger.

Amadou sees the main contraints to peanut production in Niger as drought and rosette virus. They also have a problem with aphids. Peanut CRSP has provided operating funds for germplasm evaluation as well as for some equipment (calculators).

2.2.4.4. Texas. The scientists involved in this project at Texas A&M University are well-trained, with enthusiasm for their work. The working relationships between the different researchers, as well as the faculty-student relationships, are very good. The panel realizes that, for U.S. citizens, the work in so-called L.D.C.'s can be frustrating at times and detected that some scientists felt they should have made even greater progress during the first six years of the program's existence. However, the establishment of a good foundation is important, and this type of research requires extra persistence, patience, and time for major benefits to surface. The support of the administration, which this program in Texas obviously has, is another pre-requisite for success.

3. INSTITUTIONAL DEVELOPMENT

3.1. Complementarity to ongoing research efforts.... HS

3.2. Strengthening of scientist/equipment/facility capabilities..... S

3.3. Extent of collaborative interactions..... HS

3.4. Training..... S

3.5. Comments:

The complementarity of the Peanut CRSP Breeding, Culture, and Production project to the ongoing research efforts at Texas A&M and in the three host countries is highly satisfactory. The French had begun a peanut breeding program at the Bambey Station in Senegal in 1926, which is approximately the same time as similar programs were getting underway in the U.S. The breeding program at the Bambey Station released many superior cultivars that helped the peanut industry of West Africa flourish, until the severe droughts and epidemics of rosette virus disease drastically reduced peanut yields in the early 1970's and periodically thereafter. For a period of 10 to 15 years, from the early 1970's to the mid-1980's, the research program at the Bambey Station had been in a state of decline until, with the aid of Peanut CRSP and a dedicated and capable group of scientists, the program now appears to be gaining momentum.

In Niger, as was the case in Senegal, the peanut research program had been in a serious slump until Peanut CRSP began to

help out, and as was pointed out in Section 2.1.4.3., the Deputy Director General of INRAN remarked that without the assistance of Peanut CRSP, the work could probably not be done. At Texas A&M, the Peanut CRSP has strengthened considerably a program that was already strong in peanut cultivar development.

Excellent interdisciplinary networks established both at Texas A&M and in Senegal have contributed to the productivity of this program. In Senegal, there are the close interactions between ITA, ISRA, IRHO and ORSTOM, as well as with ICRISAT. Peanut genotypes from Dr. Mortreuil's breeding program at Bambey are screened for tolerance to A. flavus in Dr. Ba's laboratory in Kaolack and for aflatoxin by Dr. Kane in Dakar. The collaboration between the breeders at Bambey/Kaolack (Drs. Mortreuil and Khalfoui) and the Physiologist (Dr. Daniel Annerose), and with the scientists on the mycotoxin project, Dr. Amadou Ba (Pathologist at Kaolack) and Dr. Kane (Food Scientist at Dakar) is commendable. ISRA scientists also collaborate with the Botswana Research Department for seed multiplication, permitting two generations per year.

The panel also noted what appeared to be excellent collaboration between ICRISAT scientists at the Sahelian Center, Niamey, Niger and the Peanut CRSP scientists as well as between the administrators of the organizations. Five of the seven ICRISAT peanut projects in West Africa mesh well with those of the Peanut CRSP, e.g., general adaptability evaluations of introduced germplasm, foliar fungal diseases, groundnut rosette and peanut clump virus, drought resistance, and resistance to aflatoxin. An example of the collaboration is the exchanges of groundnut rosette virus stocks with the Peanut CRSP scientist working in Nigeria, Ms. Phindile Olorunju. INRAN also has good working relationships with ICRISAT.

ICRISAT scientists indicated that they would like more interaction with Peanut CRSP scientists in the research development phases and by the same token believe that Peanut CRSP scientists should be invited to participate in research planning sessions of ICRISAT and CORAF.

In each of the other two host countries, Burkina Faso and Niger, only one collaborator is assigned to the project, Dr. Philippe Sankara, ISP-Ouagadougou, and Mr. Amadou Mounkaila, INRAN, Maradi, respectively. In Burkina Faso there is a national program on foliar diseases and breeding with which Dr. Sankara collaborates. Materials identified as having resistance to diseases are being quickly moved to the National program.

The panel believes, as was pointed out in Section 1.1. of this review, that a major and long-lasting achievement of the project is the training at Texas A&M University of four M.S. degree students and four short-term non-degree trainees, representing

all three of the host countries.

The French scientists on the Peanut CRSP breeding project at Bambey have had five students from Dakar University working with them for several months to give them practical on-the-job experience. The one or two most promising will likely be hired for full-time work by ISRA.

The Peanut CRSP collaborates with National Departments of Agriculture in Senegal (ISRA and ITA) and in Niger (INRAN); while in Burkina Faso the collaboration is with the University at Ouagadougou. A difficulty with the arrangements in Senegal and Niger is that they do not provide for a teaching function whereby those that are trained in the U.S. would be in a position to train others when they return. The training aspects of the Peanut CRSP would likely benefit from linkages with universities in Senegal and Niger, as is presently the case in Burkina Faso, Nigeria, Thailand, and the Philippines. However, the University of Dakar has been shut down by student and faculty strikes for extensive periods during the past two years, so it may be fortunate that Peanut CRSP is with ISRA and ITA.

One of the problems associated with the training of host country scientists in the U.S. and other developed countries is that many of them frequently do not return to their home country to work upon completing their graduate degrees. Dr. Waliyar, Pathologist at the ISC, estimated that 80% of the Senegalese Ph.D.'s now work in France. Senegal does not require that their students return to Senegal to work after receiving their degree, whereas some other African countries have requirements that their students must return to the host country for various periods of time, e.g., 2-3 years for M.S. degrees and 5 years for a Ph.D. A major problem seems to be a lack of funds for the salaries of the returning students. Utilization of the graduate training opportunities at ICRISAT should be explored.

Mr. Mahama Ouedraogo from Burkina Faso is scheduled to complete an M.S. degree in Plant Breeding from Texas A&M University in May 1990. Dr. Sankara will ask the President of Ouagadougou University for a staff position for Mr. Ouedraogo to assist on the Peanut CRSP project. However, the International Programs Officer recommends that he should go on for the Ph.D. degree now if funds are available, since faculty tenure requires a doctoral degree.

4. ADEQUACY OF SCIENCE

4.1. Progressiveness and innovativeness of the Science/Research..... HS

4.2. Social Science/Economic Implications..... S

4.3. Appropriateness of Basic/Adaptive Research..... S

4.4. Comments:

In applied programs of plant breeding and crop production research, evidences of progressiveness and innovativeness are less obvious than in laboratories conducting basic research using the latest in high technology equipment. The panel in its review of this project noted that the scientists had utilized numerous innovations to aid them in progressing toward solving the problems and therefore give the project a highly satisfactory rating in this category.

In the semi-arid zones of West Africa, the climatic conditions vary from year to year and many different factors influence the final expression of yield. Since 1973, an overall annual reduction in rainfall has been observed, as well as a shortening of the useful duration of the rainfall season.

Prior peanut breeding research in West Africa concentrated on improving and stabilizing the agronomical performance of peanut by exploiting under field conditions the considerable between-cultivar variations in adaptation to drought conditions. The large annual variations in the environment in West Africa make it difficult to accurately assess the performance of peanut genotypes, and Annerose (Oleag. 43:217-221.1988) concluded that selection indices, based on physiological characteristics, would be a more rational approach to use in selecting parental lines and in the evaluation of the progenies from crosses for improvement of drought adaptation.

Two major climatic zones were distinguished in the northern half of the peanut basin affected by drought; a northern zone distinguished by a reduction in the potential length of the rainy season but with relatively low drought risks; and a central-northern zone distinguished by a longer rainy season but with considerable risks of drought during the growing season (Khalfoui, J.L.B. and D.J. Annerose. Colloque. Arachide. Niamey, p. 127-134. Sept. 1985). The aim of the breeding program for the northern zone is the development of peanut cultivars that mature in less time than the 90-day maturing cultivars currently being used there (e.g., in 75 to 85 days) and the goal for the second (longer rainy season) zone is to incorporate into the cultivars physiological characteristics likely to improve the plant's drought adaptation ability.

Dr. J.C. Mortreuil, the Co-PI on the TX/BCP/S,BF,N project, upon failing to find sufficient genetic variability in the U.S. germplasm looked elsewhere and commenced using recurrent selection breeding as a way of bringing more genetic variability into the Senegal program. He identified a line from China (PI 1174) that matures in 90 days and produces superior yields.

To speed progress, the breeders in Senegal, through collaboration with Botswana, produce two generations per year of some of their peanut crosses. Dr. Sankara, to enhance the work of screening genotypes for resistance to rust disease, is detaching leaves from plants and inoculating them with rust spores in an incubator. This technique permits him to screen for rust disease in those years when rust is absent or spotty in the field plots. However, his incubator capacity is too limited to screen all entries of a test simultaneously. He is also proposing to artificially inoculate plots with Sclerotium rolfsii, the principal soil-borne disease in Burkina Faso, to get around the problem of nonuniform natural field infections.

Peanut breeders in Senegal are already planning experiments for irrigated peanut crops as the reservoir above the new dam on the Senegal river near St. Louis is beginning to fill with water. When the reservoir is filled approximately 250,000 hectares in Senegal can be available for irrigated crops.

The economic and social science implications of the research on this project were judged as satisfactory and the panel was favorably impressed with the balance of the basic/adaptive aspects and with the appropriateness of the research program.

5. APPLICABILITY OF RESEARCH

5.1. Relevancy and Transferability of Research to Host Country/U.S. Programs..... HS

5.2. Relationship to Other International Research Programs..... S

5.3. USAID Perceptions..... HS

5.4. Comments:

The relevancy and transferability of research on this project is highly satisfactory to the host countries and the U.S. At the present time, however, the results appear to be more relevant to the needs of the host countries than to the U.S.

The identification of line GC8-35 that matures in 80 days will provide more dependability for farmers in northern Senegal. The yields of GC8-35 are not high, but in northern Senegal peanut is grown mainly for food and farmers will likely utilize this new line as insurance.

At Nioro, Senegal yield losses of 30 to 40% have been reported from cercospora leafspot diseases which reinforces the need for resistant cultivars. Similar results were obtained in Niger

and Burkina Faso, and plant disease surveys conducted in the three countries also reinforce the need for rust and rosette virus resistant cultivars.

The average peanut yield in Senegal is approximately one ton per hectare, while the average yield in Experiment Station research plots is three tons per hectare indicating to some extent a need for better technology transfer.

Transferability of research is much needed and emphasized in Niger. The Winrock organization has recently employed a full-time person from England (Ms. Christine Okali) to develop closer liaison between research, extension and farmers in Niger. The Niger government currently is buying peanut seed from Nigeria to give to their farmers for planting.

Trials conducted with high yielding rosette resistant genotypes in different parts of Niger showed that the RMP 12 cultivar was suitable for the Gaya area and KH 149 B was suitable for the Maradi and Zinder areas. There is an urgent need for the multiplication and distribution of these cultivars to farmers. The government of Senegal is trying to encourage the private sector to supply farmers peanut production needs, such as seed, fertilizer, pesticides, etc. The government had been providing all the planting seed but now supplies only one third of the seed (seed for one out of three years). Farmers must save their own seed for two out of every three years and can buy some fertilizer and other production needs from the market.

During the meeting in Niamey with ISC personnel, the consensus of the scientists present was that peanut production for local edible uses will be increasing in West Africa in the future.

The U.S. will absorb and apply technology developed in this program as will other areas of the world. The peanut germplasm collected from the host countries and throughout the world will be utilized to continue the improvement of U.S. peanut cultivars as the achievements reported by this program illustrate.

The U.S. and host countries of the TX/BCP/S,BF,N project have very good working relationships with ICRISAT and IRHO. Dr. C.E. Simpson, Co-PI at TAMU, also collaborates with FAO-IBPGR in peanut germplasm collection and evaluation. While relationships with international peanut research organizations are generally advantageous, it is important that the objectives of the different organizations do not overlap significantly. This is especially important in peanut breeding research since a breeder and his limited help can handle only a relatively few trials before becoming overwhelmed with the physical aspects, and this problem can be even more pronounced for the PI's in the host countries.

All the panel were present for a meeting with two of three USAID officers stationed in Niamey, Mr. K. Mullally and G.F. Fuller. The third officer, Mr. E. Gibson, was on vacation at the time of the panel's visit. The Peanut CRSP seems to have excellent rapport with USAID/Niamey. The USAID officers thought that Peanut CRSP was getting a lot out of the little money ($5,000/year in support of Mounkaila's program) that they are putting in Niger. For comparison, the USAID support of INRAN in the cowpea, millet, and sorghum program is 20 million dollars over five years.

In addition to rosette disease, the need for trained personnel was discussed as being a major constraint to peanut production in Niger. If Mr. Mounkaila meets the requirements, USAID would be willing to support his Ph.D. program for three years, providing he starts by the Fall of 1989. Station Management training is currently receiving short term training emphasis in Niger. Last year, due to the better than recent years' amounts of rainfall, Niger was self-sufficient in cereals. The USAID/Niamey officers didn't know much about CORAF, the new peanut research network in West Africa, but questioned overlapping and why ICRISAT could not handle the objectives of CORAF.

The panel found the USAID Mission personnel in Ouagadougou to be well-informed and highly supportive of Peanut CRSP. They had also been involved with the Title XII Strengthening Grant with the University of Georgia and University of Ouagadougou. The panel met with Mr. Herbert Miller, USAID Mission Director, and Dr. B.B. Traore, Rural Economist.

The USAID /Dakar Mission involvement with the Peanut CRSP is currently focused on monitoring program progress and participating in briefings by the Peanut CRSP scientists. The officers interviewed, Mr. Wayne Nilsestuen (ADO) and Mr. Doral Watts (Project Officer and Peanut CRSP Coordinator), see the Peanut CRSP as complementing their efforts to develop a sustainable agricultural research network. The USAID/Dakar Mission has worked through bilateral projects with both ISRA and ITA, the institutions involved in the Peanut CRSP projects. The current USAID officers in Dakar appear to have a very positive relationship with the Peanut CRSP and, on the basis of the 1985 EEP report, the situation in the USAID/Dakar office has improved 100%. In this review, the USAID/Dakar officers met with the panel on two occasions: on Monday morning before the panel reviewed the Peanut CRSP program and on Friday afternoon for a longer session prior to the panel's departure from Senegal. During the last session, which included the Director General of ISRA, Dr. Mahamodou Ly, Mr. Watts pointed out the need of providing a technology transfer package approach - moving the research to the farmers - a point which was given full backing by Dr. Ly.

6. OBSERVATIONS

6.1. Strengths.

6.1.1. The ingenuity of the scientists in using the best known breeding methodology to increase the chances of success in their programs, e.g., broadening the genetic variability base of the program by introductions and through the use of recurrent selection, and by using the best known screening methods in breeding for aflatoxin and leafspot disease resistance.

6.1.2. The panel sensed a high degree of expertise and new approaches to attacking drought at the Bambey Station in Senegal, site of the world's oldest research program on peanut drought resistance. The Physiologist, Dr. Annerose, working closely with the Breeder, Dr. Khalfoui, is making some progress in the search for suitable selection criteria that can accelerate progress on the complex challenge of breeding for drought resistance.

6.1.3. The graduate training provided at Texas A&M University of four M.S. degree students and short-term training programs for the host country's collaborators and other non-degree scientists is worth noting.

6.1.4. Excellent collaboration was observed between the scientists in the different disciplines within the U.S. institution and within the host countries, and between all the institutions and ICRISAT.

6.1.5. The relevancy and transferability of the research, not only to the U.S. and host countries but also to other countries with similar agroecological environments will stimulate progress.

6.1.6. The transfer of immunity to several important species of nematodes and resistance to cercospora leafspot diseases from wild Arachis species into the cultivated species by Texas A&M University scientists opens the door for peanut breeders to vastly improve or eliminate these two weaknesses in the commonly grown peanut cultivars.

6.1.7. The several drought and disease tolerant lines under multiplication for cultivar release exemplifies the accomplishments of the project.

6.2. Weaknesses and Options to Improve.

6.2.1. Some of the host country PI's have been slow in getting their results summarized and reported. At the time of the

panel's visit to Senegal the 1988 results had not yet been sent to the U.S. PI for incorporation into the Annual Report.

6.2.2. The host country PI's would like to receive more complete and punctual reports from the U.S., more rapid responses to their letter requests, and more timely information on the budget.

6.2.3. The lack of close collaboration with the peanut virus project (GA/PV/N,TP) may be delaying progress on the development of rosette virus resistant cultivars.

6.2.4. Much of the equipment that was available to the host country collaborators was old and in various stages of disrepair, transportation vehicles included.

7. RECOMMENDATIONS

7.1. To date, peanut breeders have no practical selection indices to assist them in breeding for drought tolerance or for aflatoxin resistant cultivars. Although some progress has been made in identifying traits related to drought tolerance and to aflatoxin resistance, this type of basic research is urgently needed but may not be best suited in this project.

7.2. Obtaining germination tests of planting seed prior to using in yield trials and other tests will permit adjusting seeding rates to compensate for inferior quality seeds. Also, by planting treated seed at a higher than recommended rate followed by thinning to desired stands should help avoid poor stands. Poor stands generally result in erroneous conclusions and the researchers would be better to destroy such tests.

7.3. Funds are needed to help get the taxonomic information describing new peanut species in which Co-PI's T. Stalker (NC/BCP/TP) and C. Simpson (TX/BCP/S,BF,N) are involved, published so it is available for use by other scientists.

7.4. This project (TX/BCP/S,BF,N) should interact more closely with the Entomology and Virus projects (GA/IM/BF, NSC/IM/TP and GA/PV/N,TP) of Peanut CRSP to incorporate into the breeding programs in Texas and West Africa the germplasm identified as having resistance or tolerance to insects and/or viruses. The GA/IM/BF project has shown that millipedes and termites increase the aflatoxin problem in peanut. The panel recognizes, however, that the breeders in the U.S. and host countries are not able to handle any extra nurseries above what they are now growing without an increase in funds for supplies, equipment and labor.

7.5. The project could expand its benefits in West Africa by collaborating with the GA/PV/N,TP project in breeding for GRV

resistance which, next to drought, is the most serious peanut production constraint in West Africa. Selection indices for GRV resistance are sorely needed since the virus is not a problem every year in all locations and progress in selection for resistance should not be tied to disease epidemics. Also, what is most needed is plant genotype resistance to the pathogen rather than resistance to the insect vector (aphids) which gives partial control.

7.6. Continue long term training (at Ph.D. level if possible) of host country scientists. The individual receives much more respect when he returns with a Ph.D. degree. Therefore, qualified and compatible student candidates for training in the U.S. should be identified. Also, the graduate training opportunities at ICRISAT should be explored.

7.7. Research is needed on how and where to grow good quality peanut seed in Senegal and on seed storage, possibly seed storage could be given more emphasis in the USAID project that, at the present, mainly involves cereals.

7.8. It would be advantageous to the U.S. and host countries if additional funding were made available in order that a nematologist could be added to this project (TX/BCP/S,BF,N) at Texas A&M University to better address the increasingly serious nematode problems in West Africa and the U.S. The increasingly stringent regulations being placed on nematocide use in the U.S. makes the development of nematode resistant varieties more important. If research on nematology is added to this project there should be close collaboration with ICRISAT and ORSTOM scientists in West Africa as well as with other nematology research programs in the U.S.

7.9. The breeding of rosette virus resistant peanut lines needs increased emphasis in all three of the host countries in collaboration with the Peanut CRSP GA/PV/N,TP project. Seed stocks of KH 149A, an early maturing spanish market-type cultivar resistant to GRV, that was released in Burkina Faso about ten years ago, should be repurified and reevaluated in Niger and in other areas where rosette virus is a problem, e.g., south of the Gambia river in Senegal. At the present time, the KH 149A (so-called resistant) cultivar is only partially resistant to rosette virus, a condition that Dr. Mortreuil attributes to either accidental seed mixtures or to a breakdown of resistance due to a variant strain(s) of the virus.

7.10. There appears to be an urgent need for a peanut germplasm maintenance bank in West Africa, and for improved seed storage facilities for the various breeding programs. The ICRISAT Center at Niamey may be planning to fulfill this need for the region, however, every breeding program should have some type of seed storage facility on location which would require some

additional funding.

7.11. The scientists in the U.S. and host countries would benefit by being able to utilize at an earlier date the research results (positive or not) from each other's evaluations of germplasm, screening techniques, etc. Also, the scientists should spend a little more time together, if possible, to discuss budgets and research progress and plans, and it would be helpful to host country collaborators if they could be supplied with periodic print-outs of money spent and balances in their accounts. Perhaps a greater use of electronic mail services could be arranged.

7.12. All host country and U.S. PI's and collaborators benefit by participation in International meetings and this activity should continue to be encouraged. Two host country collaborators at the Bambey Station in Senegal have not had an opportunity to visit peanut research centers in the U.S. and would benefit by participation in a training session in one or more U.S. programs, possibly in conjunction with attending an annual meeting of the American Peanut Research and Education Society (APRES). To date the APRES meetings scheduled in July have conflicted with their peanut crossing experimental work.

7.13. Mr. Amadou Mounkaila should be receiving earlier generation materials from Texas for evaluation in Niger. The panel feels that Mr. Mounkaila is capable of handling the selection work, but someone should go to Niger after a year or so to review his progress and assist him if necessary. Dr. Waliyar, ISC Pathologist, is willing and could be of much help to him in this work.

7.14. Summary TX/BCP/S,BF,N. This project as currently planned is sound and its continuation is strongly recommended by the panel. Significant strides, as outlined in the achievements, have been made in the four major areas of the project: Germplasm exchange and evaluation, disease resistance, productivity under drought stress, and training. The project's goals continue to be highly relevant and complementary to the research programs in the host countries and the United States. The attitudes and involvements of the project's PIs, cooperators and administrators are outstanding and greater expectations from this project are on the horizon. The panel feels that the above recommendations would help improve the project but for various reasons may not be possible to carry out.

4.2. EXTERNAL EVALUATION PANEL REVIEW

Peanut CRSP Code: **NCS/BCP/TP**

Project Title: **Peanut Varietal Improvement for Thailand and Philippines**

Principal Investigators and Collaborating Institutions: Dr. Johnny C. Wynne, North Carolina State University, Raleigh, NC; Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD), Dr. Remedios Abilay, University of Philippines at Los Banos (UPLB), and Institute of Plant Breeding (IPB); Dr. Aran Patanothai, Thailand - Department of Agriculture (DOA), Khon Kaen University (KKU), and Kasetsart University (KU).

Three members of the Panel visited NCSU at Raleigh, NC, 23-24 February and all four EEP members visited the Philippines 10-15 March and Thailand 16-22 March 1989. We interviewed the principal and co-principal investigators and senior agricultural administrators of the participating institutions and the agricultural personnel of the USAID missions in Manila and Bangkok (for details, see Appendix I).

The review was conducted on the basis of discussions with the personnel visited, oral and visual presentations, handouts, previous annual progress reports, the 1985 Triennial Review, a brief summation of graduate theses, training rosters, conference reports and other materials developed through peanut research of the Collaborative Research Support Program.

Peanut is presently the most important field legume crop in the Philippines in terms of area planted, total production and economic value. With the national average pod yield of about 900 kg/ha, domestic production does not meet consumer needs. Breeding is geared toward developing higher-yielding, disease- and pest-resistant cultivars for upland, lowland, and partial shade environments.

Peanut is the major food legume and oil crop of Thailand. Yields are low, averaging about 1250 kg/ha on the approx. 100,000 ha grown annually. The crop is generally grown in the upland area in the rainy season (rainfed) and in paddy fields following rice in the dry season (irrigated). The breeding goals are very similar to those in the Philippines.

The NCSU peanut breeding project, begun in 1929, has long had a leadership role for research capabilities in peanut cultivar improvement. The program has the major responsibility of developing the large-seeded peanut for production in the Virginia-Carolina area.

Assessment Ratings* for Host Countries and U.S.

1. **ACHIEVEMENTS**.....: ____E____

1.1. Philippines

1.1.1. A multidisciplinary team (breeders, plant pathologists, entomologists, and a virologist) was organized and met annually for planning research to solve problems associated with adapting peanut to the different growing conditions and to overcome factors limiting production.

1.1.2. Three cultivars have been released: 'UPL Pn2', 'UPL Pn4' and UPL Pn6. 'UPL Pn6' has moderate resistance to leafspot and rust diseases, superior seed shape and color, market product quality, and has an average yield advantage of 14 percent compared to the standard cultivar. Pn6 has the potential of increasing the return to the Filipino grower by more than $3.5 million. Also, the new cultivar sustains production at less cost.

1.1.3. Cultivar UPL Pn6 is currently being promoted through the PCARRD-funded and coordinated Peanut Development Action Project (PDAP), part of the Government of Philippines' thrust on improved food and nutrition, increased income generation and accelerated countryside delopment. This on-farm program introduces and tests new technologies. In 1989, PCARRD involved 172 farmers with a total of 65 ha of peanut in the Project.

1.1.4. Many new genotypes were introduced into the Philippines from NCSU or ICRISAT and a significant hybridization program was initiated. The program has evolved into a full-scale breeding program where hybrid populations appropriate to the production environments have been observed and measured for agronomic potential, pest resistance, and drought tolerance in nurseries, multi-year and multi-locational yield trials. The latter included on-farm trials for candidate cultivars.

1.1.5. The PI, Dr. Remedios M. Abilay has reorganized the IPB peanut investigations into seven major thrusts that focus upon production constraints. Women scientists are project leaders in most instances.

1.1.6. Thirty shade tolerant genotypes have been identified and placed in intercropping yield trials under coconut in

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*Code: E=Exceptional; HS=Highly Satisfactory; S=Satisfactory; NS= Not Satisfactory.

Quezon, Davao, Bicol, and Leyte. This transfer of technology program is being funded by the Rainfed Resources Development Project (RRDP) of USAID. Shade tolerant genotypes have the potential for great impact for food security by expanding the peanut production area through intercropping.

1.1.7. Four new entries (JL-24, IPB Pn48-75, IPB Pn48-90, and IPB Pn42-14) have been accepted into the National Cooperative Testing (NCT) project which is funded by World Bank. Through NCT, the best entries in terms of yield and other agronomic characters are approved and released by the Philippine Seed Board as cultivars recommended for commercial planting.

1.1.8. A new testing site for wet season yield trial and seed production was established at San Fernando, Pampanga to facilitate the peanut cultivar improvement program.

1.1.9. Scientific knowledge and professional expertise of Philippine peanut scientists have been significantly expanded through on-site reciprocal visits, in-country workshops, international conferences, sharing of publications, and professional study leaves (see Section 3.5.1 and Appendix II for more detail).

1.1.10. Three excellent publications concerning peanut were published in the Philippines in 1985 by PCARRD with Peanut CRSP support:

A) Peanut, is a 116 page Proceeding of the first national peanut consultation and Peanut-CRSP review, PCARRD Book Series No. 39, and contains 13 technical papers.

B) The Philippines Recommends for Peanut, PCARRD Tech. Bul. Ser. No. 35A, is a 76 page manual on production, harvesting, aflatoxin, and food technology.

C) Abstract Bibliography of Peanut Researches is a state of the art publication of information from the PCARRD computer information system.

In addition, the Collaborative Research Project prepares an annual progress report for the several studies conducted by IPB peanut investigators.

1.2. Thailand

1.2.1. The Thailand Coordinated Groundnut (peanut) Improvement Program was established for the purpose of utilizing the strengths of the individual institutes and unifying the research effort. The Coordinated program developed a viable national scope of work and served as the basis for initiating support in 1982 with both the Peanut CRSP and the International

Development Research Centre (IDRC) of Canada. The sixth annual workshop was held in 1989.

1.2.2. Three new cultivars have been released with Peanut CRSP support: 'Khon Kaen 60-1', '60-2' and '60-3'. 'Khon Kaen 60-1', a medium-seeded type, yields more and has larger fruit and seed than local cultivar 'Tainan 9'. 'Khon Kaen 60-2', the first improved boiling type peanut released in the country, has superior yield and better pod characteristics than the standard cultivar previously grown for this commercial use. 'Khon Kaen 60-3' has the largest (73 g/100) seed of all Thai cultivars, has higher shelling percentage and yields than the standard, and exhibits some resistance to diseases and insects. 'Khon Kaen 60-3' was re-selected in Thailand from 'NC7' material supplied by NCSU to Thai breeders as part of Peanut CRSP support. In addition, cultivar 'Lampang' has been recently selected and recommended for the before-rice cropping system. The release of 'Khon Kaen 60-3' was awarded the outstanding research accomplishment for 1988 by the Thai Department of Agriculture. The new cultivars have average yield increases ranging from 10 to 20 percent. When coupled with recommended cultural practices (which are available to farmers), an average advantage of 24 percent occurred in farmers' field. Using the new cultivars and the low input, management practices have the potential to return an additional 42,000 metric tons of peanut with a current value of $20 million.

1.2.3. More than 2,800 peanut genotypes have been introduced and screened in the Thai peanut improvement program sponsored by CRSP and 300+ local crosses have been made by breeders.

1.2.4. Six major diseases occur on peanut in Thailand and their epiphytological patterns have been elucidated in project research. Notable among these investigations are:

1.2.4.1. Symptoms similar to those caused by Peanut Stripe Virus (PStV) were noted in Thailand as early as 1973. PStV has been extensively investigated by Dr. Sopone Wongkaew, a Co-principal investigator of this project, Khon Kaen University, as to symptomatology, mechanical and insect (aphid) transmissibility, morphology, seriology, epidemiology, host range, inoculation technique, molecular biology, economic importance and resistance screening. More than 30,000 genotypes/breeding lines were screened <u>without finding useful resistance</u> to the disease. Dr. Wongkaew spent the first six months of 1989 in a laboratory in Montpellier, France comparing "live" isolates of PStV from around the world.

1.2.4.2. No evidence was found for different races (or biotypes) of peanut rust, but isolates of black leaf spot differed in virulence.

1.2.4.3. Several genotypes have been identified with useful resistance for both leaf spot and rust. (This result confirms cooperative research between USDA-ARS, the University of Georgia, and ICRISAT, published earlier in this decade).

1.2.4.4. Over 13,000 progeny were screened for resistance to toxin-producing Aspergillus flavus. Although some material was initially classified as "resistant", that reaction did not hold under all environmental conditions. These findings are similar to results reported under Peanut CRSP project TX/MM/S elsewhere in the EEP review.

1.2.4.5. Screening for reaction to Aspergillus crown rot has detected some lines that appear useful.

1.2.5. The cooperation between breeders, pathologists, entomologists, virologists, and others interested in peanut has improved in Thailand under the CRSP.

1.3. North Carolina State University

1.3.1. The peanut breeding project at NCSU was able to expand research capabilities due to support from the Peanut CRSP. This increased effort contributed to the development and release of three cultivars: the higher yielding 'NC 9' and 'NC-V 11' and the cylindrocladium-black-rot-resistant "NC 10C'.

1.3.2. 'NC 10C', a large-seeded virginia market type, is expected to become a key component of a program to control the fungal disease by genetic resistance, with a minimum hazard to the environment from chemical use. The disease is a major limiting constraint in the Virginia-Carolina production area.

1.3.3. At least 20 theses and dissertations have come from the project and some 10 graduate students are currently investigating a core of problems at the cutting edge of peanut science (see Appendix II).

1.3.4. At the time of our review, project participants had published 28 refereed journal articles, had numerous manuscripts in review or in press, had published 35 abstracts of presentations at scientific societies, and had contributed to and/or edited Proceedings of workshops/conferences at ICRISAT, Khon Kaen, Thailand, and Malang, Indonesia (Appendix III).

1.3.5. Interspecific hybridizations were effected to introgress desirable traits from wild Arachis species into the domestic A. hypogaea cultigen.

1.3.6. The Arachis wild species living plant collection was maintained at NCSU and evaluated cytogenetically.

1.4. General accomplishments

1.4.1. A commonality of breeding aims and disease constraints in the host countries and in North Carolina has facilitated communication between scientists, enhanced research progress, and expedited transfer of results to farmers and consumers.
1.4.2. Germplasm from NCSU was introduced into the Philippines (178 crosses, 210 germplasm accessions) and Thailand (629 crosses and 1603 accessions).

1.4.3. Native cultivars collected in Thailand and Philippines were added to the world germplasm pool.

1.4.4. Hybrid populations appropriate for researching the constraints identified in each HC were developed at NCSU and sent to the HC and evaluated for agronomic potential, disease-insect-virus reaction, maturity, drought tolerance and other ecological parameters.

1.4.5. In collaborative research among the three institutions, the biology and ecology of major pathogens were studied to provide information, techniques, and germplasm which became the nucleus for new breeding initiatives in each country.

1.4.6. Scientific knowledge and expertise were expanded in the Philippines, Thailand, and the U.S. The impact of these accomplishments will continue long beyond the life of the project.

2. IMPLEMENTATION AND MANAGEMENT OF PROJECT

2.1. Administrative involvement

2.1.1. Attitude toward, support and perceived relevancy to the institution.....: E

2.1.2. Fiscal/logistical assistance.....: S

2.1.3. Resources commitment (faculty/facilities)..: HS

2.1.4. Comments

2.1.4.1. Philippines

The Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD) is the institution in the Department of Science and Technology with the specific task to manage basic and applied agricultural research across

disciplines through national research centers and universities. There are 48 colleges/universities in the network. Four centers were initially designated for peanut research with University of Philippines at Los Banos (UPLB) having the lead multidisciplinary role. Among legumes, peanut has the No. 2 national priority (behind mungbean).

The cultivar improvement team at UPLB is comprised of the PI/breeder as team leader and another breeder, a pathologist, an entomologist, and associates in plant physiology, microbiology, virology, and soil science for the seven project leaders. The scope of the disciplines reflects the support and perceived revelancy of the Peanut CRSP project(s) to the Institute of Plant Breeding of UPLB.

Working within the government's thrust on improved food and nutrition PCARDD conceived the Peanut Development Action Project (PDAP) to accelerate movement of technology to the country side. The PDAP initially evaluated peanut component technologies only in two locations in the major production area, but for the 1988-89 season two additional regions were included.

A further measure of administration support is shown by the research on shade tolerant peanut genotypes in field trials at 5 locations, which is financed by the Rainfed Resources Development Project (RRDP).

The EEP met with PCARDD Executive Director Dr. Ramon V. Valmayor; Deputy Director for Research and Development Dr. Dely P. Gapasin; and Dr. Crisanto R. Escano, Director, Crops Research Division and Peanut CRSP coordinator for the Philippines. They are enthusiastic supporters of the cultivar improvement and the other Peanut CRSP projects at UPLB. The EEP also had a brief visit with Dr. Ricardo Lantican, previous PI for NCS/BCP/TP and CRSP coordinator, who is currently Undersecretary of Science and Technology (see Appendix I).

The objective of the project is to improve the research base to provide technology for increasing peanut production to meet the increasing consumer demand.

2.1.4.2. Thailand

Peanut CRSP funding in Thailand is administered through the Department of Agriculture (DOA) and Dr. Vichitr Benjasil, Director, Field Crops Research Institute, is project coordinator. DOA has overall responsibility for production research. The Coordinated Groundnut (Peanut) Improvement Research Program linked DOA with Khon Kaen (KKU) and Kasetsart Universities (KU) as participating institutes, and established the basis for collaborating with Peanut CRSP. Assistance from

the Canadian International Development Research Centre (IDRC) was also available (1982-88).

Peanut research personnel in Thailand participate in annual research planning sessions. When we compared the level of research in peanut cultivar improvement reported by the PI, Dr. Aran Patanothai, at the Bangkok Workshop in 1983 with that reported by him to the panel in 1989, the gains that have accrued with the coordinated scheme are immediately apparent. (see Accomplishments, Sec. 1.2, above).

Resource commitment is Highly Satisfactory for Thailand.

2.1.4.3. North Carolina State University (NCSU).
The senior administrators in the College of Agriculture and Life Sciences (CALS) (see Appendix I) perceive the Peanut-CRSP as the most highly effective and visible of the three CRSP programs in which NCSU participates. They view the Peanut CRSP in general, and the NCSU projects in particular, as having:

- enabled the PIs to expand North Carolina peanut research in ways they could not otherwise have done (see Section 3.5.3., below);
- provided new insights in genetic enhancement and pathogen/pest resistance (examples are cited in Section 4.4.3., below);
- increased significantly the quality and quantity of graduate, undergraduate, and post-graduate training (Appendices II and III).
- developed new knowledge and technology of benefit both to LDC and U.S. agriculture, and began transfer of the technology to farmers, and other users of research;
- enhanced worldmindedness on the part of participating faculty; and
- forged new linkages on a continuing basis with PCARRD, Thai DOA and Universities, ICRISAT, IDRC, ACIAR, IRRI (Appendix V).

Peanut CRSP is cited by the administrators as having encountered fewer fiscal or management difficulties than other CRSP programs. As an example of resource commitment, the CALS provided "bridge funding" during a money shortage as Peanut CRSP changed to a different fiscal year.

The EEP rated Administrative Involvement of the project at an

overall Highly Satisfactory level. The attitude of agricultural research administrators in the two host countries and at NCSU, together with their perception of two-way benefits of Peanut CRSP, is such that the full and continued involvement of the administrators is assured.

2.2. Researcher involvement

2.2.1. Attitude toward, support and perceived revelancy to the institution.....: E

2.2.2. Fiscal/logistical assistance.....: HS

2.2.3. Resources commitment (faculty/facilities).: E

2.2.4. Comments

2.2.4.1. Philippines

The CRSP project in the Philippines collaborates with the Institute of Plant Breeding (IPB) at the University of Philippines Los Banos (UPLB). Breeding work at UPLB started on a modest scale in the early 1970's. During the Peanut CRSP work has expanded to cover the major thrusts of a conventional peanut breeding project. The breeder and PI (from 1986), Dr. Remedios M. Abilay reorganized the unit into seven studies, each with a team leader. Dr. Abilay received her degree at UPLB in 1981 where her thesis research established criteria of selection for shade tolerance in peanut and mungbean.

After her designation as host country PI, Dr. Abilay spent a six-month study leave in 1986 as a visiting scientist at NCSU where her breeding research focused upon biological nitrogen fixation.

The panel perceives Dr. Abilay as a competent breeder who has done a good job, but she appeared to be somewhat reticient in taking credit for the achievements. Instead, she gave generous credit to the study leaders, each of whom presented their field and/or laboratory research progress to the Panel.

We noted that more than one-half of the study leaders were women. (Well trained women scientists were encountered by the EEP on Peanut CRSP projects in the Philippines, Thailand, and in Jamaica).

In addition to her responsibilities of leading the multidisciplinary team for peanut, Dr. Abilay also has duties of teaching plant breeding in the graduate program at UPLB.

Dr. Virginia Ocampo, PI for a companion project, NCS/IM/TP at UPLB, is the co-principal investigator for the entomologic

component of the peanut breeding program in the Philippines. Also, Dr. Marina Natural, a plant pathologist and PI for the GA/PV/N,TP, project at UPLB, is the co-principal investigator for the virology component in peanut breeding. These cross-linkages are perceived both by UPLB/IPB and NCSU as advantageous for all projects.

The contributions and evaluations for Drs. Ocampo and Natural are given in the other respective project reports.

2.2.4.2. Thailand

When the Peanut CRSP linked with the Thai Coordinated Groundnut Improvement Program the project involved personnel at three research institutions: The Department of Agriculture (DOA), Kasetsart University (KU), and Khon Kaen University (KKU). DOA Bangkok had the mandate for peanut but lacked personnel; KU had some personnel but lacked field plot land; KKU had a mandate for the Northeast and the best trained breeder. During the life of this project the major thrust has shifted to KKU.

Dr. Aran Patanothai, the PI, is a well-trained, experienced peanut breeder, who participates in international scientific conferences and cooperates well with NCSU PI and co-PIs. He leads a strong and progressive team. The coordinated peanut program involves breeders, entomologists, virologists. The field crop area includes 40 hectares and the project has 20 professional staff.

Three breeders work with Dr. Aran Patanothai at KKU, Mrs. Somjintana Toomsan and Mr. Surapong Charoenrath are with DOA, and Dr. Sanun Jogloy is assigned to KKU. Mr. Charoenrath is completing the field phase of his research at KKU for the Ph.D. at NCSU. Dr. Jogloy recently completed his graduate studies in peanut breeding with Dr. J. C. Wynne at NCSU (Appendix II).

The EEP was impressed with both the extensive trials and the diversity of research in progress. The program includes the entire spectrum of peanut breeding from the crossing nursery to farm trials.

At Khon Kaen the working collaboration is very strong between co-principal Thai investigators for the three Peanut CRSP projects: NCS/BCP/TP, NCS/IM/TP, and GA/PV/N,TP.

At Kasetsart University, the major thrust for the NCS/BCP/TP project is the plant pathology component, under the leadership of Dr. Tharmmasak Sommartaya. Continuous progress has been made concerning disease constraints with four graduate students - all women - conducting thesis investigations on

Aspergillus flavus/aflatoxin, biocontrol of leafspot, rust, and southern blight.

Dr. Aran Patanothai mentioned to the EEP that there had occasionally been delays in fund transfers (see Section 6.2.3.)

2.2.4.3. North Carolina State University

The PI, Dr. Johnny C. Wynne, is an outstanding research scientist and teacher, with an excellent performance as the leader of the CRSP peanut cultivar improvement projects in the U.S. and Southeast Asia. He and his co-principal investigators, Drs. M. K. Beute and H. T. Stalker, integrated and welded together a single multidiscipline project by combining three separate proposals originally submitted to Peanut CRSP. Each of the three scientists exhibits full appreciation for the collaborative mode and their program exemplifies how three disciplines can work together toward a common goal.

Researcher involvement is rated as Excellent. The attitude and enthusiasm of these scientists and their graduate students are evident in their maintaining a strong relevance for U.S. research interests while giving logistical support with personnel (Messrs. Anderson and Fitzner) on year-long assignments in the Philippines and Thailand and providing excellent graduate and post-graduate training for personnel from those and other countries. The three PI's and their students are at the "cutting edge" in peanut scientific research.

Dr. Wynne recently assumed the position of Department Head for Crop Science at NCSU. Senior administrators in the College of Agriculture and Life Sciences assured the EEP that they are committed to sustaining a high level of expertise in the peanut breeding programs in North Carolina and in this Peanut CRSP, with minimum slackening as an experienced breeder and CRSP project PI is recruited.

3. INSTITUTIONAL DEVELOPMENT

3.1. Complementarity to ongoing research efforts.: ___E___

3.2. Strengthening of scientist/equipment/ facility capabilities.....: ___E___

3.3. Extent of collaborative interactions.....: ___E___

3.4. Training.....: ___E___

3.5. Comments

3.5.1. Philippines

Linkage with the Peanut CRSP unified the peanut researchers into a collaborating multidisciplinary team. Projects expanded to ten study areas each with a team leader, but the program was later re-focused on seven areas of research to develop cultivars adapted to the upland, lowland and partial shade environments available for expanding peanut production to meet the needs of the small farmer.

An annual consultation of peanut researchers developed from the workshop jointly sponsored by PCARDD and Peanut CRSP in 1985.

Equipment funded by Peanut CRSP for use in the Philippine breeding project included a peanut thresher, a programmable electronic calculator, an IBM compatible computer with hard disc, a motorcycle, a pickup truck, soil testing equipment and materials.

PCARRD's State of the Art Abstract Series for Peanut, and the Scientific Literature Service, with a computerized data bank including current projects and peanut literature, are resources available to IPB and Peanut CRSP needs.

Perhaps the most significant impact of the project has been the improvement of expertise through graduate and short term training. A domestic degree candidate at NCSU worked on breeding for a year at IPB where he grew the F_1 and F_2 progenies of crosses between drought-tolerant and agronomically adapted cultivars, and assisted with the overall program. Two Filipino scientists (V.M. Aguino and Victoria Matalog) obtained M.S. degrees in plant pathology at NCSU in 1987 with total support from CRSP.

The PI, Dr. Abilay, trained for 6 months at NCSU, and other project personnel have trained for shorter periods at NCSU (E. D. Redona) or ICRISAT (A. Pua, C. B. Adalla, R. E. Tabien).

The EEP was somewhat surprised that the UPLB with its excellent facilities has not granted any recent M.S. or Ph.D. degrees in peanut breeding or the related sciences. Thus, there appears to be a continuing need for sending students overseas.

We were not impressed with the field plots we observed where screening for tolerance to strongly acid soils was apparently being conducted with an inappropriate statistical design.

3.5.2. Thailand

Since Peanut CRSP linked with the Thai coordinated peanut program, eight annual national meetings have been held to plan and coordinate research.

The Thai PI, Dr. Aran Patanothai, participated in "post-doctoral" research in peanut breeding at NCSU for eight months and has studied for shorter terms at ICRISAT.

Two Thai students received Ph.D. training in peanut breeding from NCSU. Ten graduate and 10 undergraduate students worked as research assistants in the Thai program and more than 50 other undergraduates received practical training in peanut improvement projects. Short course training on peanut production was organized for DOA and Extension personnel.

The EEP noted that one of the peanut breeders at DOA-KKU and the four graduate students completing M.S. theses in peanut plant pathology at KU were women. The number of well-trained women scientists affiliated with the Peanut CRSP projects in Thailand was impressive.

Bill Anderson, a Ph.D. candidate at NCSU spent one year at KKU in Thailand performing collaborative research on resistance to foliar fungal disease under CRSP support.

Peanut CRSP funds provided germplasm, technical expertise of the U.S. PI's visiting Thailand, books, scientific literature, and equipment for strengthening the project. Project personnel participated in international conferences at Malang, Indonesia and ICRISAT, at the CRSP workshop at Khon Kaen, and at annual meetings of the American Peanut Research and Education Society (APRES).

Additional information concerning collaborative interactions is reported in Section 5.4.2. (below) and in Appendix V on linkages to other international programs.

3.5.3. North Carolina State University

The EEP observed and reviewed considerable evidence that this CRSP has strengthened institutional development at NCSU and the research capabilities of the three U.S. principal investigators (Drs. Wynne, Beute and Stalker) in numerous ways, including by:

- Funding to permit expansion of the breeding/pathology/cytogenetics program to areas of U.S. constraints in ways it could not have expanded solely with State support;

- Forging a more-closely knit group of senior scientists in all phases of peanut research and enhancing the synergistic interchange of information and ideas between team members, other Peanut CRSP PI's, their graduate students, research fellows and assistants;

- Generating a global awareness on the part of some cooperators which led to a re-evaluation of the University's role in international agriculture;

- Attracting quality graduate students and post-doctorals;

- Attracting mature scientists from other countries (and international centers) to conduct sabbatic research at NCSU;

- Making very significant contributions to international and national scientific literature (See Appendix III); participating more frequently and at a higher level in international and domestic scientific conferences, symposia and workshops (Appendix IV), and providing editorial leadership for publications in the peanut venue; and

- Enhancing the reputation of NCSU as a recognized world leader in peanut research.

The EEP toured the laboratories and greenhouse facilities for peanut research at NCSU in Raleigh, and two of us (AJN & ROH) are familiar with the land available for field plot research and the long-term germplasm storage unit at Lewiston. We believe the facilities are appropriate for the research.

The team at NCSU has integrated the in-state and host country projects into complementary programs. Competent NCSU personnel were placed for one year each in Thailand and the Philippines for research on problems of mutual interest. Two Filipino and two Thai students have received graduate training at NCSU and three of these have returned to the host countries to apply new technologies. Both host country PI's spent 6-8 months at NCSU conducting studies of mutual interest there and at home (see Appendix II).

Dr. Wynne and Co-PIs (Drs. Beute, Stalker and Gross) have directed 7 completed Ph.D. dissertations and 13 completed M.S. theses investigations on peanut with full or partial support from Peanut CRSP. Another 6 Ph.D. and 4 M.S. studies are in progress (Appendix II). The PIs have served on the graduate committees for students trained at NCSU under CRSP projects NCS/IM/TP and NCS/SM/TP.

Dr. Dale Rachmeler, a former USAID project officer, completed his Ph.D. training in peanut research at NCSU with total support from CRSP. He is currently a contractor with USAID in Niamey, Niger.

From the information available the EEP perceives that the NCSU PIs have worked well together despite budget constraints, including re-allocation of funds, and the loss of funds when budget cuts were made.

We assign the rating of Excellent for the Institutional Development portion of our report.

4. ADEQUACY OF SCIENCE

4.1. Progressiveness and innovativeness of the science/research.....: HS

4.2. Social science/economic implications.....: HS

4.3. Appropriateness of basic/adaptive research..: E

4.4. Comments

4.4.1. Philippines

Peanut is one of the major edible legume crops in the Philippines where about 66% are consumed as food, 26% as feed, and 8% are used as seed. The goals of this project are not only to reduce the constraints of low yields and disease susceptibilities, but to exploit the advantages of new cultivars and new technologies in the cropping systems used in the country.

Research has been more sharply focused by CRSP participation and is now organized into seven studies with a responsible study leader. Since each of these used established procedures of applied crop biology and production, there are few measures of "progressiveness". However, several facets of the work are noteworthy:

- The number of ongoing studies on peanut cultivar improvement in 1989 was 3.6 times the number of projects undertaken in 1982 (11 vs. 3).

- The budgetary allocation for research had a corresponding increase since peanut was assigned a top priority in the National Legumes Research and Development Program (3.4 million Pesos, with 1.4 million contributed by CRSP).

- o Peanut was chosen for one of the 18 Development Action Projects under the coordinating umbrella of PCARDD's Crops Research Division.

- o Peanut is also a test crop included in the Negros Province Crops Diversification Project.

4.4.2. Thailand

The three new cultivars will increase supplies of food for each of the several ways peanut is consumed: boiled, roasted, snacks, food ingredients, and as peanut butter.

Significant progress was made in all breeding objectives in Thailand. Several genotypes with desirable traits and higher yields than standard cultivars have been identified and advanced to widespread final trials. This is applied research at its best.

However, the breeders at Khon Kaen are well-trained, progressive, and have field trials equivalent to those at any world location observed by the panel members. They have introduced into Thailand germplasm (in large part from cooperation with NCSU) that has become the nucleus for new breeding initiatives. They have integrated the disciplines of crop science, plant pathology, and entomology.

Moreover, a Thai co-principal investigator on this project, Dr. Sopone Wongkaew, is one of the more knowledgeable and productive peanut virologists in the world. (He has become the in-country PI for the GA/PV/N,TP CRSP).

We encourage Thai breeders to continue emphasis on developing additional cultivars of the boiling and large-seeded types, and urge them to co-ordinate this research with the food technology Peanut CRSP (GA/FT/TP) at KU.

4.4.3. North Carolina State University

NCSU scientists in this project are using basic and applied research to develop stable improved cultivars, buffered against major production constraints, for use in the cropping systems of North Carolina and the host countries.

Basic and applied research was used in North Carolina to develop and release cultivar NC 10C with resistance to the debilitating fungal pathogen Cylindrocladium black rot (CBR).

Innovativeness is shown by the decision to station two NCSU research associates in the host countries (one each in Thailand and Philippines) for one year to give assistance in all aspects of the overall programs while placing personal emphasis upon

research for their eventual Ph.D. dissertations.

A "conventional" peanut breeding program is generally considered to be applied research. The one at NCSU is applied in that it meets the needs of the growers, industry, and consumers in the state and area.

There are, however, several areas of very progressive basic research underway. Examples:

- The scope of scientific tools that can be brought to bear on peanut breeding has been broadened by the introduction of biotechnology to affect hybridizations between different wild relatives (*Arachis* species) of the cultivated peanut, using the "embryo rescue" technique.

- Resistance to peanut rust and leafspot diseases has been transferred from *Arachis* species into the cultigen *A. hypogaea*, and an acceptable market type is under development.

- Five or 6 genetic linkage groups have been mapped for peanut, which is much more difficult for cytogenetic research than most crop species.

- Peanut CRSP has permitted NCSU investigators to collaborate on research concerning pathogens and disease problems which are not yet present in the U.S. peanut belt.

- NCSU researchers have grown in their ecological perception and in their geographic perspective of world agriculture.

- CRSP is partially supporting work on genetic transformation of peanut for resistance to the tomato spotted wilt virus (TSWV).

- Scientists in other disciplines at NCSU are bringing their techniques to peanut because they are attracted by the levels of skill and cooperation among members of the multidisciplinary group.

4.4.4. General Comments

One of the goals of the research is to exploit the advantages of newly-developed adapted cultivars in the cropping systems of Thailand, Philippines, and North Carolina. We believe that the symbosis between CRSP projects NCS/BCP/TP and NCS/IM/TP has facilitated progress toward this goal.

The Peanut CRSP BCP is essentially applied biology. As such it depends primarily upon the disciplines of agronomy, genetics, plant pathology, entomology, etc. However, for inputs in the rural social sciences and agricultural economics, Peanut CRSP depends upon PCARRD in the Philippines and the Department of Agriculture in Thailand for the supporting contributions to farming systems studies. These agencies can then assimilate and advance the technology and promote its transfer and adoption once they are attained.

The agricultural knowledge level in Thailand and the Philippines has been strengthened to a significant degree as there were effective HC institutions with which to interact. Small farmers (including women) are expected to benefit most, in the short term, from the newly-improved cultivars which diminish certain production constraints (early-maturing, more disease/insect resistant) and therefore, should be more cost effective. In the long term the LDC population will benefit from the wider selection (boiling type, better quality) of edible protein food, the lower production costs, reduced human health hazard, and enhanced nutritional value of the new cultivars.

5. APPLICABILITY OF RESEARCH

5.1. Relevancy and transferability of research to Host country/U.S. programs.....: ___E___

5.2. Relationship to other international research programs.....: ___E___

5.3. USAID perceptions of Peanut CRSP.....: ___S___

[The EEP visited with USAID Missions in Manila and Bangkok concerning common interest items pertaining to the active Peanut CRSP projects in the Philippines and Thailand. Therefore, the material in Section 5.3 should be similar for each project report: NCS/BCP/TP, NCS/IM/TP, GA/FT/TP, and GA/PV/NI,TP). See Appendix I for itinerary and individuals contacted.]

5.3.1. CRSP relationships with USAID Missions in Manilla and Bangkok are good. Mission directors and agricultural officers are knowledgeable about and supportive of Peanut CRSP. An aura of good will, particularly with the Mission in Manila, was developed during the two-year Joint Career Corps assignment of Dr. David Cummins there.

5.3.2. The EEP discussions in Manila were with R. W. Ressequie, Chief, Agricultural Development Division. The Mission does not really get involved in Peanut CRSP but shifts the burden of disbursing and monitoring funds to PCARRD (which is part of PCARRD's function). Peanut CRSP is perceived as fitting well

in its niche. Future thrusts in agriculture include natural resources and transfer of technology. The Rainfed Resources Development Project (RRDP) of USAID, which has supported the variety improvement project's yield testing of shade tolerant peanut cultivars intercropped with coconut at five locations, will end in 1991. This appears to be an adequate time frame.

The new strategy is for USAID to become more involved in science (read as biotechnology) according to Mr. Ressequie.

Currently, there is no support within the Mission for "buy-ins" with Mission funds.

5.3.3. In Bangkok, the EEP met with Doug Clark, Director, Office of Technical Resources, and Dave Delgado, Director, Agricultural and National Resource Development. Briefly stated: "USAID has no problems with CRSP. It is doing well. We approve travel".

We were told that Thailand now had achieved all of the bench marks of a Newly Developed Country (NDC).

Many traditional USAID projects are being concluded and replaced. The future thrusts are: Science and Technology, Natural Resources and the Environment, and Agricultural Technology Transfer. Basically, this will boost extension. There will be more support for developing food standards, food processing, etc. The aflatoxin concern seems to be focused upon corn.

Subsequently, we were informed that the new USAID strategy for Thailand was due to commence in October.

Peanut CRSP was advised to keep centrally-funded projects. Then the "window" would be open for "buy-ins" if funds became available.

5.4. Comments - Applicability of Research

5.4.1. Philippines

Peanut cultivar improvement research at IPB is generally on target. Cultivar development has been accelerated. In addition to the release of UPL Pn-2, UPL Pn-4 and UPL Pn-6, a stem rot resistant cultivar candidate, 'Pn 1-174', is awaiting approval for release by the Phillippine Seed Board.

National Cooperative Tests funded in collaboration with the World Bank has expanded these trials to several Universities in Luzon and other Regions. The shade tolerant trials interplanted with coconut at five research centers is funded by the Rainfed Resources Development Project of USAID. PCARRD

has funded the Peanut Action Development Project as part of its program to extend technology to the small farmer.

By exchange of germplasm IPB obtained several nurseries from the ICRISAT Center.

IDRC Canada co-sponsored peanut variety improvement research at IPB for several years and has entered selections from IPB in the Asian Rice Farming Systems Network.

Acid tolerant genotypes developed in IPB have been entered in the ACIAR funded trials in Indonesia. Also, since IPB is adjacent to IRRI, pest-tolerant or higher-yielding cultivars and genotypes tolerant of shade or acid soils can be introduced through the ASEAN Farming Systems Network to 14 countries in Southeast and South Asia. (See Appendix V for more information concerning these linkages).

5.4.2. Thailand

While the breeding program in the Philippines is geared toward developing cultivars for upland, lowland, partial shade and acid soil environments, that in Thailand aims to develop better cultivars for the main rainfed and dry season (irrigated) production but also for before-rice and after-rice rainfed growing conditions. Specific emphasis is placed upon end-use suitability for the boiling and roasting trade, and on tolerance to soil salinity.

Therefore, the programs have common goals only for the central core of breeding objectives: desirable agronomic traits and resistance to plant pathogens. While there is specific germplasm exchanges of advanced breeding lines with these characteristics between the two host countries, we found no plans for a cooperative binational cultivar testing program.

Much of the Thai peanut crop is grown in the Northeast where Khon Kaen is located. This region is recognized by the government as the most poverty stricken region of the nation.

Two major developments in this region can be combined to help achieve the Peanut CRSP goals to improve availability and consumption of food, and increase the income of the poor.

First, the CRSP-sponsored cultivar improvement project has developed and released three improved peanut cultivars in the program headquartered at Khon Kaen University. These cultivars are moving into Thai peanut production channels. Seed available for planting in the 1989 rainy season were 20 tons for KK 60-1 and 7 tons for KK 60-2. Cultivar KK 60-3 is under seed multiplication for extension to farmers.

Second, Department of Agricultural Engineering at Khon Kaen University has developed several machines to facilitate peanut production, harvesting, and shelling. These machines are of simple and efficient design, comparatively low cost and some of them have different models for small-farmer commercial use vs. seed production. The sheller has been motorized for use by larger-scale farmers, farmer cooperatives, and local traders. Dissemination of the equipment has been done through demonstration and three local manufacturers have started producing and marketing the machines. This research was funded by the IDRC of Canada.

Thai plant pathologists have made a thorough disease survey in farmer's peanut fields and used the information to refine project research. This work is ongoing at more than 50 locations in the North, Northeast and Central regions.

Thailand has a very well-trained complement of breeders, plant pathologists, and entomologists on the multidisciplinary project(s), several of whom have recent graduate degrees from NCSU (Appendix II). Graduate programs at KKU and KU are training other scientists for peanut research in these disciplines as the research core of the nation expands.

A Compendium of Groundnut Diseases in Thailand has been published, with CRSP support, and distributed in the country.

The Peanut CRSP has strengthened the linkages between DOA, KU, and KKU faculty, and these institutions have organized training for the Extension Directorate. This close collaboration of research with extension enhances on-farm testing of the most promising genotypes and farming practices.

International germplasm pools have been accessioned to the extent that Thailand now has the broadest collection of peanut genotypes in Southeast Asia (excepting China), including material from NCSU, from the INPEP and WAPEP CRSP projects (now TX/BCP/S, BF, N), several ICRISAT nurseries, and introductions collected through the U.S.D.A. National Plant Germplasm System (NPGS) and transferred via the Southern Regional Plant Introduction Station at Griffin, GA, to the above-named institutions.

In addition to NCSU and ICRISAT, the Thai breeding project collaborates with IRRI, which distributes cultivars and other technology through their Farming Systems Network.

A co-principal investigator of this project, Dr. Sopone Wongkaew, has conducted detailed investigations of the Peanut Stripe Virus in Thailand. He will be a strong asset to the GA/PV/N, TP as work is initiated in Thailand.

5.4.3. North Carolina

Because overseas research develops in parallel with laboratory and field work in North Carolina, the faculty, students, farmers, and consumers in the state (as well as those in the contiguous Virginia production area) benefit from the program:

First, new technology and germplasm are being rapidly developed. Five projects in Crop Science at NCSU are devoted to peanut, plus others in plant pathology, entomology and related sciences. Earlier-maturing, disease-resistant cultivars with the seed size, product quality, and market acceptability for the Virginia-Carolina area have been released, seed-multiplied, and commercialized.

Second, interest in this area is in the virginia-market type. In much of the LDC's, spanish or valencia types are grown. Once disease-resistant cultivars are developed, strategies must be developed and communicated to manage the disease. Peanut CRSP has broadened the pathological perspective; diseases common in North Carolina and the host country are being studied in different market types and environments, where virulence and effect varies, to shorten the period for developing and understanding resistance.

Third, the team approach has been broadened to include any scientist who has an interest in working with the crop and its pests. Thus, the project has innovative, cooperative research on several fronts which is relevant for the host country/U.S. growers.

Genes in Tomato Spotted Wilt Virus have been identified and the polypeptide protein has been synthesized in CRSP-supported research upon a disease now important in the host countries and a potential threat in North Carolina and to the U.S. peanut crop.

Nitrogen fixation by peanut appears more important in LDC's than in North Carolina. A soybean/peanut plant physiologist at NCSU can detect fixation directly in the field, which opens a pathway for investigating competition between bacteria strains.

- Biotechnology research can move a trait from a wild species to an adapted cultivar in CRSP-related research.

- The Indian peanut genotype U 4-7-5 which is infected by *Aspergillus flavus* but apparently does not produce aflatoxin has attracted attention of a molecular biologist seeking the reason.

These and other problems under investigation at NCSU show the basic nature and potential applicability of this research.

Fourth, research on Peanut Stripe Virus in Thailand where it is endemic permitted intensive investigation without risk of causing an epidemic in the U.S.

Fifth, significant advances were made in understanding the pathogenicity and epidemology of foliar fungal pathogens. Examples: *Cercospora* isolates do not produce cercosporin. Slow rusting (slowing the disease cycle) is a component of resistance. Temperature and day length influence the stability and durability of the leafspot pathogens. Leafspot pathogen isolates from Thailand may be 20% more virulent than those in North Carolina. Breeding research to investigate these variables is solid and far reaching.

Sixth, the Peanut CRSP has developed a network among U.S. and international scientists who exchange information, technologies, germplasm, and ideas. This attracts top scientists for cooperative research. Dr. Ron W. Gibbons, Director of the ICRISAT Sahelian Center (ISC), Niamey, Niger, and a member of the Peanut CRSP Board of Directors, spent his sabbatic working with project scientists at NCSU. ICRISAT cytogeneticist Dr. J. P. Moss chose to do his sabbatical with Dr. H. T. Stalker, co-PI (Appendix II).

The CRSP project at NCSU has linkages with the U.S. peanut research programs in Virginia, Georgia, Florida, Texas, Oklahoma, and New Mexico, and with ICRISAT, IBPGR, IRRI, AGLN, ACIAR, IDRC (Appendix V).

In addition to the host countries of Thailand and Philippines and the U.S., graduate students have been attracted from Pakistan, Germany, Burma, Japan, Cameron, and Venezuela.

This is unquestionably the most outstanding peanut breeding research center in the world.

6. OBSERVATIONS

6.1. Strengths

6.1.1. Philippines and Thailand

The strength upon which the project has made sustained progress is the professional competence and enthusiasm of scientists in these countries and the well defined coordinated plans they put into place to interface with Peanut CRSP.

The annual program planning meetings in each country brought together as a team individuals who had previously not been

accustomed to working together and has led to systems approaches in research.

Thai and Philippine peanut scientists improved their participation and recognition in the international agriculture venue. These trained scientists, and the ones they train, will have a synergistic influence upon peanut production in Southeast Asia.

Publication of quality literature in recognized scientific journals was increased.

The Philippines and Thailand published bulletins on Peanut and Peanut Diseases, respectively.

Equipment to perform research was upgraded (Appendix VI).

Progress occurred in each breeding program to the point where more crosses and backcrosses are generated locally without depending upon NCSU or ICRISAT for special germplasm needs.

6.1.2. North Carolina State University

The primary strength of the peanut variety project is the dedication, leadership and enthusiasm of the PI, co-PI's, and the cooperating scientists in several disciplines at NCSU. They are forward thinking, aware and willing to make necessary changes. This was particularly noticeable to the panel as we observed the personal and professional interactions between and among the PI's and their graduate students.

The graduate program for crop breeders at NCSU requires a strong minor in plant pathology. The graduate and short-term training provided by the Peanut CRSP is a major and continuing strength of the program.

Sending Bill Anderson to Thailand and Mike Fitzner to the Philippines for one year terms added strength to both programs, and particularly, eased the transition between PI's in the Philippines.

6.2. Weaknesses

6.2.1. Philippines

Several changes occurred in the principal investigator. The transition was mitigated, in part, by the presence and assistance of Mike Fitzner from NCSU for a year at IPB. Stabilizing influences were operative on the part of Dr. Ricardo Lantican, IPB, coordinator for Peanut CRSP in the Philippines, and Executive Director R. V. Valmoyor and Deputy Executive Director Dely P. Gapasin of PCARRD. The current PI,

Dr. Remy Abilay exercises a low-key, but effective team leader role.

The panel noted that the term "resistance" is incorrectly used. "Tolerance" appears more acceptable.

Several of the field trials that we observed in the seven study areas were well-designed and appropriately replicated but others were not. We were particularly dismayed by the lack of border rows and by the non-randomized sequence of entries and the variable stands in the soil acidity study. The stripe virus study and some breeding trials also had inadequate stands. Germination tests and overplanting/thinning could do much to alleviate these problems. Otherwise experiments should be discarded without drawing any conclusions concerning treatment effects.

Philippine peanut breeders are encouraged to publish their research results in the scientific journals.

6.2.2. Thailand

Initially, Thai scientists obtained germplasm from ICRISAT without ascertaining whether that material was specifically needed.

The Compendium of Groundnut Diseases was published with Peanut CRSP funding but that support was not acknowledged. (This omission was not an isolated instance but was noted for publications with CRSP support in several projects).

Extension of newly-developed cultivars through Southeast Asia via AGLN has apparently not been effective. The proper linkages are there, but some problems hamper progress.

6.2.3. Philippines and Thailand

Delays in transfers of funds were mentioned in both host countries (and in other countries the EEP visited). Dr. Wynne informed the panel that he releases an advance in funds to keep the projects going and then makes re-imbursements as expenditures are documented to him. This is slow. Appropriate procedures have been developed by the Managing Entity to at least partially alleviate the problem.

While data collected in the host countries and compiled in annual reports is often extensive, we found too few instances of statistical significance or correlation coefficients. Appropriate field plot design and computer analyses should be employed to establish validity of the tests.

6.2.4. North Carolina State University

The EEP questions the practice of tabulating every detail in the annual report (genotype listing, seed/pod yield, disease/insect ratings, time of treatments). Their place should be in project notebooks or computer files. Only the more significant data should be reported.

Communication between Philippines and NCSU was perceived as a problem. Use of the Fax service should remedy this.

7. RECOMMENDATIONS

7.1. Philippines

7.1.1. Continue emphasis upon the Peanut Action Development Project as a basis for introducing improved cultivars and other technology on a semi-commercial scale as a promising option to increase local production of this important food legume.

7.1.2. Adopt appropriate strategy to insure adequate stands for all trials where yield and disease assessments are being investigated.

7.1.3. Develop a research agenda which will lead to results which can be published in appropriate scientific journals.

7.1.4. Continue the close collaboration of the multidisciplinary team and expand linkages as recommended in Section 7.3.3. below.

7.2. Thailand

7.2.1. A gradual change in emphasis is recommended: from relying upon introduced genotypes and/or segregating low generation populations toward developing crosses or backcrosses made by Thai scientists for specific needs, such as backcrossing to add disease or insect resistance while retaining yield and quality.

7.3. Philippines and Thailand

7.3.1. All experimental trials where yield and other characteristics are compared should use commonly designated check cultivars.

7.3.2. Procedures to best fit the research findings into the cropping systems of the small farmer should continue to be implemented by more training of DOA extension personnel in Thailand and by adding the prospective new cultivars to the Peanut Development Action Project in Philippines.

7.3.3. Collaboration of the breeding project with the food technology project (GA/FT/TP) is strongly urged. We encourage the two groups of scientists to implement procedures to analyze developing candidate cultivars for selected biochemical components and sensory qualities that can guide breeders in releasing material with improved quality and yield. Complementary of the research can be insured by providing the food technologists with seed/pod samples of known genetic origin and known production environments.

7.3.4. A network for exchanging promising cultivars/genotypes between Philippines and Thailand could be established. After evaluation in the two-nation trials, the more promising materials could then be entered into the multinational projects already in place for Southeast and Southern Asia (see Appendix V).

7.3.5. Sound experimental designs and appropriate statistical analyses are recommended for all yield trials.

7.3.6. We recommend the adoption of common assessment scales for disease evaluation and their reference in reports and tables.

7.4. North Carolina State University

7.4.1. There is currently a world-wide interest in breeding peanut for resistance to pathogens. The complementarity at NCSU between breeders and plant pathologists is exemplary and should continue. We were pleased to learn that emphasis is being given on how disease "resistant" cultivars should be managed. We commend the PIs for collaborative investigations in tissue-culture techniques, molecular biology, and genetic engineering procedures. We believe that these approaches could lead to efficient technologies for the genetic transformation of peanut - both to facilitate genetic studies and to allow the introduction of agriculturally useful genes.

7.4.2. As the GA/PV/TP project is further implemented in the Philippines and Thailand, the EEP urges the NCS/BCP/TP to maintain close collaboration to avoid duplication of effort and to provide efficient use of host country scientific effort. We were especially impressed with the PStV research information already available from investigations by Dr. Sopone Wongkaew at KKU. A major goal of the Peanut CRSP cultivar improvement and virology projects should be to enhance understanding of the causal agents and the virus, and to develop "control" methods.

7.4.3. Utilization of germplasm resources of the wild *Arachis* species through direct hybridization with *A. hypogaea* and the use of growth regulators and embryo rescue techniques is perceived by the panel as important and this research should

continue to seek new ways to tap the valuable sources of insect and pathogen resistance resident within the genus.

7.4.4. The panel encourages further interaction between the two Peanut CRSP breeding projects, NCS/BCP/TP and TX/BCP/S, BF, N. We noted that genotypes from the earlier CRSP INPEP nurseries were under evaluation in Philippines and Thailand, and suggest that promising genotypes/cultivars from these countries could be evaluated in West Africa via WAPEP. We suggest that the Peanut CRSP breeders may wish to join with ICRISAT, ACIAR, CORAF, IBPGR, FAO, and other agencies to sponsor an International Peanut Breeding Workshop in 1991 or 1992.

7.4.5. Plant breeders and their cooperators should agree upon and use uniform names for peanut genotypes. (We found far too many instances where names, numbers and other designators were misapplied, obscured, or otherwise improperly identified. As an extreme example, we noted a genotype with a USDA plant introduction number was being reported as an ICRISAT line!). Where germplasm has been released in the U.S. and registered in Crop Science, the American PIs should insure that host country PIs have a copy of the registration article or release document.

7.4.6. We commend project PIs for the excellent record of training, and we note that selection for quality students has been effective. We urge Peanut CRSP to continue sponsoring travel of host country PI's to meetings, including APRES - perhaps on a biennial schedule.

7.4.7. The relationship with ICRISAT in Southeast Asia may still need refining further.

7.4.8. With the recent advancement of the PI to department head for Crop Science, we recommend that NCSU fill the vacancy with a well-qualified, experienced breeder with some interest in international agriculture. The current PI, Dr. Wynne, will be in the position to bridge the change in project leadership without seriously limiting productiveness of the research effort. The presence of the excellent co-principal investigators, Drs. Beute and Stalker, will be an asset during the interim period.

7.4.9. The EEP concludes that the NCS/BCP/TP project is well-designed, is relevant to Peanut CRSP goals and to LDC needs and benefits U.S. agriculture. The scientific and support staffing appear adequate and the research is fully supported by Thai, Filipino, and North Carolina State University administrators. The project has addressed and continued to address the original constraints of low yields because of unadapted cultivars and lack of cultivar resistance to

diseases, insects, and stresses. By any measure the project has been highly productive. Considerable information has been developed on germplasm, pathogens, insects, and agronomic performances and much of this has been published. The project has developed at least nine new cultivars which fit the current trend in agriculture of reducing chemical inputs while at the same time sustaining or enhancing quality and yield. These cultivars have moved through seed multiplication into market channels to benefit small farmers and rural/urban consumers. The EEP is confident that the transition to a new U.S. principal investigator can be made smoothly as planned. The project is realizing its potential in the Philippines and Thailand and has sufficient momentum for additional outreach to other Southeast Asian countries.

The EEP strongly supports continuation and adequate funding of this project.

4.3. EXTERNAL EVALUATION PANEL REVIEW

Peanut CRSP Code: GA/IM/BF

Project Title: IPM STRATEGIES FOR PEANUT INSECTS IN SAT AFRICA

Principal Investigators and Collaborating Institutions: Dr. Robert Lynch, The University of Georgia, College of Agriculture, Athens; the Georgia Coastal Plain Station, Tifton, GA; and Solibo Some, The University of Ouagadougou, Institut Superieur Polytechnique, Ouagadougou, Burkina Faso.

The review was conducted on the basis of visits of EEP members with senior agricultural administrators in The Universities of Ouagadougou and Georgia; oral, visual and written presentations by and discussions with host country and U.S. PIs; talks with USAID personnel and the U.S. Ambassador in Ouagadougou (See Appendix I for itinerary and persons contacted); and by EEP perusal of previous CRSP annual reports and other relevant materials.

The research was identified as a priority need for Burkina Faso, where expertise in basic and applied entomological research for all crops was meager, knowledge of the major arthropod pests of peanut was limited, and the understanding of insect management was inadequate prior to the initiation of this Peanut CRSP project in 1983 and its implementation in crop year 1984.

1. ACHIEVEMENTS.....: Highly Satisfactory.

1.1. The research program is linked with the University of Ouagadougou where in-country administrators perceive that the research/teaching format provides the highest level of collaboration. The project provided guidelines and focus to more fully utilize the knowledge and capabilities of the host country PI, Mr. Albert Patoin Ouegraogo, one of a very few entomologists in Burkina Faso.

1.2. The survey of arthropods throughout the year on peanut in Burkina Faso involved local personnel at six locations across three seasons and gave, for the first time, adequate information on the insect population densities and damage in production and post-harvest agriculture of the crop. Yield losses to insects ranged from 10 to 30 percent (average 20 percent) over the 4-year study. These data, which were published, provided the basis for initiating further research on insect management.

1.3. A major achievement was the determination of the severity of termite and millipede damage. Aflatoxin contamination was directly related to damaged pods and also related to delaying the harvest date beyond the normal maturity of the crop.

1.4. Participation by University of Ouagadougou professors in

the Peanut CRSP insect management program enhanced their capabilities for teaching the entomological sciences and for conducting research -- basic functions of the University -- and, thereby, expanding an embryonic program there.

1.5. The Peanut CRSP cooperated with the University in identifying and encouraging in-country scientists to continue graduate studies for the doctorate to provide a larger pool of trained entomologists: Mr. A. P. Ouedraogo (the PI) at the University of Rabelais in Tours, France, and Mr. I. Dicko at the University of Georgia (SECID support).

1.6. The acting PI, Mr. Solibo Some, was taught to use the computer by Mr. Beque Dao, Center Director, when the computer stations were installed at the University of Ouagadougou. Dr. Lynch gave basic instruction for the SASS during his 1988 visit and Mr. Some now uses this technology to transfer data by disc to the U.S. to greatly expedite analyses.

1.7. The project added a vehicle, refrigerator, freezer (Appendix VI); laboratory and field supplies; and techniques in field plot experimental design and analyses with which Burkina Faso scientists can themselves start new research projects, or expand this one.

1.8. Leaves, seed and cake of neem, Azadicachta indica, a medicinal plant widely available in SAT-Africa, is under evaluation as a natural, nontoxic, harmless and cheap insecticide, easy to obtain and to apply. Ground neem leaves and seed applied in a grandular formulation significantly reduced thrips damage but had little influence on other defoliators or on termite damage, or yield.

1.9. New knowledge about peanut insects has been integrated into an evolving program where CRSP-trained scientists are passing on their skills and techniques to a new generation of in-country graduate students at the 3rd or 5th cycle degree level (Appendix II).

1.10. Burkina Faso scientists on the CRSP project have had broader contact and exposure with other entomologists and the experience of presenting results at the APRES meetings and at the Agrometeorology (1985) and the West African Regional Groundnut Meeting (1988) (Appendix IV). New scientific information has been generated and shared with the world by publication in appropriate journals and proceedings (Appendix III). In the words of a former Director General of research in Burkina Faso, "Information developed from this research eventually benefits all countries; it is not a one-way flow."

1.11. Peanut germplasm previously identified by ICRISAT as resistant to termites in India, when observed for agronomic

potential, susceptibility/resistance to termite/millipede damage, maturity and drought tolerance in Burkina Faso, has exhibited higher percentages of undamaged pods, and lower percentages of scarified and penetrated pods than local cultivars. This appears to be a fruitful area for unified investigation by the three Peanut CRSP projects in Burkina Faso: GA/IM/BF, AAM/FT/BF, and TX/BCP/S,BF,N.

1.12. An international collection of 24 genotypes, selected for multiple insect resistance in the NCS/IM/TP CRSP project, has been evaluated cooperatively in North Carolina, Georgia (GA/IM/BF), Florida, Alabama, Virginia, and Thailand, providing newly-identified germplasm for possible release in USA and Asia, and, after testing, in SAT-Africa. U.S. breeders are using these genotypes as sources of insect resistance.

1.13. Bermudagrass pellets, alfalfa pellets, and peanut meal each were suitable substitutes for pinto beans in the meridic (known ingredients) diets for rearing the fall armyworm at Tifton in the very large numbers needed for uniformly infesting experimental fields.

1.14. Peanut stripe virus (PStV) did not significantly influence growth, development, yield, or market grade of cultivar Florunner in South Georgia in a 3-year field study cooperative between CRSP projects GA/IM/BF and GA/PV/N,TP. Florunner is the most widely grown U.S. cultivar and Georgia grows ca. 45% of the U.S. crop. As a result of this research the Georgia Department of Agriculture recinded restrictions upon the interstate movement of peanut seed for an estimated sales of $100,000 annually.

2. IMPLEMENTATION AND MANAGEMENT OF PROJECTS

2.1. Administrative involvement.

2.1.1. Attitude towards, support and perceived relevancy to the institution.....: HS

2.1.2. Fiscal/logistical assistance.....: S

2.1.3. Resources commitment (faculty/facilities).: S

2.1.4. Comments:

2.1.4.1. Senior administrators at both Universities strongly support the collaborative research support programs and this component project. The University of Georgia for several years administered the USAID Title XII Strenthening Grant (SECID) with the University of Ouagadougou. Adminstrators at Athens perceive the peanut insect management project as a vehicle for developing a meaningful peanut entomological

program in the host country and as improving the research capabilities in both countries. The graduate study at Athens and the field training in entomology at Tifton is beneficial to both programs. The interpersonal linkages are viewed as facilitating the initiation of new projects in the future.

2.1.4.2. In previous years the resident director at Tifton had concerns about the Peanut CRSP because of possible grower reaction. Since the Bumpers Amendment in the 1986 Supplemental Appropriations Act has apparently clarified the CRSP activities, the director currently has "no problems" with the entomology project. Earlier grower concerns with the CRSP mission have not adversely impacted GA/IM/BF. The Georgia Agricultural Commodity Commission for Peanuts (a grower group which uses $2/ton from the annual crop for promotion, research and education) has supported the Georgia PI in the amount of $5,000 to $6,000 annually since the CRSP program has been in operation.

2.1.4.3. Officials at the University of Ouagadougou voiced concern to the EEP about the turn around time for reimbursement of expenditures for the three Peanut CRSP projects in Burkina Faso. The immediate delay called to our attention was an apparent failure of timely delivery of funds by a courier service which has an otherwise good record according to the USAID Mission Director. The program director has impressed upon the collaborators that established procedures should be followed to insure the orderly flow of funds.

2.1.4.4. A commitment to international programs was frequently reiterated by senior University of Ouagadougou administrators. The Rector (President), Dr. Nindaoua Alain Savadogo, would like to see the CRSP programs strengthened. The Director of International Programs, Dr. Mouhoussine Nacro, was deeply involved in carrying-out the various facets of the USAID Strengthening Grant. The University and the USAID mission are actively seeking to bring the Small Ruminant Animal CRSP to Burkina Faso, where a herd of 600 goats is currently in an animal science research program. That event could provide another linkage for research on mycotoxins under all three of the current Peanut CRSP projects.

2.1.4.5. The Institut Superieur Polytechnique (ISP) was reconstituted in 1988 at the University of Ouagadougou under the directorship of Dr. Alfred S. Traore (also the PI for Peanut CRSP project AAM/FT/BF). ISP has two major components: The Institute of Natural Sciences (ISN) (agronomy, plant pathology, entomology, teaching, research, graduate programs, etc.) and the Institute for Rural Development (IDR). Plans have been formulated to move the College of Agriculture and its ISP arm to the Gampela agricultural research facility some

1988-1991.

b) Mr. Solibo J. Arsene Some completed an M.S. degree at the University of Georgia, Athens with Peanut CRSP support for training at the Insect Biology laboratory in Tifton. After returning to Burkina Faso, Mr. Some was assigned to the peanut insect project as an assistant collaborator and became acting PI when Mr. Ouedraogo left for France.

c) Mr. Idrissa Dicko studied for the doctorate in entomology at the University of Georgia 1985-89 in research supported by Peanut CRSP (Appendix II). His dissertation, "Seasonal abundance of selected pest and beneficial insects in relation to peanut phenology, irrigation and insecticides," is listed in Appendix III.

2.2.4.3. Throughout the project period, these three researchers have shown enthusiasm for the project, recognized its objectives, and perceived its relevancy in the national research program priorities.

2.2.4.4. Dr. R. E. Lynch successfully led his collaborators through the start-up of the project, with the shifts in in-country collaborators, and has become increasingly involved in the host country program. He has personally dedicated himself to ensuring that entomology graduate students from Burkina Faso received quality instruction in the classroom, laboratory, and field while studying at the University of Georgia. About 30% of his time is spent on the Peanut CRSP insect project.

2.2.4.5. The University of Georgia mycotoxin laboratory, in Tifton, recognized as one of the best in the nation and fully equipped to perform any required analyses, is a resource committed to this project. Pod samples from Burkina Faso field trials have been shipped to the U.S. PI, via the Plant Introduction Office in Beltsville, for determination of the aflatoxins levels in the seed.

2.2.4.6. We observed excellent research collaboration in Burkina Faso between the plant pathologist, Dr. Philippe Sankara, in-country PI for TX/BCP/S,BF,N, and the entomologist, Mr. Some for the insect management investigations. They conduct the core of their research at the Gampela Station 20 km from the University campus. The three U.S. PIs and the three Burkina Faso PIs held joint planning sessions at Niamey, Niger in September 1988 to initiate 3-way complementarity among the projects in 1989.

3. INSTITUTIONAL DEVELOPMENT

3.1. Complementarity to ongoing research efforts.: HS

3.2. Strengthening of scientific/equipment/facilities/ capabilities.....: S

3.3 Extent of collaborataive interactions.....: S

3.4. Training.....: HS

3.5. Comments

3.5.1. This CRSP project was designed around the primary constraint of low yielding peanut cultivars in the developing country, Burkina Faso, where yield losses from insect pests were poorly known. A knowledge of the prevelance and damage potential of the complex of arthropods was needed to develop a program of insect management. At the time the project was initiated the then-director of the National Institute for Agricultural Research (INERA) said that a peanut entomological program fitted very well into the national program but INERA lacked personnel and funds to do this work. A selection program (Peanut CRSP INPEP, subsequently WAPEP) was in operation and complementarity between the entomology and cultivar testing programs was operative from the beginning.

3.5.2. Prior to the initiation of the Peanut CRSP entomology project, the major, entomological research effort in Burkina Faso involved: a) the cash crop cotton, b) some work at Bobo-Yeg by an entomologist employed by the French Annual Oil Crops Department (IRHO), and c) the ICRISAT cereal grains research program (which moved to Mali in 1989). The program leader for INERA's annual oilseed, grain and legume crops is an entomologist, Mrs. Clementine Dabire. She previously had teaching responsibilities for the entomology program in the University of Ouagadougou and had trained Mr. Some. The CRSP program was built from this base.

3.5.3. Strengthening of the Peanut CRSP entomology program in Burkina Faso has been acccomplished in several ways:

a) The U.S. PI visited Burkina Faso seven times to discuss research plans, introduce improved field design, assist with planting, provide training for tabulating data on computer discs, consult with in-country cooperators in manuscript preparation, define budget needs, and evaluate research progress.

b) A pick-up truck was acquired by CRSP for transportation of personnel, seed, plot samples, insects collected for identification, and other project needs.

c) A small computer center was established at ISP through the Title XII program and entomology project personnel are receiving training there. We commend the TX/BCP/S,BF,N CRSP project for sending Dr. Gregg Parker to Ouagadougou in July 1989 to train Peanut CRSP personnel to better use this center, with particular emphasis on the SASS program for statistical analyses.

3.5.4. Preliminary plans were made at Niamey, Niger in 1988 for closer cooperation between the three Peanut CRSP projects in Burkina Faso. When a promising genotype is found in the breeding or entomology field trials, seed can be exchanged for cross-evaluation in the other discipline. To complement these biological programs, the same genotype(s) can be investigated by the food technologists for food safety, biochemical composition, and nutritional quality. Further complementarity can come by collaboration with INERA for multilocational trials, seed multiplication for commercial use, and technology transfer to the SAT African farm family.

3.5.5. The entomology project has developed collaborative interactions with a number of institutions for germplasm support, including the U.S. National Plant Germplasm System (NPGS); the U.S. Regional Plant Introduction Station (RPIS) at Griffin, Georgia; the extensive peanut germplasm pool developed during 60 years of cooperative breeding research in Georgia; the pool of peanut cultivar/lines assembled at ICRISAT (many of which came from U.S. breeders); the Texas A&M resources (WAPEP) including the Senegal and IRHO materials (see the TX/BCP/S,BF,N project); and the rosette resistant genotypes originally collected along the Burkina Faso/Ivory Coast border.

3.5.6. Collaboration is also evident in the participation by Burkina Faso and U.S. entomologists in joint authorship of presentations at two international symposia (co-sponsored by ICRISAT and Peanut CRSP) and at annual program meetings of the American Peanut Research and Education Society (APRES) [See Appendix IV].

3.5.7. Training has had three aspects: First, three Burkina Faso collaborators received graduate degree training - Mr. Some and Mr. Dicko at the University of Georgia, and Mr. Ouedraogo at the University of Rabelais, Tours, France. Second, each of these scientists has had short-term field training at the Insect Biology Laboratory in Tifton. Third, since 1984, the project has given training opportunities to seven students at different levels at the University of Ouagadougou [four at the IDR3 level, three at the ITDR3 level, and one of these (Mr. Thiam Daouda) currently at the IDR5 level]. Students assisted in conduct of research in the GA/IM/BF project, and each wrote a paper, presented to his/her advisor, and received credit for the research (Appendix II).

4. ADEQUACY OF SCIENCE

4.1. Progressiveness and innovativeness of the science/research.....: S

4.2. Social science/economic implications.....: S

4.3. Appropriateness of basic/adaptive research..: S

4.4. Comments

4.4.1. Without going into the fields of pheromones and toxicologies, there is no handy yardstick for measuring "progressiveness or innovativeness" in an applied entomology project. However, when we viewed the previous lack of entomologic research on peanut in Burkina Faso, where priority was given to cotton and cereals, the identification of this problem and the expenditure of funds, the assignment of research personnel and plot land, and the posting of students for graduate training by the University can be considered as a "progressive" move.

4.4.2. The previous EEP concluded that the University of Ouagadougou was "a fully convenient partner" in this investigation. We perceive the location as far more than "convenient." This is the only location in the host country with the teaching/research base for training in entomology. The commitment to other CRSP projects here in peanut breeding and food technology broadens the base and provides for interaction. The scientists are enthusiastic and their administration is supportive of the CRSP program. We believe the location is the best choice.

4.4.3. Trials with leaves, seed and cake of neem as an insecticide on peanut could have promise for agricultural use in a country where chemical control is prohibitively expensive and constitutes a hazard to human health and the ecology.

4.4.4. Thorough evaluation of U.S. genotypes for reaction to new and different insect populations gives a better understanding of peanut germplasm and may ultimately offer the most economical control to the small African farmer or to the U.S. farmer in the event African insects are introduced here.

4.4.5. In a country like Burkina Faso where men traditionally work the cash crops and women work food crops such as peanut, the development of insect management strategies would benefit women in the home/village by allowing a more stable crop production.

4.4.6. The current level of investigation of mycotoxins on peanut in Burkina Faso is inadequate. A weakness in the program is described below in section 6.2 and one option for improving the research forms a principal recommendation in section 7.

4.4.7. Important to note in a country where women do not often have a prominent role in agricultural research is the presence of an entomologist, Madame Dabire as program leader in INERA for annual oilseed (peanut, sesame), edible legume (cowpea, soybean) and grain (maize, sorghum, millet) crops.

5. APPLICABILITY OF RESEARCH

5.1. Relevancy and transferability of research to Host Country/U.S. programs.....:_____S_

5.2. Relationship to other internal research programs.:_____HS

5.3. USAID perceptions.....:_____HS

5.3.1. We found USAID Mission personnel in Ouagadougou to be well-informed and highly supportive of P-CRSP. They had also been thoroughly involved with the Title XII Strengthening Grant with which the University of Georgia assisted the University of Ouagadougou. We met with Mr. Herbert Miller, USAID Mission Director, and Dr. B. B. Traore, Rural Economist. (Appendix I). Unfortunately Mr. McCarthy, the Agricultural Development Officer was unavailable.

5.3.2. The Panel learned that there are 14 active USAID projects in the country and a P.L. 480 program. There is currently only one CRSP, Peanut, with three sub-projects. The only problems called to our attention are the timely receipt of funds and mechanisms for technology transfer. USAID serves as a conduit for money to the University for the food technology, the insect management and the cultivar improvement projects. As discussed in Section 2.1.4.3. (above) the CRSP program director encourages host country scientists/administrators to "pre-bill." Also, the ME is considering increasing the amount of funds advanced so the reserve will not be depleted during the reimbursement process. (also see Section 6.2.6., below)

5.3.3. Burkina Faso is interested in having the Small Ruminant Animal CRSP relocate there, and the Mission supports that proposal.

5.3.4. The EEP members were informed that USAID has a new project (ready for signing) for strengthening agricultural research at the University of Ouagadougou. This would provide some on-site staffing with technical expertise.

5.3.5. Current organization in Ouagadougou places research in the University and INERA (applied research) under the same agency, the Ministry of Higher and Secondary Education and Scientific Research. Efforts are underway to strengthen interaction between these two research groups. Technology transfer to the small farmer/home/village is the responsibility of the Ministry of Agriculture, Extension Division. Research and extension should work to strengthen their interaction. The EEP had a brief visit with the Minister of Higher Education who expressed a high interest in cooperating with U.S. scientists (Appendix I).

5.3.6. During a general discussion of mycotoxins, the EEP learned that corn meal is imported to Burkina Faso from the U.S. under P.L. 480 for food in sufficient quantity that every primary school child gets one nutritious meal per day. Whether or not adequate monitoring for aflatoxins is performed for these shipments was not known. Since mycotoxins are a concern of all three Peanut CRSP projects in Burkina Faso, an educational program on this health hazard would be of interest to project personnel.

5.4. Comments

5.4.1. The identification of peanut germplasm with resistance to any of the arthropod pests in Burkina Faso would not only have immediate and practical use in the country, but could have impact anywhere that peanut is grown and that particular arthropod is of economic importance. Transfer to other locations in SAT-Africa and Asia could readily be effected through CRSP/ICRISAT linkages.

5.4.2. Damage studies with insects unknown in the U.S. strengthens the research capabilities of the University of Georgia, offers insurance to U.S. peanut growers, and improves the world knowledge on sources of resistance.

5.4.3. Insect resistant peanut genotypes found in the cooperative multilocation tests currently underway in five U.S. states, Thailand, the Philippines and ICRISAT, can be rapidly disseminated thru CRSP and ICRISAT linkages either for use directly as a cultivar or for hybridization and/or back-crossing with locally adapted, productive cultivars.

6. OBSERVATIONS

6.1. Strengths.

6.1.1. The enthusiasm and dedication of host country and U.S. PIs.

6.1.2. The project is well received and supported by the University of Ouagadougou's ISN/IDR. CRSP has promoted research on the insect constraints of peanut in Burkina Faso.

6.1.3. USAID is very supportive. There are currently some 14 USAID projects in Burkina Faso but this project was specifically noted for its linkage with the SECID project (see 6.1.4.).

6.1.4. Graduate training of Mr. Some and Mr. Dicko in entomology under the strengthening grant administered by the University of Georgia, Athens, and their on-site training with Dr. Lynch in the field and insect research laboratories at Tifton.

6.1.5. The former IRHO/CIRAD unit in Burkina Faso and the frequent opportunity of project personnel there to interact with its entomologist during the start-up phase of the CRSP project.

6.1.6. Transportation facilitated by the purchase of a project vehicle.

6.1.7. Good prospects for more timely transmission of data from and/or analysis of data in the host country via the computer center recently established at the University of Ouagadougou.

6.1.8. The research conducted in Burkina Faso can be extrapolated and/or used as a model for assessing insect damages in other LDC SAT-African countries.

6.2. Weaknesses and options to improve.

6.2.1. Two upheavels in the host country government may have impacted agricultural research priorities and funding. The current re-alignment of research/teaching in ISN/IDR may usher in a new "climate" for moving along with agricultural needs. The fact that Dr. Alfred S. Traore, the Director of ISN/IDR is the PI for the Peanut CRSP food technology project may focus better attention to CRSP goals. However, we are concerned about the amount of time Dr. Traore can devote to P-CRSP with his overall responsibilities in ISP.

6.2.2. The proposal to move the University's College of Agriculture to Gampela could initially impact the Peanut CRSP since the three project leaders would be involved in the move, but the long-range benefits of having the research/teaching faculties (and students) at the country's main agricultural experimental station should outweigh any short-term problems.

6.2.3. A permanent network of expanded entomological research at the INERA stations, (i.e., Bobo, Boromo, Deolougou, Niangoloko, Po, Tenkodogo), can be implemented only when more trained in-country entomologists, funding, and transportation becomes available or if Peanut CRSP funding is markedly increased.

6.2.4. The administration (University and ISP/IDR) have yet to share with the Peanut CRSP their plans for the future leadership of the entomology project when Idrissa Dicko returns this year with the Ph.D. degree and/or when Patoin Ouedraogo completes doctoral studies in France (in 1991). The acting PI, Mr. Solibo Some (M.S., Georgia) desires to continue graduate work. USAID could possibly fund the initial two years under a current grant, but the time for initiating the work may pass before the host country administrators can decide on an appropriate field of study.

6.2.5. Where qualified individuals are identified for graduate training, interruption of the degree program at the master's level with a return to host country for several year's employment before pursuing the Ph.D., appears to place an undue burden upon both the individual, the position, and the administration. The options are to identify candidates capable of the more advanced graduate training, or use only short-term, on-the-job assignments. This weakness appeared in several host countries.

6.2.6. Concerns about the transfer of funds from the U.S. to the University of Ouagadougou should be resolved through a concerted effort by the PIs, host country administrators, the ME and USAID.

6.2.7. The tentative plans discussed at Niamey, Niger by the U.S. and Burkina Faso PIs to increase cooperation between the three Peanut CRSP projects need to be reviewed, finalized, and put in place, with maximum linkage necessary to achieve mutual goals. Several options may be mentioned. Mycotoxins are of concern to all three projects. In the entomology project, termite penetration or millipede scarification of pods permits Aspergillus sp. invasion; pod samples are presently shipped to Tifton, Georgia for aflatoxin analysis. In the WAPEP project, samples are shipped to Texas for aflatoxin analysis. The food technology project in Burkina Faso could provide these analyses as a simple service, as part of the teaching/laboratory training of students. Detection can easily be done with polyclonal antibodies, without the need for HPLC. The test is a simple card, with low cost, requiring little training to use, and reads in the ppb range. The advantages for saving funds and complementary research are obvious.

6.2.8. The food technology project needs cultivars of known genetic composition and known field environments for investigations of seed quality, composition, and nutritional value, and as raw material for preparation of various foods. Both the entomology and cultivar evaluation projects produce ample quantities of such seedstocks. The EEP urges the implementation of fundamental linkages between these projects in Burkina Faso.

7. RECOMMENDATIONS

7.1. Mycotoxins are a concern of each of the three Peanut CRSP projects in Burkina Faso, and are a world-wide hazard in food and feed. Strategies are needed to solve the problem, and to increase awareness of the toxin by explaining aflatoxin to the people who grow and consume peanut. In reviewing TX/MM/S, the EEP learned that Dr. R. E. Pettit, the PI, is preparing a publication on the human health hazard of aflatoxin for use in Senegal. We recommend CRSP support for also making that information available in Burkina Faso and other SAT African nations.

7.2. As trained personnel return to Burkina Faso from graduate studies in entomology, we encourage focusing on expanding the insect management investigations to other locations using the INERA network of stations where peanut production research can be conducted.

7.3. Host Country entomologists should develop a research agenda that will attain results suitable for publication in appropriate scientific journals.

7.4. We encourage Peanut CRSP to continue to send host country PIs to international meetings, including APRES. They should prepare papers for presentation at such meetings. The publication record for host country entomologists is shallow for this CRSP project.

7.5. The newly-formed peanut research network, CORAF, has a joint project with participating scientists in Burkina Faso and Senegal, for selecting peanut cultivars resistant to *Aspergillus flavus*. The three Peanut CRSP projects in Burkina Faso could benefit from working with the CORAF team. We invite the program director of CRSP to seek linkages with CORAF for complementary interaction.

7.6. We ask the PIs for GA/IM/BF, AAM/FT/BF, and TX/BCP/S,BF,N, to link their projects in Burkina Faso. The benefits are numerous:

a) Insect management and cultivar improvement could exchange promising genotypes from each program for evaluation in tandem

(if not concurrently) in the other research area.

b) Both projects could provide sufficient quantities of seed of known genetic origin and known production regime to the food technologists for developing standard parameters (biochemical constituents, quality components and mycotoxin analyses) for evaluating these characteristics in candidate cultivars arising from the insect and breeding projects. The costs for shipping samples to Georgia and Texas for mycotoxin determinations can then be directed into research channels.

7.7. Procedures should be developed to transfer findings from the insect management research into the cropping systems of the Burkina Faso peanut farm families.

7.8. The reviewers conclude that the insect management project as conceived and implemented is sound. In collaboration with the University of Georgia SECID grant program, the project has been successful in training entomologists at the cost of having an acting PI for some time. Now is the time to initiate other types of training and other avenues of research. We recommend increased funding to expand research to other locations in Burkina Faso, to intensify investigations at the primary host country site, to screen genotypes for resistance to arthropods and mycotoxins, and to coordinate this research with three other Peanut CRSP projects: TX/BCP/WA, GA/PV/N,TP, and AAM/FT/BF.

4.4. EXTERNAL EVALUATION PANEL REVIEW

Project Code: **NCS/IM/TP**

Project Title: **Management of Arthropods on Peanut In Southeast Asia**

Principal Investigators and Collaborating Institutions: Dr. W. V. Campbell, North Carolina State University; Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD); Dr. Virginia Ocampo, University of the Philippines, Los Banos (UPLB); Dr. Sathorn Sirisingh, Thailand-Department of Agriculture; and Dr. Manochai Keerati-Kasikorn, Khon Kaen University (KKU). (see Appendix I for detailed list of all cooperators).

Basis for ratings and comments.

Three members of the EEP visited North Carolina State University (NCSU) at Raleigh, North Carolina February 23-24, 1989, and all four EEP members visited the Philippines March 10-15 and Thailand March 16-22. Principal and co-investigators, and administrators of the participating institutions were interviewed plus USAID Missions in the two Asian countries (for detailed itinerary, and persons contacted see Appendix I). The following evaluation resulted from these discussions plus written materials and Annual Reports provided by the Management Entity (ME). Additional publications of an informational nature, progress reports and slide presentations were often provided by the various persons interviewed.

Background information on the status of peanut in the Philippines and Thailand was previously presented in the Preface and in the External Evaluation of the preceding NCS/BCP/TP.

Assessement Ratings for Host Countries and U.S.

1. ACHIEVEMENTS.....: HS

1.1. Philippines

1.1.1. Insects are a primary factor in the rather low (.87 t/ha) average peanut yield in the Philippines. In insect trials at different locations the check or untreated plots yielded 40-60 percent less than treated plots without insects.

1.1.2. Early in the project Philippine entomologists made extensive surveys and identified the following as the major peanut insect pests in decreasing order of occurrence and importance.

Leaf Folder	Homona coffearea
Common Cutworm	Spodoptera litura
Leafhopper	Empoasca sp.
Leaf Miner	Aproaerema modicella
Bean Pod Borer	Maruca testulalis
Black Bean Aphid	Aphis craccivora
Pod Borer	Heliothis (Helicoverpa) armigera
Tussock Moth	Dasychira mendosa
Tussock Moth	Orgyia postica australis
Bean Leaf Roller	Lamprosema hedylepta indicata

Each of these insects has been closely studied as to their life cycles, alternate hosts, time of appearance in the peanut crop, population levels, and subsequent damage to the plant and seed yield. This research formed the basis for the integrated pest management (IPM) recommendations now being introduced in the Philippines.

1.1.3. Peanut CRSP has provided the thrust for a National Program on Peanut Improvement under the aegis of Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD). The First National Peanut Consultation and Review and the ensuing proceedings were partially sponsored by Peanut CRSP in 1985. This now has become an annual national research review and planning meeting involving Philippine peanut researchers, and including entomologists, breeders, pathologists, agronomists, food technologists, and social scientists.

1.1.4. On-Farm Pilot Production Programs are rapidly expanding to introduce and test new peanut technologies. This includes a package of simple practices including a new cultivar, inoculant and in some cases, pest control. Last year 78 farmers participated utilizing a total of 27 hectares. This year PCARRD estimates that 65 hectares and 172 farmers will be involved. All trials are evaluated in a Farming Systems context, including such socio-economic factors as cost-benefit ratios and farmer reactions. Early evaluations indicate the program is highly successful and the technology is being observed closely and tried by neighboring farmers.

1.1.5. An excellent Technical Bulletin The Philippines Recommends for Peanut has been made available by PCARRD and financially supported by Peanut CRSP. This 76 page publication covers all phases of peanut production, storage and marketing. In addition, there are colored pictures of primary insects and diseases along with recommended control methods. A second PCARRD publication also supported by Peanut CRSP contains 49

pages of Abstracts of Peanut Researches. The abstracts are taken from Philippine journals, bulletins, reports, proceedings of workshops and conferences, and student theses. The abstracts are arranged by discipline with authors in alphabetical order and include both an author and subject index.

1.1.6. Entomologists have worked closely with plant breeders in introducing and identifying germplasm with tolerance to insects. Several lines have been identified as having multiple insect tolerance. Among these, TG-1 x GP-NC343, Robut 33-1 x NC2214, NCAc343, NCAc2214, IPB-Pn12-5 and NCAc17011, are in advanced stages of testing under different insect environments, and serving as a source of breeding material. Such cultivar resistance will ultimately offer the most economical and safest control for the small farmer. Excellent progress is being made in incorporating this resistance into acceptable agronomic and market types.

1.1.7. Economic threshold levels (plant damage and stage of development and/or insect numbers) have determined when chemical spraying would pay off for several insects - cutworms, aphids, thrips, leafhoppers, defoliators, leaf miners and pod borers. Such information is being utilized in Integrated Pest Management (IPM) recommendations in pilot production areas.

1.1.8. Many field trials have led to the following chemical insect control recommendations for peanut: Monocroptophus for leafhoppers, and aphids; Carboryl for thrips and cutworms; and Carbofuran for pod borers and soil insects. However, chemical recommendations are now few and "only as needed" and based upon careful monitoring of the plant growth stage and severity of insect damage rather than the former recommendation of spraying weekly or fortnightly. This new recommendation saves money and also reduces the health hazards. Several years ago some Philippino rice farmers were observed broadcasting Carbofuran granules by hand, and then immediately smoking cigarettes.

1.1.9. Research conducted on the effect of cultural practices on the insect species and populations indicated that both plant population and planting date influenced the insect complex. Increasing plant population generally increased insect populations, while planting dates gave different results depending on the insect species being observed.

The use of calcium (gypsum) as a soil amendment had little effect on insect populations but significantly increased pod yields.

1.1.10. The Philippine entomology group has made tremendous strides in biological control of peanut insects. Two biocontrol agents for the control of cutworm (Spodoptera

litura) are commercially available. A large laboratory colony of this insect is maintained to test microbial controls. Nuclearpolyhedrosis viruses (NPV) and Bacillus thuringiensis appear extremely promising. A dosage of 1.73 x 10^9 NPV resulted in 98% mortality of third instar S. litura. A new strain of Bacillus thuringiensis, (SV-10), appears more effective against both S. litura and pod borer, Heliothis armigera, than the present available DIPEL. Commercial interest is growing.

The egg parasitoid, Trichogramma sp. which attacks leaffolders (Homona coffearea) and pod borer (Heliothis armigera) has been successfully mass reared in the laboratory and released in the field. The Philippine Bureau of Plant Industry is now selling these predator insects to farmers for use in sugar cane and peanut fields.

1.1.11. A recommended IPM system of (1) using an improved cultivar, (2) introducing Trichogramma predators at seven weeks after planting and (3) one or two well timed chemical sprays during the eight and ninth weeks after planting resulted in average yield increases of 34 percent over a local variety with farmer practices.

1.2. Thailand

1.2.1. Training of Thais for entomological research on peanuts is an achievement of Peanut CRSP. Ms. Turnjit Satayavirut received a Ph.D. at NCSU and the two Thai Principal Investigators have attended American Peanut Research and Education Society (APRES) meetings and spent time in NCSU Entomology Laboratories.

Dr. Bill Campbell the U.S. Principal Investigator (PI) spent his sabbatic leave living and working alongside Thai Entomologists at Khon Kaen.

1.2.2. The twenty insects found to damage peanuts in Thailand are listed below. An asterisk beside the species name indicates the three leaf defoliators, the five sucking insects, and three pod feeders that Thai researchers found to cause the greatest yield losses and have received the most research attention during the Peanut CRSP program. Without treatment insects may cause 40-60 percent yield losses. In addition, some sucking insects transmit plant viruses and pod feeders encourage invasion by aflatoxin-producing fungi with their attendant health concerns.

Important Peanut Insects in Thailand

Leaf defoliators

1.	Leafminer	- *Aproaerema modicella**
2.	Leafrollers	- *Archips micaceana* - *Lamprosema diemenalis* - *Lamprosema indicata*
3.	Cutworms	- *Heliothis armigera** - *Spodoptera litura** - *Agrotis ipsilon*
4.	Blister beetles	- *Mylabris phalerata* - *Epicauta maklini* - *Epicauta waterhousei*

Sucking insects

1.	Thrips	- *Frankleniella* spp.* - *Caliothrips indicus** - *Scirtothrips dorsalis**
2.	Leafhopper	- *Empoasca* sp.*
3.	Aphids	- *Aphis craccivora**
4.	Mite	- *Tetranychus urticae*
5.	Whitefly	- *Bemisia tabaci*

Pod feeders

1.	Subterranean ant	- *Dorylus orientalis**
2.	White grubs	- *Coleoptera*: *Scarabaeidae*
3.	Termites	- *Isoptera sp.*

*denotes the nine most destructive insects.

1.2.3. Information has been compiled on the life cycles, habitat, alternate hosts, natural enemies and population dynamics of the nine primary ones indicated in the table in 1.2.2.

1.2.4. Thai entomologists have progressed from monitoring the seasonal distribution and life cycles of peanut insects to economic threshold studies and finally the development of IPM Programs for growers in the primary peanut growing areas.

1.2.5. The Peanut CRSP program has encouraged entomologists from different institutions to plan and work together. All peanut scientists now meet annually to review past research and plan future strategy. This was not so before 1982, when scientists often did not know what was going on elsewhere and the research was fragmented and sometimes duplicative rather than complementary. The 6th Thailand National Groundnut Meeting was held in 1989.

1.2.6. Artificial defoliation studies of field and potted plants at different phenological stages indicated to what extent leaf feeders could affect yields. Such studies have led to a reduction in use of chemicals. For example leaf damage below 50 percent for leaf miners (Aproaerema modicella) did not necessitale chemical spraying. With higher leaf miner populations, one or two carefully timed sprays at 15 or preferably 45 days after planting prevented yield losses.

1.2.7. Over 2800 peanut lines/populations have been introduced and screened for various breeding objectives, including tolerance to the indigenous insect pests. More than 300 local crosses have been made and backcrossing will be used more in the future to incorporate desired genes for insect resistance.

1.2.8. Several of the insect resistant lines selected in Thailand trials have acceptable agronomic and quality characteristics and have outyielded the widely grown local cultivar Tainan 9. The recently released new cultivar KK 60-3 has multiple insect tolerance, and is a product of collaborative research between plant breeders and entomologists.

1.2.9. The thrip, Scirtothrips dorsalis was identified as the primary vector for yellow spot virus.

1.2.10. An example of individual insect studies was the question of determining the field distribution of the white grub (Mekadera sp.) which often causes severe damage to peanut pods. These were found to exist or colonize close (< 10 cm) to the peanut plant and at shallow depths (5-20 cm). This has implication in devising chemical controls. Early harvesting

was found to be beneficial when white grubs were present. Pod damage increased six-fold if harvest was delayed two weeks.

1.2.11. The subterranean ant (Dorylus orientalis) was found to be the most serious pest of peanut. Yield losses in field trials ranged from 15-48 percent. Secondly, aflatoxins were more prevalent on the seed when these pests were present. The population peak coincides with pod development. The most promising control thus far is poison baits, placed in coconut shells. American peanut growers should be particularly interested in progress in controlling this insect pest, which now is not presently in the U.S. but might inadvertantly be brought in.

1.2.12. Prediction equations were developed to assess the effect of insect damage on unfilled pods and seed yields. Losses from unfilled pods and seed yields were related to foliage damage from leafminer, leafhopper and thrips at the R_4 and R_5 plant growth stages. These equations will lead to modeling and refinements in IPM.

1.3. North Carolina State University

1.3.1. Entomological Training of three graduate students to the M.S. and Ph.D. level has been provided at NCSU by Peanut CRSP. One of these was from Thailand. In addition, the project's two principal investigators Drs. Sirisingh of Department of Agriculture (DOA) and Keerati-Kasikorn, Khon Kaen University (KKU) have visited Raleigh for a period of several weeks.

1.3.2. This project and the NCSU Principal Investigator has provided impetus to entomologists in Southeast Asia to initiate research to identify and control their primary peanut insect pests and to aid their efforts to develop a low input, safe, sustainable agriculture.

1.3.3. The early finding that similar peanut insect genera are generally present in the Philippines, Thailand and the North Carolina/Virginia peanut belt has facilitated rapid transfer of control technology.

1.3.4. Twenty four multiple insect resistant lines were identified. These make up a Uniform Peanut Insect Nursery now planted in Thailand and five southern U.S. states including one with the PI for the GA/BF Project. The use of pheromone traps at each location monitors the insect species and populations over time. U.S. plant breeders are already utilizing this germplasm as a source for insect resistance.

1.3.5. An interesting laboratory observation was made that some lines with field insect resistance exhibited resistance

to the post harvest seed insects, Indian meal moth (Plodia interpunctella) and almond moth (Codra cautella). This suggests an opportunity for chemical analyses to identify the responsible compounds, which impart susceptibility or resistance to insects.

1.3.6. Insecticide time and rate studies, based on insect population, and plant growth stage have resulted in recommendations for only one or two sprays using lighter rates at a specific plant stage rather than the previous intensive spray schedules,

1.3.7. Cultural studies involving the effects of date and rate of planting and tillage practices on insect populations have aided North Carlina peanut producers in adjusting planting dates and using slightly higher seeding rates.

1.3.8. Pheromones have been found to be reliable and more effective than sticky traps in monitoring insect populations,

1.3.9. Economic threshold level studies of insect population, damage and yield are progressing. One for southern corn rootworm in North Carolina has been completed and is now included in IPM recommendations. Such programs are cheaper and safer than previous recommendations.

2. IMPLEMENTATION AND MANAGEMENT OF PROJECTS

2.1. Administrative involvement

2.1.1. Attitude towards, support and perceived relevancy to the institution.....: HS

2.1.2. Fiscal/logistical assistance.....: S

2.1.3. Resource commitment (faculty/facilities)....: HS

2.1.4. Comments

2.1.4.1. Philippines

Overall planning, coordination and monitoring of agricultural research in the Philippines is handled by PCARRD with headquarters at Los Banos. This organization reviews all agriculture research proposals and recommends the allocation of government funds to the Department of Budget and Management. They also program or manage foreign agricultural support funds such as Peanut CRSP. PCARRD is also responsible for upgrading agricultural research facilities and manpower. One can readily understand why PCARRD has become a model widely copied by many other developing

countries. The extensive use of computers to track all agricultural research within the country was noteworthy.

PCARRD Executive Director Ramon Valmayor, Deputy Executive Director for Research, Dely Gapasin, and Crops Research Department Director Cristano Escano all spent time with the EEP and were enthusiastic supporters of Peanut CRSP. These leaders are disappointed with the country's average peanut yield of .86 t/ha (unshelled) and have initiated Pilot Testing Programs in the primary producing areas. A National Peanut Research Planning Workshop is held annually at PCARRD Headquarters to ensure the coordination and integration of all peanut research. Their objective, relating to this Peanut CRSP project, is to develop an environmentally sound and economical insect pest management package for Filippino peanut farmers.

2.1.4.2. Thailand

The administration of Peanut CRSP funds and coordination of peanut research in the country is under the aegis of the Thailand DOA with Headquarters in Bangkok. Dr. Vichitr Benjasil serves as Coordinator Peanut CRSP, Thailand and is Director, Field Crops Research Institute, DOA, Bangkok. Peanut CRSP activities are an integral part of the Thailand Coordinated Groundnut Improvement Program, which also maintains close ties with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the International Rice Research Institute (IRRI) farming systems programs.

Annual research planning meetings are held and attended by all DOA and University peanut researchers. One administrator stated that these workshops "had started with the advent of Peanut CRSP". We perceived more attention being given to peanut production in more ecological zones and cropping systems. This has concurrently increased the research challenges for both breeders and entomologists.

2.1.4.3. North Carolina State University

The administrative support for Peanut CRSP at NCSU is excellent. The Dean, and the Director believe that the project has given the University more visibility, added linkages, enhanced the staff's research and attitude toward solving world food problems, and encouraged interdisciplinary research. NCSU is involved in three CRSP programs. Peanut CRSP is perceived by top administrators to have encountered fewer fiscal or management problems. Examples of higher administrative support for the Peanut CRSP program were evident when inadvertant money shortages occurred. If these could not be covered by the department, then the agricultural

college provided "bridge funding". When the TROPSOIL CRSP at NCSU experienced a major short term fiscal problem, money was sought and obtained from the University Chancellor.

NCSU administration perceives a strong relevancy of Peanut CRSP collaborative research in the host countries to the interests of North Carolina, and this position is supported by the North Carolina Peanut Growers Association.

2.2. Research involvement

2.2.1. Attitude towards, support and perceived relevancy to the institution.....: E

2.2.2. Fiscal/logistical assistance.....:

2.2.3. Resource commitment (faculty/facilities)....: HS

2.2.4. Comments

2.2.4.1. Philippines

This entomology project's research base is in the Entomology Department of the University of the Philippines, Los Banos (UPBL). The PI is Dr. Virginia Ocampo, an enthusiastic and capable researcher with a degree in Economic Entomology from the University of Wisconsin about three years ago. She collaborates with researchers in the National Crop Protection Center (NCPC) on Biocontrol agents and with breeders at the Institute of Plant Breeding (IPB) on insect resistance screening programs. These institutes are also located in the UPLB campus area.

Dr. Ocampo has a split appointment in UPLB: 20% Teaching, 20% Extension, and 60% Research. She estimated approximately one-third of her research time was spent on Peanut CRSP. She does have an M.S. degree Research Assistant on the Peanut CRSP project. She has not visited North Carolina or Thailand yet, but Dr. Campbell helped greatly on his visits during his sabbatic leave in Thailand and since.

We were impressed with her energy and obvious talents, but more importantly, her willingness to travel frequently to her insect nurseries in the Cagayan Valley of Northern Luzon.

2.2.4.2. Thailand

The entomology research on this project is split between the DOA, Field Crops Research Institute Entomology Division in Bangkok, and KKU Department of Entomology at Khon Kaen. The respective PIs are Dr. Sathorn Sirisingh, DOA, and Dr. Manochai Keerati-Kasikorn, KKU. Both are well trained field

oriented entomologists who collaborate well. Dr. Sirisingh estimated that 60-70 percent of his time was devoted to peanut research. Dr. Keerati-Kasikorn had University teaching responsibilities, so estimated 40 percent of his time was devoted to Peanut CRSP. Each had several able assistants including several women. The laboratories toured in Bangkok were first class and we were even more impressed with the extensive field research plots viewed near Khon Kaen. Many insect trials were underway with irrigation. These encompassed a wide range of adaptive research questions. A second series of trials is conducted during the rainy season. Khon Kaen is in the primary peanut production area of Thailand. Other location "hot spots for specific insects" are used for screening germplasm and control practices. Pilot IPM trials have been established in a few areas and the results closely monitored. There appeared to be a particularly close and long term working relationship between the entomologists and breeders. Some aid is provided the KKU Farming Systems program which is interested in intensifying cropping patterns and planting peanut within coconut and rubber plantations in South Thailand.
The only problem mentioned was the occasional times in the past when Peanut CRSP funds were late in arriving.

2.2.4.3. North Carolina State University

The involvement of the Principal Investigator has been excellent in all instances. This in spite of the fact that his field research program involves several North Carolina crops and their insect problems.

The PI admitted that in the beginning he had some reservations about becoming involved in an international program. As the program progressed, his enthusiasm grew to such an extent that he chose to spend a 1986 sabbatic leave in the host countries working on peanut insect problems with the collaborating PIs. We believe he was an excellent "Scientific Ambassador of Good Will" for the U.S.

The PI has a 90-10 Research and Teaching appointment. He estimated 33 percent of his total time was devoted to Peanut CRSP activities, and that 66 percent of his operating budget came from CRSP.

There is excellent research collaboration among the entomologists, plant pathologists, soil microbiologists and particularly the plant breeders on this and other NCSU Peanut CRSP projects.

The PI has secured permission to delay his retirement until the end of the cropping season to better evaluate and

summarize the research findings from both U.S. and host country trials.

The External Evaluation Panel's (EEP) greatest concern with this project is the PI's planned retirement. We discussed this development with NCSU administrators, who seemed to be sympathetic to the suggestion that the position might be filled with an experienced entomologist as expeditiously as possible.

3. INSTITUTIONAL DEVELOPMENT

3.1. Complementarity to ongoing research efforts.....: E

3.2. Strengthening of scientist/equipment/ facility capabilities.....: HS

3.3. Extent of collaborative interactions.....: E

3.4. Training.....: S

3.5. Comments

3.5.1. Philippines

The Peanut CRSP program not only complements the peanut research efforts in the Philippines but has seemingly been "the yeast and catalyst" to both expand and bind the program together. The annual National Conference for Peanut Researchers originated as a Workshop sponsored by PCARRD and Peanut CRSP. These meetings have promulgated interdisciplinary collaboration between entomologists and other scientists.

While we were a little disappointed with Filippino graduate training efforts documented in this project, we assume that UPLB with its well trained staff and excellent facilities and equipment is now granting M.S. and Ph.D. degrees in Entomology and there is less need for sending students overseas than previously. Thus Peanut CRSP funds are used primarily for research support.

Excellent field and laboratory facilities were observed at UPLB; and the labs in IPB and in the relatively new Institute of Biotechnology were superior. We did not enter the new building of the NCPC. We were not impressed with the facilities that Dr. Ocampo's Biological control cooperators were using to raise the egg parasitoid, Trichogramma, nor the facilities or equipment being used to multiply Bacillus thuringiensis strains. We would hope that these programs could be relocated in one of the new buildings referred to above.

3.5.2. Thailand

Prior to 1982 and the advent of Peanut CRSP, research on peanut was planned and conducted separately by the DOA, KKU, KU and Ching Mai University (CMU). The Coordinated Groundnut Improvement Program was formed in 1982 and annual meetings are now held for all researchers to report research results and to plan and coordinate the next years program. This is "ground up" research planning rather than "top down" to solve peanut constraints in Thailand.

Peanut CRSP has provided funds and equipment to the project, germplasm and breeding materials, technical advice, books and literature, training (both graduate degree and short term, and travel funds to participate in national, regional, and international meetings and workshops) and lastly, an experienced entomologist who took his sabbatic leave living and working with Thai entomologists at Khon Kaen. Both Thai PIs have visited NCSU to learn certain research techniques. These same PIs participated in the Groundnut Scientists Meeting in Malang, Indonesia Nov. 14-17, 1988 on Peanut CRSP funds.

We commend the extensive nature of the national Thai peanut testing program and the entomological information being gathered. We commend the plans for including relevant Colleges of Technical and Vocational Education as network test sites in the future.

3.5.3. North Carolina State University

This project has strengthened the international capabilities of the participating scientists in a <u>highly satisfactory</u> manner and the development of collaborative endeavors with other disciplines at NCSU and entomologists of the two host countries to solve field or "real world" entomological constraints of peanut is <u>excellent</u>.

Two U.S. and one Thai student have received graduate training in Entomology at NCSU supported by Peanut CRSP funds. The two Thai PIs visited NCSU for varying periods of time learning about IPM and techniques to determine economic threshold levels of insects.

The U.S. PI has unlimited enthusiasm and has visited the host countries annually, in addition to a sabbatic spent there in 1986-1987. Two of the benefits in his view is the close working relations now existing between the Thailand DOA and the two Universities in that country, and PCARRD's leadership role in coordinating all peanut research in the Philippines.

4. ADEQUACY OF SCIENCE

4.1. Progressiveness and innovativeness of the science/research.....: HS

4.2. Social science/economic implications.....: S

4.3. Appropriateness of research (basic/adaptive).....: E

4.4. Comments

4.4.1. Philippines

The PI in the Philippines is well trained for adaptive research and is making excellent progress on simple questions, i.e. what insects are predominant, when do they appear, how much damage do they do, and how can they be controlled economically. This is exactly the type of research needed by small subsistence farmers in the Philippines and Southeast Asia. Her results have allowed pilot IPM programs to be conducted in the primary peanut growing areas; however, she admits that further refinement is needed.

Concurrently she is collaborating closely with biocontrol scientists in field testing their agents for peanut insect control. The most promising ones thus far are Trichogramma sp. which attacks the eggs of leaffolders and pod borers, and Bacillus thuringiensis which infects cutworm and pod borer larva. However the relatively short effective life (2 days) of the latter continues to be a challenging problem. Another fascinating biocontrol agent, Nuclear Polyhedrosis Virus (NPV) has been propagated in the Philippine program and found extremely effective in controling the cutworm (Spodoptera litura). Unfortunately, tests with other insect larvae were disappointing. This biocontrol research has drawn world wide attention and is being closely monitored by commercial interests.

The EEP was surprised at the large number of highly trained women scientists and technicians encountered in this and other Peanut CRSP projects in the Philippines. Dr. Ocampo visits outlying research sites and makes special effort to visit with farmer wives, who according to her "play an important role in agricultural decision making".

4.4.2. Thailand

The scientists involved with this project in Thailand were observed to be well trained, progressive, and innovative. Both their laboratory and field facilities were impressive. Peanut CRSP has provided a diversity of equipment items including two microcomputers, air conditioners, Thai-English

typewriter, gas chromatograph, motorcycle and a two wheel tractor (Appendix VI).

As in the Philippines, women scientists are active in this CRSP program. Dr. Satayavirut completed her Ph.D. at NCSU in 1988. The social implications of overcoming the production constraints of peanut has a two fold effect on farm women. First, a significant part of farm labor is done by this gender in Thailand and much of Asia, and the predominantly rice based family diet could be improved by having larger supplies of peanut.

Commendations are due the Department of Entomology and Zoology of the DOA in Bangkok for their outstanding Insect Museum. The quality of the specimens were equal or superior to any previously viewed by EEP members.

Dr. Keerati-Kasikorn of KKU is systematically working toward an improved IPM program with research on four components: biological, genetical, chemical and cultural controls. We observed the first breakthrough to be the identification of multiple insect resistant genotypes. In fact, the three cultivars recently released by Thai breeders have tolerance to certain insects. Biological control is the weakest link at present, with considerable attention paid to insect predators such as spiders (Arachnida) and Tachinidae. The only beneficial one identified thus far is ladybugs (Coccinellidae) for aphid (Aphis craccivora) control. Help in this area will be provided by Dr. Songyot Phisitkul who just completed a Ph.D. at UPLB on peanut insect predators. There is also interest in using leaves of the Neem (Azadicachta indica) tree as an insecticide. Somewhat similar research with neem is taking place in Burkina Faso in the GA/IM Peanut CRSP program.

Both PIs are making progress in insect threshold level studies designed to reduce the number and amount of chemical insecticides.

A close working relationship exists between Thai entomologists and plant breeders. The latter are now at the stage where they are only interested in receiving early generation breeding lines from ICRISAT and NCSU, to make their own selections for breeding insect resistant cultivars. Several hundred such crosses have already been made in Thailand. Both breeders and entomolgists have hopes for earlier maturing lines with acceptable yield and seed quality, for these will fit better in intensified cropping systems and possibly suffer less injury by pod feeding insects (subterranean ant, white grub and termites).

4.4.3. North Carolina State University

Most researchers would classify the research at NCSU as applied. But it is generating needed information that could have impact in all peanut growing areas of the world. We feel the research is appropriate and meeting the originally designated program objectives. Both social and economic benefits will arise from the threshold studies of insect damage and their incorporation in IPM recommendations or packages for Southeast Asia and the U.S. The damage potential of specific peanut insects and the insect damage/plant phenological relationships have been documented.

The overall objective is to develop a low input, safe, and sustainable agriculture. The science in this project is on target.

5. APPLICABILITY OF RESEARCH

5.1. Relevancy and transferability of research to Host country/US programs.....: HS

5.2. Relationship to other international research programs.....: HS

5.3. USAID Missions perceptions of Peanut CRSP.....: S

5.3.1. We found USAID Mission personnel in Manila and Bangkok knowledgeable and supportive of Peanut CRSP.

5.3.2. The USAID Mission in the Philippines has recently undergone several key personnel changes and a reduction in staff. Ken Prussner is the new Chief of the office of Agriculture and Rural Development and Bob Resseguie is in charge of the Agricultural Development Division. We missed seeing a key Agricultural Development officer, Kevin Rushing, who was on emergency health leave. The Missions future agricultural portfolio will include more extension or technology transfer projects rather than research projects. The management of Peanut CRSP funds is left to PCARRD.

5.3.3. The USAID Mission personnel interviewed in Thailand were Doug Clark, Director, Office of Technical Resources and Dave Delgado, Director Agricultural and National Resource Development. We learned that Thailand is now classified as an "advanced developing country" because of recent high GNP growth rates. Future portfolios will include more support for small business or for commercialization of agricultural products and research.

5.3.4. While the interest in peanut production, quality and processing seemed high in both missions the EEP question of

possible support or "buy ins" with AID mission funds was turned aside with the observation that (1) all money was committed, or (2) the host country did not support buy ins to U.S. projects. However the Thailand mission is funding a variety of research projects through the Science and Technology Development Board, and encourages Peanut CRSP researchers in Thailand to apply for these grants to supplement CRSP funds.

5.4. Comments - Applicability of research

5.4.1. Philippines

As stated before much of the research is of a practical nature, and should be. The studies are designed for low-input technology for small peanut farmers. Other projects are more basic and long term, such as the studies of the biology and ecology of primary peanut insects and the biocontrol portions. While insect populations vary somewhat with ecology, we suspect that the same insects attack peanut throughout South and Southeast Asia. Therefore the insect research results should be transferable to other Asian or tropical peanut growing countries. PCARRD publications and regional workshop presentations are already accomplishing this.

By being located adjacent to IRRI new insect tolerant varieties, insect control, or technology can be easily introduced into the ASEAN Farming Systems Network which includes 14 countries in South and Southeast Asia.

Both ICRISAT and International Development Research Centre - Canada (IDRC) indirectly support this project by their interest in insect tolerant varieties. ICRISAT supplied breeding materials and co-sponsored conferences. IDRC supported the peanut breeding program at IPB which had as one objective - better insect tolerance.

5.4.2. Thailand

The objective of this Thailand project is to develop environmentally sound and economical insect management. The casual observer might think there is a degree of duplication between Thailand and the Philippines and to a certain extent that may be true. However the variation in growing conditions, soil types, cultural practices, etc. supports each country seeking effective, economical control measures and IPM packages. As these are refined and cross checked in specific environments they should be transferable to similar ecologies in non-participating countries.

However, we were pleased to note emphasis being placed in slightly different areas by Thailand entomologists. For example, the National Biological Control Center in Thailand

is avidly pursuing the identification and role of insect predators in peanut production. Certain spiders (Araneida), Syrphus sp. and Coccinellidae sp. appear promising and efforts to increase and test releases are progressing. The most promising one appears to be lady bugs (a Coccinellidae) for aphid control. The recent return of Dr. Songyot Phisitkul from the Philippines will add impetus to this research. His Ph.D. thesis studies were on Peanut Insect Predators.

Thai entomologists are also working on the role and control of insect vectors which transmit peanut viruses. We anticipate this research will take on even greater importance as parts of the Peanut CRSP virus program is moved from Africa to Asia, with headquarters in Thailand (see GA/PV/NTP for greater details).

Thai entomologists are concentrating on certain insects important to their country, but not present in North Carolina or less important in the Philippines. Examples are the underground pod feeders such as the subterranean ant and millipedes. Pod damage ranged from 10-20 percent when the ant was present and both insects encourage the presence of aflatoxins on the harvested seed.

Thai peanut researchers cooperate closely with ICRISAT and IRRI. The former provides breeding materials, including promising insect tolerant lines, and IRRI provides cultivars and other technology through their Farming Systems Network. We were pleased to learn that IRRI is decentralizing their training programs and plan to hold a Farming Systems course in Thailand this year. The course will include peanut production and constraints, including insects.

5.4.3. North Carolina

This research is highly relevant to host country and U.S. goals. Early on it was discovered that many of the same peanut insect genera were present in Asia and the U.S. Thus control technologies or resistant plant genotypes may be transferable. Conversely some insects, such as the subterranean ant in Southeast Asia, afford the opportunity to develop control methods there that could be used in the event that such pests are inadvertantly introduced into peanut areas of the U.S. The identification and knowledge of vector insects for various peanut viruses in Asia are being documented in the event that the latter are found at some future date in this country.

The geographic and long term implications of this project will be facilitated by the linkages already formed between NCSU and research institutions in Thailand and the Philippines in addition to ICRISAT, IDRC and the Australian Centre for International Agricultural Research (ACIAR). These three are

widely involved in various phases of peanut research in several developing countries.

Within the U.S., the PI has initiated an insect nursery network of 24 elite multiple insect resistant lines selected from an original 250 ICRISAT genotypes grown in Thailand and the Philippines, with colleagues in five states (Alabama, Florida, Georgia, North Carolina, and Virginia). These nursery results will provide useful agronomic and insect information for entomologists, plant breeders and ultimately benefit U.S. growers by providing adapted, insect tolerant cultivars.

6. OBSERVATIONS

6.1. Strengths

6.1.1. Philippines and Thailand

6.1.1.1. The strength of this project lies in the high quality and the professional commitment of the staff involved in these two countries to accomplish the well defined objectives. We commend all the Principal Investigators and their staffs for the progress made in a relatively short period of time. Facilities and equipment were judged to be excellent with one exception (noted in 6.2. below).

6.1.1.2. The administration and integration of the Peanut CRSP program into the total peanut improvement programs by PCARRD and the Field Crops Division of the Thailand DOA are tremendous accomplishments. EEP members were particularly impressed with the Annual National Peanut Planning Workshops initiated by these agencies since Peanut CRSP started.

6.1.1.3. The research has been keyed to practical low-cost insect control methods after first gaining base line information on the insects present, their life cycles, alternate plant hosts, population dynamics and threshold damage levels at different plant growth stages. Progress made has allowed early pilot IPM programs to be established in both countries. A strong foundation for economic entomology has been built. However, many of the exciting biocontrol research potentials have just been opened up and should be avidly pursued.

6.1.2. North Carolina State University

6.1.2.1. The primary strength of this project lies to a great degree in the enthusiasm and unique background and knowledge of the type of research needed by Dr. Bill Campbell, the North Carolina PI, to solve the identified constraints. His leadership and ability to stimulate foreign nationals is outstanding.

6.1.2.2. The PI and collaborators in the host countries have either received graduate or short term training at NCSU. Thus personal friendships as well as scientific know how have been developed. Added to this was the spending of a sabbatic leave by the American PI in the two host countries to actively advise or aid their planning, implementation and interpretation in situ.

6.1.2.3. The policy of allowing the host country PI's to occasionally attend the annual APRES meetings is a strength.

6.1.2.4. The interdisciplinary collaboration within all countries is evident in the project and exemplary.

6.2. Weaknesses

6.2.1. Philippines

6.2.1.1. A change occurred in the Philippine PI about half way through the project. While the first EEP had high praises for Dr. Eliseo Cadapan, this EEP came away with the same observations for his successor, Dr. Virginia Ocampo. So we are not certain Dr. Cadapan's departure created loss of momentum.

6.2.1.2. After viewing the superb laboratories and facilities in the Institute for Biotechnology, and the new NCPC building we were disappointed to find Dr. Edwin Benigno's exciting Bacillus thuringiensis program housed in very poor facilities in an old NCPC building. Hopefully more suitable facilities to conduct this research will be forthcoming.

6.2.1.3. The same comments as above might be made on the shed across the road from the old NCPC where colonies of the egg parasite Trichogramma, Heliothis and Spodoptera were being reared for Biocontrol studies.

6.2.1.4. While we viewed few entomology field plots, we were disappointed with some of the breeding, soil acidity, and virus experiments from the standpoint of poor stands, and field plot design techniques. Poor or erratic stands were blamed on poor seed quality. We suspect poor planting techniques were partially responsible, and suggest germination tests be conducted for seed lots near planting time and used to compensate planting rates. A second alternative for critical trials with small plot size, would be to overplant and hand thin. Lastly, it is far better to discard plots or an experiment, rather than selectively harvest a certain number of plants from plots having variable stands, and "estimate" yields.

6.2.1.5. Great numbers of virus infected plants were observed in seed increase plots. We suggest other areas might be sought for this purpose where the presence of virus and/or the vectors is less than in Los Banos fields; or that chemicals be used to control the insect vectors.

6.2.1.6. Dr. Virginia Ocampo should visit North Carolina and Thailand to view the research and exchange views.

6.2.2. Thailand

6.2.2.1. While the panel appreciated the extensive tables of data distributed by the Thai entomologists, often there was no indication of the statistical significance of the data. In many trials agronomic and insect data were presented with no effort made to correlate the two. This happened where computer facilities were available.

6.2.2.2. While glowing reports were received of the three newly released cultivars and their tolerance to certain insect pests, we noted in many trials that the new material did not outyield the long time local variety Tainan 9. This might suggest a backcross breeding program in the future, or more use of Tainan 9 as a parent.

6.2.2.3. Both Thailand and Philippine researchers mentioned delays in Peanut CRSP funding had been a difficulty in the past. It appears they rely on these funds heavily for operating funds such as labor, supplies and travel.

6.2.3. North Carolina

6.2.3.1. We were told that communication could be improved between the Philippines and North Carolina. This pertains to timely submission of expenditure receipts and data summarization and exchange. We attribute this to staff turnover, mail service and the many responsibilities of the present PI. The newly established Fax service at Peanut CRSP headquarters should aid this.

6.2.3.2. While we were impressed with the progress, achievements and extensive data tables presented in the annual reviews from this project, we found very few publications listed. Consideration should be given to making the solid research findings more available in the scientific literature. This comment is apropos also in the Philippines and Thailand.

7. RECOMMENDATIONS

7.1. Philippines

7.1.1. Continue to determine insect damage and economic threshold levels on the primary peanut insects and thereby refine and improve the early pilot IPM programs. Work closely with extension to get such information to farmers.

7.1.2. The close collaboration with plant breeders of IPB in identifying insect tolerant germplasm should be continued for herein lies one of the least expensive and safest insect control methods for the small farmer. Since we learned that IDRC is closing out their project supporting peanut cultivar improvement at IPB, it will be important for Peanut CRSP to play a greater supporting role.

7.1.3. Continue and increase the studies of biocontrol agents (predators, parasites and microbials) for peanut insect control. Recognizing the presence of trained staff and potentially available well equipped laboratories, UPLB could become a regional or even world center for peanut biocontrol research. Scientists at nearby IRRI have extensive experience in this type of research on rice, and could offer advice. The PI should seek suggestions from Dr. Ramesh Saxena, entomologist at IRRI, who is one of the most experienced researchers in the world on use of plant substances, and particularly neem, for insect control.

7.1.4. Closer collaboration is needed between entomologists and virologists to determine and monitor the role of insects as vectors of the several viruses found in the Philippines. Viruses were observed to be present in abundance in all unsprayed fields viewed by the EEP in the Los Banos area, and also in field trials visited in Thailand.

7.1.5. As previously mentioned we believe the Philippine PI, Dr. Ocampo should visit NC after the replacement entomologist for Dr. Campbell is aboard. One point of discussion might well be training for we note that no Philippine gradaute student has come to North Carolina on this project.

7.1.6. Closer cooperation and sharing of information is suggested between the peanut entomologists of the Philippines and Thailand.

7.2. Thailand

7.2.1. We were impressed with the quality of a new publication on peanut diseases of Thailand supported by IDRC. We recommend (1) that Peanut CRSP (perhaps with ICRISAT) consider providing funds for a similar one on peanut insects, and (2) encourage distribution of the two publications in the peanut growing areas of Asia. Conferences with Thailand entomologists indicated that colored pictures are available. If not, an excellent insect museum containing over 50,000 specimens is

located in the Entomology and Zoology Division of the DOA in Bangkok where photos could be taken.

7.2.2. While early progress has been made on developing an IPM program, much more study and refinement is needed.

7.2.3. Developing countries need low-input pest control so emphasis on insect tolerant germplasm or cultivars should continue to receive high priority by entomologists and plant breeders.

7.2.4. While Thai entomologists say biocontrol has been a difficult challenge, we encourage more emphasis or funds to go to this environmentally safe and possibly low cost control method.

7.2.5. We commend Peanut CRSP for sponsoring travel of host country PI's to meetings outside their country and occasionally to APRES meetings. We recommend this practice be continued, or increased as funds permit.

7.3. North Carolina State University

7.3.1. High priority should be given to the extension of this project at NCSU and with the present two host countries.

7.3.2. With the retirement of the PI (November 1989) and our high evaluation of the progress and accomplishments obtained, we recommend that NCSU expeditiously fill the vacancy with an experienced field-oriented entomologist with some interest in international development.

7.3.3. We recommend to Peanut CRSP management that the present PI, Dr. W. V. Campbell, be engaged as a consultant on occasion. He could be particularly effective as a kind of roving scientific adviser for Peanut CRSP programs in Asia. He should continue as the PI during the transition period between retirement and replacement, for this project has been fruitful and we anticipate even more success in the future.

7.3.4. Increased efforts should be made to introduce the multiple insect resistant germplasm identified by the project to other peanut growing regions of the world. This might be accomplished through established networks such as ICRISAT, CORAF (Conference des Responsables Africans et Francais de la Recherche Agronomique), ASEAN, (Association of Southeast Asian Nations), or developing new ones. The PI of the Ga/IM/BF Peanut CRSP project should test these genotypes in Burkino Faso at the earliest opportunity. Texas, Oklahoma, and New Mexico entomologists and breeders should also look at the material as potential breeding stock.

7.3.5. Continued close liaison should be maintained with the ICRISAT program to seek even closer complementarity and to minimize duplication of efforts. The continued service of Dr. Ron Gibbons of ICRISAT on the Peanut CRSP Board should facilitate this.

7.3.6. We encourage continued liaison with IDRC, ACIAR, and other donor agencies who sponsor agricultural research in Asia. Opportunities for jointly sponsored workshops and publications should be avidly pursued.

7.3.7. High priority should continue on developing insect threshold levels for the indigenous pests of peanut with the objective being to develop IPM programs for a low cost, safe, sustainable agriculture.

4.5. EXTERNAL EVALUATION PANEL REVIEW

Peanut CRSP Code: GA/PV/N,TP

Project Title: PEANUT VIRUSES: ETIOLOGY, EPIDEMIOLOGY AND NATURE OF RESISTANCE

Principal Investigators and Collaborating Institutions: Dr. J. W. Demski, University of Georgia; Dr. Steve Misari and Dr. Okon Ansa, Ahmadu Bello University, Nigeria; Dr. Sopone Wongkaew, Khon Kaen University, Thailand; Dr. Marina Natural, University of the Philippines at Los Banos, Philippines.

The following project profile evaluation resulted from visits to the University of Georgia in February and to Thailand and the Philippines in March 1989 by all four EEP members. None of the panel visited the Nigeria host country, since the Technical Committee and Board of Directors of Peanut CRSP had in July 1988 shifted most of the virus research from Nigeria to Thailand and the Philippines. The EEP had discussions with agricultural officers and administrators, personnel of linkage organizations and USAID, as well as the Principal and Co-principal Investigators, with the exception of Dr. Sopone Wongkaew, the PI in Thailand, who was characterizing peanut stripe virus samples from different countries in a laboratory in France at the time of the EEP visit. The persons visited and the itineraries of the EEP for the U.S. University and host countries are given in Appendix I. In addition to the first hand discussions, the evaluation is based on visits to research laboratories, field plots, and on the Annual Reports and other written materials provided by the hosts and by the Peanut CRSP Program Director.

1. ACHIEVEMENTS.....Highly Satisfactory

1.1. The most significant impact of this project is the training of graduate students and improving the capabilities of other researchers by organizing training meetings and making possible their participation in international meetings, symposia and laboratory visits (Appendix II). Two students, one each from Thailand and Brazil, received their Ph.D. degrees in Plant Pathology-Virology with Peanut CRSP support from the University of Georgia in 1987, and a third student (from Nigeria) is in the final stages of completing her degree. In addition, on site consultations in host countries were provided by the U.S. scientists, and host country scientists received short term training in the U.S.

1.2. The basic research supported by Peanut CRSP led to the description in 1985 of the two causal agents for Groundnut Rosette Virus (GRV). Rosette virus is one of the two major constraints to peanut production in Africa; the other being

drought. Because of the serious losses caused by rosette virus epidemics in West Africa in 1975, 1983, and 1985, many farmers eliminated peanut production from their farming operation. Now, as a result of this research, it is recognized that two agents are associated with the groundnut rosette disease; the groundnut rosette virus (GRV) which is responsible for the symptom expression; and the groundnut rosette assistor virus (GRAV) which, when alone, is symptomless. When plants are infected with both GRV and GRAV the detrimental effect is greater than when plants are infected with GRV alone. Aphid transmission of both of the symptomatic forms of GRV (chlorotic and green rosette), the physio-chemical properties of the viruses and their manual transmission were determined. Although GRV has been known for over 80 years, the etiologic agents such as these determined by Peanut CRSP were not known, and thus control measures were not clearly established. In addition the PI's in the U.S. and Nigeria established the ability, through the use of linkages in Germany and Scotland, to handle live viruses.

1.3. The 1985 epidemic of peanut rosette in West Africa, although devastating to farmers, permitted a crucial evaluation of 12 lines selected the previous year as being resistant to rosette virus and two lines were released in 1986 and increased in 1987. For the 1988 season, 20 tons of seed of the GRV resistant line RMP-12 was available to farmers. Line RMP-12 has a 120-day maturity requirement, which is too long for much of the peanut-growing area but could be a major source of resistant germplasm to reduce the downward trend of peanut production in West Africa.

1.4. For areas north of Zaria, Nigeria, an integrated pest management (IPM) program was developed by the host country faculty at the Institute for Agricultural Research (IAR) at Samaru, Nigeria. They selected peanut cultivars with high yield, earliness, and drought tolerance that when used with a combination of chemical seed and soil treatments combined with early planting and sowing sufficient seed to have close plant spacings, gave excellent protection from peanut rosette insect pests.

1.5. Peanut Stripe Virus (PStV), first discovered naturally infecting peanut in the U.S. by PI Dr. J.W. Demski in 1982, is found to be less of a threat to peanut production in Georgia than first believed. Georgia PI's Drs. R.E. Lynch (entomologist), J.W. Demski (virologist), and co-workers reported after several years of study that PStV did not influence measured components of growth, yield and grade of peanut and that the amount of seed transmission averaged less than 2% under field conditions, similar to that reported

earlier for peanut mottle virus (Peanut Science 15:47-52, 1988). As a result of this research all restrictions in Georgia on movement and testing PStV-infected germplasm have been rescinded. Preliminary greenhouse and field studies in North Carolina also do not support earlier reports that PStV infection is a major yield-reducing factor in peanut. Seed transmission of PStV in preliminary tests in North Carolina also was low, characteristic of potyvirus infection in other legumes (M.K. Beute and B.B. Shew, Proc. Peanut CRSP Workshop, Khon Kaen, Thailand:29-32, 1986). Effects of PStV on peanut yield in Thailand are conflicting and seed transmission varied from 0 to 7% depending on cultivar (Sopone Wongkaew, Proc. Peanut CRSP Workshop, Khon Kaen, Thailand:86-90, 1986). Peanut yield loss assessment from PStV in the Philippines has not been completed (R.M. Abilay, Peanut Varietal Improvement in the Philippines. p. 18, Annual Progress Rept. Jan. 1 to Dec. 31, 1988. UPLB-Peanut CRSP-PCARRD).

1.6. Peanut stripe virus (PStV) was characterized: the morphology of the PStV particle, methods of identity developed, three symptom variations were identified (Ring spot, Green blotch and Mild mottle), and the serological relationships of PStV with other legume potyviruses was established and published.

1.7. Procedures to screen for resistance to groundnut rosette virus based on evaluation of the pathogen and effects of pathogen on the host were developed for both field and greenhouse studies.

1.8. Peanut diseases, including PStV and yellow spot viruses, were monitored in a total of 57 plantings in Thailand, disease surveys were made in farmers peanut fields in 50 locations, and a "Compendium of Peanut Diseases in Thailand" was published in 1985 and distributed. Monitoring of peanut diseases in farmers' fields in Thailand is now done routinely.

1.9. It is now possible through an antisera bank maintained by the University of Georgia to achieve rapid diagnosis of peanut virus diseases in any part of the world without sophisticated facilities by serological tests and host reactions. In addition, where the written instructions for diagnosis are inadequate, short course presentations were/can be made.

1.10. Two new viruses (in addition to peanut stripe virus), bean yellow mosaic and cowpea chlorotic mottle virus, have been identified as naturally infecting peanut in the United States but are expected to have little economic impact.

1.11. The Peanut CRSP improved the virus research capabilities of the U.S. institution and that of the host countries, Nigeria, Thailand, and the Philippines (in addition to the training discussed in 1.1) by providing equipment and supplies, providing and sharing publications, and forming collaborative linkages with other organizations such as; ICRISAT in India and Africa, IRHO in France and Africa, IDRC in Canada and S.E. Asia, IRRI in the Philippines, ACIAR in Australia and Indonesia, FAO in Rome, AGLN the Asian Grain Legume Network, CIMMYT in Thailand, and laboratories in Scotland and Germany. Prior to Peanut CRSP the linkages among the various agencies or institutes were primarily on a personal basis and work plans were rarely discussed which led to fragmentation and slow research progress. Peanut CRSP instigated an international consortium of peanut virologists. Also, due to the Peanut CRSP, improved relationships now exist between the pathologists, virologists, entomologists and breeders.

2. IMPLEMENTATION AND MANAGEMENT OF PROJECTS

2.1. Administrative Involvement

2.1.1. Attitude towards, support and perceived relevancy to the institution..... E

2.1.2. Fiscal/logistical assistance..... HS

2.1.3. Resource commitment (faculty/ facilities)..... S

2.1.4. Comments:

2.1.4.1. Although the Plan-of-Work for the virus project in both Thailand and the Philippines was signed in November, 1988, some peanut disease surveys and preliminary studies on peanut viruses by the host country PI's had been undertaken previously.

2.1.4.2. The panel was favorably impressed with the attitude of the administration in Georgia and in the host countries, Thailand and the Philippines, with regard to support and perceived relevancy of the project to the institution and gave this category a rating of <u>excellent</u>.

Administrators in Georgia related the many positive spinoffs of the Peanut CRSP program such as student and post graduate training and the broadening effect on the research perspectives of the faculty. The fact that the participating faculty had to be away from their in-state

responsibilities for considerable periods of time did not seem to be a problem. In Athens, Georgia, Dean W.P. Flatt of the College of Agriculture related to the panel how the positive response of the Peanut CRSP has overtaken any negative reaction of the industry, and how it has resulted in Georgia scientists becoming more effective by giving them a better world-wide perspective and improved collaboration among the scientists within and among states and internationally. The Resident Director of the Georgia Station at Griffin, Dr. G.F. Arkin, now senses a strong commitment to International Agriculture at the University of Georgia. The Peanut CRSP plays an important role in Georgia and he would like to see more of the faculty have an opportunity to participate.

2.1.4.3. Resource commitment received a satisfactory rating. Although facilities are currently lacking at IPB in the Philippines, the PI does have access to the excellent equipment and facilities in the laboratories of the Institute of Biotechnology. Ms. Araceli Pua, who will be working with Dr. Marina P. Natural, is obtaining a Ph.D. in Plant Pathology/Virology under the supervision of Dr. Natural at the University of the Philippines, and will be the first virologist in the Philippines. She was spending a year as a non-degree student in the Virology lab at the University of Georgia, and the EEP visited with her briefly during their visit to Athens. The primary laboratory equipment needs, when she returns to the Philippines, will be an ultra centrifuge, ELISA reader, and a pH meter. In addition to her research she will also be teaching a course in virology. Until her laboratory is equipped, Dr. Teresita Espino of the Institute of Biotechnology assured the panel that Ms. Pua would also have access to their equipment and facilities.

2.2. Researcher Involvement

2.2.1. Attitude towards, support and perceived relevancy to the institution..... HS

2.2.2. Fiscal/logistical assistance..... S

2.2.3. Resources commitment (faculty/facilities)..... S

2.2.4. Comments:

2.2.4.1. While it is early to be making judgments of the researchers involvement in Thailand and the Philippines, the commitment and enthusiasm of those PI's that the panel was able to interview, Drs. Demski and Kuhn in Georgia, and

Dr. Natural in the Philippines, is especially noteworthy. The panel did not interview the PI in Thailand, Dr. Sopone Wongkaew, or visit his pathology/virology laboratory at Khon Kaen University since he was in France during the panel's visit. However, a review of some of Dr. Wongkaew's recent papers and the high regard his administrators and peers, including the U.S. PI's, have for him, gives the panel assurance of his capabilities, and that his collaboration in the peanut virus work will help to assure progress in solving the problems.

2.2.4.2. Dr. Marina Natural is a general plant pathologist at UPLB who spends about 30% of her time on virology research and the remainder on fungal and bacterial diseases, in addition to teaching. The main emphasis of her peanut virus research will be concerned with bud necrosis caused by tomato spotted wilt virus (TSWV) and PStV. At the present, as was pointed out in section 2.1.4., she works in collaboration with Dr. Teresita Espino of the Institute of Biotechnology, since her laboratory does not yet have the necessary materials or equipment for plant virus work.

2.2.4.3. Although Peanut CRSP funds were used to purchase an ultra centrifuge for Dr. Demski's laboratory at Griffin, some of the laboratory equipment there, as was the case for Dr. Kuhn's laboratory at Athens, appeared to be well used, not in itself a negative observation, only that this equipment will likely need to be replaced soon.

2.2.4.4. The first EEP in 1985, after their visit to the laboratory of the Nigerian PI's (Drs. Steve Misari and Okon Ansa) in the Institute of Agricultural Research (IAR) at Samaru, found a need for several items of equipment. Dr. Demski told the 1989 panel that the Peanut CRSP virus project provided the laboratory in Nigeria with a balance, pH meter, and an ELISA reader, and that the equipment would remain there. Mrs. Phindile Olorunju is a graduate student from Nigeria completing her Ph.D. degree in Plant Pathology at UGA, Athens. Mrs. Olorunju had taken her course work and made peanut crosses of susceptible and resistant peanut cultivars at the UGA to determine the inheritance of rosette virus resistance. However, evaluation of the progeny for rosette virus resistance is being done in Nigeria under the supervision of Dr. Misari. Peanut CRSP plans to continue support of this student's program.

2.2.4.5. The financial aspects of the project appear to be handled effectively. However, there is an imbalance of the money budgeted and expended between the U.S. and the host countries. This may be due to the fact that the

logistics of working in Nigeria have been difficult, e.g. travel into and out of the country, transfer of funds, accounting of expenditures, etc. From the inception of the Peanut CRSP through 6/30/88 the U.S. portion expended 10% more dollars than budgeted, while the host countries expended 33% less dollars than budgeted.

3. INSTITUTIONAL DEVELOPMENT

3.1. Complementarity to ongoing research efforts..... HS

3.2. Strengthening of scientist/equipment/ facility capabilities..... S

3.3. Extent of collaborative interactions..... E

3.4. Training..... HS

3.5. Comments:

3.5.1. The overall rating of Institutional Development is highly satisfactory, however, the excellent extent of the projects collaborative interactions is one of the most significant contributions thus far to the overall objectives of the Peanut CRSP. The collaboration fostered by this project among scientists in the peanut production areas of the U.S., in the Peanut CRSP host countries, and in many other countries without formal ties to the Peanut CRSP, has brought special attention to peanut virology programs, especially those at the UGA, and to Drs. Demski and Kuhn. In addition to the excellent collaborative research accomplished between the U.S. PI's and the Nigerian host country PI's (Drs. Misari and Ansa) there were valued friendships established, and Dr. Demski related to the panel that he had mixed feelings about the discontinuance of the virus work in Nigeria. He mentioned the difficult logistics of working in Nigeria, as well as the fact that ICRISAT also had a mandate to work on groundnut rosette virus in Africa, as being the main reason for shifting the virus project to Thailand and the Philippines. The problem of logistics in the HC existed from the onset and the first Triennial Review EEP made a number of suggestions they thought would help lessen the problem, e.g. (page 100, sec. 1.14).

3.5.2. The international attention that the Peanut CRSP virus program has focused on Georgia is illustrated by the fact that Dr. D.V.R. Reddy, ICRISAT's principal virologist, spent most of his sabbatical year in Dr. Demski's laboratory at Griffin characterizing, preparing antiserum, and studying methods of detection for PStV. Also, by the international

invitations that Dr. Demski has received (outside of Peanut CRSP) e.g.: (a) presentation on peanut mottle virus during the First International Plant Virus Epidemiology meeting held in Oxford, England; (b) lectures on various phases of virology and counseling graduate students at the University of Pernambuco in Brazil, February 24-March 6, 1986; (c) as one of four lecturers in an "FAO Training Course on Detection of Groundnut Viruses" in Malong, Indonesia, July 11-26, 1988; and (d) a presentation on tomato spotted wilt virus to professionals from around the world working on TSWV, in Honolulu, Hawaii, March 27-29, 1989.

3.5.3. The entire collection of peanut germplasm being held by the USDA Southern Regional Plant Introduction Station located at Griffin, Georgia, is currently in the process of being screened for virus diseases in Dr. Demski's laboratory, an illustration of collaboration indirectly related to the Peanut CRSP virus work.

3.5.4. Collaborative interactions which are directly related include; the close relationship with ICRISAT (Drs. Ron Gibbons and D.V.R. Reddy), a relationship that has been very strong from the beginning; cooperators from Scotland (Drs. Murat and Harrison); with Drs. Rudolf Casper and Erich Breyel from the Institute of Plant Viruses (BBA) in West Germany; IDRC-Canada; IRRI-Philippines; with Dr. A.J. Gibbs and Ms. K.F. Boswell of the Australian Virus Ecology Group of the National University, Canberra; ACIAR - the Australian Center for International Agricultural Research in S.E. Asia; and with the CIMMYT Asian Center in Thailand.

3.5.5. As was pointed out in section 1.1. the panel feels that the training of the three Ph.D. degree students at the University of Georgia, and others on a short-term basis, will have a beneficial and long lasting impact. Three of the short-term trainees at the UGA, including the host country PI, were from the Institute of Agricultural Research, Samaru, Nigeria. The Co-PI, Dr. Ansa, spent a month in molecular biology training in Scotland and a month in virus purification in Germany. Dr. Ansa, who received his Ph.D. degree from the University of California in molecular biology, supervised graduate student work on the purification of single strand RNA(s) from GRV and GRAV, in the Dept. of Plant Pathology, Institute of Agricultural Research, Samaru-Zaria. Dr. Steve Misari, a Vector Entomologist, who also received his Ph.D. from the University of California, supervised two M.S. students at Ahmadu Bello University, Samaru-Zaria. One student, from Nigeria, worked on GRV epidemiology from the viewpoint of control of the vector, and the other from India on transmission of the disease. Dr. Misari, as was discussed

in section 2.2.4., is also supervising the field research, on GRV resistance, of Mrs. Phindile Olorunju, who is completing her Ph.D. degree in Plant Pathology at the University of Georgia, Athens (for training details, see Appendix II).

3.5.6. Peanut CRSP sponsored a workshop in Khon Kaen, Thailand in 1986 which included two reports by the host country PI, Dr. S. Wongkaew, on peanut stripe virus and other viruses in Thailand, and a report on PStV, by Dr. Demski. The Proceedings of this Workshop were edited by Peanut CRSP investigators Drs. H.T. Stalker, A. Waranyuwat and B.B. Shew, and published in 1987 by Peanut CRSP. In 1987 and 1988 workshop meetings sponsored by ICRISAT, with

Peanut CRSP participation, at Malang, Indonesia, were attended by representatives of ten Southeast Asian countries.

4. ADEQUACY OF SCIENCE

4.1. Progressiveness and innovativeness of the Science/Research..... S

4.2. Social Science/Economic Implications..... S

4.3. Appropriateness of Basic/Adaptive Research..... HS

4.4. Comments:

4.4.1. The panel rated the progressiveness and innovativeness of the science/research for this project as satisfactory, which is below the highly satisfactory rating given by the first EEP in their 1985 report. Early in the Peanut CRSP virus program (1982) Dr. Demski presented the first documentation of a new virus on peanut, peanut stripe virus (PStV). Later, PStV was found, in a survey of Dr. D.V.R. Reddy, ICRISAT virologist, to be present in several S.E. Asian countries, including Thailand and the Philippines. In addition many significant advances were being made by the Peanut CRSP virus team in Georgia and Nigeria (with collaboration from other groups) toward solving the problem of groundnut rosette virus, which is generally considered, after drought, as being the most serious constraint to peanut production in Nigeria and other West African countries. With these early results and the very favorable impressions received by the first EEP in the on-site visits and discussions with the PI's in the U.S. and HC, it is easy for this second EEP to understand their

rating. Unfortunately, none of the current EEP made an on-site visit to Nigeria and Dr. A.H. Bunting was the only member of the first EEP to make an on-site visit to Nigeria. However, Dr. K.H. Garren did have personal discussions with the Nigerian PI's at a conference in England. Both Drs. Bunting and Garren were favorably impressed with the work of Drs. Misari and Ansa. Concerning the progressiveness and innovativeness of their research, Dr. Bunting wrote on page 103 of the 1985 EEP report, "It is not too much to say that the two days at IAR with Dr. Misari and Dr. Ansa were as exciting scientifically as any this reviewer can remember. Of course, it is impossible to separate the contributions of these two from those of the U.S. investigators and of the rest of the international community with which they all collaborate; but our colleagues at Samaru have the inestimable comparative advantage of sitting on top of the material in its own environment." Dr. Garren wrote, on page 125 of the first EEP report, that Dr. Casper of the Plant Virus Institute in West Germany felt that, at that time, Dr. Ansa's virus research work in Nigeria was ahead of theirs in this area; and on page 112, concerning the adequacy of science in the host country, Dr. Garren wrote: "The reviewer was favorably impressed with the scientific acumen of the Nigerian Co-PI's. He finds justification for regarding this as perhaps the greatest strength of the Nigerian arm of GA/PV/N."

4.4.2. One of the main purposes of the Peanut CRSP is to relieve constraints that would enable an increase in production and utilization of peanuts in the LDC's. The Peanut CRSP Planning Report of 1981 listed the three most destructive viruses affecting peanut, on a world-wide basis, as peanut mottle (PMV), groundnut rosette (GRV), and bud necrosis caused by tomato spotted wilt virus (TSWV). PMV is worldwide in distribution. However, most of the research on PMV has been done in the U.S. and more specifically in the State of Georgia. After years of extensive and intensive research on PMV, Georgia virologists, C.W. Kuhn and J.W. Demski, felt that sufficient information was known about PMV so that control recommendations could be made for this disease. In 1975 they authored University of Georgia Research Report No. 213 entitled "The Relationship of Peanut Mottle Virus to Peanut Production", and discussed three methods of control: (a) the use of resistant or tolerant cultivars, (b) the use of virus-free seed and (c) elimination of the insect vectors. They wrote that "although PMV causes a peanut disease which is endemic, there is no immediate urgency in 1975 to organize a crash program to develop control measures," and currently to the panel's knowledge no PMV control measures are being used in Georgia or elsewhere.

4.4.3. Peanut mottle virus, although it belongs to the same group of viruses as PStV, is more detrimental to peanuts in terms of its effect on yield and quality than is PStV. As was pointed out previously in Section 1.5., after several years of research, Georgia scientists, Drs. R.E. Lynch, J.W. Demski, W.D. Branch, C.C. Holbrook and L.W. Morgan, reported (Peanut Science 15:47-52, 1988) that PStV did not influence measured components of growth, yield and grade of peanut and that the amount of seed transmission averaged less than 2% under field conditions, similar to that reported for peanut mottle virus. The results of preliminary studies on yield damage assessment by PStV in North Carolina by Drs. Beute and Shew, and in Thailand by Dr. S. Wongkaew, corroborate the Georgia find-ings (Proc. Peanut CRSP Workshop, Khon Kaen, Thailand. pp. 29-32 and 86-90, 1986). A one-year study of yield loss due to PStV, conducted in Thailand in 1986 by North Carolina State University graduate student, Mr. W.F. Anderson, did indicate that PStV can have a detrimental effect on yield. Anderson indicated, however, that environmental factors may have confounded his results; since the virus plants were surrounded by healthy plants affecting the competitiveness for nutrients and water. Anderson's results did, however, corroborate the other investigators as regard to the low seed transmission of PStV.

4.4.4. The EEP was fortunate during their visit to Thailand to see numerous field experiments and peanut seed increase plots. The plantings were in various stages of growth from mid-season maturity to full maturity. The fully mature plots had been grown under rain-fed conditions and were in the process of being harvested. The panel observed widespread PStV symptoms, especially in entomological research plots receiving no insecticides for control of the insect vector (aphids). In these plots it would be impossible to separate the damage caused by insects from that caused by diseases. In the breeding and seed increase plots receiving recommended cultural practices, PStV symptoms, though present, were minimal; and the plots appeared similar to those one would find at most peanut research stations in the U.S., which is a tribute to Thai research workers.

5. APPLICABILITY OF RESEARCH

5.1. Relevancy and Transferability of Research to Host Country/U.S. Programs..... S

5.2. Relationship to Other International Research Programs..... E

5.3. USAID Perceptions..... HS

5.4. Comments:

5.4.1. The GA/PV/N,TP project, targeted to yield loss constraint by rosette virus, was well designed and highly relevant to host country/U.S. programs during its first five years of operation. However, the panel feels that the changes made during the past two years, in shifting the program from West Africa to S.E. Asia, have resulted in the project no longer being highly satisfactory in relevancy, especially to the host countries.

5.4.2. With peanut production decreasing in many West African countries, especially in Nigeria, Niger and Burkina Faso due in large part to rosette virus disease, there was no question about the urgency and relevancy of the virus program. Although rosette virus is not yet found in the U.S., giving U.S. scientists advance knowledge of this devastating virus disease is of value for future protection strategies should the virus enter the U.S. and is certainly of benefit to the U.S. if the disease can be controlled and contained where it is. In S.E. Asia, on the other hand, none of the virus diseases that infect peanuts are considered by the host country scientists or others as being the primary disease constraint to peanut production.

5.4.3. In the Philippines, peanut virus diseases ranked behind the cercospora leaf spot diseases, rust, stem and root rots; and some pathologists placed the virus diseases after bacterial wilt and damping-off as being major threats to peanut production (Proc. First Natl. Peanut Consultation and Peanut-CRSP Review. pp. 63-80, 1985, PCARRD, Los Banos, Philippines). Of the virus diseases affecting peanuts in the Philippines, peanut mottle virus (PMV) was considered most prevalent followed by peanut yellow spot virus (PYSV) and peanut stripe virus (PStV). Thrips (*Scirtothrips dorsalis*) transmit PYSV, while aphids are the insect vector for PMV and PStV. The Peanut CRSP project NCS/IM/TP has identified peanut genotypes with resistance to thrips in North Carolina, Philippines and Thailand.

5.4.4. In Thailand the major peanut disease constraints are the leafspots (early and late), rust, seedling blight (*Aspergillus niger*), stem rot (*Sclerotium rolfsii*) and the viruses; PYSV, PStV, PMV and TSWV. Bud necrosis, caused by tomato spotted wilt virus (TSWV) was noted in Thailand for the first time in 1984. Based on 1984 and 1985 peanut disease surveys, TSWV ranked far below peanut yellow spot virus (PYSV) as a yield constraint of peanut in Thailand.

Tomato spotted wilt virus, PStV, and PMV were severe in only a few locations in Thailand. In India, however, TSWV is a very damaging disease to peanut, and ICRISAT is directing a major research effort towards the problem. This virus was also found to be damaging on peanut to a limited extent in the U.S. (a three county area in Texas).

5.4.5. In Senegal rosette virus is a serious problem south of the Gambia River. Peanut clump virus, which has not as yet been characterized, is serious on peanut at the Bambey Station in Senegal but not in farmers fields. Rosette is also a very serious problem in Niger, especially in the Maradi Region, in southern Burkina Faso, and on sandy soils in other areas of West Africa.

5.4.6. Assessing yield damage and other detrimental effects of viruses on peanut is a vital but very difficult task, since there are so many factors that can confound the results when not controlled; such as differential plant competition, damage from insects, including that of the insect vectors, and damage from other peanut diseases, etc. This accounts for the conflicting yield loss results sometimes reported from these experiments. In this regard the panel was impressed with the collaborative research effort of the Georgia PI's of the Peanut CRSP Projects GA/IM/BF and GA/PV/N,TP in assessing the effects of PStV on peanut in the commercial production area of Georgia.

5.4.7. Six years is too short a period of time to develop and transfer technology. However, in the Philippines, PCARRD has initiated with Peanut CRSP collaboration, a Peanut Pilot Program, that appears to be an effective and efficient technology transfer system for getting newly developed peanut cultivars and production and post harvest technologies to the farmer. In its first year, 1987-88, the average peanut yield in the pilot areas by farmers utilizing the recommended technologies was 21% greater than where farmers used their traditional practices.

5.4.8. There has been no progress to date in finding peanut genotypes with resistance to PStV, although 5400 genotypes were evaluated in Indonesia and lesser numbers in Georgia, Thailand, the Philippines and ICRISAT. The EEP suggests that, while continuing the search for naturally resistant germplasm, a greater emphasis be placed on other avenues of control of this virus such as: (a) more intensive studies on the agronomic and consumer acceptability of those genotypes which exhibited zero seed transmission; (b) in collaboration with entomologists, search for genotypes having less attraction to the insect vectors (aphids, thrips), and for methods of controlling the insect vectors.

The variation in both insect damage and PStV symptoms between different genotypes in a replicated field trial of Project NCS/IM/TP at Khon Koen University was apparent during the panel's visit on March 20, 1989. In another experiment in an adjacent field, where the insects were chemically controlled, only a few plants were noted with PStV symptoms. In a previous years' experiment of peanut yield-loss assessment for PStV in Thailand, the virus spread from the inoculated to non-inoculated plants so rapidly that by 80 days all treatments had equal virus incidence. Since Southeast Asia peanut fields have both a high incidence of PStV and high populations of the insect vectors responsible for spread of the virus, the panel has serious questions about the value of attempting to provide virus-free seed to growers. A similar program suggested for producing PMV-free seed in Georgia in 1975 has yet to be implemented. Such a program would likely not be economically feasible in Thailand or the Philippines. Also, the panel is not convinced that the necessary effort and costs expended to continually be monitoring peanut in the U.S. and host countries for new viruses, strains or isolates is a valid objective. Especially when there are more important problems to solve with the viruses already known to be serious than there are scientists and facilities to handle them. This kind of work, if done at all, should be a spin-off of the main objectives of removing the known constraints to peanut production.

5.4.9. The panel, after reviewing the minutes of the Peanut CRSP Technical Committee (TC) and Board of Directors (BD) understand the reasons why, two years ago, they approved a transfer of the GA/PV/N project from Nigeria to Thailand and the Philippines. Unknown to them at the time were the recent reports and publications disclosing PStV as being much less of a threat to peanut production than originally believed, both in the U.S. and in S.E. Asia; the recent epidemics of rosette virus in Niger, Burkina Faso and Nigeria that have reduced still further the peanut production in West Africa; that ICRISAT has only one person working on viruses in all of Africa, and ICRISAT is also working on six other projects in West Africa, including foliar fungal diseases (leaf spots), drought (2 aspects - terminal and intermittent), crop growth variability, etc. Hindsight is generally better than foresight. The panel sensed, in reviewing the minutes of the TC and BD meetings, feelings of skepticism among the members about leaving Nigeria, that working conditions seemed to be improving, and possibly they shouldn't act too quickly about moving projects out. Dr. Demski, who has had an excellent working relationship with the host country PI's, told the TC during their meeting (2/10/87) that he felt progress was being made

and the goals of the project could be accomplished even though travel was difficult in Nigeria, and that he would rather stay there. Another point is that peanut now (and for the future) appears to be more of a food crop in all of West Africa. In Burkina Faso, a country with 8 million people, for example, all of the production (150,000 T/year) is used for local consumption; and this is estimated to be only about one fourth of what they could use.

5.4.10. Currently Dr. Demski is shifting his research emphasis in Georgia from PStV to tomato spotted wilt virus (TSWV) which is not seed borne; while in S.E. Asia the major thrust of the GA/PV/N,TP project is PStV, TSWV, and possibly peanut yellow spot virus (PYSV).

5.4.11. The relationship of the GA/PV/N,TP project to other international research programs is excellent. As was discussed earlier in this review concerning the extent of collaborative interactions in terms of institutional development (Section 3.5.), the panel feels that the excellent collaboration fostered by the U.S. PI, Dr. Demski, has enabled this project to attain some of the most significant contributions thus far to the overall goals of the Peanut CRSP. The international research programs which the U.S. PI has interactions with include: ICRISAT, FAO, AID-WINROCK, ACIAR, IDRC, IRHO, ATA and he has informal relationships with research groups in France, West Germany, Scotland, England and Australia. In fact, at the time of the panel's visit to Thailand, the host country PI, Dr. Sopone Wongkaew, was working in a laboratory in Montpellier, France for four months on the Peanut CRSP project with FAO paying for his airline travel, ICRISAT for his food and lodging, and Peanut CRSP paying only for his laboratory expenses. The relationship is especially close with the principal virologist, Dr. D.V.R. Reddy, of the legume program at ICRISAT so that work is coordinated and not duplicated.

5.4.12. The panel's perceptions of USAID concerning the applicability of Peanut CRSP research in the host countries was generally highly satisfactory. In the Philippines USAID was relying quite heavily on PCARRD in following up on the work of the Peanut CRSP. They currently are placing increased emphasis on getting the research out. In Thailand the USAID mission also was shifting more emphasis to agricultural technology transfer.

6. OBSERVATIONS

6.1. Strengths.

6.1.1. The significant advances (discussed in Section 1.) in alleviating the seriousness of groundnut rosette virus.

6.1.2. The training of graduate students in both the U.S. and Host country, and others on a short term basis; and in training programs, symposia, and conferences in other countries.

6.1.3. The significant collaboration that was fostered among scientists and research organizations throughout the world. This project is seen by the international community as being highly relevant.

6.1.4. The discovery of PStV, although recently determined not to be a serious yield constraint, did provide Dr. Demski a tool to create much impetus for the Peanut CRSP and helped in the formation of national and international linkages.

6.1.5. Dr. Demski's shifting of his emphasis away from PStV to TSWV, a virus disease which is currently damaging the tobacco crop in Georgia and could spread to peanuts.

6.2. Weaknesses and Options to Improve.

6.2.1. The lack of close collaboration with entomologists and breeders, especially in the early stages of the program.

6.2.2. The design of the first tests to assess yield losses due to PStV and seed transmission of the virus were not scientifically sound; and, as a consequence, the widely disseminated results from the tests gave unwarranted fears of PStV to the industry and agricultural administrators, especially in the peanut production areas of the U.S.

6.2.3. The recent emphasis of virus research in Southeast Asia at the expense of the work in West Africa where the need is much more critical.

7. RECOMMENDATIONS

7.1. The virus project must continue in closer collaboration with entomologists. Aphids are the insect vector primarily responsible for the spread of both peanut mottle and peanut stripe virus, while thrips are the vectors involved in the spread of TSWV. Among the major accomplishments of the Peanut CRSP (NCS/IM/TP) include the identification of peanut lines with resistance to thrips. Also a peanut genotype with resistance to aphids (Aphis craccivora) was reported from Malawi (Proc. Peanut CRSP Workshop, Khon Kaen, Thailand. p. 75, August 19-21, 1986).

7.2. Discontinue attempts to produce PStV-free seed in Thailand or S.E. Asia. Even with zero seed transmission, the insect vector populations are too high; and potyviruses are known to inhabit many weed hosts. Weeds are frequently the source of new infections annually. Thus, the possibility of producing virus-free seed seems to be remote.

7.3. Increase the allocation of research funds on this project to the host country (or countries).

7.4. Concentrate less on looking for new viruses and more on solving the problems associated with the old viruses (the original intent of the project), such as GRV, and PMV, that are known to be major yield constraints, and peanut clump virus which is a problem in all four of the West African Peanut CRSP countries.

7.5. Summary of GA/PV/N,TP: A highlight of this project, in addition to the training aspects, is the excellent collaboration fostered by the PI's with other national and international scientists. Basic research on this project led to the discovery of two causal agents of groundnut rosette virus (GRV), a devastating constraint in Africa. The GRV problem, a major objective of this project from the start, is still considered, after drought, as being the most serious constraint to peanut production in Nigeria and other West African countries. Efforts must be continued toward development of early maturing GRV resistant cultivars, a program that would be enhanced if selection progress wasn't dependent upon the occurrence of natural epiphytotics.

Peanut stripe virus (PSTV) was first documented as a new peanut virus by PI Dr. Demski in 1982. Since 1982 PSTV has been painstakingly studied and found to be less of a threat to peanut yield and quality in Asia and the U.S. than originally predicted. The panel recommends that the virus research program be continued in West Africa according to the original intent of the project. If unable to do so in Nigeria, then in some other West African country such as Niger or Burkina Faso, where other Peanut CRSP projects are in place. We believe the TC should reconsider shifting to an area (Asia) where virus diseases are less important as a peanut constraint than in Africa. If both areas are continued more funds will be needed.

4.6. EXTERNAL EVALUATION PANEL REVIEW

Peanut CRSP Code: TX/MM/S

Project Title: Mycotoxin Management in Peanut by Prevention of Contamination and Monitoring Introduction

Principal Investigators and Collaborating Institutions: Dr. Robert E. Pettit, Texas A&M University; Dr. Amadou Ba, Senegalese Institute for Agricultural Research (ISRA); Dr. Amadou Kane, Food Technology Institute (ITA).

Mycotoxins comprise a diverse group of naturally occurring poisons produced by fungi. Because mycotoxin contaminants have been implicated in the toxicity of man and animals, there is a growing awareness of their potential hazards in food and feed. Management strategies to solve the problem are clearly warranted and will have world-wide application wherever peanut is grown and/or utilized. In countries such as Senegal, after the family crushes the oil from peanut they consume the meal, and therefore the aflatoxin problem is likely to be more serious than in many other countries where the peanut meal is fed to animals. Also Senegalese farmers frequently market the best quality peanut, and inferior peanut is consumed by the family. Another practice which can encourage aflatoxin problems is that of placing peanut in large open piles that may contain pockets with high moisture or insects.

The following project profile evaluation resulted from visits to Texas A&M University on March 29-30, 1989 by three EEP members: Drs. R.O. Hammons, A.J. Norden, and J.W. Pendleton; and to Senegal on April 9-14, 1989 by Drs. A.J. Norden and J.W. Pendleton accompanied by Dr. R.E. Pettit, U.S. Principal Investigator for the Project. The panel had discussions with administrators, Principal and Co-Principal Investigators and Cooperators on the Project in Texas, as well as the Director General, and scientists and administrators of ISRA and ITA in Senegal, and USAID Officers in Dakar. The persons visited and the itineraries of the panel members for Texas A&M University and for Senegal are given in Appendix I. In addition to the personal interviews, the evaluation is based on visits to research laboratories, and on the Annual Reports and other written materials provided by the hosts and by Dr. D. G. Cummins, Program Director.

1. ACHIEVEMENTS.....Highly Satisfactory

1.1. Peanut breeding lines were identified with moderate levels of resistance to invasion by the aflatoxin-producing fungus, *Aspergillus flavus*. Genetic differences were detected in the degree to which pegs, pods, and seed from different genotypes were invaded.

1.2. The investigators discovered that a local Senegalese clay (ground attapulgite) and clay-like compounds (processed aluminosilicates) function as high affinity sorbents for aflatoxin in peanut oil and in animal feeds respectively. Over 90% of the aflatoxin in peanut oil was bound by this clay, and subsequent poultry feeding trials in Texas showed that a small percentage of the clay in an aflatoxin contaminated ration prevented accumulation of aflatoxin in the poultry livers. This research has created worldwide interest on the part of both scientists and industry.

1.3. The training of three Ph.D. and two M.S. degree students and improving the capabilities of four non-degree scientists in short-term training programs at Texas A&M University is a major achievement of the project. The TX/MM/S project does not involve the University in Senegal but, rather, two government organizations (ISRA and ITA).

1.4. Differences were revealed in the protein patterns of the peanut seed cotyledons between A. flavus tolerant and susceptible peanut genotypes and the response of live seed to invasion by A. flavus by producing pathogenesis-related proteins (PP). Genotypes with more resistance to A. flavus/aflatoxin retained this ability under drought stress, while susceptible genotypes generally lost the ability. These traits may serve as molecular markers to characterize resistant or susceptible genotypes.

1.5. The discovery that certain inorganic materials can selectively adsorb mycotoxins (SAM) and react to produce easily visualized fluorescent bands in a small glass column is a rapid, inexpensive, field-practical assay procedure for initial screening of peanut and various grains for aflatoxins.

1.6. Analyses of foodstuffs sold in Senegal markets for contamination with aflatoxin revealed the highest mean concentration levels in peanut seed (230 ppb), white corn (124 ppb), yellow corn (65 ppb), and peanut paste/butter (62 ppb). These results corroborate evidence of similar research throughout the world; that these two commodities, peanut and corn, pose serious health problems in food and feed quality in terms of their aflatoxin contamination. In the U.S., the maximum level allowable for edible peanut is 15 ppb.

1.7. At ITA in Dakar the aflatoxin content of contaminated peanut paste (butter) was reduced by approximately 80% of the original concentration after boiling for two hours in water.

1.8. Studies in Senegal revealed that applications of gypsum at 30, 45, and 60 days after planting reduced the activity of Aspergillus flavus in the pod zone at harvest time.

1.9. Evidence was obtained indicating that peanut pegs function as a primary point of invasion by the aflatoxin-producing fungi. Pods are also invaded while in the soil and more severely when under drought stress or if damaged.

1.10. Shells of the more resistent peanut genotypes were found to contain lignified tissue on the shell surface and in the central mesocarp and more compact arrangements of the sclerenchyma tissue. Similar defense barriers exist within the seed coats.

1.11. Field tests in Texas and Senegal verified that genotypes with resistance to in vitro seed colonization by Aspergillus flavus (IVSCAF) contained lower levels of aflatoxin when grown under field conditions.

2. IMPLEMENTATION AND MANAGEMENT OF PROJECTS

2.1. Administrative Involvement

2.1.1. Attitude towards, support and perceived relevancy to the institution..... HS

2.1.2. Fiscal/logistical assistance..... HS

2.1.3. Resource commitment (faculty/ facilities)..... HS

2.1.4. Comments:

The administrative involvement in the Mycotoxin Management project both at Texas A&M and in the host country, Senegal, was highly satisfactory in all three categories. The panel had an opportunity to visit with the Director General of ISRA, Dr. Mahamadou Ly, on April 10 and 14, as well as with the Director General of ITA, Dr. Ababacon Ndoye, and with Directors of the Experiment Stations at Bambey and Kaolack. Both Directors General emphasized the importance of the training aspects of the Peanut CRSP to Senegal. At the present, ISRA has approximately 200 scientific staff of which 75% are Senegalese and 25% French. The long term goal is to have all Senegalese, but the present economy is not strong enough for this to occur soon. At the Bambey Station IRHO currently pays the French scientists' salaries. The Directors and Directors General appear to have harmonious collaboration with the USAID/Dakar Officers and with the U.S. PI, Dr. Pettit. Dr. Amadou Ba, the host country PI on

this project, was recently made Director of the Kaolack Station; but he feels that he can still spend 60-70% of his time on research. Dr. Ba was also appointed as Coordinator of the new peanut network, CORAF, which at the present includes ten African countries and France. When concern was raised about the effect of Dr. Ba's new administrative responsibilities on his Peanut CRSP program, the Director General said they were looking for an assistant or a technologist to aid Dr. Ba's research. The value of the mycotoxin management project to Senegal is greatly appreciated and its major objectives are perceived to be very relevant to country needs.

Most of the logistics problems reported by the 1985 EEP have either been corrected or significantly minimized. Dr. Pettit still has some problems with delays in receiving reports, expenditure receipts, etc.; and the host country would like to have budget information sooner in order to make commitments to their technical help. However, the problems of transportation and extra laboratory space needed at Kaolack by Dr. Ba have been corrected. The panel was told that the Bean/Cowpea CRSP as compared with the Peanut CRSP was better financed in Senegal; and as a result was able to make closer linkages, provide more secure budgetary information, and provide for an annual planning meeting.

Both the host country and Texas A&M benefitted from Peanut CRSP providing scientists an opportunity for international exposure without having to commit them for long term assignments. The administration at Texas A&M encourages faculty interchanges and foreign visitors and gave the panel a definite impression of being firmly in favor of the Peanut CRSP. The CRSP concept of two-way benefits is strong at Texas A&M.

The Mycotoxin Management research of the Peanut CRSP appears to mesh well with the on-going peanut mycotoxin research at Texas A&M and is well managed and supported by the administration. The Peanut CRSP seems to have benefited the mycotoxin and public health program at Texas A&M; a program that was already strong with an international reputation.

The facilities and equipment in both the U.S. and host country, and the highly competent and dedicated PI's, have and should continue to contribute to the success of this project.

2.2. RESEARCH INVOLVEMENT

2.2.1. Attitude towards, support and perceived relevancy to the institution..... E

2.2.2. Fiscal/logistical assistance..... S

2.2.3. Resources commitment (faculty/facilities)..... HS

2.2.4. Comments:

The Researchers' involvement on this project for both the U.S. PI, Dr. R. E. Pettit, and for the Co-PI's from the Counterpart Institutions in Senegal, Dr. Amadou Ba (ISRA), and Dr. Amadou Kane (ITA), including the Cooperators and Technicians, was excellent. All the scientists involved are dedicated to the goals of the project and believe that results from their efforts will lessen the impact of the aflatoxin problem not only in the U.S. and Senegal, but worldwide. The researchers are well-trained, highly motivated and capable of solving problems. Dr. Pettit currently spends 100% of his time on peanut mycotoxin research, and the Peanut CRSP funds support approximately 80% of his research.

The fiscal/logistical assistance, though satisfactory, could be improved. For example, budgetary problems still exist in Senegal. The host country PI's need budget information sooner even if the money is late in arriving; and much discussion centered on the very limited budget. Also, Dr. Pettit mentioned the problems encountered by the frequent changes in the host country administration, though there is little that can be done about this.

The facilities available at Texas A&M are excellent as well as those in Dr. Amadou Ba's (ISRA) laboratory at Kaolack, and certainly the facilities of Dr. Amadou Kane's (ITA) mycotoxin laboratory in Dakar are adequate to conduct the required research.

The Peanut CRSP purchased a compound microscope with camera and miscellaneous chemical supplies for Dr. Ba's laboratory, which appeared to have all the necessary equipment and in working order. His laboratory was a busy place during the time of the panel's visit. He was in the process of screening 140 experimental peanut lines, from the breeder, Dr. Mortreuil, for tolerance to *Aspergillus flavus* using the IVSCAF method. A high pressure liquid chromatograph (HPLC) was installed by Peanut CRSP in the ITA laboratory of Dr. Kane to facilitate the detection and quantification of mycotoxins in peanuts. Maintenance of the equipment purchased with Peanut CRSP funds still poses some problems, and some breakdowns have held up analyses for several months, e.g., they have had trouble keeping the radio

compression units operating in Dr. Kane's laboratory. The air freight for shipping plus clearance and storage costs are expensive in addition to being time consuming. The panel was told, however, that a new replacement radio compression unit costs only about $200.00, which emphasizes the shortage of funds in this project.

3. INSTITUTIONAL DEVELOPMENT

3.1. Complementarity to ongoing research efforts... E

3.2. Strengthening of scientist/equipment/facility capabilities..... HS

3.3. Extent of collaborative interactions..... E

3.4. Training..... S

3.5. Comments:

The complementarity of the Peanut CRSP Mycotoxin Management project to the ongoing research efforts at both Texas A&M and in Senegal is excellent. With the strong leadership of Dr. Ba, the research on aflatoxin, which was begun by IRHO in Senegal in 1973, is gaining in international stature and likewise at Texas A&M, under the leadership of Dr. Pettit who has been working with aflatoxin for 23 years. The aflatoxin programs of ISRA and ITA in Senegal; the Department of Veterinary Public Health, Texas A&M; and of the Department of Agriculture at Prairie View A&M University, located about a one-hour drive from College Station, have been strengthened as a result of this Peanut CRSP project. The laboratories of Dr. Kane (ITA) and Dr. Ba (ISRA) have been improved, are now well-equipped; and the activity and productivity is apparent. Peanut CRSP finances one of the three Research Technicians working in Dr. Ba's laboratory in Kaolack.

Excellent interdisciplinary networks established both at Texas A&M and in Senegal have contributed to the outstanding productivity of this program.

In Senegal there are the close interactions between ITA, ISRA, IRHO and ORSTOM, as well as with ICRISAT and the laboratories at Montpellier, France (see Appendix V). Peanut genotypes from Dr. Mortreuil's breeding program at Bambey are screened for tolerance to A. flavus in Dr. Ba's laboratory in Kaolack and for aflatoxin by Dr. Kane in Dakar. Dr. V. K. Mehan, an ICRISAT scientist spent six months sabbatical at Kaolack working on the aflatoxin problem, and the Soils Department of OSTROM does the clay analyses for Dr. Kane's research on detoxification of peanut oil and meal.

The Mycotoxin Management project at Texas A&M, largely through the efforts of Dr. Pettit, has attracted a wide range of expertise to work on the aflatoxin problem. The program of Dr. T. D. Phillips, Department of Veterinary Public Health, appeared to be one of the main contributors to the success of the program. However, the importance of the other Co-PI's: Dr. Olin Smith, Department of Soil and Crop Sciences; Dr. Ruth Ann Taber, Department of Plant Pathology and Microbiology; Dr. R. L. Geiger, Electrical Engineering; and Dr. J. C. Reyes, Department of Agriculture, Prairie View A&M University must be emphasized. In addition there is the collaboration with the laboratory in Montpellier, France on the work of relating the amino acids in the peanut seed coat with the tolerance or susceptibility to A. flavus.

The Peanut CRSP mycotoxin management project is helping to provide the training of several students at Texas A&M University. Mr. A. Bachir Sarr, who the panel met while at Texas A&M, is a permanent staff member of ITA in Senegal. He is in his third year toward a Ph.D. degree in the Department of Veterinary Public Health. He has compared different methods of detection of aflatoxins in peanut samples while gaining additional experience on the use of HPLC, ELISA, and SAM assay procedures for mycotoxins analysis that will be very helpful when he returns to Senegal. Mr. Julius E. Fajardo, a second year Ph.D. degree student from the Philippines, in the Department of Plant Pathology and Microbiology, is also gaining valuable experience in detection of mycotoxins in peanut. Another Ph.D. student working with the PI and Co-PI's on mycotoxin problems at Texas A&M is H. A. Azaizeh from Israel. Others who received training at Texas A&M and contribute to the Peanut CRSP mycotoxin work are: Dr. Amadou Ba from Senegal, for 3-months, Dr. V. K. Mehan, Pathologist from ICRISAT, and currently, Dr. J. B. Szerszen from Poland, who is on a two-year Post Doctoral program. Dr. Pettit and Dr. Ba participated in an aflatoxin workshop sponsored by ICRISAT with collaboration of Peanut CRSP at Hyderabad, India in October, 1987.

4. ADEQUACY OF SCIENCE

4.1. Progressiveness and innovativeness of the Science/Research..... HS

4.2. Social Science/Economic Implications..... HS

4.3. Appropriateness of Basic/Adaptive Research... HS

4.4. Comments:

The achievements discussed in Section 1. attest to the fact that this project is highly satisfactory in each of the three categories relating to Adequacy of Science. The search for aflatoxin-resistant cultivars; research on cultural practices, such as gypsum applications to reduce aflatoxin; studies to determine the pre-harvest avenue of seed infection by toxin producing fungi; researching methods of detoxifying peanut oil and meal using clays and clay-like compounds; attempting to reduce the aflatoxin levels present in peanut butter by cooking it in water; investigating practical methods for detecting mycotoxins in peanut and peanut products; and the search for selection indices (e.g. molecular marker) that could help in breeding for aflatoxin resistant cultivars are examples of the kinds of research being conducted by the team of scientists on the Peanut CRSP Mycotoxin Management project.

The social science implications of the research on this project are especially significant in Senegal, and yet many of the Senegalese people are as yet either unaware or unable to do much about it. Aflatoxin analyses of food products in the markets of cities in Senegal revealed that 29% of all samples contained aflatoxin and 60% of the processed peanut products. The practice of Senegalese farmers is generally to sell the best peanuts to traders and keep the poorer grades for their own consumption, thus exposing themselves and their families to higher levels of aflatoxin. An educational publication helping to explain aflatoxin to the people of Senegal is currently being prepared by Dr. Pettit for Peanut CRSP and will be reviewed by Senegalese co-workers this year. In addition, the publication will reinforce in the African scientific community that aflatoxin is an important and dangerous food problem. This effort the panel finds highly commendable. Research results of this project will also lessen the impact of the aflatoxin problem to the peanut industry in the U.S. through resistant cultivars, and as related to the diversion and detoxification of aflatoxin in peanut, peanut products and other commodities.

Although in the beginning a disproportionate amount of the research on this project could be considered basic or speculative, the reviewers at this time were favorably impressed with the balance of the basic/adaptive aspects and with the appropriateness of the research program. The panel feels that the project, as currently planned, is sound and should continue. To date, peanut breeders have no useful selection indices to assist them in breeding for aflatoxin resistant cultivars. Some progress has been made in identifying traits related to aflatoxin resistance and this

type of basic research is urgently needed and should continue.

5. APPLICABILITY OF RESEARCH

5.1. Relevancy and Transferability of Research to Host Country/U.S. Programs..... E

5.2. Relationship to Other International Research Programs..... S

5.3. USAID Perceptions..... HS

5.4. Comments:

The relevancy and transferability of the research in this project is excellent, not only between the U.S. and host country, but to all other countries where peanut is grown and/or utilized; and there is potential transferability to other crops species. Some of the results obtained from this project are already receiving world-wide attention, such as the use of clay in detoxifying peanut oil and meal. In this regard the results are clearly more relevant to the goals of the host country and other LDC's than to the U.S. In the U.S., as a result of applied research, guidelines are being used with regard to harvesting, drying and storage that are keeping the aflatoxin hazard for peanut within reasonable bounds. In Senegal and other West African countries peanut is placed in large open piles after harvesting which can encourage aflatoxin problems if there are pockets of high moisture or insects in the pile.

Research on the project has shown the removal of over 90% of the aflatoxin from peanut oil by the use of highly sorptive clays, obtained as a by-product of the phosphate industry in Senegal. The fine clay particles are slow to settle however; and without centrifugation, the procedure is not yet applicable to village conditions. The research is continuing in Dr. Kane's ITA laboratory with some success using different sizes of clay particles; however, the coarse clay particles removed much less of the aflatoxin from the oil.

In the U.S. the results of Peanut CRSP Mycotoxin Management research have recently expanded into the cattle industry with the marketing of 'NovaSil' an aluminosilicate feed additive to help reduce the exposure of animals to mycotoxins. Poultry feeding trials in Texas have shown that the addition of small percentages of clay to an aflatoxin contaminated poultry ration prevented accumulation of aflatoxin in the poultry livers. A goat feeding study is being initiated at Prairie View A&M in which clay mixed with aflatoxin

contaminated meal is fed, and the milk is analyzed to see if the aflatoxin is bound and not released in the milk. The above are some examples of the transferability of the research on this project. The relevancy and transferability of research on the development of aflatoxin resistant peanut cultivars are obvious. This is a long-term program, but even the small genotypic differences obtained in resistance to invasion of toxin producing molds is a valuable contribution. A 2 to 3% invasion of peanut pegs, for example, is enough to give Segregation III peanut, which are unmarketable for human use in the U.S.

The Senegalese institutions seem to have good working relationships with each other (ISRA and ITA), and also with international (ICRISAT, IRHO, ORSTOM, and CORAF) programs. While Texas A&M has good working relationships with ICRISAT and IHRO, there was not much evidence of collaboration with the aflatoxin research programs in other states, e.g. Georgia and North Carolina, and that of the USDA-ARS National Peanut Research Laboratory at Dawson, Georgia. CORAF is a newly formed groundnut research network of primarily, but not limited to, francophone West African countries: Burkina-Faso, Cameroon, Chad, Congo, Ivory Coast, France, Guinea, Madagascar, Mali, Niger, and Senegal. Including the non-CORAF countries of Botswana, Brazil, Barundi, Greece, Portugal, Spain, and the United Kingdom, there are a total of 79 researchers in the network. The Coordinator of the network is Dr. Amadou Ba, Co-PI on the Mycotoxin Management project. The ISRA Station at Bambey, Senegal, is the recommended base center for the network. Since several of the research priorities of CORAF are similar to those of the Peanut CRSP, the organizations could benefit by working together. One of the joint projects CORAF has underway is a study for selection of Aspergillus flavus resistant cultivars with participating researchers from Burkina Faso and Senegal.

The USAID/Dakar Mission involvement with the Peanut CRSP is currently focused on monitoring program progress and participating in briefings by the Peanut CRSP scientists. The officers interviewed, Mr. Wayne Nilsestuen (ADO) and Mr. Doral Watts (Project Officer and Peanut CRSP Coordinator), see the Peanut CRSP as complementing their efforts to develop a sustainable agricultural research network. The USAID/Dakar Mission has worked through bilateral projects with both ISRA and ITA, the institutions involved in the Mycotoxin Management project of Peanut CRSP. The current USAID officers in Dakar appear to have a very positive relationship with the Peanut CRSP; and, on the basis of the 1985 EEP report, the situation in the USAID/Dakar Office has improved 100%. In this review, the USAID/Dakar Officers met with the

panel on two occasions: on Monday before the panel reviewed the Peanut CRSP program, and on Friday for a longer session prior to the panel's departure from Senegal. During the latter session, which included Director General Dr. Mahamadou Ly of ISRA, Mr. Watts pointed out the need of providing a technology transfer package approach - moving the research to the farmers - a point which was given full backing by Dr. Ly.

6. OBSERVATIONS

6.1. Strengths.

6.1.1. The relevancy and transferability of the research, not only to the U.S. and host country, but to other countries and to other crop species is a primary strength of this project.

6.1.2. The well-trained, highly motivated research leaders working on the project, in excellent collaboration with each other, and with scientists in a wide range of disciplines; and interacting with the pertinent national and international research networks is another major strength.

6.1.3. The providing of graduate training at Texas A&M University of three Ph.D. and two M.S. degree students, and short-term training programs for the host country's PI's and other non-degree scientists involved in mycotoxin management programs.

6.1.4. The complementarity of the project to the ongoing research programs in mycotoxin management at Texas A&M University and in the Institut de Technologie Alimentaire (ITA) and Institut Senegalais de Recherches Agricoles (ISRA) in Senegal.

6.1.5. Another strength of the project is the linkage with Prairie View A&M University, a historically black institution, collaboration with Peanut CRSP project TX/BCP/S,BF,N, and collaboration with ICRISAT, IRHO, and ORSTOM.

6.1.6. The appropriateness and balance of the basic and adaptive research on the project. The laboratory equipment and facilities are adequate and the researchers capable of handling high levels of experimentation at both Texas A&M University and in Senegal. The simplified aflatoxin detection and decontamination procedures developed for use in the villages of Senegal; and the progress made in searching for selection indices that can help the breeder make more rapid progress in developing aflatoxin resistant

cultivars, are examples of the scope of work underway.

6.2. Weaknesses and Options to Improve.

6.2.1. Although most of the logistic problems that hindered work on the project in the early years have been either corrected or minimized, the U.S. PI still has some problem with delays in receiving the expenditure receipts, reports, etc.; and the host country PI would like to have the information on his budget sooner, even if the money is late in arriving. Greater use could possibly be made of electronic mail services (FAX and C.G. Net). Also, delays due to equipment breakdowns in the ITA laboratory hold up analyses for seemingly long periods.

6.2.2. There was no collaboration of the U.S. Mycotoxin Management Project with the year-old peanut research network, CORAF, which is centered in West Africa; and the collaboration with other mycotoxin research programs in the U.S., e.g. Georgia, North Carolina and the National Peanut Research Laboratory at Dawson, Georgia, seemed minimal.

6.2.3. Although not as yet a weakness, the fact that the host country PI, Dr. Amadou Ba, was recently made Director of the Research Station at Kaolack, and also Coordinator of CORAF may reduce the level of his participation in the Peanut CRSP Mycotoxin Management Project.

7. RECOMMENDATIONS

7.1. Increase efforts to assist the breeders with the screening of peanut genotypes for resistance or tolerance to Aspergillus flavus/aflatoxin and in devising simpler and more precise procedures for screening.

7.2. A linkage of the project to the Peanut CRSP Food Technology projects (AAM/FT/BF) and GA/FT/TP) would seem beneficial.

7.3. The Panel recommends feeding trials, using goat herds at Prairie View A&M University and in Africa, with clay added to aflatoxin contaminated grains.

7.4. The project would benefit by working with the new CORAF network to be sure the work complements and not duplicates the Peanut CRSP research.

7.5. It would be a good investment for the host country collaborators to attend and participate in the annual meetings of the American Peanut Research and Education Society (APRES) at least on alternate years.

7.6. **Summary.** No one can question the world-wide importance attached to solving the mycotoxin problems, and especially for the health benefits of people living in the less developed countries. Aflatoxin management is a difficult task, and at times the research can become frustrating to the best of scientists. However, with the commitment and zeal of the team of scientists on this project, and the excellent support of the U.S. and host country administration and the management, training and research is beginning to pay off. Eleven of these payoffs are discussed in the achievements section. The EEP finds the research and training strategies of this project clearly warranted and highly recommend its continuance and if possible with greater emphasis on the search for simpler and more precise selection indices.

4.7. EXTERNAL EVALUATION PANEL REVIEW

Peanut CRSP Code: **AAM/FT/BF**

Project Title: **An Interdisciplinary Approach to Optimum Food Utility of the Peanut in SAT Africa (Burkina Faso)**

Principal Investigators and Collaborating Institutions: Dr. Bharat Singh, Alabama A&M University (AAMU); Dr. Alfred S. Traore, University of Ouagadougou (OU, West Africa)

Collaborating institutions include Alabama A&M University (AAMU); and University of Ouagadougou (OU), and Ministry of Agriculture's L'Institute D'Etudies Et De Recherches Agricoles (INERA), Service Technologie Alimentoire, and Bureau of Extension, Service of Nutrition, Ouagadougou, Burkina Faso.

Two members of the EEP and the Peanut CRSP Director visited AAMU and the institutions in Burkina Faso (for details, see Appendix I).

The project was established in 1982 to address the constraints of peanut utilization in SAT Africa. Initially, consumption and postharvest surveys were conducted in Sudan, one of the major peanut producing countries in SAT Africa, to determine current and potential dietary roles of peanut and to assess postharvest practices that impact the supply of peanut including storage techniques. Research was conducted both at AAMU and the Food Research Centre, Sudan, to address the problems. In 1987, the project was terminated in Sudan because of political unrest and was transferred to Burkina Faso, where peanut is widely used in various forms. The constraints of peanut utilization in SAT African countries are more or less similar. The research of the project is applicable to Burkina Faso as well as other SAT African countries. Other projects on cultivar improvement and insect resistance in peanut exist in Burkina Faso for close collaboration with postharvest/utilization research. Research on peanut production and utilization in SAT Africa is of vital significance because peanut plays an important role in human nutrition and there is an urgent need to reduce food shortages and combat nutrition deficiencies in this part of the world. A combined effort by breeders, agronomists, entomologists and food scientists/technologists will contribute to achievement of the goal to self-sufficiency in food production in SAT Africa.

Assessment Ratings for Host Countries and U.S.

1. **ACHIEVEMENTS** .....: HS

1.1. The development of human capital (education/training

of personnel) and subsequent increases in knowledge base (research) being accomplished in Sudan, other SAT African countries (e.g., Nigeria), and now in Burkina Faso, directly, and by collaborative efforts, due to postharvest/utilization research partially or fully supported by Peanut CRSP, are major achievements; similar benefits are occurring in the U.S. Eleven students from Sudan (former Peanut CRSP country (2), non-Peanut CRSP countries (in SAT Africa) (7), and the US (2) have received or are studying for MS degrees from AAMU. Two PIs from Sudan and two from Burkina Faso received short term (2 weeks) training at AAMU. US and SAT African country PIs have made regularly scheduled visits to their Peanut CRSP collaborating countries.

1.2. In the first four-years, data were collected in Sudan, including those of a survey, to determine variations in environment, socioeconomics and food technologies as they constrain the preservation and utilization of peanut and peanut products. Constraints that limit the maximum utilization of peanut for human consumption in SAT Africa were addressed. These data were published and showed that peanut utilization could be considerably increased if efforts were made to convert peanut into more refined/processed forms; improve packaging of peanut and peanut products to increase shelf-life; utilize peanut meal (oil-extracted) to increase protein value of cereal-based foods; and to improve methods of storage, handling and inventory management. These efforts are being extended to Burkina Faso.

1.3. Work with a local company, Tigadigire, has produced a commercial peanut paste product, Pate d'Arachide, and is presently sold in Ouagadougou, Burkina Faso. Peanut CRSP-supported research helped develop the process, quality control, and proper composition of the product. This accomplishment is an extension of research to improve grinding with a hand-operated plate mill and handling of peanut paste in villages of Burkina Faso. Over 80% of locally processed peanut is used as a paste in foods and because of poor hand-grinding and handling practices, about one-half is lost due to spoilage or unacceptable flavor.

1.4. At OU, production and utilization scientists are collaborating in studies that are developing basic composition data on peanut protein, fat, vitamins and aflatoxin in research for selection of improved cultivars and food products. These studies, with peanut pastes, show the quality of products made with peanut from different cultivars from various localities in Burkina Faso. Aflatoxin monitoring aids breeding and aids entomology studies on the causes of this contamination. The peanut processing industry realizes the value of these studies, especially aflatoxin

contamination and ways to control this problem.

1.5. An acceptable defatted peanut flour fortified (30%) sorghum-based food product, 'kisra' (a thin pancake-like leavened bread), with nutritionally superior quality, was developed at AAMU. Addition of peanut flour improved baking-ease, color, and texture of the final product. The increase in protein quantity and quality is important, especially the favorable alteration of the ratios of leucine/isoleucine and leucine/lysine in sorghum-peanut composite flours so as to diminish the pellagragenic characteristics of food products derived from sorghum flour. A major benefit of this achievement is the savings of medical costs due to the sorghum-induced pellagra effect. Efforts are underway to commercialize kisra and extend this technology to another similar product 'toe,' a food in Burkina Faso, Mali and Niger.

1.6. A method was developed at AAMU, to prepare a spiced yogurt-like product called 'mish' from peanut milk. The consistency, flavor and texture of this product were found to be similar to the traditional mish prepared from whole milk. Efforts are underway to extend this technology to rural villages of Burkina Faso and other SAT African countries.

1.7. Fortification to enrich 'gari,' a high starch farina-like food product made from cassava, was successfully developed at AAMU. Products blended with peanut or cowpea flour (in collaborative studies with the Bean/Cowpea CRSP) improved nutritional value.

1.8. The flavor of peanut was discernible in sugar snap cookies fortified with 20% peanut flour in place of whole wheat flour. This research was completed at AAMU. The peanut fortified cookies were comparable to faba bean and full wheat formulated cookies.

1.9. Water or steamed blanched peanut packaged in glass jars were shown to have improved stability and extended shelf-life in studies at AAMU. Steam blanching prolonged shelf-life (sensory-evaluated flavor scores) of roasted peanut.

1.10. Research at AAMU showed that stored peanut paste stability was improved with a manually operated plate mill with or without a chelator, EDTA, over that prepared by traditional milling with stone grinding processes. Variables affecting storageability were temperature and the interactions of light x temperature and air x temperature. Because of improved handling, losses of paste products were due to spoilage or unacceptable flavor were reduced. In addition, this development reduces the human labor factor,

specifically drudgery work of women in villages.

1.11. An alternate method employing ceramic beads as a particle-bed heat transfer medium (in place of traditional sand) with peanut in a deep, cast iron frying pan or wok pan, was shown by Sudan and AAMU scientists to produce roasting characteristics (improved aesthetic properties, i.e., a reduction in grittiness due to sand) similar to those with the air convection roaster in the U.S. This technology is being studied and transferred to Burkina Faso and other SAT African countries.

2. IMPLEMENTATION AND MANAGEMENT OF PROJECTS

2.1. Administrative involvement

2.1.1. Attitude towards support and perceived relevancy to the institution .....: E

2.1.2. Fiscal/logistical assistance .....: HS

2.1.3. Resource commitment (faculty/facilities): S

2.1.4. Comments

2.1.4.1. Although a relatively young institution, OU is making great progress toward its commitment to research including enhancement of international programs. Starting with the president of OU, administrative and faculty support for Peanut CRSP and collaboration with AAMU, is clearly evident. Faculty and students greatly benefit from their involvement with international programs. Their efforts have developed a favorable environment for facilitating collaborative studies and training programs in agriculture among OU faculty and US scientists that will benefit Burkina Faso.

2.1.4.2. A need was noted for a more timely transfer of Peanut CRSP funds from US collaborators to OU. Presently, quarterly reports must be submitted before the release of funds. As a result, OU must advance funds from its limited reserves and meet research costs to prevent interruption of programs. One option to resolve this problem is that Host Country collaborators submit their documentation for reimbursement before their advances are expended. A concerted effort by PIs, Host Country administrators, the ME and PD is needed for the timely transfer of funds among Peanut CRSP institutions.

2.1.4.3. Presently, OU does not charge overhead costs to Peanut CRSP. Plans are to implement a 10% charge to all international programs to develop a pool of funds for

support of new project proposals in agricultural research from faculty.

2.1.4.4. A newly formed Office of International Development, headed by Dr. M. Nacro, is located at OU. Efforts are making funds available to this office's programs which include training (Ph.D.-degreed faculty) and a long-term institutional development plan composed of programs (academic/foundation), physical facilities (infrastructure) and finance (cost/resources).

2.1.4.5. Dr. Nacro, stated that Peanut CRSP's focus on peanut production and utilization meets the immediate needs of agriculture in Burkina Faso. He feels that accomplishment of these needs is having an immediate impact on peanut production and food use. The results of these experiments may contribute to peanut technologies in the US. Peanut CRSP has brought in scientific equipment and helped develop research facilities. The interpersonal link between Burkina Faso and US scientists will continue long after Peanut CRSP is ended. Scientific knowledge which is being shared with the rest of the world eventually benefits everyone, i.e., it's not a one-way flow of information, training and development.

2.1.4.6. A commitment to promote and enhance international programs, specifically a "hands across the sea" concept for developing countries including Africa and the Caribbean, is very evident at AAMU. The philosophy includes the pooling of available resources to maximize them, i.e., to work for quality, not quantity. An international cooperative program at AAMU recognized as the best among Historically Black Colleges and Universities (HBCU) is being developed. Plans are to host an International Development Conference in 1990. Two Centers, the International Development and Education, and the International Relations and Cultural Affairs, are being developed. Each Center will have a Faculty Advisory Council headed by Dr. B. O. Okezie, member of the Peanut CRSP Board of Directors.

2.1.4.7. Minimum support is received for international programs at AAMU from the State of Alabama. Efforts are underway to establish an Alabama Council for International Development in the State Legislature. Administrators are working to educate Alabama Legislators in the benefits of international programs to the State. Knowledge gained is contributing to the needs of small farmers in Alabama. These efforts are proving successful as State matching funds for faculty research programs are being increased. Approximately 55% of AAMU's budget of $40 million comes from other than State appropriations. Research grants

support AAMU at about $10 million. AAMU is setting up a $5 million seed money fund for a Minority Research Center for Development.

2.1.4.8. The Administrative Offices have been restructured to allow for efficient business and monitoring of financial practices relative to research progress at AAMU. Problems with past due financial reports are being corrected. Spent funds are being reported in a timely fashion to prevent perceived problems of no work being done. These actions will benefit Peanut CRSP. A Grants, Contracts and Federal Relations Office has been developed and is being computerized to aid faculty identify and develop funding opportunities. A favorable environment for facilitating collaborative studies among faculty is developed. The objectives are strengthening AAMU's international image through teaching, research and exchange programs.

2.1.4.9. Except for the problem of timely transfer of funds to Host Country PIs, fiscal or operational problems with Peanut CRSP are minimum. The program has given AAMU international visibility, and faculty have benefited from their involvement. The University is expanding its role in training foreign (particularly African) and U.S. graduate students in agriculture. Recently, a Ph.D. program was approved in the Department of Plant and Soil Science, and plans are to add one to the Department of Food Science and Agricultural Industries.

2.2 Researcher involvment

2.2.1. Attitude towards, support and practical relevancy to the institution.....:____E____

2.2.2. Fiscal/logistical assistance .....:____HS____

2.2.3. Resources commitment faculty/facilities):____HS____

2.2.4. Comments

2.2.4.1. Faculty in agriculture at Ouagadougou University are committed to equal time in teaching and research including technology transfer. One Ph.D. graduate student, five undergraduate students and two technicians presently work in the food science and technology program.

2.2.4.2. Dr. A.S. Traore, Director, ISP(ISN/IDR), OU, is PI of Peanut CRSP in Burkina Faso. He is the only member of the faculty with experience in food science and technology. Students have been identified for graduate programs in food chemistry. Scholarships and Peanut CRSP support educational and research expenses to develop these

students. Everyone is looking forward to approval of the new Ph.D. program in the Department of Food Science and Agricultural Industries at AAMU and the opportunities it will offer to international programs.

2.2.4.3. Dr. A.S. Traore, OU, has responsibilities as Director of ISP (which includes ISN and IDR), Head of the Department of Applied Biochemistry and Nutrition (which includes Food Science), supervisor of the graduate student program and a coordinator of the transfer of agricultural programs to the Gampela Station in addition to his assigned PI duties for Peanut CRSP. The EEP is concerned that Dr. Traore is the only faculty with food science experience at OU, and that his many responsibilities can cause less than optimum progress of the project. Consideration by OU administration should be given to adding to the food science faculty and support staff.

2.2.4.4. Prospects for success of Peanut CRSP at OU are greatly accentuated by collaboration among faculty in food science (A.S. Traore), agronomy/breeding (P. Sankara) and entomology (S.J.A. Some). This collaboration is producing new insect/disease resistant high yielding peanut cultivars. The peanut harvested from these cultivars have improved compositional and nutritional properties for processing into quality food products. Increased collaboration among the faculty and their staff are encouraged to optimize improved peanut quality in Burkina Faso.

2.2.4.5. AAMU faculty teach, do research and are involved in extension. International programs are added responsibilities, causing further constraints to AAMU's already critical mass of faculty. However, it is clearly recognized that the faculty benefit greatly from international programs by gaining a better appreciation of world food problems.

2.2.4.6. The dedicated efforts of AAMU faculty led by B. Singh, PI, are contributing to the many achievements of the assigned Peanut CRSP project. This is in spite of the many assignments of these faculty. Based on these observations, it is important to note the distribution of AAMU's faculty assignments. Most faculty lecture 50% of their time, and direct up to six graduate students. Dr. B. Singh, PI, at AAMU, is a typical example. Dr. Singh estimates that of the time (50%) he spends on research, 25% is to Peanut CRSP and 25% to other CSRS projects. Dr. J.C. Anderson, Food Engineer and coinvestigator with Dr. Singh, spends 65% of his time teaching, and 35% on research, of which 15% is on Peanut CRSP and 20% on a CSRS project. He supervises five graduate students. Dr. D.R.

Rao, Food Scientist, works 50% of his time on research, including 25% CSRS, 15% Peanut CRSP and 20% NIH. The remaining time is devoted to teaching. He also works on a NSF grant. Faculty from AAMU would prefer reduced teaching responsibilities and increased research assignments.

2.2.4.7. AAMU faculty use Peanut CRSP funds to visit host countries up to twice/year. Peanut CRSP funds are used to support OU scientists for travel to the annual meeting of the American Peanut Research and Education Society to present papers and discuss/review research progress with U.S. researchers.

3. INSTITUTIONAL DEVELOPMENT

3.1. Complementarity to ongoing research efforts.: HS

3.2. Strengthening of scientist/equipment/facility capabilities .....: HS

3.3. Extent of collaborative interactions.....: HS

3.4. Training.....: S

3.5. Comments

3.5.1. Adequate laboratory facilities and equipment are available to meet the present level of research in food science and technology at OU. As faculty and students are trained in the advanced sciences, improved facilities and state-of-the art instrumentation will be required.

3.5.2. Presently, facilities at OU include an analytical laboratory with equipment necessary to do official methods for proximate analyses; this includes a Kjeldahl apparatus, and a Spectronic 20 for nitrogen and protein analyses, soxelet equipment for oils, ashing ovens, temperature controlled water baths, growth incubators for microbial studies, low and high speed centrifuges, drying ovens, autoclaves, a lyophilizer, and a Gas Cathometre chromatograph for selected H, N, Me and CO2 analyses for microbial growth in foods. The capability exists for analyses of Salmonella, Shigella, E. coli, Staphylococcus, yeasts/molds and parasite number. Aflatoxin analyses are being conducted with the mini-column technique used at AAMU. A food engineering pilot plant is being planned at OU with engineers at AAMU. An Agricultural Engineer in the Department of Agronomy, OU, is collaborating with food scientists in the construction of processing equipment for food processing of peanut samples.

3.5.3. Impressive was the effort to establish institutional linkages and researcher involvement by training of faculty and students from Sudan and non-Peanut CRSP African countries at AAMU. Graduate students from OU need to be identified for degree programs, especially to the new Ph.D. program in food science, expected to be approved at AAMU. Training lectures to fifth year students at OU have been conducted by invited US university faculty in courses of Food Biochemistry and Food Microbiology - more are wanted. The graduate studies, training and operating expenses for research are from Peanut CRSP.

3.5.4. Five IBM personal computers have been installed at OU to train scientists in the application of statistical (SAS) tests in research programs. A two-three week training course in personal computers application by a U.S. expert was conducted in the summer of 1989.

3.5.5. Research at AAMU is adequately supported with laboratory facilities and equipment. Food and nutrition facilities include dairy products, cereals and legumes, breadmaking/bakery, meat processing, instrumentation, taste panel/food preparation and remote sensing laboratories. Other laboratories include a pilot plant to support postharvest research, provide technology transfer capabilities and commercialization of food products; e.g., cottage industry development in the U.S. and entrepreneurs in Host Countries. For example, commercial scale extrusion equipment is allowing development of new foods with unique functional properties and shelf life. Close collaboration is occurring between scientists working on breadmaking properties of grains and legumes and plant breeders. The rapid capillary column technique is being used for detection/quantitation and monitoring of aflatoxins in peanut. The instrumentation laboratory is well equipped with HPLC, GC and gel electrophoretic instruments for compositional analyses (proximates, lipids, and amino acids) of peanut and their protein products. A new scanning electron microscope has just been purchased for expanded research into structure-function properties of foods.

3.5.6. Collaborations are strong between faculty in the School of Agriculture and Home Economics, especially the Departments of Food Science and Animal Industries, Plant and Soil Science and Agribusiness at AAMU. The just-approved Ph.D. program in the Department of Plant and Soil Science, and plans for one in the Department of Food Science and Animal Industries, will strengthen AAMU's educational programs. Approximately one-third of the faculty have experience in international programs. Research to improve food processing technologies is especially noteworthy. Studies on problems in this area with Host

Countries will also benefit the US. Plans are to develop collaborative efforts with other CRSP including those of Bean/Cowpea, Sorghum/Millet and Small Ruminants.

3.5.7. A significant portion of Peanut CRSP funds at AAMU, is used for training graduate students from Host Countries. Faculty and universities benefit from publication of data in theses. Noted was that only a few students completing their degree programs have published their thesis in refereed scientific journals. The PIs are encouraged to work more closely with the students to publish their data in refereed journals. These efforts are high priority because of the limited scientific expertise, and the need for recognition of the research achievements in Host Countries.

4. ADEQUACY OF SCIENCE

4.1. Progressiveness and innovativeness of the science/research .....: HS

4.2. Social science/economic implications.....: S

4.3. Appropriateness of basic/adaptive research: HS

4.4. Comments

4.4.1. Approximately 146,000 mt of peanut are grown in Burkina Faso and processed to roasted (salted, non-salted, sugar-coated and paste) products and oil for food. A survey is ongoing to analyze the composition (protein, oil, carbohydrate, minerals, vitamins A and C, caloric values, microbial and parasite counts and aflatoxin of pastes (Osterizer-Galaxie grinder) of peanut cultivars grown at different locations in Burkina Faso and US. Plans are to send a student trainee from OU to AAMU to analyze these samples for amino acid content for nutritional evaluations. Samples are from breeding and agronomic studies at the Gampela Station, and the Agricultural Ministry's INERA field locations. Variables include effects of location, seasons and growing (rainfall, soil types) and handling conditions; all planting, harvesting, drying and storage conditions are done by hand similar to on-farm conditions in Burkina Faso. This research is directed toward identification of the best cultivars for local planting. Improved methods for drying and storage of peanut are also being studied.

4.4.2. Studies in Burkina Faso involve collaborative efforts among the food scientist, plant breeder, entomologist and extension. These collaborative efforts

need to be further strengthened. Cultivars with the greatest potential for commercial development are being identified and analyzed for composition and food product development.

4.4.3. The research at AAMU is increasing potential for utilization of peanut in new and existing foods. This program includes the impact of socioeconomics and food technologies on utilization of peanut, the dietary role of existing peanut products, and assessing sensory, nutritional, and microbiological/toxicological quality parameters.

4.4.4. Particularly noteworthy were discussions on the uses of peanut in Africa during the review at AAMU and confirmed while visiting OU. Traders are key to peanut production by contracting small farmers. At harvest, the highest quality peanut are purchased by Traders and resold or crushed for oil. Peanut remaining in the fields are gleaned and processed to foods by village entrepreneurs and sold at the marketplace for local consumption. The peanut handled in this manner varies in maturity, and is of poor quality and usually aflatoxin-contaminated. Scientists and graduate students from Africa studying in the U.S. have been eager to learn how to overcome these problems.

4.4.5. Research has been extremely successful in advancing the development of endemic foods, such as gari, mish and kisra, fortified with peanut ingredients. These experiments have been enhanced by the availability of adequate laboratory facilities and equipment in the US that are not always present in Host Countries. Efforts are underway to extend these research capabilities to OU and collaborating institutions of the Ministry of Agriculture for extension to entrepreneurs and farms in Burkina Faso. These developments are particularly noteworthy because of the protein-deficient diets of village peoples in rural Africa. The high protein peanut products help to alleviate deficiencies due to limited meat supplies.

5. APPLICABILITY OF RESEARCH

5.1. Relevancy and transferability of research to Host Country/US programs .....: S

5.2. Relationship to other international research programs.....: HS

5.3. USAID perceptions .....: HS

5.4. Comments

5.4.1. Product development presently ongoing at OU includes Coura-Coura (a crispy onion ring-like cracker), peanut paste, and roasted and sugar-coated whole peanut. Work with a local company, Tigadigire, has produced a commercial peanut paste product, Pate D'Arachide, sold in Ouagadougou; OU research helped develop the process, quality control, and content. Defatted peanut meal is being used to develop peanut milk, fermented products (mish) and supplemented baby food; the objective of this research is to raise the protein content of foods for infants and children in a country where diets are protein deficient. These developments are improving traditional foods and increasing potential for improved consumption/utilization and production of peanut in Burkina Faso.

5.4.2. Programs need to be developed as part of Peanut CRSP to transfer technology developed at AAMU to Host Countries. The potential exists for marketing products developed under Peanut CRSP in the US, a positive spinoff from this research that should be explored. Postharvest surveys of mold-infected, aflatoxin-contaminated peanut at OU are shedding light on the cause of these occurrences in peanut during harvest, handling and storage in Burkina Faso. The food industry in Burkina Faso is realizing the value of these monitoring studies. These efforts are linking laboratory studies with plant breeding programs in the US and Host Countries, an important bridge to improving peanut quality.

5.4.3. The plan of work for 1988-1989, is ambitious and indicates increasing activity will take place in Burkina Faso. Indications of planned linkages with other research institutions and programs on the Bean/Cowpea CRSP, Sorghum/Millet CRSP and ICRISAT were noted and bodes well for the future.

5.4.4. H.N. Miller, Mission Director, and B.B. Traore, Rural Economist, USAID stated that scientists in Ouagadougou, Burkina Faso, especially OU, are very competent and are doing technically sound research, particularly in the breeding, entomology and food science programs. Much of this is due to the strong collaborative studies between OU and AAMU because of the newly implemented Peanut CRSP. The successful development of Peanut CRSP is introducing interest in bringing a Small Ruminant CRSP to Burkina Faso. Increasing peanut production may introduce collaborative studies between these CRSPs to use the peanut plant as a source of forage for small ruminants.

5.4.5. Aflatoxin in the diet, particularly in peanut and imported cornmeal (PL 480 program) for school age children are a major concern to the USAID Mission in Burkina Faso.

The extent of damage to human health is not understood. Efforts are underway through educational and extension programs of the Ministry of Agriculture and Higher and Secondary Education and Scientific Research. USAID is developing a contract that will fund a proposal on farming systems (production or sustainable agriculture) that will increase interactions between INERA and OU through Peanut CRSP. The long-term plan includes work with OU to adopt technology transfer/extension programs. The Ministry of Higher and Secondary Education and Scientific Research through INERA, is developing a demonstration program with selected farmers. Knowledge and expertise gained at the demonstration farms would be used to educate other farmers. Peanut CRSP has an opportunity to collaborate in these studies and add to its international contributions in SAT Africa.

5.4.6. According to USAID Mission spokesmen, INERA's experiment stations, which are located throughout Burkina Faso, are responsible for eight programs including soil fertility and water, farming systems, both basic to crop production, cereal grains, millet/sorghum/maize, legumes (cowpea, peanut, sesame), tubers, rice and cotton. Most of the work is applied research, i.e., application of available technology, and is in collaboration with farmers, and OU. This institute's relationship to OU includes teaching, training (students) and university teachers working on INERA programs. Peanut CRSP's interactions with INERA include disease resistance, entomology and new cultivar testing. The program fits well with national priorities and there is a desire to expand it. Opportunities abound for transfer of technologies developed by Peanut CRSP through collaborations with INERA.

5.4.7. The Ministry of Agriculture, Bureau of Extension, Service of Nutrition is responsible for applied nutrition, food technology and planning/teaching in Burkina Faso. Discussions with personnel showed that collaborative studies are ongoing with OU through Peanut CRSP. Specifically, samples of peanut are being examined for composition relative to cultivars grown throughout the country and stored and processed under varying conditions. A need has been identified to develop a computer statistical design for analysis of data obtained in these surveys. The purchasing of personal computers at OU and training of personnel in their use, will meet this need. With food product development, technology transfer and sampling for compositional analyses are at the village level working directly with the entrepreneurs and farmers. This includes accumulating data on consumption of food types and quantities. The objective is to introduce new foods, like peanut products, and increased protein levels in a

protein-deficient diet. In-village evaluation of eating habits shows that the people will not readily accept new products. The best approach is to introduce new food ingredients like peanut meal as blends with already accepted products.

6. OBSERVATIONS

6.1. Strengths

6.1.1. The AAMU scientists and EEP are highly impressed with the OU scientists' determination to be successful, their expertise and desire to learn, and willingness to make the most of available equipment in Burkina Faso. It was a prudent move for AAMU faculty to redirect their Peanut CRSP project to this latter Host Country.

6.1.2. The 1987-1988 annual report was well prepared and quite extensive on the research objectives under study. Most of the research took place at AAMU. However, this is understandable since the project with OU was signed in January 1988. References to the Host Country concern peanut statistics, food use and observed constraints. Baseline data of physicochemical composition of 10 peanut cultivars grown at three locations in Burkina Faso in 1988, were summarized.

6.2. Weaknesses and options to improve

6.2.1. The EEP is concerned that Dr. A.S. Traore, Director, ISN/IDR, OU, and PI of Peanut CRSP, is the only faculty with food science experience. His many responsibilities may be causing less than optimum progress of the project. Consideration by OU administration should be given to adding to the food science faculty and support staff.

6.2.2. Postharvest technology transfer needs to be strengthened in developing SAT African countries. Extension personnel are turf-protective. Peanut CRSP is just beginning to expand into this phase of research. A bridge between research, the farmer, and industry needs to be strengthened in Host Countries (and in the US), and Peanut CRSP has the wherewithal to make it happen.

7. RECOMMENDATIONS

7.1. According to USAID, Burkina Faso, OU scientists are making progress in working together (collaborative problem solving). Approximately 150,000 mt of peanut are produced in Burkina Faso which has 8 million people. The potential is for production of 500,000 mt of peanut; i.e., there is ample opportunity to produce more peanut for food use. Food

scientists with strong chemistry backgrounds are needed at OU to work with breeders, agronomists and entomologists. Chemistry/compositional data are needed to relate food technology and nutrition to breeding, agronomy and entomological practices. The Peanut CRSP should reexamine present priorities to focus projects in the training of personnel to strengthen expertise in selected areas, e.g., food chemistry and engineering. As part of technology transfer, Peanut CRSP should continue to sponsor conferences, meetings (both nationally and internationally), training programs, public actions, etc.

7.2. Research on appropriate technologies for maintaining quality peanut during harvesting, storage, handling and utilization is being initiated in Burkina Faso. As these studies progress, awareness is increasing on the degree of aflatoxin contamination in peanut. The level of aflatoxin contamination is being determined in peanut from several locations and new cultivars being tested throughout Burkina Faso. These studies are leading to an awareness of the causes for aspergilli infestation and aflatoxin contamination in peanut. At Khon Kaen University, Thailand, engineers have developed and are transferring simple, low-cost and efficient production/post-production mechanization technologies to peanut farmers. The machinery includes planters, diggers, strippers/winnowers, and hand-operated or motorized threshers, shellers, sizers, shakers and grinders. Field demonstrations, exhibitions, training and distribution of these machines and their designs have been extremely successful in commercializing these technologies. Observed has been improved peanut quality, especially less aspergilli infestation and aflatoxin contamination, because these tools have improved efficiency of post-production processes and reduced the time interval of handling peanut between the farmgate and the food processor. Opportunities abound for the transfer of these technologies through funding and coordination by Peanut CRSP to Burkina Faso and other SAT African countries.

7.3. Peanut CRSP should strengthen its commitment to Host Country scientists returning home after studying in the U.S. with start-up funds. New funding increases to Peanut CRSP should be directed to meeting these needs. This will assist them in efforts to initiate new programs. These trained scientists with their newly learned expertise are capable of rapidly developing new programs that meet the immediate needs of the Host Country, if funds were available. Noteworthy is the observation that these newly trained scientists can do more with less.

7.4. In summary, research on an interdisciplinary approach to optimize food utility of peanut in SAT Africa is being

developed. Future efforts on Peanut CRSP in SAT Africa should include increased review of projects for accomplishments, publication of data in refereed journals, and to publicizing achievements. Food scientists completing Ph.D. programs at US institutions are needed to strengthen departments at OU and the Ministry of Agriculture in Burkina Faso. The question of how is the US benefiting from Peanut CRSP needs to be examined. Clearly, the Peanut CRSP is contributing to the development of Host Countries as US allies. Efforts to bridge technology transfer of scientific achievements between the institutions and the user, need to be strengthened. The basic/fundamental sciences in the institutions of Host Countries need to be improved, i.e., upgrade equipment and facilities, and step up research by challenging the design of experiments used as approaches to solve problems. Research on foods of Host Countries at US institutions in collaborations with industries, have the potential of opening new markets to gourmet enthusiasts in the US. Research from collaboration of food scientists with plant breeders, agronomists and entomologists in production or sustainable agriculture, is developing technologies for new cultivars for use by Host Countries and the US. Collaborations among CRSP (peanut, bean/cowpea, sorghum/millet and small ruminant) can vastly improve the potential for breakthrough developments. These collaborations need to be strengthened in and among both Host Country and US institutions. The results of these efforts will lead to healthier and improved opportunities for all involved.

4.8. EXTERNAL EVALUATION PANEL REVIEW

Peanut CRSP Code: **GA/FT/TP**

Project Title: **Appropriate Technology for Storage/Utilization of Peanut**

Principal Investigators and Collaborating Institutions: Dr. L. R. Beuchat, University of Georgia; Dr. P. Chompreeda, Thailand - Kasetsart University; Philippines - Dr. V.V. Garcia, University of the Philippines at Los Banos (UPLB).

Collaborating institutions include the Food Science and Technology Department, University of Georgia (UGA); Philippine Council for Agriculture and Resources Research and Development (PCARRD), and Institute of Food Science and Technology (IFST), University of Philippines at Los Banos (UPLB), Laguna; and Ministry of Agriculture and Cooperatives, Department of Agriculture (DOA), Food Crops Research Institute and Department of Product Development, Kasetsart University (KU), Bangkok, and Khon Kaen University (KKU) and DOA Northeast Experiment Station, Thailand.

All four members of the EEP and the Peanut CRSP Director visited UGA, and the institutions in the Philippines and Thailand (for details, see Appendix I).

During the initial years of the project, procedures for handling, sorting, packaging and storing peanut were evaluated. Objectives were accomplished and demonstrated procedures to eliminate aflatoxin-contaminated peanut and prevent aspergilli infestation during storage and handling in Southeast Asia. The next phase concentrated on developing and adapting technologies to utilize peanut and peanut products in traditional and new foods. The choice of products was based on consumer surveys and intuitions/insights to consumer behavior in the Philippines, Thailand and the US. This is of particular importance because the long range food needs are projected to be in Asia where population pressures will continue to increase. The objectives of Peanut CRSP are properly prioritized to the needs of this critical area of the world. Food scientists/technologists made substantial progress on the objectives of this project. Noteworthy are the human capital developments in the Philippines and Thailand as a result of this project. Collaborative efforts by sustained agricultural (production) and postharvest/utilization scientists are being strengthened to improve the potential of peanut as a major contributor to self-sufficiency in food production in Southeast Asia. According to USAID Mission personnel, Thailand is becoming self-sufficient and is now recognized as an Advanced Developing Country.

Assessment Ratings for Host Country and US.

1. **ACHIEVEMENTS**.....:_____E_____

1.1. The development of human capital (personnel/education/training) and subsequent increases in knowledge base (research) being accomplished in the Philippines, Thailand and the US, directly, and by collaborative efforts due to postharvest/utilization research partially or fully supported by Peanut CRSP, are major achievements. Eleven students, from Thailand (1), Philippines (3), non-Peanut CRSP countries (in Southeast Asia) (4) and US (3), have received or are studying for M.S. (5) and Ph.D. (6) degrees from UGA. Five students have received or are studying for M.S. degrees in Thailand. Two Thailand scientists have completed postdoctoral studies at UGA. Short-term trainees included 7 from the Philippines, 3 from Thailand and 1 from Malaysia. US and Southeast Asian PIs have made regularly scheduled visits to institutes in their Peanut CRSP collaborating countries.

Philippines

1.2. A collaborative survey by UPLB and UGA in the Philippines was completed to determine different uses of peanut as food ingredients. This survey to identify perceptions of Filipino consumers toward peanut and related products was published (Peanut Consumption Patterns in the Philippines, Terminal Report, "Peanut CRSP- UPLB-PCARRD, Project 89-268-21," V.V. Garcia, S.M. Rubico, R.C. Arenas, and R.D. Valmonte). In addition, a collection of 84 samples representing 18 different peanut products and recipes manufactured in 13 regions of the Philippines, was completed and eight selected products were published in pamphlets entitled "Sugar Coated Peanut," "Peanut Candy," "Pastillas de Mani," "Peanut Brittle," "Peanut Butter," "Mazapan de Mani," "Polvoron de Mani," and "Peanut Bar." These publications are available to food processors and in doing so, helping to expand commercialization of peanut products in the Philippines.

1.3. A total of 142 peanut samples (58 raw peanut and 18 different peanut products consisting of 84 samples) collected from various regions of the Philippines were analyzed for aflatoxin content. Results of the analyses showed that 55% of the raw peanut samples and 27% of the products were positive for aflatoxin. This research is creating an awareness of aflatoxin contamination in foods of the Philippines and a need for production, storage, handling and processing technologies to control this problem.

1.4. Mold isolates (159) from soil, water and air were screened

for their ability to inhibit or have antagonistic properties against Aspergillus parasiticus. A few strains of the A. niger group were capable of outgrowing A. parasiticus, but the latter was able to recover in three days. Another species, A. fumigatus, was capable of restricting the growth of A. parasiticus, but it can be a more potent toxin-producer. A mold isolate possessing characteristics typical of Cladosporium fulvum suppressed the growth of A. parasiticus. Further studies are defining the mechanism of inhibition and assessing the efficacy and safety of using this isolate to inhibit or biologically control growth of A. parasiticus and subsequently reduce or eliminate aflatoxin in peanut and peanut products.

1.5. Modifications of the conventional method for protein film ("Yuba") preparation, like creaming, starch removal and prolonged boiling, with peanut milk from whole peanut and partially defatted peanut are proving successful. Films with improved strength properties and resistance to hydrolytic rancidity are being produced. Partially defatted films, although containing a higher amount of water-soluble constituents, were generally stronger than full-fat films. Scanning electron microscopy also revealed that partially defatted films have a more uniform and compact structure than full-fat films where fat globules are liberally distributed. The utilization of peanut film as an edible packaging material has great potential and could be one answer to the growing need for similar products in the food industry.

Thailand

1.6. A collaborative study, completed at UGA by P. Chompreeda, A.V.A. Resurreccion, Y.C. Hung and L.R. Beuchat, showed that acceptable peanut-supplemented Chinese-type noodles could be prepared from blends of durum wheat flour and partially-defatted peanut flour. Physical measures, sensory quality, lightness, cutting force and firmness studies showed that replacement of up to 15% of wheat flour with peanut flour resulted in noodles judged to have acceptable sensory and nutritional qualities. Efforts are now ongoing with a Bangkok, Thailand food company, Thai-Food Industry, to conduct consumer marketing studies of this product.

1.7. Research at KU developed a highly acceptable formulation for a peanut butter bar. An improved formulation consists of 72% fine ground roasted peanut, 12% maltose syrup, 10% fine ground sugar, 3% roasted desiccated coconut, 2% fine roasted rice, 1% roasted sesame seed and 0.5% salt. Sensory evaluation by consumers revealed that 57% rated the product at a high level; 74% indicated they would buy the product.

1.8. A spread containing a mixture of 20% fruit (banana, papaya or durian powders) and 80% peanut butter was highly

acceptable. Sensory analysis showed that taste panelists preferred the banana-peanut butter spread. Additional formula modification and shelf-life tests are developing new similar products.

1.9. A chocolate-flavored peanut beverage containing 3.5% peanut protein-isolate, 3.5% fat, 8% sugar, 0.7% cocoa powder, 0.1% stabilizer and water was highly acceptable to taste panelists. Larger scale consumer tests are confirming acceptance of the product.

1.10. A peanut protein isolate, 7% lactose and water mixture fermented with yogurt culture starter produced a product similar to milk yogurt except with a peanut flavor. Strawberry-flavored syrup reduced the peanut flavor. Results of a sensory evaluation of the strawberry-flavored product showed that color, texture, and flavor scores were acceptable.

1.11. Ice cream was prepared with peanut protein isolate to replace non-fat dry milk. Textural quality of peanut ice cream was similar to the control. Consumer panelists preferred durian-flavored peanut ice cream over cocoa and other flavored products.

1.12. A low cost nutritious food for preschool children in Thailand, formulated with partially roasted peanut flour, rice meal, sesame meal, egg, sugar, full-fat dried milk, mashed papaya and natural orange flavor, rolled into a dough, baked and ground, has potential of being processed and commercialized by cottage industries in Thailand. Low and medium income families can afford the product and improve the nutritional status of their children.

1.13. Sensory qualities of ground chicken extended with 15-20% defatted peanut flours are proving to be accepted in taste panel studies. Cooking losses and shrinkage of extended ground chicken patties are less than those of control products.

1.14. Sensory analyses showed that Thai sausages supplemented with 20-25% roasted peanut flour, or up to 20% raw peanut flour were equally acceptable to unsupplemented products. Sausage in which 25% of ground pork was replaced by roasted peanut flour was preferred over the control formula.

1.15. KU researchers have made recommendations to peanut farmers, shellers and marketers concerning procedures for removing aflatoxin-contaminated peanut and maintaining aflatoxin-free products. Hand-picking discolored, immature and damaged peanut and processed produced aflatoxin-free products. Peanut obtained from 10 cultivars were analyzed for composition (protein, oil and fatty acids) to emphasize quality and nutritional value. High quality peanut that was oil-roasted and

stored for up to six-months had acceptable shelf-life based on peroxide value and sensory panel analysis.

UGA

1.16. Six formulations of an imitation cheese spread were prepared by mixing cheese flavoring, coloring, salt and buttermilk into a bland, light-colored peanut paste in collaborative studies by UPLB (B.L. Santos, V.V. Garcia) and UGA (A.V.A. Resurreccion) scientists. Compared to commercial cheese spreads, these peanut-based imitation cheese spreads have higher protein and oil contents, and lower moisture indicating more nutritious, potentially shelf-stable products. Production of the pastes do not require the use of sophisticated processing equipment, and thus are being encouraged for commercialization in the Philippines. Use of quality, locally-grown peanut as a replacement for dairy ingredients, would make the product less expensive than its dairy counterpart.

1.17. A collaborative survey to identify perceptions of Thai consumers toward peanut and related products was published at UGA. A nation-wide survey of educated young adult Thais residing in the US was included. These studies identified new peanut products that exhibit good potential for being accepted. Food groups were identified as snacks, and everyday/general use, special occasion and value/convenience products. Snack foods were deemed appropriate for special occasions and children, while the everyday/general use products were included as part of the meal; nutritional value and convenience foods were important in the decision to include peanut as part of the meal. Three peanut-based products representing good potential for acceptance were identified as ice creams, milks and peanut butter spreads/pastes.

1.18. Studies of 1.6 on Chinese-type noodles were extended by the UGA researchers (and published) to include wheat flour fortified with defatted peanut (7-21%) and cowpea (4-12%) flours. This is an example of collaborative studies of scientists of Peanut CRSP and Bean/Cowpea CRSP. Computer-generated analyses revealed that up to 15% peanut flour and 8% cowpea flour supplementations produced Chinese noodles with acceptable physical and sensory qualities while improving protein content. These data show that the fortified peanut-cowpea Chinese noodles would contribute to the nutritional status of the low income populations in Thailand and other southeast Asian countries.

1.19. Hot water-, compared to steam- and dry-heat-treated peanut, produced a paste with lightest color and most bland flavor. Particle size of chopped peanut contributed to paste quality, with those of 3.4-4.8 mm exhibiting the most desirable

sensory qualities. This paste containing greater than 90% peanut was easily flavored with cheese, meat, fruit and chocolate and allows development of spreads or fillings for bread, crackers and confectionery foods.

1.20. The hypothesis that peanut shell color can serve as a single index to group peanut with similar physical properties and in turn relate to maturity and harvest time was successfully tested. The hardness and brittleness of peanut increased with harvest time and maturity. These studies indicate that physical properties of peanut can be predicted from the maturity distribution of those peanut.

1.21. Fermentation of peanut meal, after being ammoniated by Lactobacillus bulgaricus to remove aflatoxin, is proving successful as a way to use this detoxified product in animal feeds. Providing such a use for the aflatoxin-contaminated product would reduce the financial loss to farmers and processors by allowing them to use peanut which would normally be used as fertilizer or considered useless. Moreover, the farmers and processors would have more incentive to remove contaminated peanut from stores destined for human use, thereby decreasing the risk that aflatoxins would be consumed.

1.22. Nondefatted and partially defatted peanut beverages were processed under high temperatures (110 C; 121 C) with homogenization pressures equivalent to 2000 or 3000 psi. These products have acceptable suspension stability, viscosity and color values. These peanut beverages have potential as dairy substitutes or supplements in Host Countries where cows' milk is expensive, insufficient in quantity or indigestible by the consumers.

2. IMPLEMENTATION AND MANAGEMENT OF PROJECTS

2.1. Administrative involvement

2.1.1. Attitude towards, support and perceived relevancy to the institution.....: HS

2.1.2. Fiscal/logistical assistance.....: HS

2.1.3. Resource commitment (faculty/facilities).: HS

2.1.4. Comments

2.1.4.1. In the Philippines, planning, prioritizing, coordinating and monitoring for agriculture, forestry, and natural resources is administrated by PCARRD. This Council is also a repository of research information and an agency for technology transfer. Revenues are allocated by PCARRD to ensure a dynamic national research and development program.

This includes a national network of centers of excellence for crops, livestock and forestry from resources and systems and socioeconomic research. As part of this administrative structure, PCARRD has developed a Revised Auditing Manual for Research Development in cooperation with the Philippine Commission on Audit to streamline and assure a responsive financial system. The manual gives guidance to managers, researchers and auditors, and emphasizes propriety in financial transactions along with speed and efficiency. Nation-wide auditing procedures are in place. A Budget Manual for Research Operations in Agriculture and Resources Research serves as a ready reference for budget officers, analysts and research administrators regarding policies, forms and procedures employed in the preparation, execution and release of government funds for the national research system.

2.1.4.2. Dr. R.V. Valmayor, Executive Director, PCARRD, confirmed unswerving and undaunted commitment to research and national development. The mandate of PCARRD is clear, i.e., research should not end with the termination of the investigation or publication of results, but with the application of the results by farmers or target users. Sixteen action projects are being technologically transferred to Philippine farmers. The research and technology transfer is done at 118 agencies and stations throughout the Philippines. In addition to maintaining quality research programs, emphasis is on upgrading facilities and equipment/instrumentation.

2.1.4.3. PCARRD's programs as part of the Agricultural Research Development Project (ARDPI,II) are funded by USAID, including Peanut CRSP, and the Government of the Philippines. Between 1979-85, funding totaled about $25 million. In this same period, 2765 scholarship grants were awarded to different government and private agencies including the Department of Environment and Natural Resources, Department of Science and Technology, state colleges and universities, community institutes and other collaborating agencies. Presently, 1204 proposed projects are being monitored to assure research quality, prevent duplication, and realize efficient use of funds. These programs have trained over 2000 non-degreed personnel and 145 Ph.D., 714 MS and 81 BS graduate/undergraduate students.

2.1.4.4. Research on appropriate technology for storage/utilization of peanut supported by Peanut CRSP is done in the IFST, UPLB. The institute was created in 1982 to conduct basic functions of instruction, research and extension at undergraduate and graduate levels. It has four divisions, Food Chemistry, Food Microbiology, Food Engineering and Food Processing and Management. Emphasis is on food production, processing, management and marketing, and the systematic development of the food processing industry, especially small-

and medium-scale food processing enterprises, in the Philippines through graduate/technician training and research. The Peanut CRSP is recognized by PCARRD and UPLB administrators as making important contributions to agricultural research, training and development in the Philippines.

2.1.4.5. The Thailand Ministry of Agriculture, DOA, KU and KKU conduct Thailand's agricultural and food research which includes Peanut CRSP. Funding for Peanut CRSP is coordinated through DOA's Field Crops Research Institute. Peanut improvement research is part of the Thailand Coordinated Groundnut Improvement Program. In this structure, DOA scientists are mandated to do field research, e.g., agronomy, breeding and entomology, and KU and KKU teaching and laboratory research.

2.1.4.6. KU first offered courses related to Agro-Industry in the Department of Food Science, Faculty of Agriculture, in 1965. Later, the importance of Thailand being able to process agricultural products to help the national economy was recognized by the country's high level administrators. This recognition produced the 5th National Economic and Social Development Plan of KU that supported the development of the Faculty of Agro-Industry. Presently, the Faculty includes four departments - Biotechnology, Food Science and Technology, Packaging Technology and Product Development. There are thirty-four academic/research faculty, of which 14 are Ph.D.-degreed, and 38 support staff make up the departments. The 6th National Economic and Social Development Plan proposes to add doctorate-degreed programs to the Departments of Biotechnology, and Food Science and Technology. A close collaborative teaching and research relationship exists among all departments in the Faculty of Agro-Industry and DOA. Research is commodity oriented and highest among its priorities is quality. The Peanut CRSP is recognized by top administrators as an intricate part of agriculture research in Thailand. The Thailand Coordinated Groundnut Improvement Program linking peanut scientists, research/reporting and meetings/conferences of DOA, KU and KKU in 1982 and continuing today, was largely due to P-CRSP.

2.1.4.7. As discussed during visits to other Host Countries, administrative personnel in the Philippines and Thailand explained that there was a need for more timely transfer of Peanut CRSP funds from US collaborators to DOA/KU and PCARRD/UPLB programs. Presently, quarterly reports must be submitted from the Host Countries before funds are released. As a result, Host Country institutions must advance funds from their limited reserves to scientists working on Peanut CRSP to meet research costs to prevent program interruptions. A policy change that would allow for a more timely release of funds to Host Country collaborators, not necessarily linked

to when the quarterly reports are due, would help to alleviate this problem. It was pointed out that Host Country and US scientists collaborating on Peanut CRSP have developed the confidence and respect for the research capabilities of each other. The Peanut CRSP project objectives, specifically on appropriate technologies for storage/utilization of peanut in Southeast Asia, are being met at this time.

2.1.4.8. The UGA has a long tradition of quality learning and research where minds are formed and directed to address the problems of tomorrow. There is also the very human and often dramatic function that deals with the problems of today - the function of service. This encompasses the concerns of solving a wide range of contemporary problems in societies of the world - from agriculture to the arts, from environmental design to ecological management, and from nutrition to community organization. It was because of these proven accomplishments that UGA was selected as the Management Entity for Peanut CRSP and received the grant in 1982, from USAID. The Management Entity office, headed by Dr. D.G. Cummins, Program Director, is located in the College of Agriculture at UGA, Georgia Experiment Station, Griffin, GA. This office subgrants to AAMU, UGA, NCSU and TAMU, who in turn lead the research projects in collaboration with Host Countries. TC, EEP, and USAID personnel advise and guide the Management Entity in areas of policy, technical aspects, budget management and review. This management organization has continued to successfully accomplish its responsibility to USAID and the participating institutions for Peanut CRSP's technical and administrative matters which includes negotiating agreements, fiscal management, progress reports and project modification.

2.1.4.9. Drs. G.F. Arkin, Associate Director and Resident Director, and T. Nakayama, Head, Department of Food Science and Technology, UGA, Georgia Experiment Station, confirmed commitment to peanut research and Peanut CRSP. They recognized the benefits of Peanut CRSP from international programs, collaborative research and teaching-training within and among Host Country and US institutions, broadening scientists' thinking-creativeness, expertise and recognition, improving faculty promotion potential, and investing in the future of the world. There was a clear appreciation for the problems that confront Host Countries and their institutions. It was understood that important to Peanut CRSP's success was that research solve high priority problems, be targeted for technology transfer to the users, improve through teaching/training the knowledge base of faculty and students, and through these educational efforts strengthen the quality/sophistication of science, equipment/instrumentation and facilities of Host Country and US institutions.

2.2. Researcher involvement

2.2.1. Attitude towards, support and perceived relevancy to the institution.....: E

2.2.2. Fiscal/logistical assistance.....: HS

2.2.3. Resources commitment (faculty/facilities).: HS

2.2.4. Comments

2.2.4.1. Responsible scientists for research on peanut storage and utilization at UPLB, IFST, were Drs. V.V. Garcia, PI, R.R. del Rosario, Co-I, and R.B. Mabesa, Co-I. Dr. R.R. del Rosario coordinated the presentations for the Peanut CRSP review since the PI was on sabbatical in Japan. These three scientists have earned their Ph.Ds. in food science at US universities. Their assignments in the institute are approximately 50% research (of which 50% is devoted to Peanut CRSP and the remainder to other legumes), 30% teaching and 20% extension/technology transfer. In the institute, 10 faculty (80% Ph.D.-degreed of which 80% received their degree from US universities), and 25 Research Associates/Assistants (BS-, MS-degreed) work with 200 students - 150 undergraduate, 50 graduate; 25 administrative-clerical, technicians and staff support the faculty.

2.2.4.2. The IFST, UPLB, working closely with PCARRD, has a program committed to teaching and research focused on improvement of traditional technology for the processing and utilization of endogenous raw materials; development of new products, processes and processing equipment; packaging, handling and distribution; management and utilization of by-products and wastes; management and maximization of energy use in food processing plants; and improving productivity and quality control. Peanut CRSP fits nicely into this program in that it emphasizes quality assessment of raw materials and products; development of peanut products; and aflatoxin control in contaminated peanut. Undergraduate and graduate students are educated for positions in academic and research institutions and the food industry.

2.2.4.3. Research on appropriate technologies for storage/utilization of peanut in Thailand is the responsibility of Drs. P. Chompreeda, PI, C. Oupadissakoon, Co-I, and V. Karuthaithanason, Co-I, Department of Product Development (DPD), KU. Drs. Chompreeda and Oupadissakoon received training in the Department of Food Science and Technology, UGA Experiment Station, Griffin. Through their leadership and close collaboration with researchers at UGA, much progress is occurring on Peanut CRSP's objectives. Their positions at KU require them to do 60% teaching and 40% research.

2.2.4.4. The DPD, KU, has a curriculum aimed at research and development in agro-industry. The aim is to teach students the ability to design and manage the development of food and non-food raw materials at low cost into higher-valued semi-processed or processed high quality finished products that are accepted by consumers. These efforts emphasize both quality control and the development of various types of agro-industrial products, namely, nutritional, institutional, catering, and consumer commodities. The areas of study include processing technologies that lead to product development, quality control and standardization, consumer evaluation, and management and marketing concepts. Presently, the DPD has six faculty and 14 graduate students working on M.S. degrees; three faculty and five students and their research facilities are committed to peanut utilization research supported by Peanut CRSP.

2.2.4.5. Areas of peanut research at KKU, include breeding, pathology, entomology, microbiology and postharvest technology. The EEP had the opportunity to visit the Department of Agricultural Engineering, Faculty of Engineering and learn about the farm mechanization program. This program was initially funded by the International Development Research Center (IDRC, Canada), and offers excellent opportunities for development of collaborative studies with Peanut CRSP scientists. The details of this program are presented under the "OBSERVATION" sections 6.1.7. to 6.1.12. Engineers at KKU are now committing resources to developing and disseminating on-farm peanut harvesting/processing machinery including threshers, strippers, shellers, sizers and screen shakers in demonstration projects. Efforts are with farmers, traders and village processors. Proper drying, handling and packaging of the peanut are included in these projects. It is becoming obvious that production technologies are contributing to the improvement of peanut quality, e.g., a reduction in aflatoxin contamination.

2.2.4.6. Drs. L.R. Beuchat, PI, R.E. Brackett, Co-I, and A.V.A. Resurrecion, Co-I, Department of Food Science and Technology, UGA Experiment Station, Griffin, GA, are successfully fulfilling the project's goals to enhance the capabilities of scientists, technicians and students at KU, UPLB and UGA. This includes training of cooperators (through MS/Ph.D. and faculty development programs) from Thailand, the Philippines and US in developing and transferring appropriate peanut storage and utilization technologies. Because of this leadership, the Host Country institutions will enhance their capabilities to improve and assist in economic and human development. Strengthening of research capabilities and developing of collaborative modes have occurred because of the excellent and committed faculty and facility resources in

the Department of Food Science and Technology and other departments at the UGA Experiment Station, Griffin, GA. The UGA faculty have played leadership roles in workshops on storage/utilization of grain legumes and grains (Griffin, GA, 1986), peanut utilization (7th International Congress on Food Science and Technology, Singapore, 1987), International Workshop on Aflatoxin Contamination (India, 1987, sponsored by ICRISAT), ASEAN Food Conference (Bangkok, 1988), and Workshop-ICRISAT (Indonesia, 1988).

3. INSTITUTIONAL DEVELOPMENT

3.1. Complementarity to ongoing research efforts..: HS

3.2. Strengthening of scientist/equipment/facility capabilities.....: HS

3.3. Extent of collaborative interactions.....: S

3.4. Training.....: HS

3.5. Comments

3.5.1. Presently, of PCARRD's 264 studies in the Philippines dedicated to legume crops, 61 are on peanut. The range of disciplines researching peanut include 72% on the development and improvement of existing production systems, 18% on varietal improvement and 10% on biocontrol of pests. Of the Philippine research institutions/stations involved with legumes, only UPLB, IFST is researching appropriate technologies for storage/utilization of peanut. Peanut CRSP chiefly supports the development and improvement of peanut varieties by providing 71% of the total funds on breeding. It sustains research on post production and utilization by infusing 91% of the total funding requirement. About $25,000 of Peanut CRSP funds supports research on profitable production and post-production technologies with emphasis on improvement of existing systems. Other sources of funds include DOA, PCARRD, and IFST, UPLB.

3.5.2. The publication "Peanut," Proceedings of the 1st National Peanut Consultation and Peanut-CRSP Review, February 7-8, 1985, PCARRD, Los Banos, Laguna, Philippines stated in a chapter "Utilization of Peanut as Food in the Philippines," by E.E. Escueta, IFST, UPLB, "Today, there are no significant research activities on the processing and utilization of peanut as food in the country. This may be explained by the policy makers' and funding agencies' low priority attitude toward peanut research. Since the area planted to peanut is small, yield and per capita consumption as food are also low. However, of the total peanut crop produced in the Philippines, 66% is consumed as food, 26% as feed, and 8% as seed; hence, the need to investigate the status of research on processing and

utilization of peanut." Peanut CRSP has responded to this concern and greatly contributed to the development of a storage/utilization collaborative research program between UPLB and UGA.

3.5.3. The initial phase of Peanut CRSP in the Philippines on storage/utilization was a survey to determine consumption patterns of peanut for raw and processed forms in Philippine households. This extensive study was published in 1987 as a Terminal Report, Peanut CRSP-UPLB-PCARRD, Project 89-268-21, "Peanut Consumption Patterns in the Philippines," V.V. Garcia, S.M. Rubico, R.C. Arenas and R.D. Valmonte, IFST, UPLB, College, Laguna, Philippines. This report has set the stage for strengthening ongoing and future complementary collaborative interactions with Peanut CRSP breeders and agronomists, and other crops researchers in the Philippines and other Southeast Asian countries, e.g., Thailand.

3.5.4. Facilities, equipment and instrumentation supporting research in the IFST, UPLB, are limited. Facilities include classrooms, food chemistry and microbiology laboratories, a sensory evaluation facility, cold storage rooms and a pilot plant. Basic wet chemistry tools are available to run compositional analyses and routine food technology and functionality tests according to the Association of Official Analytical Methods. A HPLC with a fluorescence detector is available for carbohydrate and aflatoxin analyses. Other support equipment include a UL-vac freeze dryer, international and Beckman centrifuges, thermobath and autostill. A gas chromatographic, atomic absorption/flame spectrophotometer, Hitachi spectrophotometer and Virtis freeze dryer purchased with funds from Japan were noted but not functional because either parts for repair or expertise to operate are not available. A food processing pilot plant is equipped with general purpose grinders, mills, homogenizers, a fruit pulper, and centrifuges for teaching purposes. No peanut processing equipment is available for use by researchers in the institute; sample preparation and processing are done by hand with basic wet chemistry methods. It is clear that P-CRSP could contribute to the development of UPLB's food science and technology program by continued training of graduate students and purchasing of selected research equipment/instrumentation for designed experiments.

3.5.5. Most of the faculty that work on Peanut CRSP in the IFST, UPLB, have Ph.D. degrees from US universities. Working on an imitation cheese flavored peanut spread, a student completed requirements for a MS degree, and one is working on a Ph.D. degree, at UGA. A Research Assistant has just begun a study period at UGA to learn aflatoxin analysis with HPLC; the plan is to expand testing peanut in collaboration with breeders developing new aspergilli-resistant cultivars, and to work with

farmers and food processing industries to control contamination. Training programs such as these and purchases of necessary equipment/instrumentation are needed to assist trained scientists in the continuation of their work when they return to the Philippines.

3.5.6. Utilization of peanut in Thailand has been greatly advanced because of the Peanut CRSP research program at KU and UGA. Collaborative involvements occur among institutions in Thailand, including KU, KKU and DOA, but could be strengthened. At this time, peanut utilization research is only done at KU. The program includes breeding, agronomy, on-farm mechanization technology and utilization research. The opportunities are present for peanut researchers from the various institutes in Thailand to exchange up-to-date information on research in progress and completed, and to jointly plan future programs in the different disciplines that include cooperative activities. Meetings among institutions have been held annually since 1981, with only a limited strengthening of collaborative efforts.

3.5.7. The DPD, KU, has strong expertise in peanut research because of Peanut CRSP and excellent collaborative interaction with the Department of Food Science and Technology at UGA; three of the six faculty are trained (two at UGA) and doing peanut research. As a result, five graduate students are working on MS degree programs and are doing their thesis research with peanut. Since 1984, 12 undergraduate students were trained in peanut research at KU. The faculty and graduate students in the four departments of the Faculty of Agro-industry work closely toward the goal of improving Thailand's ability to process agricultural products to help the national economy.

3.5.8. Researchers at KU are equipped to meet the present research program. Instruments/equipment purchased with Peanut CRSP funds include a computer, a gas chromatograph, multi-vacuum packaging machine, and peanut roaster, grader, buttermill and hydraulic press. Other equipment include Hunterlab colorimeter, spectronic-20, Kjeldahl apparatus and capillary columns/thin layer systems with a densitometer for aflatoxin analyses. Facilities include teaching, analytical, and microbiological laboratories, and a kitchen and taste panel facility.

3.5.9. Dr. T. Pukrushpan, Dean, Faculty of Agro-Industry, KU, discussed the importance of developing soybean meal as a source of protein isolates and concentrates as food ingredients in Thailand. Presently, most soybean protein products are processed to modified/hydrolyzed components for their functionality in food systems, e.g., soy sauces. The Science Technology Development Board is supporting research to expand utilization of meals from soybean oil crushing mills for foods in Thailand. Top administrators are looking to the US and Peanut CRSP for collaborative research and support to develop

this program. These efforts would then include peanut protein products.

3.5.10. Research at UGA is developing new and improved technologies for handling, storing and processing food commodities (nuts, legumes, oilseeds, fruits, vegetables and fish) through studies on nutritional, functional, fermentation and physicochemical properties, sensory qualities and microbial safety. Post-harvest engineering technologies include energy conservation, dehydration, packaging, refrigeration, freezing and computer modeling systems. Important to these programs is consumer oriented product research -- factors affecting consumer perceptions/attitudes, food purchase behavior and use. Complementarity of Peanut CRSP to these ongoing research efforts, and in turn to the development and adaptation of technologies to utilize peanut and peanut products in traditional and new food products are very evident.

3.5.11. The Food Science and Technology Department, UGA, is equipped with the most modern equipment/instrumentation and facilities. A complete food processing pilot plant supports laboratory research. This pilot plant consists of storage environmental rooms and a complete peanut processing line including pod sizer, sheller, roaster, blancher, oil press, colloid mill, homogenizer and packaging equipment. Items purchased on Peanut CRSP funds include IBM personal computer and peripherals, digitizer, labscale homogenizer, vacuum can sealer, HPLC fluorescence detector, culture media maker, evaporator, HPLC, LVT viscometer and laser printer. Items purchased with non-Peanut CRSP funds and directly supporting this program include colony counter, microscope, gas chromatographs (2), HPLC, HP spectrometer, Gardner Colorimeter, Instrom, peanut processing line (mentioned above), sensory laboratory network (11 personal computers) and vacuum sealer for flexible packaging.

3.5.12. A major benefit noted at UGA was contributions of scientist expertise, and instruments, equipment, facilities and research, at no cost to the Peanut CRSP through collaborative programs; a benefit of research in the university setting. In spite of limited funding, the programs are productive and are accomplishing more than expected. An example of these developments is the collaboration occurring among faculty of Peanut CRSP and Bean/Cowpea CRSP. Research is showing that fortified peanut-cowpea Chinese noodles would contribute to the nutritional status of the low income populations in Thailand and other southeast Asian countries. Also demonstrated was that peanut and cowpea are acceptable as appropriate substrates for preparing natto-like products similar to those traditionally fermented from soybean in Japan and other parts of the Orient.

4. ADEQUACY OF SCIENCE

4.1. Progressiveness and innovativeness of the science/research.....: HS
4.2. Social science/economic implications.....: HS
4.3. Appropriateness of basic/adaptive research..: HS
4.4. Comments.

4.4.1. A Peanut CRSP-funded survey was conducted to determine the existing consumption patterns of peanut for raw and processed forms in Philippine households of 13 regions of the country; the consumer's perception of peanut and peanut products; the consumption patterns of various food items compared to that of peanut; and the identification of determinants of peanut consumption and utilization. The peanut was found to be popularly used or consumed fried, boiled or in the form of peanut butter. Peanut oil was relatively unknown. Some peanut products were area-specific, but peanut butter was produced in all 13 regions of the Philippines, followed by fried, roasted, greaseless and brittle candy. The attitudes toward peanut were that they were nutritious, delicious, a health food and expensive. The average per capita consumption per month of peanut was about 183 g. The survey confirmed the high acceptability of peanut among Philippine consumers, but the cost consideration of the commodity may explain its minimal consumption in the Philippines. Peanut was consumed less frequently (weekly or monthly) as compared to cereals, meat/poultry/fish and vegetables which were regularly consumed daily or weekly.

4.4.2. As with other Host Countries, the primary reason for high peanut prices in the Philippines is on-farm production costs - labor and inadequate storage facilities. It is understood that few studies on production/postharvest handling have been made to investigate and upgrade the present status of the peanut industry. Needed is research on peanut harvesting, threshing, shelling, curing/drying and storage. An excellent opportunity exists for Peanut CRSP to transfer the labor-saving machinery technologies for production/postharvest handling/storage already available at KKU, Khon Kaen, Thailand (see "OBSERVATIONS." 6.1.7-6.1.12). These devices have been designed, fabricated, tested, modified and placed into on-farm use. Peanut CRSP can fund the transfer of this technology by training Philippine scientists/engineers and supporting research to adapt these developments to the needs of Philippine farmers at PCARRD research institutes.

4.4.3. Peanut CRSP-supported research in the IFST, UPLB, has resulted in improved peanut product development of imitation cheese spreads, nougat, peanut sauces, spicy greaseless peanut, protein lipid films (Yuba or edible packaging food), peanut beverages (milk, fermented products) and peanut butter. The

consumption survey identified favored consumer peanut products and publication of their recipes in booklets for use by the food industry to expand their peanut commodity products; these are sugar-coated peanut, peanut candy, Pastillas de Mani (high protein peanut milk), peanut brittle, peanut butter, Mazapan de Mani, (baked peanut, milk, cheese and egg snack food), Polvoron de Mani (a blend of sugar, powdered milk, margarine, roasted wheat flour and chopped peanut) and peanut bar.

4.4.4. An aflatoxin surveillance of commercially consumed peanut and peanut products at UPLB has shown that 55% of raw peanut and 27% of peanut products are contaminated. This research is showing the food industry the importance of quality/acceptability of peanut products. Further studies are evaluating methods (hydrogen peroxide, sodium hypochlorite, ammonium hydroxide and sodium bisulfite) for aflatoxin removal. The problem is that treated products are off-colored and off-flavored. Research is ongoing to identify A. parasiticus-antagonistic microorganisms. To date, 252 microorganisms from soil, air and water have been isolated on culture plates and are being tested for aspergilli growth inhibition; a few microorganisms look promising.

4.4.5. A Peanut CRSP-funded survey of eating habits of Thailand's people showed that peanut consumption could be divided into three parts -- general background, peanut consumption, and attitudes towards peanut consumption. It was found that people in the Northeast and North, consume more peanut than the other areas. In all areas, people did not store peanut at home but bought them as needed or else they were stored raw for use in cooking. Boiled whole peanut, roasted, fried and ground peanut were popular products. Peanut butter consumption was rare. The reason may be due to the food habits of the Thailand people, who do not consume bread as a staple food. These observations identified research areas that could enhance peanut utilization, e.g., incorporating peanut butter into snacks and introducing them into the diet.

4.4.6. Research activities on storage/utilization of peanut at KU are well planned and appropriate relative to the objectives of the assigned Peanut CRSP project. Specifically, the research is examining ways to improve peanut quality and local (Bangkok) product quality. A peanut consumption survey has been completed and will be published. This survey has clearly defined peanut eating habits in Thailand and identified new utilization thrusts that will increase the use of the peanut in the diet. New drying and storage studies are being conducted on in-shell and shelled peanut. This includes testing technologies for detecting aflatoxin contamination. Efforts are underway to train the industry in better drying-storing technologies and testing for aflatoxins to ensure quality peanut products. Food development with roasted products includes: oil roasted, hot air

roasted and coated (sesame seed, chocolate, coffee-flavored) roasted peanut, fried peanut-rice flour pattie, peanut brittle and peanut butter bar; these are considered to be high energy foods. Ground peanut products include: peanut grits, peanut butter, peanut butter bar, and a peanut steak currie. Thai sausage, chicken burger and supplemented sommanut cookie and bakery products are being made from peanut flour ingredients. This is an impressive food technology program meeting the needs of Thailand's food industry and consumers. Can packaging has proven very successful in maintaining quality and flavor of roasted peanut products.

4.4.7. At KU, studies are showing that quality of peanut is also affected by post-harvest techniques. Insufficient drying leads to moisture levels over 10% and conditions of high relative humidity and temperature encouraging growth of fungi, e.g., aspergilli species and aflatoxin contamination. Improper storage of peanut on-farms, at shellers, and in wholesale or retail merchant godowns, e.g., peanut are sun-dried in the open air by piling them on concrete floors, in an open yard or under a house and with no cover to protect them from rain, water drops and dust, for about one week, conditions that can cause peanut deterioration. The quality of shelled peanut is also affected by unsuitable packaging such as old fertilizer bags or jute bags, storage at ambient temperature and exposing to air which are major causes of rancidity.

4.4.8. Research is ongoing at KU and KKU to develop proper drying methods readily applicable to on-farm and sheller conditions. Mechanization techniques to carefully grade and select defective seed are being researched to improve quality and reduce aflatoxin contamination. Presently, the dried, shelled peanut is hand-sorted to remove low quality (about 40%) or immature dark-colored peanut; this is a high cost, labor-intensive process. New packaging and storing technologies are prolonging the shelflife of peanut. From a survey of planted areas, shellers and wholesalers or retailers, it was concluded that the starting quality of the peanut appeared to be good but often improper packaging and storage conditions aggravated the aflatoxin problem and affected peanut quality. As a result of this study, it was concluded that the problem of aflatoxin-contamination could be solved by working with farmers and industrial personnel to improve use of recommended postharvest technologies; these efforts have begun at KU.

4.4.9. Research at DPD, KU, on solar and gas dryers for on-farm and factory use are proving feasible. These developments and recommendations/training in the proper storage and handling of peanut are being successfully performed with positive results. It should be noted however, that an introduction of mechanical dryers and storage technologies to small farmers may not be suitable unless there is a premium paid for high quality peanut

which does not exist presently. This premium would come if farmers could rapidly dry their peanut to a proper moisture level and store them under carefully controlled conditions until market prices were favorable.

4.4.10. The collaborative surveys UGA scientists conducted with researchers in the Host Countries, Thailand and the Philippines as part of P-CRSP, identified consumer perceptions toward peanut and related products. Ways to nutritionally and functionally improve traditional foods and to develop new products that would be consumer acceptable were identified. Clearly evident was the need to develop and demonstrate procedures to prevent growth of aspergilli species in peanut and in doing so, eliminate aflatoxin contamination on farms and during storage and handling to processors. Maintenance of sensory quality of raw and roasted peanut was also a high priority. The research development plan instituted by UGA scientists to meet these needs of Host Countries is appropriately divided into three parts as pre-process, process and application. Engineering, social science and economic studies are included in this program. Shown is that progressiveness and innovativeness is needed, first to extend 10- to 20-year old technologies to present applications in Thailand and the Philippines. Then, once these technologies are in place, further advances should occur at a pace acceptable to these Host Countries. The UGA scientists are collaborating with the researchers in these developing countries in a way that allows them to set their own standards for advancing and adapting new research concepts and available technologies. Furthermore, new research concepts and available technologies are being linked with the social science/economic implications identified in the above identified surveys. What is needed is to take this information from the different Host Countries and cross utilize it; i.e., the developments or policies learned about one country may contribute to ways of solving problems in other countries.

4.4.11. Socio-economic constraints affecting peanut production and other food legumes in the Philippines are receiving much attention from PCARRD. Similar observations were made in Thailand and are being examined by this country's DOA, KU and KKU. The UGA scientists are also collaborating with these two Host Countries on this issue. The constraints include inadequate resources allocated to the development of food legumes; small farmers' financial inability to maintain production infrastructure, purchase inputs, and adopt new technology; lack of agricultural credit; lack of transportation and marketing facilities; price relations for inputs and outputs; government marketing organizations' preference to purchase rice and corn more than food legumes; and communication gap between producers and consumers. Research is focusing on an alternative marketing and pricing institution; government

incentives and/or restraints; market access for small farmers; and systems analysis of marketing systems.

5. APPLICABILITY OF RESEARCH

5.1. Relevancy and transferability of research to Host Country/US programs.....: E

5.2. Relationship to other international research programs.....: HS

5.3. USAID perceptions.....: HS

5.4. Comments

5.4.1. In the Philippines, PCARRD uses two strategies to assure that research-based technology, e.g., from Peanut CRSP, reaches the end-users, fast and efficiently for financial payoff from the high amount of resources invested in research. They are pilot projects - a technology package is tried in farmers' fields and provided with relevant support such as credit, market, extension and training; and outreach program - the Applied Communication Department publishes a series of publications, distributes mass media materials, uses the Scientific Literature Service, includes Regional Applied Communication Offices to implement localized activities and operates the Technology Packaging for Countryside Development project for situation-specific technologies. Since its inception, PCARRD can claim many concrete outputs of the research system in technical feasibility, economic viability, social acceptability and environmental soundness.

5.4.2. The consumption survey conducted by scientists at the IFST, UPLB, has been published as "Peanut Consumption Patterns in the Philippines, Terminal Report, Peanut CRSP-UPLB-PCARRD, Project 89-268-21, V.V. Garcia, S.M. Rubico, R.C. Arenas and R.D. Valmonte. This effort identified peanut product recipes which were published in booklets for distribution to the food industry to help them expand their peanut commodities for sale. Other peanut products are being researched to improve their acceptability; these products and those published from the survey are noted in 4.4.3. above. Particularly noteworthy is the development of peanut-based imitation cheese spreads that are being encouraged for commercialization as a replacement for similar dairy products in the Philippines. Data on the aflatoxin surveillance of commercially consumed peanut and peanut products, and methods to detect these contaminants are also published. Short courses in the use of these recipes and analysis of aflatoxin contamination, are presented to small scale food and cottage industries at UPLB.

5.4.3. The 1986 publication, "The Philippines Recommends for

Peanut" PCARRD Technical Bulletin Series No. 35A, published by PCARRD and Peanut CRSP has a chapter entitled "Aflatoxin in Peanut." The chapter briefly explains the causes of aflatoxin contamination in peanut and presents sections on prevention and detoxification including methods. This information is available to farmers, postharvest traders and the food industry.

5.4.4. Studies at UPLB are only beginning on the quality (composition, nutrition) assessment of raw peanut and peanut products. Plans are developing with funding support from P-CRSP for UPLB scientists to collaborate with breeders/agronomists on nutrient composition and aflatoxin contamination of peanut in selected cultivar studies. Noted was that of the 16 PCARRD, Philippines, Development Programs (Action/Pilot Projects), one is a four-year Peanut Pilot Production Project. This project is a collaborative undertaking between PCARRD and DA-Region II to demonstrate to peanut farmers the merits of the newly developed cultivars and inoculation technology; evaluate the benefits by farmers from using new cultivars and inoculation; gauge farmers' reaction to the introduction of the new technologies; and assess the institutional and social requirements of the accelerated adoption of the new technologies. The project began with a 30 ha area and is envisioned to expand to 120 ha by the fourth year. An excellent opportunity exists for Peanut CRSP to coordinate a collaborative study of scientists in the IFST, UPLB and PCARRD in compositional and aflatoxin contamination studies in this Philippine Development Program with peanut.

5.4.5. Roasted products (oil roasted, hot-air roasted and sesame seed, chocolate, and coffee-flavored coated roasted peanut), confectionary products (peanut brittle, peanut-rice flour pattie, and peanut butter bar), ground products (peanut butter, grits and steak butter, grits and steak currie), flour-supplemented products (sausages, chicken burgers, Chinese-type noodles, peanut chip, and sommanut cookie) and milk/fermented products (temphe, yoghurt, and peanut milk) being developed in the DPD, KU, are making their way into the food and cottage industries. Scientists at KU are assisting the food industry in quality control of peanut products. A collaborative effort between KU and the Thai-Food Industry is working to test market the peanut supplemented Chinese-type noodle.

5.4.6. Scientists in the DPD, KU, are beginning work with Thailand's DOA researchers in evaluating the compositional properties of peanut from newly developed peanut cultivars. These data are being related to peanut utilization/functionality in new and improved foods.

5.4.7. Several Peanut CRSP-supported research advances of the DPD, KU, are being technologically transferred to industry. This includes drying and storage technologies and aflatoxin

detection methods that maintain quality after harvest to processed foods. Researchers at KU present scheduled training courses to industry personnel on these technologies. Solar and gas dryers developed by KU and KKU are being field-tested with farmers and shellers. Thailand's DOA is working with corn drying methods to determine their applicability to peanut.

5.4.8. Researchers at UGA are extending research programs of Host Countries to improve understanding of compositional and functional properties of peanut and peanut products for new and improved foods and tests for aspergilli/aflatoxin contamination and their removal to improve quality. Maintenance of sensory quality of raw and roasted peanut is also a high priority program. The capabilities of researchers in the Philippines and Thailand have been greatly improved by training and collaborative studies with UGA. Through Peanut CRSP and UGA, increased collaborations have occurred with ICRISAT, and other USAID CRSP, etc. Such upgrading of capability has enhanced the confidence of Host Country researchers in the development of quality research programs. Researchers have had opportunities to visit/observe research facilities and expand collaborative efforts worldwide. Through Peanut CRSP, attendance to international and national scientific meetings/symposia have been realized. For example, a very successful workshop on "Peanut Utilization" was organized by Drs. L.R. Beuchat and T. Nakayama and held at the 7th World Congress on Food Science and Technology, September 28-October 2, 1987, in Singapore. Included among six speakers from six countries, were Drs. V. Haruthaithanason (KU), V.V. Garcia (UPLB) and R.E. Brackett (UGA). Other project investigators attending the Congress were Drs. A.V.A. Resurreccion (UGA), C. Oupadissakoon (KU), P. Chompreeda (KU) and R.R. deRosario (UPLB) and R.C. Mabesa (UPLB). The proceedings from the workshop were published by the Congress organizers.

5.4.9. Mr. R.W. Ressequie, Chief, Agricultural Development, USAID Mission, Manila, Philippines, expressed strong confidence in PCARRD. Plans are to shift more responsibilities for coordinating funds and research from USAID to PCARRD. In the Philippines, USAID is emphasizing support for extension of research to users. It is USAID's opinion that research data is piling up on shelves so now is the time to support technology transfer and demonstration programs. Training of extension personnel and demonstration field projects/trials that link research and farmers are being emphasized; i.e., to transfer research into the Philippines' agricultural community. The consensus of USAID was that Peanut CRSP research has advanced to the stage where it should increase its role in demonstration projects and extension programs.

5.4.10. In Bangkok, D.J. Clark, Director, Office of Technical Resources, and D.A. Delgado, Director, Agricultural and Natural

Resource Development, USAID, stated that Thailand was considered as self-sufficient in the production of foodstuffs for its approximately 55 million people. Thailand is considered to be an advanced developing country. They were impressed with Peanut CRSP, especially its peanut breeding program at KKU. Also, Thailand's Food and Drug Administration, like that of the US, was very concerned with toxic contaminants in foods. Policies were being developed for quality certification of foods and to provide standards for in-country processing conditions and products for the food industry.

5.4.11. USAID noted that in Thailand, people living in Bangkok and surrounding provinces, have much better incomes than those who are mostly farmers living in the northern provinces. One reason for the disparity is that research developments are readily transferred to both large- and small-scale industries and commercialized. Research accomplishments need to be extended to the farmers and village food entrepreneurs/ processors in the rural provinces. It is here where Peanut CRSP can strengthen its program and in particular, through increased support for research in postharvest technologies. USAID is funding a new thrust to strengthen rural agriculture technology transfer. For example, on-farm mechanical drying technologies to control mycotoxin contamination in raw food materials. Funds of this USAID program are available via applying for competitive grants. Thailand's research institutions, including Peanut CRSP scientists are welcome to compete for grants. Training opportunities are strongly endorsed in this program. In Thailand, emphasis is on research and training programs that will build linkages between its scientific institutions and users, specifically farmers and industry. Technology transfer of research is being emphasized as a way to build a strong private sector. Peanut CRSP should strengthen its involvements in technology transfer.

6. OBSERVATIONS

6.1. Strengths

6.1.1. In the Philippines, Thailand and the US, researchers have made significant progress toward developing and utilizing technologies to use peanut and peanut products in traditional and new foods. The consumer surveys in both Host Countries (which included Host Country populations in the US), were extremely successful and informative. They provided intuition and insight to consumer behavior toward the peanut and peanut products, showed the potential for success of peanut-based products under various stages of development and identified research priorities. In place is a several-pronged approach in all cooperating laboratories which has as its objectives increased utilization of peanut, in whatever form. Expected are increased nutritive value and safety of peanut products to

the consumer.

6.1.2. The consumption survey conducted at IFST, UPLB, the Philippines, was published. Selected peanut product recipes of small scale industries from throughout the Philippines were published. Data on an aflatoxin surveillance of consumer available peanut and peanut products, and methods to detect these contaminants are also available. Short courses in the use of these recipes, developments with new products, and the results of the aflatoxin surveillance study are presented to small scale food and cottage industries at UPLB. These efforts are strengthening awareness of peanut as a nutritious food ingredient.

6.1.3. The research in Thailand to improve and develop peanut foods is being closely coordinated with the food industry. A breakthrough is the peanut flour-supplemented Chinese-type noodles which is being consumer-tested by the Thai-Food Industry, Bangkok; this is an especially noteworthy example of Peanut CRSP-funded technology transfer. At UGA, these studies have been extended to include cowpea flour in a collaborative study by P-CRSP and Bean/Cowpea CRSP scientists. These studies showed that peanut and cowpea alone and in combination, will contribute to nutritional status of low income populations in Southeast Asian countries.

6.1.4. A consumer test on a peanut bar and the development of three new peanut products, peanut spread with fruit powder, chocolate flavored peanut beverage and ground chicken patties extended with peanut flour was conducted by DPD scientists at KU, Thailand, during the National Agriculture Fair. Two hundred and fifty-one questionnaires were randomly distributed to consumers of different background. The majority of consumers tested showed interest in buying the products. Input suggested ways to improve the quality of the products before further market testing. This effort is an example of a pro-active effort by food scientists moving their technological advancements to the consumer and eventual commercialization.

6.1.5. Peanut research on drying and storage technologies and aflatoxin detection methods that maintain quality after harvest to processed foods is being presented in scheduled workshops to industries at DPD, KU, Thailand. These efforts are creating an awareness for proper storage of peanut and the control of aflatoxin contamination. Noteworthy in these efforts is the presentation of the study that shows removal of off-colored, immature and damaged peanut eliminates aflatoxin contamination in peanut products.

6.1.6. The capabilities of researchers in the Philippines and Thailand have been greatly improved by the training and collaborative studies with UGA. Such upgrading of capabilities

through Peanut CRSP has enhanced the confidence of Host Country researchers and resulted in quality research programs. Researchers have had opportunities to visit/observe research facilities and expand collaborative efforts worldwide. Through Peanut CRSP, attendance to international and national scientific meetings/symposia/workshops have been realized.

6.1.7. Mentioned in sections 2.2.4.5 and 4.4.2 was the EEP's visit to the Department of Agricultural Engineering, Faculty of Engineering, KKU, Thailand to learn about the farm mechanization program initially funded by IDRC, Canada. The following observations, 6.1.8-6.1.12., were presented and offer excellent opportunities for development of collaborative studies, including technology transfer, with Peanut CRSP scientists in Southeast Asia, SAT Africa and the Caribbean.

6.1.8. On December 15-16, 1987, the first workshop for peanut mechanization, organized by the KKU Groundnut Mechanization Project was held at Khon Kaen, Thailand. The workshop was attended by 48 participants from different organizations. A series of similar technology transfer workshops including dissemination of specialized equipment, e.g., threshers, shellers and strippers/winnowers, through field demonstrations, projects, exhibitions and training of farmers and local manufacturers, have successfully extended mechanization developments of KKU, Department of Agricultural Engineering, Faculty of Engineering. Direct technical assistance was also given to selected manufacturers for fabrication and sale of the promising machines. Over 100 farmers have purchased these machines. These same impressive advances were presented/demonstrated to the EEP and are summarized in the following sections 6.1.9.-6.1.12.

6.1.9. The achievements of section 6.1.8. at KKU, Department of Agricultural Engineering, Faculty of Engineering, were realized through the developments of the "Groundnut Shellers/Strippers Project," supported by IDRC, Canada. The general objective of the project was to develop a simple, low-priced and efficient peanut stripper, and to extend its use to the farmers. The following field-tested advances were presented for on-farm use: a manually-operated paddle stripper/winnower; an axial flow rice thresher modified for use as a peanut stripper; and a manually-operated rubber tire sheller -- farmers in Kalasin and Roi-Et provinces demonstrated that the use of this machine in combination with the stripper/winnower for both shelling for seed and commercial shelling was profitable.

6.1.10. Also presented at KKU, Department of Agricultural Engineering, Faculty of Engineering, were the developments of the "Groundnut Mechanization Project," supported by IDRC. Noted was that peanut is one of the major cash crops in Thailand.

However, groundnut production is now facing the problems of low land productivity, low labor productivity and poor quality peanut. The general objectives of this project were to improve land and labor productivities and peanut quality through increased mechanization of production and processing. The specific objectives were: to identify opportunities for researching and introducing selected component technologies; to modify/evaluate, on-station and at field sites, the technical and economic changes as a result of introducing selected component technologies; and to recommend technologies for wider introduction/assessment in the Northeast and/or Northern peanut producing regions.

6.1.11. Highlights of the "Groundnut Mechanization Project shown at KKU included: field surveys and measurements indicate that there is need for mechanization of peanut to improve land and labor productivities and peanut quality; aflatoxin contamination was found at farm level for peanut grown in irrigated areas - harvesting, stripping and drying of peanut at the beginning of rainy season are vulnerable to aflatoxin contamination; the Rolling Injection Planter was modified for peanut planting - this machine is technically and economically promising for irrigated areas and up to 20% of seed can be saved; an Inclined Plate Planter was modified for peanut planting - this machine is technically and economically promising for rain-fed areas and could also increase crop yield for planting under compacted soil conditions; a push-pull weeder, star wheel weeder, and wheel hoe were found not promising for local conditions; a peanut digger developed, modified and tested, proved technically promising for dry soil conditions; a Motorized Rubber Tire Sheller was modified and shown applicable for shelling peanut - the machine is now used by Surin Seed Center; a peanut Grinder was designed and developed - eight units were immediately purchased by the farmers in Roi-Et province who commercially process peanut; and peanut pod sizer, sample sheller and seed screen shaker were fabricated to support Peanut Breeding Programs at KKU and Khon Kaen Field Crops Research Center - these machines are now used effectively.

6.1.12. The use of machinery is enabling farmers to plant earlier and complete harvesting and stripping in a short time period. This allows drying before the beginning of the rainy season. The result is improved peanut quality, i.e., less aspergilli infestation and aflatoxin contamination.

6.2. Weaknesses and options to improve

6.2.1. Composition and aflatoxin contamination of peanut and peanut products are being researched at UPLB, Philippines and KU, Thailand. Efforts have advanced in both countries where methods and data are available for distribution and discussion

at workshops to train personnel of the food and cottage industries in the importance of understanding peanut quality. These efforts have involved collaboration with peanut breeders, agronomists and entomologists in studies on development of new cultivars; however, these collaborations could be greatly strengthened. The development of information on potential new cultivars relative to composition, functional and nutritional value in food systems should be increased. Moreover, the potential for aspergilli-resistant (partially or fully) cultivars exists. The scientists in the IFST, UPLB, and DPD, KU, have the methods and expertise to analyze for aflatoxin contamination in peanut. Yet only limited collaboration is occurring between these scientists. PIs on the Peanut CRSP project should organize a workshop, discuss advances in their respective fields, identify areas for collaborative studies, and the strategies that assure these developments.

6.2.2. Post-production handling of peanut, collectively denoting harvesting, picking or threshing, curing and drying, storage and shelling is undeveloped technology in the Philippines. In Thailand, the greatest advances in mechanization (manual and powered) of harvesting, threshing and shelling machinery have occurred. Drying technologies are available but little in storage concepts is being done in Thailand. Similar problems as in the Philippines exists in African countries. The Caribbean countries are doing research with all of the post-production technologies. Little coordination of these developments is occurring within and among the institutions of these Host Countries. For example, KKU and KU have only limited collaboration on ways to control aspergilli contamination via the advanced post-production mechanized machinery. Yet, KKU engineers have indicated that contamination may be reduced or prevented because the new equipment allows for rapid and efficient harvest and field handling of peanut for market.

6.2.3. At IFST, UPLB, researchers are studying ways to control aflatoxin in contaminated peanut by chemical and microbial detoxification. Years of study on aflatoxin removal in peanut by US institutions have occurred with limited success. To date, the best way to control aflatoxin contamination is by maintaining post-production handling conditions that prevent aspergilli infestation. Moreover, processes to remove aflatoxins are either too harsh and reduce sensory and/or functional/nutritional properties, or would require extensive safety review by the Food and Drug Administration, a costly process few industries are willing to pay. The only potential is to use these treated aflatoxin-removed peanut products as animal feeds. These observations suggest that the scientists in Southeast Asia should collaborate with breeders and engineers in the development of aspergilli-resistant cultivars and new post-production handling techniques that prevent aspergilli

contamination.

6.2.4. Administrative personnel in the Philippines and Thailand pointed out the need for more timely transfer of Peanut CRSP funds from US collaborators. Presently, quarterly reports must be submitted before funds are released to the Host Countries. A policy change that would allow for a more timely release of funds, not necessarily linked to quarterly reports would help to alleviate this problem. Host Country and US PIs collaborating on Peanut CRSP have developed confidence and respect for the research capabilities of each other. However, this problem could also be resolved through a concerted effort by the PIs and Host Country administrative offices to work out procedures that allow submitting of documents for reimbursement before all of the advances are expended.

7. RECOMMENDATIONS

7.1. Scientists from Host Countries being trained in the US are developing expertise with modern/sophisticated equipment/instruments, facilities and experimental designs. All efforts are toward advancing available technologies to commercialization of quality peanut and peanut products in the marketplace. Peanut CRSP has done much in the way of training/educating Philippine and Thailand food scientists, especially at UGA. During their visits to US institutions, these Host Country scientists have learned advanced technologies in facilities with the most modern/sophisticated equipment and instruments. However, when they return to their own institutions the newly learned skills are of limited use because equipment, instruments and facilities are partially or not available. This stymies their ability to begin immediate development of programs that will solve the problems confronting the Host Country. One approach to possibly reduce this problem is that Host Country and US PIs examine equipment, instrument and facility needs when scientists are identified for training. Funds from a number of sources could be identified to complement those of Peanut CRSP, and purchased during the training period. This would improve the potential for scientists upon returning to their institutions to use their newly learned expertise to solve problems. In addition, this would have the added feature of increasing the sophistication of basic/fundamental sciences in Host Country institutions, i.e., step up research by challenging the design of experiments used as approaches to solve problems.

7.2. Food science and technology research should be closely coordinated with breeding and variety evaluation programs through collaborative studies. However, this realization has not been fully appreciated. Production programs have mainly concentrated on agronomic factors, yields and disease/insect resistance. Limited research has been done on compositional and nutritional properties. Moreover, breeding, agronomic, entomological and

food science studies should be coordinated with post-production handling, storage and processing conditions, and marketing and consumer acceptance factors. An additional point on post-production handling studies is that modern mechanical harvesting, threshing, shelling, etc., techniques have been directed toward efficiency rather than quality. The result is losses due to damage. Attempts to improve yield, disease/insect resistance, etc., cannot be assumed successful unless postharvest technology and food quality are improved, or at least, not impaired. Close collaboration of peanut breeders, agronomists, entomologists, engineers and food scientists is important in overcoming this gap in Host Countries.

7.3. Aflatoxin is a serious problem in Host Countries and is very much related to post-production handling and storage conditions of peanut. One must not forget that the peanut plant and its growing environment are important parts of this formula. The toxin-producing, A. parasiticus and A. flavus, can occur at any stage. At present, scientists in Host Countries do not have the entire picture as to which stage the problem occurs most under present production and post-production handling and storage systems. Moreover, aspergilli-resistant (partially and totally) peanut cultivars have been identified under selected production experimental conditions. However, this resistance is not always maintained when experimental conditions are changed. Studies also showed that the improved/efficient postharvest mechanized on-farm post-production equipment reduces chances for aspergilli/aflatoxin contamination. Good understanding of handling processes and storage conditions, at various stages from the field through the farmgate to commercial products in relation to fungus development, and the conditions that induce it to produce aflatoxin, are prime prerequisites to the development of means to minimize the problem. Collaborative studies among food scientists, engineers, breeders, agronomists and entomologists must occur if the aflatoxin problem is to be resolved. Obviously, the variables are complex and highly interactive when one identifies them as plant, microorganism, environment, harvest/storage, etc., etc., etc.

7.4. The advancements were impressive on manual and powered mechanized machinery (tillers, planters, weeders, strippers, threshers, shellers, cleaners, sizers and grinders) for peanut production and postharvest handling in the Department of Agricultural Engineering, Faculty of Engineering, KKU, Thailand. Dr. W. Chinsuwan, Associate Professor, was quite proud, and rightly so, of their IDRC-funded research achievements. This equipment has been successfully demonstrated by KKU engineers to extension personnel and farmers in training workshops with exceptionally positive responses via purchases that are improving on-farm operations. The designs are being used for manufacture of equipment by local companies. Observations suggest that improved postharvest equipment speeds up harvesting, cleaning and

shelling of peanut and reduces the chances for aspergilli/aflatoxin contamination. It was suggested that training in the use of this equipment should include information on how to optimize reduction of aspergilli/aflatoxin contamination. These developments are available for technology transfer via workshops at KKU to other Southeast Asian, African and Caribbean countries, and the US. It is through this type of technology transfer where Peanut CRSP can make a strong contribution.

7.5. The consumer surveys conducted in the Philippines and Thailand have fulfilled their designed purpose by becoming excellent indicators of how research might expand the market potential of the peanut. These surveys have focused primarily on what the populations of these Host Countries are consuming in today's market. It is the hope of Peanut CRSP scientists that the surveys will become the basis for identifying and developing future market potentials. The desires of the consumer should be a main driving force behind studies on functional, nutritional and quality specifications of foods. Once a product has been developed and accepted by the population, these specifications should be defined by the food scientist for the breeder, agronomist, entomologist and equipment engineer. This further reinforces the need for collaboration of scientists working on production and post-production technologies.

7.6. On the question of socio-economics, the statements made in the report of the 1985 EEP Ad Hoc Committee remain true. Production and post-production research should also include evaluations of the economic feasibility of adopting new technological advances in Host Countries; Understanding of socioeconomic constraints, as well as food science and technology, are needed if sufficient cost effective tasty, nutritious and aflatoxin-free peanut and peanut products are to be made available. Socio-economic aspects or impacts need to be researched relative to the costs of developing and commercially advancing new peanut products. Furthermore, when the many years of work to develop a cultivar and a product is identified for commercialization, will it be accepted by the consumer? This question needs to be examined closely in future designs of Peanut CRSP projects.

7.7. In summary, the observations and recommendations of an EEP-Ad Hoc Committee (formed at the request of the Peanut CRSP-Board of Governors, December 1985) still hold and are clearly being met with the postharvest/utilization programs in Southeast Asia; i.e., Peanut CRSP was extremely successful in its concepts and most objectives were being met relevant to the food needs of Host Countries. Peanut CRSP is staffed with competent scientists successfully working within funding constraints to design programs in food science, technology and production. One major benefit noted and continues today, was contributions of

expertise, equipment/instruments and facilities, at no cost from scientists not on the Peanut CRSP through collaborative programs; this is especially noted at UGA. In spite of limited funding, the programs are productive, and are accomplishing more than expected. To date, a strong research foundation has been built and will serve as a springboard for a 5-year extension of Peanut CRSP. The postharvest/utilization research could proceed much more rapidly if additional funds were provided or redirected to this program. Host Country researchers are developing the expertise and facilities to provide a broad program of food science/technology and nutritional analyses, including aflatoxin detection, removal and prevention. Collaborative studies and meetings/workshops among institutions doing sustainable agriculture and postharvest/utilization research within and among Host Countries and US should be strengthened and regularly occur. Peanut CRSP is the vehicle through which all of these needs can be developed.

4.9. EXTERNAL EVALUATION PANEL REVIEW

Peanut CRSP Code: GA/PH/CAR

Project Title: **Postharvest Handling Systems for the Small Peanut Producer**

Principal Investigators and Collaborating Instutions: Dr. Manjeet Chinnan, University of Georgia (UGA); Dr. B. R. Cooper, Caribbean Agricultural Research and Development Institute (CARDI), Trinidad, Antigua, Belize, St. Vincent and Jamaica, and University of West Indies (UWI), St. Augustine, Trinidad.

Two members of the EEP and the Peanut CRSP Director visited UGA and the institutions in two countries (Trinidad and Jamaica) of the Caribbean, respectively (for details, see Appendix I).

In 1982, an International Peanut Evaluation Program (INPEP) was established as GA/INPEP/N,BF,CAR. The program's direction was changed to GA/BCP/CAR, Breeding and Cultural Practices (BCP) for the Caribbean in 1985. The overall goal was to identify superior cultivars and cultural practices for the Caribbean to improve the potential of peanut as a food. In the past year, it was concluded that the overall goal, specifically to identify improved cultivars and limiting cultural practices were mostly accomplished. It was proposed that emphasis be shifted from increasing production to identifying suitable methods for maintaining postharvest quality and to developing approaches for reducing cost associated with harvesting, threshing, storage and handling. Based on these observations, a new project GA/PH/C, "Postharvest Handling Systems for the Small Peanut Producer," was initiated. The objectives are to investigate appropriate technologies for drying, and storage of in-shell and shelled peanut; to identify and/or develop labor saving devices for production and postharvest operations; and to develop strategies for linking Southeast Asia Peanut CRSP projects on peanut breeding, farming systems and food science/technology to the Caribbean countries. To date, research on this project is increasing the availability of low cost nutritious peanut foods to the rural and urban poor through the introduction of more efficient production, harvesting, drying, storage and handling technologies.

Assessment Rating for Host Countries and US

1. **ACHIEVEMENTS** .....:_____HS_____

1.1. Training has been an important component of Peanut CRSP in the Caribbean. Mr. U. Wilson was recruited for graduate studies (MS) working on mechanical harvesting equipment for peanut at UWI, Trinidad. This has also strengthened linkages between UWI and CARDI. Mr. J. Grant, Agricultural Engineer, from Jamaica received two weeks of training at UGA. Dr. T.

Oz-Ari, Research Engineer, UGA, spent two weeks each in Belize and Jamaica training staff in the operation and evaluation of postharvest equipment. Two graduates (MS) from non-Peanut CRSP countries received partial support in research at UGA contributing to peanut needs in the Caribbean. Similarly, two non-Peanut CRSP trainees contributed concepts to the Caribbean program. The US and Caribbean PIs are making regularly scheduled trips to review their programs.

1.2. A successful shift in emphasis on cultivar evaluation to postharvest handling operations including organizational and personnel changes in CARDI, was completed. The three-year project was approved for July 1987 to June 1990, to replace GA/BCP/CAR, "Breeding and Cultural Practice for the Caribbean." Information was collected on existing peanut production and postharvest approaches in selected collaborating CARDI countries. A research engineer was hired at UGA with experience in designing and fabricating equipment for small farms in Caribbean countries.

1.3. An International Peanut Evaluation Program (INPEP) was established as one of several priorities in four Caribbean countries in the previous Peanut CRSP. The primary constraints in Jamaica included low yields and susceptibility to foliar pathogens. After appropriate evaluation of more than 200 accessions, under farmers' management and end-product commercial processing, the high yielding, USDA/GA-developed genotype 'Tifrust-2' was chosen, re-named CARDI-PAYNE, and released for seed multiplication and commercial production in Jamaica and Belize. In Jamaica, demand for seed was strong in 1989, with 34 farmers growing 42 acres; traders and processors were sold over 1934 kg of this peanut.

1.4. In field studies, 'Georgia 207-3-4' and 'Virginia Bunch 67' proved to be the best peanut cultivars for Antigua's calcareous soils. Presently, 'Tennessee Red' is the locally grown cultivar in Antigua. The new cultivars outperformed the locally grown peanut with better plant stands, less chlorosis, vigorous growth, more pods per plant and a higher shelling outturn, all contributing to the improved yields. Seed is being bulked for expanded production. Both cultivars were developed in the UGA's breeding program. In similar studies, the cultivar NC-2 is being recommended for St. Vincent and Trinidad.

1.5. In Belize, peanut is consumed as peanut butter, a roasted ballpark snack, and as salted in shell. One (or more) of the accessions evaluated in the INPEP period is being considered for release to farmers linked to these different end-use outlets.

1.6. Ongoing achievements in the Caribbean due to Peanut CRSP include improvements on mechanical threshing, shelling and

storage technologies in Jamaica; improved mechanical threshing, storage and dryer designs in Belize; monitoring of aflatoxin contamination at the farm and steps to the processor in St. Vincent; and solar drying processes in Antigua.

1.7. Two old peanut CeCoCo threshers were refurbished, modified to be transported on a three-point hitch and operated from a tractor PTO drive, and provision made so that a 5-8 hp gasoline engine could be mounted, if necessary, to power the machine. The threshers were shipped to Jamaica and Belize, and successfully field-tested in 1988, on the peanut crop.

1.8. Hand-operated shellers with replaceable screens were fabricated at UGA and CARDI, Jamaica, further modified to adapt to pedal power operation, and successfully tested on different seed-size peanut.

1.9. Two lifters (digger/inverters) were designed and constructed as attachments to standard tractor mounted tool-bars to lift peanut plants from the soil in St. Vincent and Jamaica at the rate of 0.45 ha/hr at a significant savings in labor costs. The traditional methods of harvesting peanut require 12 man days/ha of labor which causes a high market price to be higher than those purchased from other countries.

1.10. Two farmers are cooperating with CARDI and the Ministry of Agriculture, Extension Service, Jamaica, to determine the effect of temperature, moisture level and 2-4 month storage time on pest control and development of aspergilli/aflatoxin contamination on peanut. The storage facility at one on-farm location was upgraded for these experiments; a second storage study is being conducted in an existing facility at another farm. These studies include neighboring farmers storing their peanut in these facilities. Storage will also enable these farmers to hold their peanut for better prices with traders.

1.11. Peanut production in Jamaica, Belize and St. Vincent is approximately 2500, 250, and 200 tons/yr, respectively. It is estimated that the quality enhancement of the peanut crop due to improved postharvesting handling systems as a result of Peanut CRSP should increase profitability to farmers up to 40% in these countries.

1.12. Peanut CRSP in Jamaica, Belize and St. Vincent have stimulated the interest of farmers to improve peanut quality. These activities have brought realization among farmers that reduced cost of production and increased value of peanut (due to improved quality) can increase profits. The stimulus provided by Peanut CRSP on the farm should raise the economic value of peanut to the farmers. Fabrication of equipment by local manufacturers and marketing of value-added peanut should further enhance the economic status of the farm community in the

Caribbean.

2. IMPLEMENTATION AND MANAGEMENT OF PROJECTS

2.1. Administrative involvement

2.1.1. Attitude towards, support and perceived relevancy to the institution.....: HS

2.1.2. Fiscal/logistical assistance.....: S

2.1.3. Resource commitment (faculty/ facilities).....: S

2.1.4. Comments

2.1.4.1. The success of projects in Caribbean countries is mainly attributed to CARDI whose mission is "To contribute to agricultural development through generation and dissemination of appropriate technology that benefits the Caribbean people." Project networking assures exchange of research data and increases potential for program successes. Peanut CRSP, like CARDI projects, has a PI to coordinate all available financial, institute administrative and research resources and to work to develop collaborative studies among Caribbean countries, universities and other programs. An economist assures that the agricultural community's needs are met. The Director of Administration and Finance provides guidance during the planning and evaluation process.

2.1.4.2. CARDI recently went through difficult times with unclear administrative policies and financial support. The member Caribbean countries restated their commitment to regional cooperation in agricultural research and development at their annual meeting in July 1987. With this mandate, a new organization, better geared to meet the needs of Caribbean farmers, emerged. During this period, research had a variable priority in CARDI with limited regional and national scientific expertise. Lack of administrative support from CARDI Headquarters hindered progress. However, with a reorganization completed, and a Strategic Plan 1988-93 in place to assist member countries grow from a period of agricultural stagnation, CARDI is meeting its primary challenge, i.e., to help achieve its objectives rapidly within the scope of resources. Coordination of Peanut CRSP was shifted to Antigua under B.R. Cooper, PI, and project leader for all CARDI locations. CARDI consists of 12 Member States of the Caribbean community including Antigua and Barbuda, Barbados, Belize, Dominica, Grenada, Guyana, Jamaica, Montserrat, St. Kitts/Nevis, St. Lucia, St. Vincent and the Grenadines and Trinidad and Tobago.

2.1.4.3. Administrative reviews of international programs are very comprehensive within CARDI and UGA. Recognized is the fact that Peanut CRSP has created a worldwide network among peanut researchers. At the time of Peanut CRSP's initiation, it was not visualized that this program would grow to what it is today. The peanut has the potential of having a great impact on world food, especially in the collaborating Host Countries of Peanut CRSP. Visions of scientists have been vastly expanded through the international efforts of Peanut CRSP. This includes contacts, collaborations, and development of a professional fraternity. Peanut CRSP also serves as a vehicle for public relations among countries, and is becoming especially helpful in this regard in the Caribbean.

2.1.4.4. Funds from all UGA grants, including Peanut CRSP, are coordinated through the UGA Research Foundation, Inc. Approximately 35% of the funds are used to pay operating expenses. Peanut CRSP contributes funds to UGA program and benefits from other project funds. All charges are carefully audited and accounts tracked for expenditures.

2.1.4.5. Top administrators consider UGA to be at the forefront of research. They stated that there is a commitment to transfer all project accomplishments to the user through careful planning. Moreover, it is an accepted fact that projects such as Peanut CRSP attract other grants. In this regard, Peanut CRSP is considered to be one of the best managed and most productive of all CRSPs.

2.2. Researcher involvement

2.2.1. Attitude towards, support and perceived relevancy to the institution.....: HS

2.2.2. Fiscal/logistical assistance.....: S

2.2.3. Resources commitment (faculty/ facilities.....: S

2.2.4. Comments

2.2.4.1. Since 1987, CARDI has refocused its efforts, reorganized its structure, and redeployed its staff to strengthen its research capability and more effectively respond to member country needs. The current staff numbers 37 professionals funded from the core budget (includes both technical and management staff) and 22 from project funds. The current core professional staff includes agricultural engineers, entomologists, agronomists, animal scientists,

animal nutritionists, economists, marketing experts, and various other specialists.

2.2.4.2. Since the 1987 restructuring, CARDI's personnel costs have been reduced to 70% with a future target of 60% for personnel and 40% for operating costs. With these new ratios, CARDI is emphasizing quality research and relevant field activities in support of international projects such as Peanut CRSP.

2.2.4.3. CARDI headquarters is located on the University of West Indies (UWI) campus in St. Augustine, Trinidad. Member country governments have provided CARDI with field stations and laboratories at several locations. These are available for investigations and demonstrations and provide resources for the introduction of new crops, maintenance of germplasm and varieties, field trials, and related activities. Peanut CRSP has strongly contributed to these resources. CARDI backs up its technical programs with support services which fall into three main areas as information, biometrics, and socio-economic analyses.

2.2.4.4. Peanut CRSP is regarded at UGA to be a quality, streamlined program. This has evolved because researchers assigned to the program have responded to recommended changes. At UGA, Peanut CRSP has become a model for other CRSP through collaborations and education. Researchers work together, identify needs, equipment and proceed to do the job. A philosophy of information exchange and productivity is maintained. Outside funds are continually sought, especially those of international programs to broaden the research base and recognition through collaborative efforts. Graduate students and postdoctoral scientists are important in these developments. These developing scientists are an effective way to enhance programs worldwide through visibility, recognition and increased promotability of programs.

3. INSTITUTIONAL DEVELOPMENT

3.1. Complementarity to ongoing research efforts.....:____HS____

3.2. Strengthening of scientist/equipment/facility capabilities.....:____S____

3.3. Extent of collaborative interactions.....:____S____

3.4. Training.....:____S____

3.5. Comments

3.5.1. CARDI is placing high priority on strengthening its organization and management systems to support the technical programs. CARDI's existing organization and management systems are not fully developed or sufficiently institutionalized to support the institute's strategic plan. In addition, CARDI's staff lack some of the skills required to handle their continuously changing organization and management roles and responsibilities. Peanut CRSP is contributing assistance at this stage of the project to solve these problems through training and other developmental programs.

3.5.2. CARDI administrators at UWI, St. Augustine, Trinidad, acknowledged the importance of learning about advanced equipment/instrumentation and facilities in the US. However, these newly learned skills are of limited use in Caribbean countries because similar conditions are not available. When they are, technicians have to be continually trained in the US to maintain the knowledge base for their use. This is costly to Caribbean institutions, where budgets are limited. Peanut CRSP can assist with supportive training funds. Furthermore, Peanut CRSP could help newly advanced degree scientists start his/her career, and aid the newly trained scientists to establish their research programs on return. Efforts are needed to support the Caribbean countries and their institutes, and stay with the new scientists to help them establish and strengthen programs.

3.5.3. The UGA Experiment Station, Experiment, GA, is fulfilling its mission to discover, develop, and disseminate scientific information for the present and future agricultural, food and environmental need and concerns of the citizens of Georgia, the nation and the world. The Peanut CRSP and PI, Dr. M. S. Chinnan, are in the Food Science and Technology Department. A collaborative effort exists with the Agricultural Engineering Department. The research thrust of the Food Science and Technology Department is to enhance the quality of life of the consumer through new and improved technologies for handling, storing and processing food commodities produced and/or marketed in Georgia. This can be achieved through improved nutritional value, safety and sensory qualities of foods, ideally offered at an economical price to the consumer.

3.5.4. The Food Science and Technology Department, UGA, has 10 faculty, assigned 100% to research and each being equipped with the most modern equipment/instrumentation and facilities. A complete food processing pilot plant supports laboratory research. This pilot plant has five environmental rooms to test storageability of peanut under varying temperatures,

moisture levels and time intervals. The facility has a complete peanut processing line including pod sizer, sheller, roaster, blancher, oil press, colloid mill, homogenizer (purchased with Peanut CRSP funds), and packaging equipment. The Agricultural Engineering Department has excellent facilities/workshop capabilities for equipment/machinery development.

4. ADEQUACY OF SCIENCE

4.1. Progressiveness and innovativeness of the science/research.....:____HS_____

4.2. Social science/economic implications....:____HS_____

4.3. Appropriateness of basic/adaptive research.....:____HS_____

4.4. Comments

4.4.1. D. Dyer, Executive Director, CARDI, located at UWI, St. Augustine, Trinidad, stated that selected high yielding cultivars producing quality peanut are available for Caribbean farmers. Harvesting, threshing, drying and storage techniques on farms need to be improved. He was aware of technologies developed in other countries and expressed a need to transfer them to the Caribbean farmers; he expressed concern about duplication of efforts which is an ineffective use of research funds. Where production and postharvest technologies are available, Peanut CRSP and CARDI do not have to do developmental research. It would be better to contract the development of some farm equipment to the Caribbean Industrial Research Institute (CARIRI), located at UWI, Trinidad. In the area of foods, the populations of Caribbean countries have ample sources, in particular, beans. Peanut will not completely replace beans as a source of food. The commercial niche for peanut is in roasted (in shell and shelled), confectionary and peanut butter products.

4.4.2. Like farmers everywhere, those of Caribbean countries are cautious before making changes in production and harvest technology but are, in many cases, quite ready to experiment on a small scale. Improvements in mechanization need to continue and be validated in the farming system. Harvesting equipment that reduces labor costs is important to development of the peanut industry. New cultivars with increased yields are also better adapted to new harvest technologies. Drying methods need to be improved. As part of this research on preparing quality peanut for processors, there is need to educate the farmer in the advantages of building proper storage facilities.

4.4.3. The Jamaica Ministry of Agriculture, Extension Service, is collaborating with Peanut CRSP and CARDI in demonstration projects on growing a number of cultivars at various sites. Among the cultivars is CARDI-PAYNE now grown and marketed by farmers. Attention is needed for production of planting seed. There are no commercial planting seed producers. Planting seed are obtained from other regions of the Caribbean for distribution by CARDI.

4.4.4. At UWI, St. Augustine Trinidad, Mechanical Engineering Department, a graduate student, Peanut CRSP-funded, is developing a production/postharvest system for peanut. A survey of existing planting, harvesting, storing, processing and marketing procedures was completed and showed the high production cost, mainly due to hand labor, to the small farmer (two acres or less); two farmers and three processors were included in the survey. A peanut digger/inverter was designed, constructed and tested and shown to reduce labor costs. Its desirable features include lifting the plant out of the ground while pulverizing the soil mass and inverting the lifted peanut mass so that it can be left to dry in windrows. Other features include light weight, low cost, good market appeal, and an operating efficiency of 98%. Further testing to improve operation of this equipment in hard clay soil is underway. Field curing tests (sun drying) show that in fair weather, the moisture content of peanut in the shell can be reduced from 25% to less than 10% in seven days. Cost of an artificial drier can be saved.

4.4.5. On-farm research in Jamaica, Trinidad and UGA is demonstrating improved technologies for reducing cost of production. These technologies include chemical weed control (pre-emergence herbicides), intermediate planting technologies (hand cultivators), and hand- and gasoline- motor operated shellers and lifters. Herbicide technologies include applicators, sprayers, etc., used for vegetable crops that can be transferred to peanut.

4.4.6. CeCoCo small plot threshers repaired and modified at UGA were shipped to Jamaica and Belize and successfully tested. Mobility was increased by adapting the machinery to tractor three-point linkages. Similar research on threshers is ongoing by CARDI engineers in Jamaica. Two small threshers are being modified in Antigua for tractor mounting and in-field mobility.

4.4.7. Improvements to forced air dryers ongoing in Belize and UGA are being completed by introduction of kerosene heaters and improved alignment of the engine fan systems. Evaluation/monitoring of farm drying procedures are underway. This includes construction of solar drying aids. Storage facility designs on a number of farms in Jamaica and Belize

are being constructed. Testing, including ambient dehumidified and sealed environments, of storage conditions have begun. Testing for aflatoxin contamination in harvested and stored peanut is underway.

4.4.8. Socio-economic studies are a primary part of CARDI's programs. These studies are developing new technologies by understanding the farmer's aspirations and the social factors that affect technology adoption. Economics figure highly in all of CARDI's work. Ex ante- and post-economic assessments are being carried out for all technical activities. Greater attention is being placed on evaluating the possibilities of commercialization before mounting research efforts.

5. APPLICABILITY OF RESEARCH

5.1. Relevancy and transferability of research to Host Country/US programs.....: HS

5.2. Relationship to other international research programs.....: S

5.3. USAID perceptions.....: HS

5.4. Comments

5.4.1. The Jamaica Ministry of Agriculture, Extension Service, Santa Cruz, St. Elizabeth Parish, has a very active program, with quality personnel transforming technologies on peanut to farmers in collaboration with Peanut CRSP and CARDI. It was pointed out that 30 yrs ago, farmers in St. Elizabeth Parish grew approximately 400 crop ac/yr (crop acres is defined as total acreas planted/yr which is usually two plantings/yr). In the planting year of 1988-89, the crop acres are 4,630. Yields per acre have gone from 30-35 to 55 bushels/ac during this 30-yr period. Jamaica's commercial processors could easily handle double the amount of present peanut production. The development of proper storage facilities would allow availability of peanut year-round for processing to roasted shelled/in-shell, confection and peanut butter products for local consumption. Presently peanut products are seasonal, especially peanut butter.

5.4.2. Peanut CRSP is playing a role in CARDI research to reduce the drudgery of peanut production in Jamaica. Similar research is ongoing at UGA. Improving labor productivity is becoming more important as the number of agricultural workers diminishes and wages increase. In Jamaica, attention is focused on equipment for peanut production that can be fabricated locally or anywhere in the Caribbean. Hand reaping costs J$300/ha (15 man-days) and is a factor that increases

cost of locally grown peanut. A lifting-blade fitted at the rear of the tractor effectively loosens the peanut plants and significantly reduces hand operations. Removal of pods from the plants is also done by hand with a good picker removing 40 kg/day. A small tractor-mounted machine has been renovated and is capable of stripping more than 100 kg/hr in Jamaica. Shelling is done either by hand or by Farmer's Cooperatives in Jamaica, which own mechanical shellers. Use of a smaller unit, which can be owned by farmers, produces more than 250 kg/hr and has proven satisfactory for producing a low-cost, convenient service to Jamaican farmers. A manually-operated sheller produces over 80 kg/hr. Modifications are being made to a manual sheller to reduce the proportion of damaged kernels.

5.4.3. Technologies developed for the lifter, thresher and sheller are being applied on farms. Concepts in herbicide/pesticide applications and double cropping with corn are being applied. Demonstration plots are in place with the new peanut cultivar, CARDI-PAYNE. These plots include the latest scientific advances in agronomic, herbicide and pesticide applications techniques. Included are the tracking of yields and quality maintenance through appropriate drying/storage/handling techniques. These studies are showing that farmers can control aspergilli growth and aflatoxin contamination on-farms.

5.4.4. Most farmers in Jamaica, and other Caribbean countries, successfully plant two peanut crops/yr depending on weather, particularly rain patterns. The trusted valencia cultivar is mostly grown. Newly developed cultivars are making their way into the farm system. As production inconsistencies are overcome, farmers gain confidence in new cultivar yields and disease resistance, and traders request them because processors find them highly desirable. Marketing of Caribbean-grown peanut is guaranteed when there is a continued source that is of high quality and low cost. As on-farm mechanization occurs, and new storage/handling concepts materialize, the local market will develop. Local entrepreneurs are building on-farm equipment, e.g., shellers, that are attracting farmers' attention.

5.4.5. In Belize, forced air drying equipment is being developed. Work was completed to improve the drying facilities at one Cooperative. Operation of the modified dryer which uses inexpensive burning arrangements (kerosene fuel) has been tested. However, large quantities of peanut were unavailable at the time the equipment was ready for field tests. These studies are planned for the Fall 1989 crop. There is a definite need for artificial drying technologies in Belize and other similarly humid regions of the Caribbean.

5.4.6. A storage facility in Belize was modified based on the recommendations of UGA researchers. Modifications were done to improve ventilation and are having a direct benefit to the maintenance of peanut quality during storage.

5.4.7. The Georgia Experiment Stations are unified in their efforts in Peanut CRSP and have gained the support of the Georgia Peanut Commission. All have learned the significance of a world economy and appreciate the value of learning how farmers work in foreign countries. Specifically, they have learned that the international programs are contributing to Host Countries to help them solve problems. The US farmer is benefiting from research in Host Countries through the exchange of research concepts.

5.4.8. USAID, Jamaica, is very pleased with the accomplishments to date of Peanut CRSP. Efforts are underway to develop a Bean/Cowpea CRSP in Jamaica because beans are a major food. A primary objective of Caribbean countries is to strive for a balance of payment. The low production of grains must be offset with improved production and processing of other commodities such as fruits, coffee, cocoa, sugar, beans, spices, milk and beef. The development of a small on-farm machinery industry to reduce production and postharvest cost is important to Caribbean countries. The technology is available and blueprints made available to entrepreneurs will encourage development of small on-farm machinery businesses. As yields increase and production technologies improve, proper storage/handling facilities will be needed; an area that is being researched.

6. OBSERVATIONS

6.1. Strengths

6.1.1. Very evident was the dedication of project personnel including Dr. Janice Reid, entomologist and Country Representative (Jamaica), CARDI; Mrs. Barbara Black, Coordinator of CARDI Projects (Jamaica); Mr. Joscelyn Grant, PI, Agricultural Engineer (Jamaica); Dr. G. Muller, PI (Trinidad); and Dr. Brian R. Cooper, PI, Agronomist, (Antigua) and project leader for all CARDI locations.

6.1.2. Impressive was the excellent cooperation from farmers, the Ministry of Agriculture, Extension Service, Santa Cruz, St. Elizabeth Parish, Jamaica, including Mrs. Carol Wilson, Extension Specialist, Mr. Robert Saunders, Extension Specialist and Mr. Marvin Montague, Minister of Agriculture Executive.

6.2. Weaknesses and options to improve

6.2.1. CARDI inputs greatly and successfully into research and extension among Caribbean countries. The institute is considered to be an important linkage to the outside world by testing/adapting and implementing technologies in the Caribbean countries. The problem is that CARDI's small budget limits its involvements mainly to priority crops. It is felt that technologies and expertise for improving crop production are available. Focus should be on on-farm application through demonstration projects. This is being initiated through a newly funded USAID mechanism, Jamaica Agricultural Research Project. A cowpea proposal with the University of Florida has just been funded. CARDI should submit a proposal for transfer of peanut production technologies and link this effort with Peanut CRSP.

6.2.2. Research on labor-saving devices for peanut production/harvesting, etc., is duplicated at UGA and CARDI, Jamaica and UWI, St. Augustine, Trinidad. These devices have been designed, fabricated, tested, modified and placed into use at Khon Kaen University, Thailand. This nullifies the need to try and duplicate this technology at UGA and Caribbean countries. What is apparently needed is to coordinate training of other Host Country's personnel for two-week periods at Khon Kaen University, fund purchases of blueprints and appropriate production modes suitable for each Caribbean country and transfer this technology to small manufacturers and distributors.

6.2.3. Presently, a time factor (e.g., 120 days after planting) is used to determine harvest time. In many instances, the marketed peanut are of poor quality, either immature or aspergilli/aflatoxin-contaminated. One approach to resolve this problem is the application of maturity indices tests. Miss Margaret Hinds is nearing completion of Ph.D. degree requirements to research the potential of applying maturity indices to determine harvesting time for peanut from selected Caribbean countries at AAMU. This research is the only remaining portion of the terminated project, Peanut CRSP-AAM/FL FT/CARDI -- Peanut Utilization in Food Systems in Developing Countries. It is recommended that this segment of the terminated project continue because of the potential of this research to improve peanut quality in Caribbean countries. The work would complement ongoing research to develop production/harvesting technologies, and storage to reduce labor cost and maintain quality. This work could continue through support of a postdoctoral position at AAMU, through collaboration with UGA, or funding of research with CARDI, Jamaica, to implement the maturity indices research for the Caribbean farmers.

7. RECOMMENDATIONS

7.1. Total consumption of peanut in Caribbean countries is estimated to be 10,000 tons. Production is 3-4000 tons on about 5-6000 ha, mainly in Jamaica, Belize, Trinidad and St. Vincent. The objectives of the original Peanut CRSP, "Breeding and Cultural Practices for the Caribbean" to identify improved cultivars has been largely met. Farmers grow peanut mainly as a cash crop, i.e., all peanut are processed to roasted shelled and unshelled products, snacks, confections and peanut butter for local consumption. Therefore, new production and on-farm postharvest technologies are needed to increase peanut as a food in Caribbean countries.

7.2. Farmers typically prepare for peanut planting by first applying herbicides, tractor plowing/harrowing, mule farrowing, hand planting, weeding, lifting, windrowing, threshing, picking and sun drying. Noted was that most of this work was done by manual labor. Peanut are then bagged and sold to traders. Approximately 40 bushels (800 lbs) are harvested/ac. Estimated production costs/acre are J$3000, of which labor is the main cost. The average price earned/bushel, is about J$100 which translated to J$4000 and a profit of J$1000/ac. Losses are not uncommon if weather conditions during the growing and harvesting season are poor. The time of year the peanut crop is harvested and made available for processors affects prices traders are willing to pay. To improve profit margins one must plant higher yielding cultivars, use on-farm mechanical equipment to reduce labor costs and build storage facilities that maintain quality to give the farmer an opportunity to await favorable market prices. Doubling yields along with developing new mechanization and storage technologies would increase year-round availability and profits.

7.3. The researchers and staff of CARDI and Peanut CRSP in Caribbean Countries and UGA are dedicated to peanut research. The excellent cooperation of the Ministries of Agriculture, Extension Service and farmers, especially noted in Jamaica assures success in achieving the objectives of the program. CARDI has just developed a "Strategic Plan 1988/93, for the Caribbean countries describing how the institute expects to meet the challenges of the 1990s. The research objectives include increasing agricultural diversification, improving food crop and animal production, lowering cost/increasing profitability of farms and expanding product diversification/utilization. A technology adaptation and transfer program is included in this plan. Opportunities for collaboration in CARDI's Strategic Plan 1988/93, abound for USAID, especially Peanut CRSP. Objectives of the Peanut CRSP project GA/PH/C-"Postharvest Handling Systems for the Small

for drying and storage of in-shell/shelled peanut; (2) Identify and/or develop labor-saving devices for production and postharvest operations; and (3) Develop strategies for linking Southeast Asia P-CRSP on breeding, farming systems and food technology, complement CARDI's plan. Of these objectives, the greatest contribution Peanut CRSP can make is to (3) by training in the use of the labor-saving machinery already available for peanut production/harvesting in Khon Kaen, Thailand. These devices have been designed, fabricated, tested, modified and placed into on-farm use. Peanut CRSP can fund the transfer of this labor-saving technology by training CARDI scientists/engineers and supporting research to transfer and adapt these developments to the needs of Caribbean farmers at CARDI research facilities, e.g., Jamaica, Belize and UWI, Trinidad. This strategy was emphasized by Dr. D. Dyer, Executive Director, CARDI, UWI, St. Augustine, Trinidad.

7.4. Clearly recognized is that CARDI in collaboration with Peanut CRSP, is providing Caribbean countries with major advances to the peanut industry through research, especially in new cost-saving technologies in production. There is now need to strengthen efforts to extend these technologies to the farmer. USAID agrees and is bringing new monies to the Caribbean countries for demonstration projects of research ready for technology transfer. New high yielding, disease-resistant peanut cultivars, e.g., CARDI-PAYNE, are available to the farmers and traders. In response to food processors, traders are paying farmers premium prices for their production. New production technologies or on-farm mechanization, inverters/lifters, threshers, shellers, etc., for the small-scale farmer are becoming available. One reason for this success is that small scale on-farm mechanization is reducing labor cost which has been the reason for high in-country prices of peanuts. As production increases, new on-farm storage practices are being researched and proven successful. Application studies of the maturity indices test and understanding the causes of aspergilli/aflatoxin contamination and pest control are assuring quality peanut. These technologies are projecting the production of a year-round reliable source of quality peanut at a reasonable cost, a breakthrough that will gain the confidence of traders and processors. There is ample market potential; the Caribbean market could easily absorb twice the present production. Peanut CRSP should now develop strategies for linking Southeast Asia Peanut CRSP on breeding and farming systems (on-farm mechanization) to the program in Caribbean countries.

7.5. The PIs of Peanut CRSP in the Caribbean should have as their primary objective the development of strategies for linking Southeast Asia Peanut CRSP on sustainable agriculture and post-production technologies, specifically, on-farm

machinery mechanization, to Caribbean countries. The on-farm mechanization developments advanced to farmers in Thailand should be readily transferable to Caribbean farmers. The EEP does not fully support the need for extensive testing and modification of Thailand's on-farm machinery before it can be applied in other countries. To a considerable degree, these research developments are directly transferable. In this regard, the EEP recommends that the Caribbean project be closely monitored in the future to assure transfer of the small farm machinery. Moreover, this project should be continually reviewed for progress and the payoffs from this research. This is an example where Peanut CRSP can benefit greatly in recognition from the transfer of technologies among Host Countries.

7.6. Noted was the close proximity of Caribbean countries to the US compared to Sotheast Asian and African countries. With proper experimental design, this proximity offers a unique opportunity for Peanut CRSP's US PIs to test selected research developments under actual field (Host Country) conditions. Scientists and engineers can frequently travel to the Caribbean countries, because of short distances and less cost, to apply their research developments on sustainable agriculture and post-production/utilization technologies. Environmental and socioeconomic similarities to Southeast Asian and African countries are likely to exist in the Caribbean. This would allow researchers to obtain additional data in support of those of the distant Host Countries. The result would enhance potential for advancing Peanut CRSP's two general objectives, i.e., to support research programs in the US and Host Countries; and to improve the research capability of US and Host Country institutions.

7.7. Since the inception of Peanut CRSP in the Caribbean, highly significant achievements have been made, and continue to develop, from the projects. They are contributions to human resources in research at Caribbean institutions, release of a new peanut cultivar, CARDI-PAYNE; application, on-farm, of improved mechanical threshing and shelling machinery, and storage technologies; awareness by farmers, traders, and food processors of the need to monitor aspergilli/aflatoxin contamination; realization among farmers that reduced cost of production and improved processing, e.g., roasted peanut products and peanut butter formulations, will increase consumer sales. These developments are increasing production and utilization of quality peanut in Caribbean countries.

7.8. In summary, A. Ali, Director, Administration and Finance, CARDI, pointed out that the EEP should view Peanut CRSP as supporting research of Caribbean countries as a whole rather than by individual countries. Examined individually, each

country's economic and research needs compared to most nations, may seem small. However, taken as a Caribbean community of 12 nations (Antigua and Barbuda, Barbados, Belize, Dominica, Grenada, Guyana, Jamaica, Montserrat, St. Kitts/Nevis,St. Lucia, St. Vincent and the Grenadines, and Trinidad and Tobago), the picture changes dramatically. Accepted is that CARDI has gone through financial problems which has limited its coordination and support of past research programs in Caribbean countries. The Institute was recently reevaluated and reorganized. As part of this self-analysis, the administration has implementd new policies to gain support (especially financial) from the member countries. CARDI's reinforced mission statement is "To contribute to agricultural development through the generation and dissemination of appropriate technology that benefits the Caribbean people." Efforts of Peanut CRSP to develop the peanut industry, specifically, e.g., in postharvest/utilization technologies of Jamaica, St. Vincent, Belize and Trinidad, are important in the support of the research needs of the 12-nation Caribbean community.

4.10.a. **EXTERNAL EVALUATION PANEL REVIEW**

Peanut CRSP Code: **NCS/SM/TP**

Project Title: **Influence of Soil Microbiology on Nitrogen Fixation and Growth of Peanuts in Thailand and Philippines: A. Rhizobia.**

Principal Investigators and Collaborating Institutions: Dr. G. H. Elkan, North Carolina State University; Dr. Nantakorn Boonkerd, Thailand - Department of Agriculture (DOA); Dr. Erlinda Paterno, University of the Philippines at Los Banos (UPLB).

This project dealt with two aspects of soil microbiology relating to peanut:

1. Rhizobium studies based at North Carolina State University (NCS/SM/TP) with the Principal Investigator being Dr. G. H. Elkan of the Department of Microbiology.

2. Mycorrhizal studies based at Texas A & M University (TX/SM/SP) with the Principal Investigator being Mrs. Ruth Ann Taber of the Department of Plant Pathology and Microbiology.

The host countries selected were the Philippines and Thailand, but with different in-country PI's for the two areas of research.

The EEP briefly reviewed these projects along with other Peanut CRSP projects at the respective institutions in North Carolina, Texas, Philippines and Thailand (see appendix I for detailed itinerary).

Based on recent decisions by the Peanut CRSP Board and Technical Committee regarding this project, and our own assessement we chose not to use the extensive evaluation form as was followed for other projects. The following somewhat brief comments are offered.

RHIZOBIUM RESEARCH: NCS/SM/TP

1. North Carolina State University

1.1. We were impressed by the enthusiasm, and commitment to the project by Dr. Gerald Elkan the NCSU PI. Administration at NCSU was also supportive.

1.2. The collaboration with NCSU plant breeders is excellent and the early finding that host/strain interactions influence nodule formation would indicate that improved yield must come from concurrent selections of genotypes and Rhizobium strains. To pursue the latter NCSU has accumulated a large collection

of Peanut Rhizobium. The NC 92 strain was reported to provide an 18 percent yield increase on certain genotypes at some locations.

1.3. We were pleased to note that both laboratory and field studies have been involved in the strain evaluations. Too often large differences in strains are found in the greenhouse for plant growth and/or yield which disappear when the same comparisons are made in the field.

1.4. The basic complex biochemical and physiology research taking place in the laboratories at NCSU is most impressive.

Dr. Elkan and colleagues at NCSU have documented the effects of Bradyrhizobium sp. strains on (1) the free amino acid composition of peanut root nodules, and (2) the fatty acid, free sugar and free amino acid content of the peanut seed. Different strains of the rhizobium did affect both the types and concentrations of free amino acids produced in the seeds and root nodules. There were no strain effects on the lipid fatty acid content, or free sugar content of seed.

Great creativity was used in this project to develop an "artificial nodular environment" in the laboratory to understand how nitrogen fixation is affected by a change in environment, or the more basic question of how symbiotic fixation is regulated.

An intriguing question also under study is whether plant passage (infection, nodulation, and return to the soil on the plants death) affects the stability of Rhizobium and if so, might this be a method for selecting superior strains.

1.5. We hope other funding may be found to support these long term basic studies. We are not convinced that the results will offer short term benefits to either North Carolina or Asian peanut growers.

2. Rhizobium Research - Phillipines

In our interview with Dr. Erlinda Paterno in the Philippines we were given no experimental results, or plans for future rhizobium studies on peanut. PCARRD had indicated that inoculum was included in some peanut pilot production trials and the results were erratic. Part of Dr. Paterno's reticence probably stemmed from no Peanut CRSP funds this year, her duties as Dean of the UPLB Graduate School, and the fact that she is receiving financial support for work on two other seed legumes, mungbean and soybean.

3. Rhizobium Research - Thailand

3.1. In Thailand passouts and slide presentation were made at the Department of Agriculture (DOA) in their new Rhizobium Institute Building by Dr. Nantakorn Boonkerd, and Dr. Banyong Toomsan at Khon Kaen University of their research conducted 1983-1987.

3.2. The new research laboratories and pilot production facilities for preparing inoculum by DOA in Bangkok is impressive. One hundred and seventy tons of Rhizobium inoculum were cultured, packaged and distributed to farmers at a relatively low price last year. Present inocculum output of DOA is about equal for mungbean, soybean, and peanut. A large Rhizobium collection is maintained at the institute.

3.3. The objective of the research program at each Thai institution is to increase peanut yield through the use of biological nitrogen fixatio technology. The research has been primarily adaptive and largely in the field.

3.4. Rhizobium strains were collected from peanut fields in different ecologies and tested against stored and introduced strains from ICKISAT and NCSU. Thai 205 and NC 92 strains appear to do well in Thailand and are being added to the government distributed peanut inoculant.

3.5. Traditional applied research has taken place on methods, placement, carriers and rates of Rhizobium, and frequency in a cropping cycle or rotation.

3.6. When questioned, the researchers admitted larger plant growth and yield differences were noted in pot culture than in the field, particularly when comparing Rhizobia strains.

3.7. In some field studies a mixture of Rhizobium and Mycorrhizal strains had shown higher yield than either the check or Rhizobium or Mycorrhizae alone. This was explained to be due to higher Nitrogen and Phosphorus uptake.

3.8. At Khon Kaen University the seasonal variation in Rhizobium populations was studied in a rainfed rice field. In general, populations were low in the dry season and high in the rainy season. Short periods of soil water logging did not decrease the population. However, a prolonged waterlogged condition reduced numbers, but did not destroy all the bacteria. This might have implications to the time of year or place of peanut in the cropping system and inoculant needs.

3.9. Using N-15 studies at Khon Kaen, Dr. Toomsan found that three varieties differed in N fixation and that about 24-40%

of final N was found in the seed and 60-74% in the vines. The Rhizobium inoculated plants fixed an average of 71 kg N/ha as compared to 62 Kg N/ha for the uninoculated check plants.

3.10. At Khon Kaen we were shown results of field trials where no, or negative yield differences occurred and trials where positive results from inoculation occurred. Part of this may have been due to the fact that trials in some years and locations encountered drought problems.

3.11. Both Thai microbiologists believe that more research is needed on identifying high nodulating N-fixing genotypes of peanut. This is an area where small expenditures of Peanut CRSP funds might continue. But a part of such studies should include screening germplasm for response to the Rhizobium already present. Dr. Eric Kuenneman was successful with this approach with soybean at IITA in Nigeria, and eliminated the need for inoculum. We were informed that very few Thai farmers use inoculum on their peanut crop.

Conclusion - Rhizobium Research Curtailment

While the EEP sympathizes with the researchers involved because of their commitment, enthusiasm and documented progress, we support the tough decision made by the Peanut CRSP Board and EC to curtail support when USAID support funds were drastically reduced. The bottom line is that short range break throughs in peanut production are not likely to happen from this research.

The justification for biological nitrogen fixation research for primary food crops has been extensively documented, and in recent years generally well supported in the U.S. and other countries. While this has elucidated a great deal of fundamental or basic knowledge on the biochemical and physiological processes related to BNF we do not believe this has yet added many bushels in the bin or money in the peanut growers pocket. Peanut CRSP funds should be used on projects where the chance of moderate term success is greater.

Hopefully the NCSU PI can locate other support funds to answer the many basic questions his excellent research has opened up. And we would hope that any present graduate students involved would be provided for.

As indicated in 3.11. above we believe there is a plant breeder and entomologist team at Khon Kaen University which should be encouraged to seek peanut germplasm which nodulates well with native rhizobium strains under the generally poor soil conditions existing in the present and future peanut production areas of Thailand. Such funds could be new or an addition to

the ongoing Peanut CRSP breeding program at Khon Kaen. The subtitle might be breeding for increased biological nitrogen fixation. We noted that IDRC stopped their support of BNF research at Khon Kaen University last December.

4.10.b. EXTERNAL EVALUATION PANEL REVIEW

Peanut CRSP Code: **TX/SM/TP**

Project Title: **Influence of Soil Microbiology on Nitrogen Fixation and Growth of Peanuts in Thailand and Philippines: B. Mycorrhiza.**

Principal Investigators and Collaborating Institutions: Mrs. Ruth Ann Taber, Texas A&M University; Dr. Omsub Nopamornbodi, Thailand - Department of Agriculture (DOA); Dr. Lina Ilag, University of the Philippines at Los Banos (UPLB).

1. Texas A & M University (Department of Plant Pathology & Microbiology)

1.1. The scientific training and committment of the PI, Mrs. Ruth Ann Tabor to this project is noteworthy. The excellent facilities and equipment available in the Plant Pathology Department of Texas A & M University permits basic studies on these fungi.

1.2. The creativity and innovativeness of the researcher was impressive. The EEP came away with the feeling that much information of both an adaptive and basic nature had been documented on the role of mycorrhizal fungi on the growth and yield of peanut.

1.3. Among the major accomplishments are the following:

1.3.1. A tabulation of vesicular - arbuscular endomycorrhizal fungi (VAMF) indigenous to peanut soils in SE Asia and the U.S. revealed that the VAMF flora of Philippines and Thailand soils is more diversified than the flora in U.S. soils. Species varied also by soil types.

1.3.2. Over 200 VAMF cultures have been collected and tested for performance on peanut plants in the greenhouse. Three species, Glomus intraradicea, G. etunicotum, and G. deserticola appeared to be the most promising for the U.S.

1.3.3. Mycorrhizal additions under low phosphorus conditions promoted the accumulation of this element, particularly in early plant growth as compared to controls. In some trials increases in manganese, magnesium and nitrogen was noted in the leaves and in nitrogen fixation, nodule numbers and size following mycorrhizal infection. In other trials plant height and root development were increased following VAMF infection as compared to non-infected plants. Under pot conditons seed yields were reported to reach a spectacular 300 percent increase with VAMF, but in the field, yield differences have

been moderate or sometimes non-significant.

1.3.4. Two interesting side effects noted was, first the presence of VAMF seemed to inhibit the growth of nematodes. Secondly, mycorrhiza survive and sporulate inside common weed seeds such as portulaca, pigweed and purslane in the soil. The first finding has biocontrol implications and should be more fully explored.

1.4. The research has been closely followed by commercial companies and two (Native Plants and Gustafson) are interested in setting up field trials in Texas to further develop the methodology for application of mycorrhizal fungi on peanut.

1.5. Collaborative research with scientists at West Virginia University, a USDA laboratory in the same state and the TAMU Veterinary College on procedures to determine hyphae species of VAMF present in peanut roots by use of monoclonal antibodies is in preliminary stages. This would allow the sorting out and identification of introduced VAMF vs. indigenous ones.

1.6. The enthusiasm and curiosity of the Texas PI is unlimited. Since VAMF inoculated peanut plants have sometimes shown phenomenal increases in aerial biomass, she is anxious to try these on leafy vegetables such as spinach and lettuce. We suspect Mrs. Tabor will continue to be a busy scientist after retirement next year.

1.7. Two Americans are completing Ph.D. degrees in 1989 on peanut mycorrhizae at TAMU.

2. Philippines

2.1. Dr. Lina Ilag and Dr. Rey de la Cruz of UPLB presented the status of mycorrhizal research in the Philippines to the EEP. Dr. Ilag is a Plant Pathologist at UPLB and served as the PI for Peanut CRSP. Dr. de la Cruz is a Forest pathologist, who has isolated, increased and pelleted VAMF with excellent results in aiding the establishment and early growth of several forest species. A commercial company is now making these available in the Philippines.

2.2. Conversely we sensed the identification and methods for applying, VAMF for peanut have not been fully worked out in the relatively short period of research (4 years) before the research funds were cut off. Dr. Ilag seemed to have worked alone. Some greenhouse pot trials were reported to have given more favorable plant growth and higher phosphorus uptake with VAMF as compared to control. Field research had generally not supported these findings but some of the promising pot cultures or isolates have not yet been tried in field trials.

3. Thailand

3.1. A brief slide presentation and report was given at the DOA Rhizobium Building of the Department of Agriculture in Bangkok by Dr. Nantakorn Bookerd on the mycorrhizal research 1983-1986. Five genera of VAMF have been isolated and identified in Thailand. These were tested in both pot and peanut field trials with varying success. In certain trials a combination of mycorrhizal and rhizobium gave higher yields than control, or either organism alone. No mycorrhiza has been distributed to farmers, and a research priority suggested by Dr. Bookerd was how to produce or increase the inoculum. We suggested he contact Dr. de la Cruz in the Philippines concerning his experiences with increasing cultures on sudangrass roots. We believe there has been a minimum of contact between the soil microbiologists in Thailand and the Philippines whereas the breeders and entomologists seemed much more aware of the others research.

4. Summary Comments - Mychorrizal project

4.1. As mentioned heretofore we were impressed by the broad and basic attack on enhancing peanut production by use of vesicular-arbuscular endomycorrhizal fungi (VAMF) taking place at Texas A & M. Some extremely interesting leads, or building blocks for future research were laid.

4.2. We viewed the one person research teams in Thailand and Philippines as having too many other commitments to make much progress in a very difficult research area in such a limited time frame. We did not note much new progress since the previous EEP report. This indicates that without Peanut CRSP funds perhaps little will occur in this area insofar as peanut is concerned for this particular research does not seem to have very high government priority.

4.3. In summary, we concur with the decision of the Peanut CRSP Board and TC in curtailing the funds of this particular project. As the former EEP report stated, and after 20 years of many conferences, workshops and research reports, this research remains speculative for food crops in farmer fields. We do not believe that Peanut CRSP has the money or luxury to continue to support mycorrhizal research. The only possible exception for consideration might be to make a small grant through PCARRD in the Philippines to Dr. de la Cruz in the College of Forestry at Los Banos to pellet mycorrhizal and Rhizobium for peanut trials to be conducted in the Cagayan Valley. For we were impressed with his simple techniques and reported successes with forest species.

4.11. EXTERNAL EVALUATION PANEL REVIEW

Peanut CRSP Code: **AAM/FT/CAR**

Project Title: **Peanut Utilization in Food Systems in Developing Countries**

Principal Investigators and Collaborating Institutions: Dr. Bharat Singh, Alabama A&M University (AAMU); Dr. Don Walmsley, Caribbean Agricultural Research and Development Institute (CARDI); Dr. George Sammy (Deceased), University of West Indies (UWI), St. Augustine, Trinidad.

The objectives of this project in the Caribbean were to examine variations in environment, socioeconomics and food technologies as they constrain the preservation and utilization of peanut supplies; to analyze the current and potential dietary role of existing peanut products; to assess the sensory, nutritional, microbiological, and toxicological quality parameters of peanut products in solid and/or beverage food systems for local consumption; to prepare and present peanut fortified foods in an effort to determine acceptability and nutritional values of such products; and to assure safety of the products with particular reference to mycotoxins in raw and finished products.

During 1986/87, research of the Peanut CRSP in the Caribbean was shifted to identifying suitable methods for maintaining postharvest quality and to developing approaches for reducing cost associated with harvesting, threshing and postharvest storage and handling steps. The project GA/PH/CAR - Postharvest Handling Systems for the Small Peanut Producer - M.S. Chinnan, evolved from GA/BCP/CAR - Breeding and Cultural Practices for the Caribbean. The project AAM/FL/FT/CAR was terminated.

These Peanut CRSP projects have established linkages and strengthened collaborative research programs on postharvest/utilization technologies in Caribbean countries between CARDI, UWI, St. Augustine, Trinidad, and the Food Technology Institute, Kingston, Jamaica.

1. **ACHIEVEMENTS**.....:_____HS_____

1.1. One graduate student from Jamaica completed requirements for a M.S. Degree in food science at AAMU on research proximate composition, amino acids and fatty acids of peanut grown in Jamaica. A second student from Trinidad is near completion of requirements for a Ph.D. in food science at AAMU working on application of the maturity indices technique to help assure peanut quality. Six scientists from Caribbean countries received short term training at AAMU.

1.2. A consumption survey was successfully completed and defined appropriate areas for peanut research in Caribbean countries, especially, Trinidad, Jamaica and St. Vincent. This survey indicated that the most utilized food was roasted peanut, followed by peanut butter, raw peanut, candy, and ground and boiled peanut. Peanut products are also used in various foods as ingredients. Cost, and availability year round, were the major reasons reported by households for not eating more peanut products. The study also showed that there is an immediate need for research on postharvest handling, storage, processing, packaging and marketing of peanut with special emphasis to less labor intensive, small-scale on-farm mechanization, harvesting and processing operations.

1.3. Proximate composition, amino acids and fatty acids of peanut from several selected cultivars grown at CARDI experimental plots, Lawrencefield, Jamaica, during two seasons (1985-86) were evaluated at AAMU. These studies completed the thesis requirements for the M.S. degree of E.A. Miller, Jamaica. Statistical analyses of data showed significant variations in composition of all components among cultivars; seasonal variations were also noted within cultivars. Other selected observations included: variations in oil content of valencia peanut among seasons could be one of the major problems peanut butter processors are having in Jamaica; peanut of certain cultivars grown in Jamaica may have better essential amino acid profiles than those grown elsewhere, but they were still deficient in methionine; and the potential exists for developing peanut cultivars with favorable oleic acid/linoleic acid ratios for improved product stability and nutritional value.

1.4. Physical (size, weight, seed/hull ratio), chemical (proximates, amino acids, fatty acids), and sensory/texture evaluations on mature, nearly mature, intermediate and composite peanut (or paste products) from plants of different ages (days after planting) are providing the basis for establishing maturity indices and optimum seed quality for peanut grown in the Caribbean countries.

1.5. Collaborative studies of AAMU scientists and food technologists at the Food Technology Institute, Kingston, Jamaica, and the Jamaica Frozen Food Plant have produced a commercially available stable and constant peanut butter product (trade name, Hope Kerr) from locally grown valencia. A problem of shelf life stability due to poor textural quality and oil separation was solved with the development of a new formula. Proximate composition, microbiological contamination and aflatoxin monitoring techniques were implemented to assure nutritional quality of the peanut butter.

1.6. Studies are ongoing in the Caribbean to determine the level of aflatoxin contamination in peanut after harvest, storage and processing to foods. The results are making farmers, traders and food processors aware of the problem and ways to control it. Research is underway at AAMU to remove aflatoxins. Aflatoxin content of contaminated peanut was reduced 30-44% after treatment with low-intensity microwave energy. Chlorine gas reduced aflatoxin content of contaminated peanut by 90%. These studies were conducted as a collaborative effort between food scientists at AAMU, the University of Florida and the Food Technology Institute, Jamaica.

2. SUMMARY COMMENTS

2.1. A committed administrative and research involvement was evident among countries collaborating on Peanut CRSP. This included a positive attitude, support and perceived relevancy to the institutions, fiscal/logistical assistance, and resource commitment.

2.2. Progressive and innovative science/research by CARDI and AAMU scientists contributed to progress on most of the objectives studied. This included completion of a consumption survey and providing the basis for improved selected food products, e.g., peanut butter.

2.3. The small farm Caribbean communities will benefit from Peanut CRSP supported research on maturity indices and processing technologies. Studies emphasizing the need for quality peanut during research on this project and instituted as part of the new GA/PH/CAR project to mechanize production techniques, will assist the farmer in this goal. Expanded research thrusts to improve drying, storage and handling techniques will allow availability of aflatoxin-free quality peanut year round.

2.4 Key to breakthroughs in growing quality peanut for continued increased food consumption in Caribbean countries is ongoing research to establish maturity indices from composition and physical characteristics of composite peanut samples whose quality have been confirmed by sensory evaluations. Presently, a time factor (120 days after planting) is used to determine harvest time. In many instances, the marketed peanut are of poor quality, either too young or too old and moldy. Therefore, there is a need to devise more reliable maturity indices. Peanut samples from St. Vincent and Antigua were collected by a graduate student, Miss M. Hinds, from Trinidad studying for a Ph.D. at AAMU. The farmers are anxiously awaiting the results and application of this study.

2.5. Discussions indicated that not all objectives were being completed in the Caribbean studies. Not all of the objectives were completed on peanut utilization in food systems. It was noted that the faculty at AAMU may have been overextended in time, staffing and/or facilities by doing research in both the Caribbean countries and SAT Africa. It was a prudent move for the AAMU faculty to focus their scientific expertise on SAT Africa, and specifically, Burkina Faso.

3. CONCLUSIONS

3.1. Presently, harvesting of peanut is based on time after planting which is 120 days. In many instances, the marketed peanut are of poor quality - either too young or too old and moldy. The research of Miss M. Hinds at AAMU, to establish the maturity indices technique for peanut cultivars based on composition and physical properties should help to resolve this problem. This research is of interest to farmers of selected Caribbean countries. Miss Hinds' plan is to complete this work at AAMU in the fall of 1989, to fulfill her requirements for a Ph.D. degree and then apply this new technology in on-farm experiments.

3.2. Discussions with S. Johnson, Business Office, UWI, St. Augustine, Trinidad, indicated that because of a financial crisis at the UWI, a position may not be available for Miss Hinds upon receipt of her Ph.D. and return to Trinidad. The death of Dr. G. Sammy, Food Scientist, and Miss Hinds' mentor, has left a void at UWI. Possibly, Peanut CRSP and/or CARDI could fund a temporary position at UWI for Miss Hinds. A mentor would then be identified to guide Miss Hinds in the development of her research program and career. However, if UWI Administrators restore the position, which seems unlikely, they would prefer to hire an experienced food scientist. Comments indicated that it would be in Miss Hinds' interest to gain expertise and experience in a postdoctoral position. Dr. B. Singh, Miss Hinds' present graduate advisor at AAMU, was suggested as a possible mentor. Possibly, Peanut CRSP could continue to support Miss Hinds in a postdoctoral position for two years in food science at AAMU. Ongoing collaborative research could be strengthened with CARDI to implement the maturity indices research for the Caribbean farmers.

4.12. EXTERNAL EVALUATION PANEL REVIEW

Peanut CRSP Code: **AAM/FT/SU**

Project Title: **An Interdisciplinary Approach to Optimum Food Utility of the Peanut in SAT Africa (Sudan)**

Principal Investigators and Collaborating Institutions: Dr. Bharat Singh, Alabama A&M University (AAMU); Drs. H. M. Ishag, and B. Bashir, Agricultural Research Corporation/Food Research Center (ARC/FRC), Sudan.

Research objectives of this project were designed to determine variations in environment, socioeconomics and food technologies as they constrain the preservation and utilization of peanut and peanut products in the Sudan, Africa. During 1986/87, political unrest hindered exchange visits and communication among scientists of the Host Country and AAMU. This unfortunate occurrence impacted on the continued progress of the project. Up to this point in time, progress on the objectives was highly satisfactory. The replacement project, AAM/FT/BF - An Interdisciplinary Approach to Optimum Food Utility of the Peanut in SAT Africa (Burkina Faso), has been successfully implemented.

1. **ACHIEVEMENTS.....:** HS

1.1. Six graduate students from SAT African countries were MS- or Ph.D.-degreed at AAMU with Peanut CRSP funding under this project. Two from Sudan received MS degrees, one of which went on for a Ph.D. Two US students also received MS degrees under this program. The PI from Sudan, trained at AAMU. These developments have contributed to the much needed expertise and collaborative efforts in postharvest/utilization research in Sudan and neighboring SAT African countries.

1.2. Data were collected by a survey in Sudan to determine variations in environment, socioeconomics and food technologies as they affect the preservation and utilization of peanut and peanut products in Sudan. These observations clearly showed that peanut utilization could be considerably increased if efforts were made to expand utilization of peanut into more refined/processed ingredients; to improve packaging for increased shelf-life; to utilize peanut meal from oil extraction mills as protein ingredients for cereal-based foods; and to improve methods of storage, post-harvest handling and inventory management.

1.3. A sorghum-based 'Kishra' product fortified with up to 30% partially-defatted high protein peanut flour (made from peanut meal obtained after oil extraction) was successfully prepared in Sudan and at AAMU and found acceptable in taste

panel studies. This research included a collaborative study between scientist of Peanut CRSP and Sorghum/Millet CRSP in SAT African countries. The research results were also considered useful in determining the application of peanut flour in a number of sorghum-based foods of Burkina Faso, Mali, Niger and Senegal.

1.4. 'Mish,' a dairy-based, spiced yogurt-like food, was prepared at AAMU from peanut milk. Taste panel studies showed that the product had consistency, flavor, and texture similar to that traditionally made from whole milk. Efforts are underway to transfer this technology to SAT African countries.

1.5. An effective, rapid means of milling roasted peanut into a uniformly spreadable paste was obtained with a newly developed, inexpensive, durable hand-cranked plate-type attrition mill at AAMU. In Sudan, efforts are underway to educate Sudanese women in the use of this mill to replace the presently-used hand stone-slab, or mortar-pestle-like grinding method. In concert with this development, improved storage procedures for pastes to reduce off-flavor formation due to lipid oxidation were developed.

1.6. Studies at AAMU and ARC/FRC, Sudan, showed that hot-water or steam blanching of peanut prior to roasting and salting, increased storability in polyethylene bags and especially glass jars, as evidenced by peroxide value, free fatty acid value and sensory analysis. Proximate composition of water and steam blanched peanut was minimally changed, showing little loss in nutrients.

2. SUMMARY COMMENTS

2.1. A committed administrative and researcher involvement was evident by AAMU and Sudan faculty/researchers. This included a positive attitude, support and perceived relevancy to the institution, fiscal/logistical assistance, and resource commitment.

2.2. Progressive and innovative science/research by Sudan and AAMU scientists contributed to the excellent progress made to increase peanut applicability at affordable costs in peanut-based processed foods. This included protein ingredients, e.g., flour, peanut butter, packaged paste and roasted products, peanut milk, candies and other confectionaries. Because of the excellent work of AAMU researchers, this project contributed to institutional development and strong research involvement, with equipment, materials, literature, and most importantly, by exchanges of scientific information to the Food Research Center, Khartoum, Sudan.

2.3. Peanut CRSP research in Sudan to determine the degree of aflatoxin contamination in peanut, has led to the awareness of and the need to monitor and control these antinutrients in the food supply for the Sudanese population. Researchers at ARC/FRC are working with farmers, traders, village women/entrepreneurs and food processors in techniques to control and eliminate aspergilli infestations.

3. CONCLUSIONS

3.1. Although Peanut CRSP was unfortunately terminated in Sudan, the quick action of the AAMU PI, B. Singh, and the enthusiastic response and capabilities of scientists at the University of Ouagadougou, Burkina Faso, have resulted in minimum interruption to the progress of postharvest/utilization in SAT Africa.

5. PEANUT CRSP MANAGEMENT ENTITY REVIEW

5.1. Background

The University of Georgia (UGA) is the Management Entity (ME) for the Peanut CRSP and receives funds from USAID. Georgia then subgrants to Alabama A & M University, University of Georgia, North Carolina State University and Texas A & M University. A principal investigator within these Universities plans and budgets the individual projects in collaboration with the host countries. A Board of Directors, Technical Committee and USAID personnel advise and guide the ME.

The UGA ME office is located in the College of Agriculture at the Georgia Experiment Station, Griffin, Georgia. The major role is the responsibility for technical and administrative matters for the Peanut CRSP. Duties include negotiating agreements, fiscal management, progress reports and project modification. The ME staff financed by Peanut CRSP is comprised of: Dr. David G. Cummins, Program Director, Mrs. Barbara Donehoo, Administrative Sectretary and Mrs. Michelle S. Dillard, Accounting Assistant. Supportive management staff (non CRSP financed): Mr. Ted Proffer, Business Manager, University of Georgia, College of Agriculture and Dr. Darl Snyder, Director of International Development and Title XII Representative, University of Georgia, Athens.

5.2. Procedures followed

For the ME review the External Evaluation Panel (EEP) visited administrators and fiscal officers at Athens and Griffin, Georgia on February 21-22, 1989 (see itinerary, Appendix I). To a certain extent the EEP reviewed the ME in all our visits with administrators and PI's at both U.S. and host countries in early 1989.

5.3. At Athens, Georgia excellent discussions were held with Mr. Ted Proffer, Business Manager, College of Agriculture and Dr. Alan Barber, Vice President for Finances of the University. Each expressed great interest in Peanut CRSP and gave insights as to how USAID funds flow through UGA to the U.S. Universities and host institutions in other countries.

The fiscal organization of Peanut CRSP appears to run smoothly. USAID funds come to the Georgia Research Foundation Inc. which in turn grants them to the UGA as ME. The ME then makes grants to UGA and to the three other U.S. Universities involved with Peanut CRSP. Bills are received on at least a quarterly basis from the institutions. Mr. Proffer and an assistant Ms. Gina Fain (has assisted Peanut CRSP since 1982, although CRSP has paid the salary of Ms. Dillard since July 1, 1985 to compensate for the work load in the business office) interacts through the ME office with USAID and the appropriate University business offices

to make certain that grant requirements are met. While the Program Director Dr. Cummins is responsible for the total CRSP program, Mr. Proffer reviews and facilitates the fiscal aspects. We sensed an empathy and willingness to meet fiscal challenges on the part of Mr. Proffer. This individual routinely participates in Peanut CRSP Board meetings and attended the USAID Financial Management Seminar for Contract Officers in Washington, D.C. in 1988.

5.4. The following comments were made by Dr. S. E. Younts, Vice President for Services, University of Georgia, when quizzed by the EEP on his impressions of Peanut CRSP and what the program had meant to Georgia.

5.4.1. The University of Georgia was pleased to serve as the Management Entity for Peanut CRSP.

5.4.2. Peanut CRSP has promoted a world wide network for peanut research.

5.4.3. Germplasm has been identified with specific characteristics such as insect or disease tolerance and new cultivars are in the pipeline for both U.S. and host country farmers.

5.4.4. Peanut CRSP has encouraged interdisciplinary cooperation across departments and colleges to solve peanut constraints.

5.4.5. The vision of participating agricultural scientists had expanded from one of provincialism to world challenges, with a broader perspective of the biological, physical and socio-economic constraints to world food production. This in turn has led to improved teaching and advising students, and more meaningful research.

5.4.6. Since 40 percent of the U.S. peanut crop is grown in Georgia, their scientists and growers must be aware of and have a better understanding of the world factors affecting peanut production and useage. Peanut CRSP has aided this.

5.4.7. Peanut CRSP has given the University of Georgia visibility in foreign countries and the number of foreign graduate students has increased significantly.

5.4.8. Peanut CRSP funds for specific research projects have sometimes served as "seedfunds" to attract other donor funds and Post Doctoral researchers to Georgia.

Note: These administrative comments by Dr. Younts are included as part of the Management Entity Review because of Georgia's serving as the "home institute". An aside would be that administrators of all participating U.S. institutions made almost

identical comments to the EEP; and perhaps for our benefit, noted that Peanut CRSP seemed to have operated more smoothly than other CRSPs.

5.5. The EEP interviewed both Dr. W. P. Flatt, Dean, and Dr. Charles Laughlin, Associate Director, for Research (substituting for Director Cleve Donoho), of the Georgia Experiment Station while at Athens. Peanut CRSP answers to these two offices administratively. Both individuals were enthusiastic in their support of, and pleased with the efficient management of the program by Dr. David Cummins.

5.6. At Griffin Georgia, the Peanut CRSP headquarters, the following observations were gleaned from discussions with Dr. Gerald Arkin, Director of the Griffin Experiment Station.

5.6.1. Working relations have been excellent with Peanut CRSP. Dr. David Cummins, Program Director, continues to hold a Station or University appointment, but responsibilities and salary comes from CRSP.

5.6.2. Research projects of the Bean/Cowpea CRSP as well as Peanut CRSP are conducted in the Food Science Department at Griffin. Both are positive assets to the station in Director Arkin's view. Staff scientists travel and become familiar with international agriculture and establish friendships with foreign scientists. In turn, visiting scientist, Post Doctoral, and graduate student numbers are increasing. Griffin now has a total of 30 graduate students, with 20 being foreign.

5.7. The EEP sensed the greatest respect for, and collaboration with, Dr. David Cummins, Program Director on the part of all Peanut CRSP personnel. This individual was involved in the Peanut CRSP Planning Report submitted to JRC of BIFAD and USAID in November 1981 and has been Program Director since the beginning of the program, with the exception of a two-year assignment with USAID in the Philippines, 1986-1988.

In fact one of the strengths of Peanut CRSP has been the relatively low turn over of Management personnel, members of the Board, TC and US and host country participating scientists. To a considerable degree, this has been due to the quiet, efficient administrative abilities of Dr. Cummins. Peanut CRSP has always been a "bottoms up" research planning operation rather than "top down". Warm personal relationships and high <u>esprit de corps</u> exists at all levels of Peanut CRSP which we again attribute to the somewhat democratic style of management promoted by Dr. Cummins. U.S. University administrators often made the point to the EEP that Peanut CRSP was operating as a model of efficiency and throughout its life had generated fewer problems necessitating their attention than other CRSP programs which the University was involved.

5.8. Another reason for the efficiency of the Management Entity office at Griffin, Georgia lies in the effective, helpful, and friendly manner in which Mrs. Barbara Donehoo, the Administrative Secretary, serves the program. Her deep knowledge, work habits and intense interest keeps the myriad of paper work flowing smoothly. The EEP was pleased to learn that the Board has authorized the purchase of a computer to facilitate her many duties and that she is already enrolled in a computer course, "to talk to the dern thing".

5.9. The EEP gained the impression from Dr. Tommy Nakayama, Program Director 1986-1988, that the ME of Peanut CRSP consisted of fewer persons and used a smaller proportion of the total budget than other CRSP programs.

5.10. We observed that the Board of Directors and Technical Committee took their policy setting responsibilities seriously and that the latter was active in reviewing annual work plans and budgets and recommending allocation of funds. Such management recommendations and decisions were particularly difficult following an 18% reduction in the 1986 budget year and an additional reduction of 13.5% in the 1987 budget year.

5.11. Peanut CRSP liaison with AID is on a continuing basis. From its earliest days Dr. Loren Schulze, Science and Technology/Agriculture, USAID/Washington has been the Peanut CRSP Project Manager. Dr. Schulze works very close in an advisory role to the Management Entity, attends the Board of Director and Technical Committee meetings and facilitates coordination with Mission programs in host countries in securing travel approvals and clearance for equipment purchases. In phone calls and meetings we observed Dr. Schulze to be an experienced, deeply committed, and valuable asset to Peanut CRSP.

5.12. The BIFAID liaison to this CRSP is Mr. William F. Johnson. He participated in the original planning sessions, annual Board meetings and two USAID reviews of the Management Entity. His counsel has been valuable.

5.13. The efforts of the Program Director in establishing linkages with other International Centers and donors interested in peanut improvement is noteworthy, see appendix V for linkage institutions. Perhaps the most significant is the complementarity of research maintained between ICRISAT and Peanut CRSP. We recommend that the ME continues to promote and sponsor the <u>International Arachis</u> (Groundnut) <u>Newsletter</u> with ICRISAT and conferences or workshops on peanut within countries, regions or worldwide with other interested parties. Attendance of the Program Director at the CGIAR Centers Week and specific conferences relating to peanut improvement should continue.

5.14. We sense that the ME of Peanut CRSP has been reticent to advertise accomplishments, preferring to prepare excellent Annual Reports which receive limited distribution (about 450). We believe a more informative and popular publication on the many noteworthy accomplishments of the program should now be considered as well as brief articles in other media.

5.15. An analysis of the funding of Peanut CRSP research projects by function (by Dr. Tommy Nakayama in February 1988) indicated that 82% supported production projects while 18% went for utilization research. This is approximately the same ratio existing in U.S. Agricultural Experiment Stations. Production research is still the greatest need in the host countries.

5.16. The EEP was sympathetic to the pleas for additional funds from many of the researchers. When the overhead is taken out, and the remainder sometime split between three institutions the researcher at the end of the line has very little to work with and at a time, when research costs are increasing sharply. However, we do not recommend accomplishing this by reducing allocations to the better funded projects, but by requesting and justifying additional funds in the extension.

Two other concerns were expressed by certain researchers regarding fiscal matters. First, the age old misunderstanding and unhappiness with increasing "overhead" charges and, secondly the funding gaps which sometimes occurred. We suspect the latter result from different fiscal years, late arrival of USAID funds, or delayed submission of expenditures and lengthly processing time. An example of the latter are vouchers received from countries in former French West Africa, which must pass through a translation prior to the usual budget channel. The ME is aware of these irritations and working diligently to correct the misunderstandings through education to expedite the flow of funds. We noted that when traveling to host countries that U.S. PIs or the Program Director often hand carry Peanut CRSP checks to make certain the proper individual receives the check and in a timely manner.

5.17. The EEP reviewed audit reports for Thailand and Senegal provided by the ME which were the host country project "samples" selected in 1987 and 1988 and conducted by private auditing firms, Ernst and Whitney and Price Waterhouse, respectively. The Thailand audit found for the items tested that the CRSP complied with the material terms and conditions of the subgrant with some exceptions. After careful review of the exceptions, we conclude that they are minor and primarily of a bookkeeping nature. In the Senegal audit report we encountered questions on financial transactions (timeliness of funds arriving, proofs of expenditures, etc.) such as to suggest that increased attention should be given by the host institution, the ME, and PI's to solve such problems as were perceived.

APPENDIX

APPENDIX I

Itinerary for External Evaluation Panel visits: Participants, dates, institutions visited, purpose of visit, and individuals contacted.

1. University of Georgia, Georgia Station, Griffin (Experiment), Georgia.

Participants: Dr. John W. Pendleton, Dr. John P. Cherry, Dr. Ray O. Hammons and Dr. Allan J. Norden, EEP; Dr. Dudley Smith, Dr. B. Onuma Okezie, Dr. Louis J. Boyd, Dr. Olin Smith, Dr. Johnny Wynne, Dr. Bharat Singh, Dr. Manjeet Chinnan, Dr. Darl Snyder, Dr. Loren Schulze, Dr. David G. Cummins and Barbara Donehoo.

January 30-31, 1989.

Purpose: Develop guidelines for Triennial Review, prepare review forms, and organize a tentative schedule for U.S. and overseas site visits.

2. Alabama A&M University (AAMU), Normal, AL, February 14-15, 1989.

Participants: Dr. John W. Pendleton and Dr. John P. Cherry, EEP; Dr. David Cummins, Program Director.

February 14, 1989

2.1. Unit: Administration

Purpose: Evaluation of the upper level administration views on the Peanut CRSP and international involvement in general.

Contacts: Dr. C. H. Marbury, President; Dr. Walter Austin, Provost; Dr. J. T. Gibson, Vice-President Administration; Dr. Oscar Montgomery, Director, Contracts and Grants; Dr. J. W. Shuford, Dean, School of Agriculture; Dr. B. O. Okezie, Special Assistant to the President and Director, International Programs.

2.2. Unit: Department of Food Science and Animal Industries

Purpose: Review of Peanut CRSP projects AAM/FT/BF and AAM/FT/CAR.

Contacts: Dr. Bharat Singh, PI, Food Scientist; Dr. John C. Anderson, Co-PI, Food Engineer; Dr. D. R. Rao, Co-PI, Nutritionist; Dr. Gerald C. Wheelock, Cooperator, Rural Sociologist, Department of Agribusiness Education.

3. University of Georgia, Athens (main campus), Georgia Station, Griffin (Experiment), and Coastal Plain Station, Tifton.

3.1. Unit: College of Agriculture, Georgia Agricultural Experiment Station, Coastal Plain Station, Tifton, GA.

Participants: Dr. Allan J. Norden and Dr. Ray O. Hammons, EEP. Date: February 20, 1989 (Followup visit on February 28 by Dr. Hammons).

Purpose: Review of GA/IM/BF project.

Contacts: Dr. Gale A. Buchanan, Resident Director; Dr. Max Bass, Head Department of Entomology; Dr. Robert E. Lynch, PI Research Entomologist; Dr. David Wilson, Pathologist, State Mycotoxin Research Laboratory.

3.2. Unit: Administration, University of Georgia, Athens.

Participants: Dr. J. W. Pendleton, Dr. John P. Cherry, Dr. Allan J. Norden, and Dr. Ray O. Hammons, EEP; Dr. David G. Cummins, Program Director.

Date: February 20-21, 1989.

Purpose: Discuss administration views on the University as the Peanut CRSP Management Entity and as a research participant.

Contacts: Dr. S. Eugene Younts, Vice-President for Services (includes International Programs); Dr. Allan Barber, Vice-President for Business and Finance; Dr. Murray Moriarity, Assistant Vice-President for Research and Assistant Director, Research Foundation, Inc.; Dr. Darl Snyder, Director, International Development; Dr. W. P. Flatt, Dean, College of Agriculture; Dr. Charles Laughlin, Associate Director, Georgia Agricultural Experiment Stations; Mr. Ted Proffer, Business Manager, College of Agriculture.

3.3. Unit: College of Agriculture, Department of Plant Pathology, Athens Campus.

Participants: Same as 3.2

Date: February 21, 1989.

Purpose: Review of GA/PV/N,TP

Contact: Dr. Cedric Kuhn, Co-PI, Virologist; Miss Araceli Pua, Virology Graduate Student from the University of the Philippines, Los Banos.

3.4. Unit: College of Agriculture, Georgia Agricultural Experiment Stations, Georgia Station, Griffin (Experiment).

Participants: Same as in 3.2.

Date: February 22, 1989.

3.4.1. Department of Food Science and Technology.

3.4.1.1. Purpose: Review of GA/FT/TP project.
Contacts: Dr. Anna V. A. Resurreccion, Co-PI, Food Scientist; Dr. Robert E. Brackett, Co-PI, Food Scientist; Dr. Robert Rauniker, Cooperator, Agricultural Economist; (Dr. Larry Beuchat, PI, was on study leave in Australia).

3.4.1.2. Purpose: Review of GA/PH/CAR project.

Contacts: Dr. Manjeet Chinnan, PI, Food Engineer; Mr. Tal Oz-Ari, Project Assistant, Research Agricultural Engineer; Dr. Brahm P. Verma, Cooperator, Head, Department of Agricultural Engineering.

3.4.1.3. Purpose: General.

Contacts: Dr. Tommy Nakayama, Department Head, for general views of GA/FT/TP and GA/PH/CAR, and as Peanut CRSP Program Director, 1986-88; Mrs. Kay McWatters, PI and Former Chairman Technical Committee, Bean/Cowpea CRSP for overview of that CRSP.

3.4.2. Department of Plant Pathology

Participants: Same as in 3.2

Date: February 22, 1989

Purpose: Review of GA/PV/N,TP (see also 2.3 which is part of same project).

Contacts: Dr. James W. Demski, PI, Virologist.

3.4.3. Directors Office

Particpants: Same as in 3.2.

Date: February 22, 1989.

Purpose: Views on researcher participation in CRSP.

Contact: Dr. Gerald F. Arkin, Resident Director.

3.4.4. Management Entity.

Participants: Same as in 3.2

Date: February 22, 1989

Purpose: Review ME participation in the Peanut CRSP.

Contacts: Dr. David G. Cummins, Program Director; Mrs. Barbara H. Donehoo, Administrative Secretary.

Note: ME administratively responsible to Dr. Clive Donoho, Director, Georgia Agricultural Experiment Stations, who was out of town during review; see 3.2.

4. North Carolina State University, Raleigh, NC, February 23-24, 1989.

Participants: Dr. John W. Pendleton, Dr. Allan J. Norden, Dr. Ray O. Hammons, EEP; Dr. David G. Cummins, Program Director.

4.1. Unit: Administration

Purpose: Evaluation of upper level administration views on Peanut CRSP and international involvement in general.

Contacts: Dr. Durwood Batemen, Dean College of Agriculture and Life Sciences; Dr. R. J. Kuhr, Director, North Carolina Agriculture Research Service; Dr. H. D. Gross, Director International Programs and Member of Peanut CRSP Board of Directors; Dr. Johnny C. Wynne, Head Crop Science Department, Designee; [Note: Plant Pathology Department Head unavailable due to illness; Entomology Department Head newly appointed and not yet on campus, but former Head Dr. Kuhr discussed that discipline; Dr. Billy E. Caldwell, Assistant Director of Extension and Former Crop Science Department Head and CRSP Board member was absent due to snow].

4.2. Unit: Department of Crop Science

Purpose: Review of NCS/BCP/TP project.

Contacts: Dr. J. C. Wynne, PI, Peanut Geneticist/Breeder; Dr. H. T. Stalker, Co-PI, Cytogeneticist; Mr. W. F. Anderson, Ph.D. Graduate Student; Mr. M. S. Fitzner, Ph.D. Graduate Student; Ms. Uta Grieshammer, Biochemical Genetics, Ph.D. Graduate Student.

4.3. Unit: Department of Plant Pathology

Purpose: Review of NCS/BCP/TP project.

Contact: Dr. Marvin K. Beute, Co-PI, Plant Pathologist.

4.4. Unit: Department of Entomology

Purpose: Review of NCS/IM/TP project.

Contact: Dr. W. V. Campbell, PI, Entomologist (also cooperator on NCS/BCP/TP.

4.5. Department of Microbiology

Purpose: Review of NCS/SM/TP project.

Contact: Dr. G. H. Elkan, PI, Microbiologist (also cooperator on NCS/BCP/TP).

5. Texas A&M University, College Station, TX, March 30-31, 1989.

Participants: Dr. John W. Pendleton, Dr. Allan J. Norden, Dr. Ray O. Hammons.

5.1. Unit: Administration

Purpose: Evaluation of upper level administration views on Peanut CRSP and international involvement in general.

Contacts: Dr. Neville P. Clarke, Director, Texas Agricultural Experiment Stations; Dr. Dudley T. Smith, Associate Director, Texas Agricultural Experiment Stations and member Peanut CRSP Board of Directors; Dr. E. C. A. Runge, Head, Department of Soil and Crop Sciences; Dr. J. Artie Browning, Head, Department of Plant Pathology and Microbiology; Dr. Norman D. Heidelbaugh, Head, Department of Veterinary Public Health.

5.2. Unit: Department of Soil and Crop Sciences.

Purpose: Review of TX/BCP/S,N,BF

Contacts: Dr. Olin D. Smith, PI, Peanut Breeder/Geneticist; Dr. Charles E. Simpson, Co-PI, Breeder/Geneticist (TAMU Research and Extension Center, Stephenville); Dr. D. H. Smith, Co-PI, Plant Pathologist (TAMU Plant Disease Research Station, Yoakum); Dr. A. M. Schubert, Co-PI, Plant Physiologist (TAMU Plant Disease Research Station, Yoakum); Dr. Gregory B. Parker, Research Associate, Dept. S & CS, TAMU, College Station; Mr. Amadou Mounkaila, Collaborator, Niger.

5.3. Unit: Department of Plant Pathology and Microbiology.

Purpose: Review of TX/MM/S project.

Contacts: Dr. Robert E. Pettit, PI, Plant Pathologist (also cooperator on TX/BCP); Dr. J. C. Reyes, Cooperator, Prairie View

A&M University.

Purpose: Review of TX/SM/TP

Contacts: Mrs. Ruth Ann Taber, PI, Mycologist (also Co-PI on TX/MM/S and cooperator on TX/BCP); Ms. Suzanne Segner, CRSP Lab coordinator; Mr. Stephen Neck, Ph.D. candidate, Mr. Randy Garber, Ph.D. candidate; Dr. R. D. Waniska, Biochemist, Phenolic analyses; Mr. J. E. Fajardo, Ph.D. candidate (from Philippines).

5.4. Department of Veterinary Public Health.

Purpose: Review of TX/MM/S

Contacts: Dr. Timothy D. Phillips, Co-PI, Mycotoxicologist; Mr. Bashir Sarr, Ph.D. candidate from Senegal; Mr. Ernest Smith, Ph.D. candidate from Jamaica; Dr. J. B. Szerszen, Post-doctoral Research Associate.

6. Southeast Asia

Philippines and Thailand External Evaluation Panel (EEP) visit, March 9-22, 1989.

Participants: Dr. John W. Pendleton, Dr. John P. Cherry, Dr. Ray O. Hammons, and Dr. Allan J. Norden, EEP; Dr. David G. Cummins, Program Director.

6.1. Philippines

March 11, 1989

6.1.1. Institution: International Rice Research Institute, Los Banos.

Purpose: To discuss cropping systems research, role of peanut, and IRRI support to "peanut in cropping systems" research for Southeast Asia.

Contacts: Dr. Mano D. Pathak, Director, Research and Training; Mr. M. Arraudeau, Upland Rice Breeder; and Dr. Ram K. Pandy, Farming Systems Agronomist; Dr. T. T. Chang, Germplasm Specialist; Dr. Ramesh Saxena, Neem Specialist.

March 13, 1989

6.1.2. Institution: Philippine Council for Agriculture, Forestry, and Natural Resources Research and Development.

Purpose: For overview of Peanut CRSP program as it relates to Philippine Research and Development. PCARRD coordinates Peanut CRSP activities.

Contacts: Dr. Ramon Valmayor, Executive Director; Dr. Dely Gapasin, Deputy Executive Director for Research; Dr. Crisanto Escano, Director Crops Research Department; Ms. Betty Umali, CRSP Coordinator Crops Research Department with direction from Dr. Escano; Dr. Ricardo Lantican, previous PI for NCS/BCP/TP and CRSP Coordinator; currently Undersecretary of the Department of Science and Technology.

6.1.3. Institution: University of the Philippines, Los Banos (UPLB), Department of Food Science and Technology.

Purpose: Review GA/FT/TP project.

Contacts: Mr. Ricardo R. del Rosario, Co-PI, Food Scientist; Dr. Reynaldo C. Mabesa, Co-PI, Food Microbiologist; (Dr. Virgilio V. Garcia, PI on short-term study leave in Japan); Ms. Pia Real, Graduate Student.

March 14, 1989

6.1.4. Institution: Institute of Plant Breeding (IPB), University of Philippines at Los Banos.

Purpose: Review of NCS/BCP/TP project.

Contacts: Dr. Evelyn Mae Mendoza, Acting Director; Dr. Remedios Abilay, PI, Breeder; Dr. Candida Adalla, Co-PI, Entomologist; Dr. Marina Natural, Co-PI, Pathologist; Dr. Randy Hautea, Co-PI, Breeder; Dr. H. P. Samonte, Co-PI, Soil Scientist; Mr. Billy E. Temanel, Cooperator, Quirino State College.

6.1.5. Institution: UPLB, Department of Entomology

Purpose: Review of NCS/IM/TP project.

Contacts: Dr. Virginia Ocampo, PI, Entomologist; Mr. Dante Santiago, Cooperator (Biological control of insects with Bacillus thuringiensis); Mr. Valeriana Justo, Cooperator, (National Crop Protection Center, Biological control with Tricogramma).

6.1.6. Institution: UPLB, Department of Pathology and IPB.

Purpose: Review of GA/PV/N,P,T project.

Contacts: Dr. Marina Natural, PI; Dr. Teresita Espino, Cooperator, Biotechnology Institute (antisera production).

March 15, 1989

6.1.7. Institution: Biotechnology Institute

Purpose: Brief review of NCS/SM/TP and TX/SM/TP projects.

Contacts: Dr. Erlinda Paterno, UPLB/Department of Soils, PI; Dr. Lina Ilag, UPLB/Department of Pathology, PI. Dr. Rey de la Cruz, UPLB/College of Forestry, Mycorrhizal research (all co-staffed with Biotechnology Institute).

March 16, 1989

6.1.8. Institution: U.S. Agency for International Development, Manila.

Purpose: Discuss Mission views on Peanut CRSP.
Contacts: Dr. Ken Prussner, Chief, Office of Agriculture and Rural Development; Mr. Robert Resseguie, Chief, Agricultural Development Division.

Travel to Bangkok, Thailand

6.2. Thailand

March 17, 1989

6.2.1. Institution: Kasetsart University Campus, Bangkok, for project overviews including Department of Agriculture (DOA) Bangkok and Khon Kaen, Khon Kaen University (KKU) and Kasetsart University (KU).

Purpose: Review of NCS/BCP/TP and NCS/IM/TP projects.

Contacts: General: Bangkok - Dr. Vichitr Benjasil, Director of Field Crops Research Institute (FCRI), DOA, Peanut CRSP coordinator for Thailand; Dr. Arwooth Nalampang, Senior Advisor for Crops Research, DOA; Mr. Nark Potan, Assistant Director, FCRI.

Contacts: NCS/BCP/TP: Dr. Aran Patanothai, Breeder KKU; Dr. Thammasak Sommartaya, Pathologist, KU; Mr. Preecha Surin, Pathologist, DOA

Contacts: NCS/IM/TP: Dr. Sopone Sirisingh, Entomologist, DOA, Bangkok; Dr. Turnjit Satayavirut, Entomologist, DOA, Bangkok; Dr. Manochai Keerati-Kasikorn, Entomologist, KKU; Dr. Montri, Director DOA Department of Entomology was met during tour of facilities.

6.2.2. Institution: DOA, Bangkok, Rhizobium Research Building.

Purpose: Brief review of NCS/SM/TP and TX/SM/TP projects.

Contacts: Dr. Nantakorn Boonkerd, Soil Microbiologist; Mrs. Yenchai Vasuvat, Program Leader.

6.2.3. Institution: CIMMYT, Bangkok (International Center for Maize and Wheat Research)

Purpose: Views on agricultural development in Thailand.

Contacts: Dr. Carlos de Leon, Maize Breeder; Dr. Gonzalo Granados, Maize Breeder; Dr. Michael D. Read, Agronomist.

March 18 open and March 19 Travel to Khon Kaen.

March 20,1989

6.2.4. Institution: Northeast Regional Research Center, Tha Pra (near Khon Kaen).

Purpose: Visit field plots related to CRSP breeding and insect management projects.

Contacts: Mrs. Somjintana Toomsan, DOA, Breeder; Mr. Surapong Charoenrath, DOA, Breeding graduate student at NCSU; Dr. Sathorn, Entomologist, DOA, Bangkok, Dr. Turnjit Satayvirut, Entomologist, DOA, Bangkok; Dr. Manochai: Keerati-Kasikorn, Entomologist, KKU; Mr. Anon Watayanont, Agronomist, DOA.

6.2.5. Institution: Khon Kaen University

Purpose: Visit laboratories and field plots.

Contacts: Dr. Aran Patanothai, Breeder KKU; Dr. Sanon Jogloy, Breeder, KKU; Dr. Banyong Toomsan, Soil Microbiologist/Rhizobia, KKU; Dr. Winit Chinsuwan, Agricultural Engineer, KKU (pre- and postharvest equipment development for small farmer under IDRC grant), [Dr. Sopone Wongkaew, Virologist in France for research/study, but observed the virus research plots].

6.2.6. Institution: DOA Research Station, KKU, Khon Kaen.

Purpose: Visit to field area.

Contacts: Staff interaction at Tha Pra Station.

Travel from Khon Kaen to Bangkok in evening of March 20.

March 21, 1989

6.2.7. Institution: Department of Product Development, Faculty

of Agro-Industry, Kasetsart University, Bangkok.

Purpose: Review of GA/FT/TP project.

Contacts: Dr. Penkwan Chompreeda, PI, Food Scientist; Dr. Chintana Oupadissakoon, Co-PI, Food Scientist; Mr. Vichai Haruthaithanasan, Co-PI, Food Scientist; Mr. Vitoon Prinyawiwatkul, Technician; Mr. Anuwat Changchat, M.S. Graduate Student; Ms. Kamolwan, M.S. Graduate Student; Ms. Woranuch Suvanich, M.S. Graduate Student; Ms. Yuwadee Wongwithoonwid, M.S. Graduate Student; Ms. Rattikorn Saokum, M. S. Graduate Student.

March 22, 1989

6.2.8. Institution: USAID, Bangkok.

Purpose: Discuss Mission views on Peanut CRSP.
Contacts: Mr. Doug Clark, Ag Development Officer; Mr. Dave Delgado, Project Officer.

Departed Bangkok March 22 for return to the United States.

7. West Africa - Senegal, Burkina Faso, and Niger.

External Evaluation Panel (EEP) visit, April 8-18, 1989.
Participants:

Senegal - Dr. John W. Pendleton, Dr. Allan J. Norden, and Dr. Robert E. Pettit, PI for Mycotoxin Management Project, Texas A&M University.

Burkina Faso - Dr. John P. Cherry, Dr. Ray O. Hammons, and Dr. David G. Cummins, Program Director.

Niger - Drs. Pendleton, Norden, Cherry, Hammons, and Cummins.

April 8-9 enroute to Senegal and April 10-11 enroute to Burkina Faso.

7.1. France

Enroute to West Africa the EEP visited with Dr. Pierre Gillier, Peanut Expert and retired Head of Peanut Investigations, IRHO, Paris. (Member previous EEP)

Participants:

April 10- Drs. Allan J. Norden, John W. Pendleton, and Robert E. Pettit.
April 11 - Drs. Ray O. Hammons, John P. Cherry, and David G. Cummins, Program Director.

Purpose: Discuss Peanut CRSP projects in Senegal, Burkina Faso, and Niger and IRHO/ORSTOM/CIRAD linkages in West Africa.

7.2. Senegal

April 10, 1989

7.2.1. Institution: USAID/Dakar, Senegal

Purpose: Discuss Mission views on Peanut CRSP.

Contacts: Mr. Wayne Nilsestuen, Agricultural Development Officer; Mr. Doral Watts, Project Officer.

7.2.2. Institution: Senegalese Institute for Agricultural Research (ISRA), Dakar.

Purpose: Discuss CRSP activities with ISRA administration.

Contacts: Dr. Mahamadou Ly, Director General; Dr. Limamoulaye Cisse, Director, Department of Vegetable Production.

April 11, 1989

7.2.3. Institution: ISRA Research Station, Bambey.

Purpose: Review of TX/BCP/S,BF,N project.
Contacts: Mr. J. C. Mortreuil, PI, Breeder; Mr. Daniel Annerose, Cooperator, Physiologist; Mr. Jean L. Khalfoui, Cooperator, Breeder.

April 12, 1989

7.2.4. Institution: ISRA Research Station, Kaolak.

Purpose: Review ISRA component of TX/MM/S project.

Contacts: Dr. Amadou Ba, PI, Pathologist/Mycotoxins and Station Director.

7.2.5. Institution: ISRA Research Station, Nioro.

Purpose: Review newly developing breeding effort linked to Bambey.

Contacts: Mr. Ousmane Ndoye, Breeder (recent M.S. graduate from Texas A&M University).

April 13, 1989

7.2.6. Institution: Institute of Food Technology (ITA), Dakar.

Purpose: Review ITA component TX/MM/S project.

Contacts: Dr. Ababacon Ndoye, Director General, Dr. Amadou Kane, PI, Research Chemist.

April 14, 1989

7.2.7 Institution: ISRA, Dakar

Purpose: Exit review of visit.

Contacts: Director General Ly; and Dr. L. Cisse, Director, Vegetable Production Department; Mr. Doral Watts, USAID/Program officer and Mr. Wayne Nilsestuen, ADO.

April 15 Travel to Niger (Dr. Pettit returned to the U.S.).

7.3. Burkina Faso

April 12, 1989

7.3.1. Institution: USAID/Ouagadougou, Burkina Faso.

Purpose: Discuss Mission views on Peanut CRSP.

Contacts: Mr. Herbert Miller, Mission Director; Dr. Bonaventure B. Traore, Rural Economist. (Dr. Dennis McCarthy, Ag. Development Officer was out of town).

7.3.2. Institution: INERA (National Agricultural Research Institute).
Purpose: To determine extent of linkages and cooperation with the University research programs.

Contacts: Mr. Celestin Pegda Belem, Director; Dr. Clementine L. Dabrie, Entomologist, and Leader of Program for Annual Oil Crops/Legumes/Grains.

7.3.3. Institution: University of Ouagadougou.

Purpose: Discuss Peanut CRSP activities with administration.

Contacts: Dr. Alain Savadogo, Rector; Dr. Mouhoussine Nacro, Director of International Programs.

7.3.4. Institution: University of Ouagadougou, Institut Superieur Polytechnique (ISP), composed of Institut du Developpment Rural (IDR) and Institut du Scientific Natural (ISN).

Purpose: Review of CRSP activities in university structure.

Contact: Dr. Alfred S. Traore, Director (Biochemist/Food Scientist).

7.3.5. Institution: University of Ouagadougou, Biochemistry/Food Technology Department.

Purpose: Review of AAM/FT/BF project.

Contacts: Prof. Alfred S. Traore, PI, Biochemist/Food Scientist; Mr. Philippe Nikema, potential candidate for Ph.D. training at AAMU.

April 13, 1989

7.3.6. Institution: University of Ouagadougou, ISP, Entomology, Pathology/Agronomy programs.

Purpose: Visit Gampela Research Station and Review GA/IM/BF and TX/BCP/S,BF,N projects.

Contacts: Mr. J. Arsene Solibo Some, Acting PI (GA/IM) project, Entomologist; Dr. Philippe Sankara, PI (TX/BCP) project, Pathologist and Cultivar Selection; Mr. Daouda Thiam, Entomology, 5th year student.

7.3.7. Institution: University of Ouagadougou, ISP, Computer Laboratory.

Purpose: Observe capacity for statistical analyses in research.

Contact: Mr. Begue Dao, Laboratory Director.

April 14, 1989

7.3.8. Institution: Ministry of Agriculture and Nutrition, Agriculture and Stock Farming Section, Nutrition Service (Extension related activities).

Purpose: Discuss cooperative efforts with Peanut CRSP Food Technolcgy project and views on peanut in human nutrition in Burkina Faso.

Contacts: Mr. Francois Tiendrebeogo, Director of Nutrition Service; Mr. Noel Kombasre, in charge of Section for Training and Planning.

7.3.9. Institution: Ministry of Higher and Secondary Education.

Purpose: Discuss research role of University and INERA and

views on Peanut CRSP.
Contacts: Dr. Clemente O. Ouedraogo, Minister (recently succeeded by Dr. Mouhoussine Nacro, University of Ouagadougou, International Programs Director).

7.3.10. Institution: American Embassy

Purpose: Discuss Peanut CRSP activities.

Contact: Ambassador David Shinn.

Depart for Niger.

7.4. Niger

April 15, 1989

7.4.1. Institution: International Crops Research Institute for the Semi-arid Tropics Sahelian Center (ISC).

Purpose: Discuss collaborative efforts between ISC and the Peanut CRSP (at Hotel in Niamey).

Contacts: Dr. Bruno Ndunguru, Agronomist, Peanut Research Team Leader; Dr. David Greenberg, Peanut Breeder; Dr. F. Waliyar, Peanut Plant Pathologist; Dr. J. H. Williams, Peanut Physiologist. Also, visited Dr. Ron W. Gibbons, ISC Director, briefly in the airport upon arrival on April 14; Dr. Bonny R. Ntare, Breeder/Agronomist (cowpea), IITA/ICS brief visit at Hotel in Niamey on April 17.

April 15, 1989

7.4.2. Institution: ISC, Sadore

Purpose: Visit new headquarters facilities and complete discussions on collaboration.

Contacts: Dr. Bruno Ndunguru, Agronomist, Peanut Research Team Leader; Dr. David Greenberg, Peanut Breeder; Dr. F. Waliyar, Peanut Plant Pathologist; Dr. J. H. Williams, Peanut Physiologist.

Dr. David G. Cummins departed for U.S.

April 17, 1989

7.4.3. Institution: USAID/Niamey, Niger.

Purpose: Discuss Mission views on Peanut CRSP.

Contacts: Mr. Kevin Mullally, Deputy Director of Mission; Mr. Flynn Fuller, Project Officer.

7.4.4. Institution: National Institute for Agricultural Research in Niger (INRAN).

Purpose: Discuss administrative views on Peanut CRSP.

Contacts: Mr. Inmarou Moussa, Adjunct Director General. (Mr. Amadou Mounkaila is on short term study leave at Texas A&M; the EEP discussed the research program with him on their visit to Texas A&M in February 1989); Dr. Paul A. Hebert, Chief of Party, Purdue University Projet de Recherche Agricola Appliquee Au Niger (NAARP) (USAID/Winrock).

7.4.5. EEP members Hammons and Cherry met Mr. Beni Prasad Agarwal, Ambassador of India - to West Africa Region, including Niger (resides in Ivory Coast) at airport and hotel, and discussed with him the Peanut CRSP program, goals and objectives.

Four EEP members departed for U.S.

8. Caribbean - Trinidad and Jamaica. External Evaluation Panel (EEP) visit, May 15-19, 1989.

Participants: Dr. John P. Cherry and Dr. Ray O. Hammons, EEP; and Dr. David G. Cummins, Program Director.

8.1. Trinidad

May 16, 1989

8.1.1. Institution: Caribbean Agricultural Research and Development Institute (CARDI). Headquarters on University of the West Indies Campus, St. Augustine, Trinidad.

Purpose: Discuss Peanut CRSP with CARDI administrative staff and GA/PH/CAR project in particular with Co-PI's of Trinidad and Antigua component.

Contacts: Mr. Derrick Dyer, Executive Director; Mr. Ashraf Ali, Deputy Executive Director for Planning and Evaluation; Dr. Sam Parasram, Director for Special Services; Dr. Gordon Muller, Programme Leader, Crops Production, Co-PI for GA/PH/CAR for Trinidad; Mrs. Nerle Robertson, Economist; Dr. Brian Cooper, Systems Agronomist, Co-PI for GA/PH/CAR for Antigua and overall coordinator of the project within CARDI.

8.1.2. Institution: University of the West Indies (UWI), St. Augustine.

Purpose: Discuss impressions on AAM/FT/CAR project and potential employment of Margaret Hinds when she completes Ph.D. cooperatively between UWI and AAMU.

Contacts: Mrs. Shirley Johnson, Business Manager; Mr. Urvan Wilson, M.Sc. graduate student, Mechanical Engineering, thesis problem cooperative with Dr. Muller on a CRSP problem.

Enroute to Jamaica on May 17.

May 17, 1989

8.1.3. Institution: Kingston/USAID

Purpose: Discuss views of Mission on Peanut CRSP in Jamaica.

Contacts: Mr. Richard Owens, Agricultural Development Officer; Mr. Leland Voth, Project Officer.

8.1.4. Institution: CARDI office in Jamaica, Mona Campus, UWI, Kingston.

Purpose: Review of GA/PH/CAR project, Jamaica component.

Contacts: Dr. Janice Reid, CARDI Country Representative for Jamaica; Mrs. Barbara Black, Program Coordinator; Mr. Jocelyn Grant, Co-PI for Jamaica for GA/PH/CAR; Dr. Brian Cooper, overall coordinator of GA/PH/CAR; Mr. D. Carnegie, Technical Assistant; Mr. Morris Taylor, Technical Assistant.

May 18, 1989

8.1.5. Institution: Ministry of Agriculture, Extension Division, St. Elizabeth Parish Office, Santa Cruz.

Purpose: To evaluate technology transfer from Peanut CRSP through extension to farmers and processors.

Contacts: Mr. Marvin Montague, Executive Agricultural Officer; Mrs. Carole Wilson, Extension Specialist for Peanut seconded to CRSP project; Mr. Robert Saunders, Extension Specialist.

May 19 Departed for U.S.

9. Winston Salem, N.C. American Peanut Research and Education Society Annual Meeting.

Participants: Dr. John W. Pendleton, Dr. John P. Cherry, Dr. Ray O. Hammons, Dr. Allan J. Norden, Dr. Dudley T. Smith, Dr. Ron Gibbons, Dr. B. Onuma Okezie, Dr. Louis J. Boyd, Dr. Douglass Gross, Dr. Olin Smith, Dr. Johnny Wynne, Dr. Bharat Singh, Dr.

Manjeet Chinnan, Dr. Robert Schaffert, Dr. Loren Schulze, Mr. William Fred Johnson, Dr. David G. Cummins, and Mrs. Barbara Donehoo.

July 10-11, 1989

Purpose: Discussion of EEP findings with Peanut CRSP Management and Principal Investigators.

APPENDIX II

TRAINING PROVIDED BY THE PEANUT CRSP

TRAINING OF FOREIGN NATIONALS - DEGREE/CRSP COUNTRIES

NAME	COUNTRY	DEGREE	PROJECT	STATUS	THESIS/DISSERTATION
1. Sanon Jogloy (Partial MS Research support; full Ph.D. support)	Thailand	M.S.and Ph.D.	NCS/BCP/TP	Peanut Breeder, Khon Kaen Univ. CRSP cooperator	Inheritance of late leafspot resistance and agronomic traits in peanut. NCSU (Director: J. C. Wynne). 1986. Estimate of gene action on leafspot resistance and agronomic traits in peanut (Arachis hypogaea L.). NCSU (Director J. C. Wynne). 1988.
2. Surapong Charoenrath (Full support)	Thailand	Ph.D.	NCS/BCP/TP	Peanut Breeder, Dept. of Agriculture Khon Kaen CRSP cooperator	Inheritance of early and late leafspot resistance and agronomic traits in Arachis hypogaea L. NCSU. (Director J. C. Wynne). 1989.
3. Victoria Matalog (Full support)	Philip-pines	M.S.	NCS/BCP/TP	Ph.D. candidate/ Clemson, first year.	Effects of shading on the growth and nitrogen fixation of selected peanut cultivars. NCSU. (Director H. D. Gross). 1987.
4. Vermando Aquino (Full support)	Philip-pines	M.S.	NCS/BCP/TP	Plant Pathology/IPB. Now at Univ. of FL for Ph.D., first yr	Biology of peanut stripe virus (PStV) on Arachis hypogaea L. NCSU. (Director M. K. Beute). 1987.
5. Turnjit Satayavirut (Full support)	Thailand	Ph.D.	NCS/IM/TP	Entomology staff CRSP cooperator	Thrips (Frankliniella fusca Hinds) population, damage and yield relationship for peanut types and selected peanut cultivars in North Carolina. NCSU (Director W. V. Campbell). 1988.
6. Surapong Sukhumsuvun (Full support)	Thailand	M.S.	GA/FT/TP	Completed degree. Presently in food industry in Bangkok	Consumer oriented product development of peanuts. 110 pp. UGA. (Director Anna Resurreccion). 1987.

TRAINING OF FOREIGN NATIONALS - DEGREE/CRSP COUNTRIES

NAME	COUNTRY	DEGREE	PROJECT	STATUS	THESIS/DISSERTATION
7. Bernadita Santos (Full support)	Philip-pines	M.S.	GA/FT/TP	Completed degree 1987. Presently Sensory Lab. Coordinator, Univ. of Wisonsin	Development of a peanut-based imitation cheese spread product. 88 pp. UGA. (Director Anna Resurreccion). 1987.
8. Kathleen Muego (0%)	Philip-pines	Ph.D.	GA/FT/TP	2nd year of program	Optimization of processing methods in the production of peanut paste. UGA. (Director Anna Resurreccion).
9. Flor C. Galvez (0%)	Philip-pines	Ph.D.	GA/FT/TP	2nd year of program	Food Products from aqueous extracts of leguminous seeds. UGA. (Director Anna Resurreccion)
10. A. Bashir Sarr (Full support)	Senegal	Ph.D.	TX/MM/S	Now in Ph.D. program 3rd year-permanent staff member/Senegal Degree completion date 8/18/91.	Detection and detoxification of aflatoxin
11. Ousmane N'Doye (Full support)	Senegal	M.S.	TX/BCP/S	Peanut Breeder/ISRA at Nioro, Received degree 8/12/88	Inheritance of earliness in five early maturing peanut (Arachis hypogaea L.) lines. TAMU. (Director Olin Smith). 1988.
12. Mahama Ouedracgo (Full support)	Burkina Faso	M.S.	TX/BCP/S	Now in M.S. program at Texas A&M, 1st year.	"Yield grade, and leafspot progression in interspecific derived peanut lines". TAMU. (Director Olin Smith)
13. Julius E. Fajardo (Partial support)	Philip-pines	Ph.D.	TX/MM/S	Degree completion date 12/15/90.	The role of phenolics in tolerant peanut hulls and testa to Aspergillus parasiticus. TAMU. (Director Robert Pettit). 1890.
14. Idrissa Dicko (Partial support)	Burkina Faso	Ph.D.	GA/IM/BF	Completed degree in June, 1989. (UGA)	Seasonal abundance of selected pest and beneficial insects in relation to peanut phenology, Irrigation and Insecticides.

TRAINING OF FOREIGN NATIONALS - DEGREE/CRSP COUNTRIES

NAME	COUNTRY	DEGREE	PROJECT	STATUS	THESIS/DISSERTATION
15. Mandhana Sukorndhaman (Full support)	Thailand	Ph.D.	GA/PV/N	Completed degree 1987. Science and Technology Development Board, Bangkok	Nucleic acid hybridization, serology and host reactions to study classification and detection of peanut mottle virus. 92 pp. UGA. (Director Cedric Kuhn). 1987.
16. Phindile Olorunju (Full support)	Nigeria	Ph.D.	GA/PV/N	In final year of Ph.D. program.	Groundnut rosette: inheritance of resistance and reaction of peanut genotypes to the causal agents. UGA. (Director J. W. Demski). 1989.
17. Araceli Pua (Partial support)	Philippines	Ph.D.	GA/PV/N	First year	Peanut viruses in the Philippines: purification, identification, seed transmission.
18. Ahmed El Murtada Ahmed (Full support)	Sudan	M.S.	AAM/FT/S	Food Research Center/Khartoum	Utilization of peanut cake in sorghum-based product (kishara). 1988.
19. Ismeldin Hashim (Full support)	Sudan	M.S.	AAM/FT/S	Ph.D. at University of Georgia	Effects of water blanching and steam blanching on storageability of roasted peanuts. 1988.
20. Margaret Hinds (Full support)	Trinidad	Ph.D.	AAM/FT/CAR	Last yr-completing program joint/AAM/UWI-will be key Food Sci. staff member at UWI	Post-harvest aspects of peanut in Eastern Caribbean. AAMU/UWI. (Director Bharat Singh). 1989.
21. Everal Miller (Full support)	Jamaica	M.S.	AAM/FT/CAR	Teaching in Florida School System	A study on proximate composition, amino acids, and fatty acids of peanuts grown in Jamaica. 1988. (Director Bharat Singh)
22. John U. Anyanwu (Full support from State matching funds)	Nigeria	M.S.	AAM/FT/S	Should complete in 1989	Processing and storage stability studies on 'kuli-kuli'.

TRAINING OF FOREIGN NATIONALS - DEGREE/CRSP COUNTRIES

NAME	COUNTRY	DEGREE	PROJECT	STATUS	THESIS/DISSERTATION
23. Abraham Idowu (Partial support)	Nigeria	M.S.	AAM/FT/S	Completed 1988 Plans to get in Ph.D. Program	Low moisture processing methods for legume seed processing for composite flours including combinations with peanut flours for baked food products. 1988. (Director John Anderson)
24. Francis Agbo (Full support)	Nigeria	M.S.	AAM/FT/S	General Foods, Starting Ph.D. Program at Cornell University	Metal-catalyzed lipid oxidation in roasted, spreadable peanut pastes during storage. 1988. (Director John Anderson)
25. Dike Ukuku (Full support)	Nigeria	M.S.	AAM/FT/BF	Will complete 1990	Characterization of soluble components of steam and water blanched leachate of peanuts.
26. Tunde Koleosho (Partial support)	Nigeria	M.S.	AAM/FT/BF	Will complete 1991	Storage studies on sorghum-peanut blend flowers at various conditions of environment.

TRAINING OF FOREIGN NATIONALS - DEGREE/NON-CRSP COUNTRIES

NAME	COUNTRY	DEGREE	PROJECT	STATUS	THESIS/DISSERTATION
1. Monteverde-Penso, E.J.-(Partial stipend and research support)	Venezuela	Ph.D.	NCS/BCP/TP	Inst. de Genetica, Fac. de Agronomia U.C.V., Venezuela	Recurrent selection for fruit yield in peanut. NCSU. (Director J. C. Wynne). 1986.
2. John B. Byalebeka (Partial support)	Uganda	Ph.D.	NCS/SM/TP	Uganda/BNF	Effect of host genotype on *Bradyrhizobium* acceptance and performance on peanut. NCSU. (Director G. H. Elkan) 1987.
3. Setyo Dwi Utomo (Partial research support)	Indonesia	M.S.	NCS/BCP/TP	In progress, Peanut Breeder/Aflatoxin resistance	Inheritance of resistance to *Aspergillus parasiticus* Speare in peanut (*Arachis hypogaea* L. NCSU. (Director J. C. Wynne).
4. Tin Htut (Partial research support)	Burma	M.S.	NCS/BCP/TP	In progress, USAID/ Burma support/ breeder	Study of genetic variance and correlation for nitrogen fixation and yield of peanut. NCSU. (Director J. C. Wynne).
5. Keerthi Hettiarchchi (Partial research support)	Sri Lanka	M.S.	NCS/BCP/TP	In progress, USAID/ Sri Lanka support/ breeder	Rust and leafspot resistance in cultivated peanut. NCSU. (Director J. C. Wynne).

TRAINING OF FOREIGN NATIONALS - DEGREE/NON-CRSP COUNTRIES

NAME	COUNTRY	DEGREE	PROJECT	STATUS	THESIS/DISSERTATION
6. Uta Grieshammer (Full support)	Germany	M.S.	NCS/BCP/TP	In progress	Establishment of isozyme patterns and their inheritance in peanuts by starch gel electrophoresis. NCSU. (Director J. C. Wynne).
7. Naazar Ali (Partial research support)	Pakistan	Ph.D.	NCS/BCP/TP	In progress	Genetics of early maturity and seed dormancy in peanut. NCSU. (Director J. C. Wynne).
8. Nong Alwi (Partial research support)	Indonesia	Ph.D.	NCS/BCP/TP	Pusat Nasional Penetitial Perkaretan, Medan	Peanut groups and their symbiotic relationship with Rhizobium strains. NCSU. (Director J. C. Wynne). 1987.
9. Charles T. Kisyombe (Partial research support)	Malawi	M.S.	NCS/BCP/TP	Plant pathology Chitedze Agricultural Experiment	Field evaluation of peanut genotypes for resistance to infection of Aspergillus parasiticus. NCSU. (Director M. K. Beute). 1984.
10. Kamariah Mohamed (Partial research support)	Malaysia	M.S.	NCS/BCP/TP	MARDI, Malaysia	Effect of flooding on rhizobial strain survival and performance. NCSU. (Director J. C. Wynne) 1985.
11. T. Mekontchou (Partial research support)	Cameroon	M.S.	NCS/BCP/TP	Agronomy Research Center, Cameroon	Inheritance and combining ability for early maturity and seed dormancy for a selected group of peanut lines (Arachis hypogaea L.). NCSU (Director: J. C. Wynne). 1987.
12. Cecilia Bianchi (Partial support)	Argentina	M.S.	NCS/SM/TP	Federal Dept. of Agriculture	Effect of plant passage through peanuts (Arachis hypogaea L.) on competitive ability of Bradyrhizobium sp. 1988.
13. Tulio Cassini (Partial support)	Brazil	Ph.D.	NCS/SM/TP	Federal University of Vicosa	Variation in symbiotic effectiveness of Bradyrhizobium sp. through plant passage in peanut (Arachis hypogaea). 1988.
14. Yun-Yun Hao (Partial support) (M.S.-61%, Ph.D.-34%)	Taiwan	M.S. Ph.D.	GA/FT/TP	Received M.S. Degree 2nd year of Ph.D. program	Removal of aflatoxin B_1 from peanut milk by Flavobacterium aurantiacum. 62 pp. UGA. (Director Robert Brackett). 1987.

TRAINING OF FOREIGN NATIONALS - DEGREE/NON-CRSP COUNTRIES

NAME	COUNTRY	DEGREE	PROJECT	STATUS	THESIS/DISSERTATION
15. Y.-Y. Chiou (0%)	Taiwan	Ph.D.	GA/FT/TP	Dept. Head, Chiayi Inst. Technol.	Covalent immobilization of papain and its application in continuous reactor for proteolysis. 115 pp. UGA. (Director Robert Brackett. 1985.
16. Chan Lee (Partial support (83%)	S. Korea	Ph.D.	GA/FT/TP	3rd year of program	Lactic acid bacterial fermentation of aqueous extracts of peanut. UGA. (Director L. B. Beuchat)
17. Hassan Azaizeh (Full support)	Israel	Ph.D.	TX/MM/S	Rec'd degree August 1987. Private Sector/Agric. Research	Screening peanut genotypes (Arachis hypogaea L.) for resistance to Aspergillus flavus group of fungi and aflatoxin contamination.
18. Kadima Ngeleka (USAID funded but not through CRSP)	Zaire	M.S.	TX/BCP/S	1st year in M.S. at Texas A&M	Thesis is not on peanuts but he is working on Peanut CRSP activities.
19. Dulce Warwick (Partial support)	Brazil	Ph.D.	GA/PV/N	Completed degree 1987. Scientist with EMBRAPA	Biological and serological properties of peanut stripe virus related to Identification, Diagnosis, Diseases and Epidemiology. UGA. (Director J. W. Demski). 92 pp. 1987.
20. Vivek Gnanasekharan (Partial support)	India	M.S.	GA/PH/CAR	2nd year of program Starting date March 1988	Physical properties of peanuts as related to development of improved separation technologies. UGA. (Director Manjeet Chinnan).
21. Deepa Pendalwar (Partial support)	India	M.S.	GA/PH/CAR	Completed program May, 1989	Design of flexible film packaging systems. UGA. (Director Manjeet Chinnan). 1989. ✓
22. Hossana Soloman (Full support)	Ethiopia	M.S.	AAM/FT/CAR	Completed 1986	Socioeconomic factors related to peanut consumption in Caribbean countries of Trinidad Jamaica and St. Vincent. AAMU. (Director Bharat Singh) 1986. ✓

TRAINING OF FOREIGN NATIONALS - DEGREE/NON-CRSP COUNTRIES

NAME	COUNTRY	DEGREE	PROJECT	STATUS	THESIS/DISSERTATION
23. Rose Muatine (Partial support)	Kenya	M.S.	AAM/FT/S	Complete program in 1989 - Part of the research on Peanut CRSP	Processing and packaging method for peanut-based "mish", a Sudanese dairy-based product.
24. Mike Ogwal (Partial support)	Uganda	M.S.	AAM/FT/BF	Will complete 1990	Studies of visco-elastic characters of peanut butter by various formulations and homogenization processes.

TRAINING OF FOREIGN NATIONALS - DEGREE/IN-COUNTRY

NAME	COUNTRY	DEGREE	PROJECT	STATUS	THESIS/DISSERTATION
1. Anuwat Changchat (Partial support materials & supplies)	Thailand	M.S.	GA/FT/TP	Dept. of Product Development KU; and continue for Ph.D.	Consumer study of supplementary food for pre-school children.
2. Kamolwan Suknark (Partial support)	Thailand	M.S.	GA/FT/TP	Dept. of Product Development KU; and continue for Ph.D.	Development and quality of tube feeding using peanut protein isolate.
3. Woranuch Suvanich (Partial support)	Thailand	M.S.	GA/FT/TP	R&D in food industry Continue for Ph.D.	Process Development and shelf-life study of peanut extended chicken patties.
4. Yuwadee Wongwithoonwid (Partial support)	Thailand	M.S.	GA/FT/TP	R&D in food industry	Development of dog food using aflatoxin-free small peanut.
5. Rattikorn Saokum (Partial support salary, materials & supplies.	Thailand	M.S.	GA/FT/TP	R&D in food industry, Continue for Ph.D.	Qualities improvement in fried peanut patties.

TRAINING OF FOREIGN NATIONALS - DEGREE/IN-COUNTRY

NAME	COUNTRY	DEGREE	PROJECT	STATUS	THESIS/DISSERTATION
6. Daguina Mahonte	Burkina Faso	IDR3	GA/IM/BF	Students at the University of Ouagadougou were trained in the GA/IM/BF project by assisting in the conduct of the research. Each wrote a paper from the research, presented it to his/her advisor at the university, and received credit toward the 3rd cycle (comparable to B.S.) or 5th cycle (comparable to M.S.) degree for the research. (Includes 6-12)	
7. O. Elie Dianda		ITDR3	GA/IM/BF		
8. Jean Ngamine		IDR3	GA/IM/BF		
9. Barce Kabore		IDR3	GA/IM/BF		
10. Daouda Thiam		IDR3	GA/IM/BF		
11. A. Florent Ngaroun		ITDR3	GA/IM/BF		
12. Olle Fran Kam		ITDR3	GA/IM/BF		
13. Urvan Wilson (Full support)	Univ. of West Indies	M.S.	GA/PH/CAR	Started program Jan. 1989	Evaluation of some selected postharvest handling equipment for peanuts.
14. _____Guetina	Burkina Faso	ITDR3	TX/BCP/S, BF,N	Student	Peanut disease evaluation in Bobo Doulasso and Niangoloko (1986).
15. Justin Yawemba	Burkina Faso	ITDR3	TX/BCP/S, BF,N	Student	Peanut disease evaluation Bobo Doulasso and Niangoloko. (1987).
16. Barnadette P. Wiminga	Burkina Faso	ITDR3	TX/BCP/S, BF,N	Student	Evaluation of peanut in five locations. (1988).
17. Pauline Kima	Burkina Faso	ITDR3	TX/BCP/S, BF,N	Student	Food technology-evaluating peanut paste from from different locations (1988).

TRAINING OF U.S. STUDENTS

NAME	COUNTRY	DEGREE	PROJECT	STATUS	THESIS/DISSERTATION
1. L. C. Mercer (Partial research support)	U.S.	M.S.	NCS/BCP/TP	Ciba-Geigy, Research Triangle Park, NC	Inheritance of fatty acid content in peanut (Arachis hypogaea L.) NCSU. (Director J. C. Wynne). 1988.
2. C. C. Green (Partial research and stipend support)	U.S.	Ph.D.	NCS/BCP/TP	Cotton breeder, USDA-ARS, Florence, SC	The evaluation and inheritance of the components of partial resistance to early leafspot (cercospora arachidicola (Hori) in peanut. NCSU. 74 pages. (Director J.C. Wynne). 1985.
3. S. Arrendeli (Partial research and stipend support)	U.S.	Ph.D.	NCS/BCP/TP	Housewife at present	Breeding for increased biological nitrogen fixation of peanut (Arachis hypogaea L.). NCSU. (Director J.C. Wynne). 1987.
4. Pamela Reece (Partial research support)	U.S.	M.S.	NCS/BCP/TP	Research Technician Plant Introduction Station, Griffin, GA	Effects of four growth regulators on the in vitro culture of peanut embryos. NCSU. (Director H. T. Stalker). 1988.
5. Stephanie Fore (Full support)	U.S.	M.S.	NCS/BCP/TP	In Ph.D. program at Miami of Ohio Univ.	The role of cercosporin in peanut leaf spot. NCSU. (Director M. K. Beute). 1987.
6. Dale Rachmeler (Full support)	U.S.	Ph.D.	NCS/BCP/TP	Was USAID/BF, now USAID/Niamey contractor	Inheritance of early maturity and fatty acid composition in peanut (Arachis hypogaea L.). NCSU. (Director J. C. Wynne). 1988.
7. William Anderson (Full support)	U.S.	M.S.	NCS/BCP/TP		Combining ability and heritability of resistance to early leafspot (Cercospora arachidicola Hoti) and late leafspot [Cercosporidium personatum (Berk. & Curt.) Deighton] for the cultivated peanut. 1985.
		Ph.D.		In progress, third year. Spent 1 year in Thailand for thesis research	Foliar diseases and early generation selection for early and late leafspot resistance in peanut. NCSU. (Director J. C. Wynne).

TRAINING OF U.S. STUDENTS

NAME	COUNTRY	DEGREE	PROJECT	STATUS	THESIS/DISSERTATION
8. Michael Fitzner (Partial research support)	U.S.	Ph.D.	NCS/BCP/TP	In progress, third year. Spent 1 year in Philippines for thesis research	Drought resistance and water relations in peanut. NCSU. (Director J. C. Wynne).
9. Tracy M. Halward (Partial research support)	U.S.	Ph.D.	NCS/BCP/TP	In progress	Application of starch gel electrophoresis techniques to a peanut breeding program. NCSU. (Director J. C. Wynne).
10. C. S. Johnson (Partial research support)	U.S.	Ph.D.	NCS/BCP/TP	In progress	The role of partial resistance in the management of Cercospora leafspot of peanut in North Carolina. NCSU. (Director M. K. Beute). 1985.
11. Gale E. McIntyre (Partial research support)	U.S.	M.S.	NCS/BCP/TP	In progress	Evaluation of selected Bradyrhizobia strains on peanuts. NCSU. (Director J. C. Wynne).
12. Mark D. Ricker (Partial research) support)	U.S.	M.S.	NCS/BCP/TP	Campbell Agricultural Research	Components of resistance of peanut to early leafspot (Cercospora arachidicola Hori). NCSU. (Director M. K. Beute). 1984.
13. Stephen B. Walls (Partial research support)	U.S.	M.S.	NCS/BCP/TP	Consultant with CIDA/Canada	The evaluation of resistance to Cercosporidium personatum in early and late generation Arachis hypogaea breeding lines. NCSU. (Director J. C. Wynne). 1984.
14. Thomas Keeley (Full support)	U.S.	M.S.	NCS/IM/TP	Dept. of Agriculture North Carolina	Effect of planting date, cultivar, and seeding rate on insect damage and yield of peanut. NCSU. (Director W. V. Campbell). 1987.
15. Joseph Browde (Full support)	U.S.	M.S.	NCS/IM/TP	Completed degree 1987.	Effect of cultivar, pesticide management method, and insecticide sequence on the profitability of insect management for peanut (Arachis hypogaea L.) production in North Carolina. NCSU. (Director W. V. Campbell). 1987.

TRAINING OF U.S. STUDENTS

NAME	COUNTRY	DEGREE	PROJECT	STATUS	THESIS/DISSERTATION
16. George Allen (Partial support)	U.S.	Ph.D.	NCS/SM/TP	Post Doc in Botany at NCSU.	Oxygen and succinate regulatory control of Bradyrhizobium sp. (Arachis) strain 3G4b20 during the shift from aerobic to microaerobic conditions. NCSU (Director: G. H. Elkan). 1988.
17. Daniel Grimm (Partial support)	U.S.	Ph.D.	NCS/SM/TP	Asst. Professor of Pulminary Medicine Duke Univ.	Influence of Bradyrhizobium sp. on nodule and seed composition in peanut (Arachis hypogaea L.). NCSU (Director: G. H. Elkan). 1988.
18. Laura Vasquez (Partial support)	U.S.	M.S.	NCS/SM/TP	Microbiologist at Amsco, Apax, N.C.	The effects of Vesicular-Arbuscular Mycorrhizal fungi and rhizobium on peanuts. 1987.
19. Seanne Udell (Full support)	U.S.	Ph.D.	NCS/SM/TP	Degree to be completed in 1990.	Selected genetic factors affecting host range in peanut rhizobia. 1990.
20. Terrence Miller (Full support)	U.S.	Ph.D.	NCS/SM/TP	Degree to be completed in 1990.	Selected genetic factors affecting host range in peanut rhizobia. 1990.
21. Steven Wagner (Partial support)	U.S.	M.S.	NCS/SM/TP	Technician/Agronomy Clemson, Univ.	Infection of nodulating and nonnodulating peanuts by vesicular-arbuscular mycorrhizal fungi. NCSU. (Director G. H. Elkan). 1984.
22. Mark Barbour (Full support)	U.S.	Ph.D.	NCS/SM/TP	Post Doc in Microbiology, Univ. of Tennessee.	Effects of plasmid curing and a plasmid copy number mutant on symbiotic and physiological properties of Rhizobium fredii USDA 206. 1988.
23. Lucy Branch (Partial support 74%)	U.S.	M.S.	GA/FT/TP	Coca Cola R&D, Houston, TX	Effects of hot water blanching and non refrigerated storage on oxidative stability of Virginia type peanuts (Arachis hypogaea L. ssp. hypogaea) 71 pp. UGA. (Director Earl Worthington). 1984.
24. Donald W. Schaffner (0%)	U.S.	Ph.D.	GA/FT/TP	Asst. Professor, Rutgers Univ.	Fermentation of aqueous plant seed extracts by lactic acid bacteria: Batch fermentation, semicontinuous fermentation and functional properties freeze dried products. 89 pp. UGA. (Director Larry Beuchat). 1985.

TRAINING OF U.S. STUDENTS

NAME	COUNTRY	DEGREE	PROJECT	STATUS	THESIS/DISSERTATION
25. Shona Holt (0%)	U.S.	M.S.	GA/FT/TP	1st year of program	Product applications from combinations of flours from cowpea, peanut, sorghum and cassava. UGA. (Director Anna Resurreccion).
26. Dalton Durio (Partial support)	U.S.	M.S.	TX/BCP/S	Discontinued training to assist with family business.	
27. Lisa Wildman (Partial support-approx. 1/4 time)	U.S.	M.S.	TX/BCP/S	Now in M.S. program Second year	Relates to inheritance of Sclerotinia blight resistance in Spanish peanuts.
28. J. Stephen Neck (Full support)	U.S.	Ph.D.	TX/SM/TP	In third year of Ph.D. program	Influence of Endomycorrhizal Fungi in a Tripartite peanut system.
29. Randall Garber (Full support)	U.S.	Ph.D.	TX/SM/TP	In third year of Ph.D. program	Physiological responses of peanut to mycorrihizal fungi and subsequent infection *Meloidogyne arenaria*.
30. E. T. Callaway	U.S.	Ph.D.	TX/BCP/TP	Study discontinued	
31. Russelyn Henson (Partial support plus Extension service)	U.S.	M.S.	TX/MM/S	Extension Assistant TAEX, C. S., Tx Degree completion date 12/15/90.	Structural Assessment of peanut pods for resistance to *Aspergillus flavus*.
32. Young Yang (Partial support)	U.S.	Ph.D.	TX/MM/S	Preliminary exam May 1989-Degree completion date 12/15/90.	Short Assay (in vitro) to assess environment and immunotoxicity of citrinin.
33. Timothy Riley (Full support)	U.S.	M.S.	TX/SM/TP	Graduated 1985 USDA in Florida	Influence of Salinity on Vesicular-Arbuscular endomycorrihizal fungus infection in *Arachis hypogaea* L.
34. Wanda Kelker (Partial support)	U.S.	M.S.	AAM/FT/S	Completed 1984	Development and nutritional value of high-protein gari. 1984.
35. Obi Warren (Full support from State matching funds)	U.S.	M.S.	AAM/FT/S	Not completed	Survey of nutrient composition and aflatoxin of peanuts in U.S. market channels.

POST DOCTORAL/SABBATICAL/SPECIAL

NAME	COUNTRY	DEGREE	PROJECT	STATUS	TRAINING
1. Penkwan Chompreeda	Thailand	Six months	GA/FT/TP	PI for Thai FT project.	Computer use and product development at Griffin, GA.
2. Sonia Rubico	Philip-pines	One year	GA/FT/TP	Research Assistant	Computer use, product development at Griffin, Ga.
3. Steve Misari	Nigeria	Three months	GA/PV/N	PI	Research techniques at Griffin, GA.
4. Okon Ansa	Nigeria	Two months	GA/PV/N	Co-PI	W. Germany, Scotland, research/rosette virus
5. Amadou Ba	Senegal	Three months	TX/MM/S	PI	Research techniques, aflatoxin at TAMU
6. Aly N'diaye	Senegal	Three months	TX/BCP/S	PI Phys/breeding	Research training/planning at TAMU
7. Ibra Fall	Senegal	Two months	TX/BCP/S	Breeding technician	Breeding techniques at TAMU
8. Sadio Traore	Mali	Two months	TX/BCP/S	Breeding technician	Breeding techniques at TAMU
9. A. Mounkaila	Niger	Three months	TX/BCP/S	PI	Breeding training - make crosses for Niger program - research planning

POST DOCTORAL/SABBATICAL/SPECIAL

NAME	EMPLOYMENT	STUDY POST	TYPE OF ACTIVITY
10. Ron Gibbons	ICRISAT/Program Leader	NCSU	Sabbatical - 1983/84
11. Phil Moss	ICRISAT/Cytologist	NCSU	Sabbatical - 1985/86
12. S. M. Nigam	ICRISAT/Breeder	NCSU	Sabbatical (to arrive soon)
13. Pala Subrahmanyam	ICRISAT/Pathologist	TAMU	Sabbatical - May 1984 - May 1985
14. D. V. R. Reddy	ICRISAT/Virologist	UGA	Sabbatical - 6 months April - Sept. 1983
15. V. K. Mehan	ICRISAT/Pathologj	Senegal	Sabbatical research related to TX/MM/S project.
16. T. Rau	ICRISAT/Breeder	NCSU	Tissue culture research for Ph.D. dissertation
17. Greg Parker	TAMU/BCP	TAMU	Postdoctoral assistant for coordination of TX/BCP/S,BF,N and Technical Assistant to Burkina Faso for computer training.
18. W. V. Campbell	NCSU/IM	Thailand/ Philippines	Sabbatical for international host plant insect resistance Aug. 1986 - February, 1987.
19. Eric Shephard	TAMU/MM	TAMU	Postdoctoral assistant for mycotoxicology component of TX/MM/S.
20. Bill Anderson	NCSU/BCP	NCSU	Project coordination while on Ph.D. program.
21. Tom Schneeweis	NCSU/SM	NCSU	Project coordinator, Technical Assistant to Cameroon.

SHORT-TERM TRAINEES

NAME	COUNTRY	PROJECT	STATUS	DATE OF TRAINING
1. Aran Patanothai	Thailand	NCS/BCP/TP	CRSP Breeding, PI, Khon Kaen University CRSP coordinator for Khon Kaen	6 mos. training at NCSU (1986/87) 3 weeks at NCSU 1984 1 week at ICRISAT for training 1984
2. Remedios Abilay	Philippines	NCS/BCP/TP	CRSP Breeding PI, UPLB/IPB	6 mos training at NCSU (1986)
3. Tharmmasak Sommartaya	Thailand	NCS/BCP/TP	CRSP Pathology cooperator/breeding, Kasetsart University	6 mos training at NCSU with Marvin Beute
4. Aree Waranyuwat	Thailand	NCS/BCP/TP	CRSP Breeding Co-PI, Kasetsart University	NCSU 3 weeks 1983
5. Edilberto D. Redona	Philippines	NCS/BCP/TP	CRSP Breeding PI, UPLB/IPB	NCSU 2 weeks 1983
6. Candida Adalla	Philippines	NCS/BCP/TP	CRSP Entomology Cooperator, UPLB/IPB	1 week at ICRISAT in 1984 for training Thailand Workshop for 1 week 1986 Indonesia Workshop for 1 week 1987
7. Preecha Surin	Thailand	NCS/BCP/TP	CRSP Pathology Cooperator/Breeding, DOA/Khon Kaen	ICRISAT in 1984 for training NCSU 2 weeks 1987, and 2 weeks 1988
8. Montien Sompee	Thailand	NCS/BCP/TP	DOA/Khon Kaen, Director, CRSP project site	NCSU 2 weeks 1988
9. Nark Potan	Thailand	NCS/BCP/TP	DOA/Bangkok,	NCSU 2 weeks 1987 NCSU 2 weeks 1988
10. Montien Somabhi	Thailand	NCS/BCP/TP	Deputy Director Field Crops Research Institute	NCSU 2 weeks 1987

SHORT-TERM TRAINEES

NAME	COUNTRY	PROJECT	STATUS	DATE OF TRAINING
11. Vichitr Benjasil	Thailand	NCS/BCP/TP	Director, Field Crop Crops Research Institute, DOA/Bangkok Thailand Coordinator for Peanut CRSP	NCSU 2 weeks 1984
12. Danilo Cardenas	Philippines	NCS/BCP/TP	CRSP Coordinator for Philippines, PCARRD	Thailand Workshop for 1 week 1986
13. Erlinda Paterno	Philippines	NCS/BCP/TP	CRSP Rhizobia PI, UPLB	Thailand Worshop for 1 week 1986
14. Lina Ilag	Philippines	NCS/SM/TP	CRSP Mycorrhizae PI, UPLB	NCSU for 2 weeks 1985 Malaysia Workshop 1986 Thailand Workshop for 1 week 1986
15. Araceli Pua	Philippines	NCS/BCP/TP	CRSP Pathology Cooperator/Breeding, UPLB/IPB	NCSU for 2 weeks 1984 Thailand Workshop for 1 week 1986
16. Ricardo Lantican	Philippines	NCS/BCP/TP	Legume Improvement Program Coordinator, UPLB/IPB	Thailand Workshop for 1 week 1986
17. Randy Hautea	Philippines	NCS/BCP/TP	CRSP Breeding Co-PI, UPLB/IPB	Thailand Workshop for 1 week 1986
18. Delfina del Rosario	Philippines	NCS/BCP/TP	CRSP drought tolerance breeding Co-PI, UPLB/IPB	Thailand Workshop for 1 week 1986
19. Kerati-Kasikorn Manochai	Thailand	NCS/IM/TP	CRSP Entomology Co-PI Khon Kaen Univ.	NCSU 3 weeks 1983 NCSU 3 weeks 1986 1 week to Hawaii for Tomato Spotted Wilt Virus Workshop 1989.

SHORT-TERM TRAINEES

NAME	COUNTRY	PROJECT	STATUS	DATE OF TRAINING
20. Eliseo Cadapan	Philippine	NCS/IM/TP	CRSP Entomology Co-PI, UPLB	NCSU 3 weeks 1983 NCSU 2 weeks 1985 Traveled to Thailand W.S. - 1 week 1986
21. Sathorn Sirisingh	Thailand	NCS/IM/TP	CRSP Entomology Co-PI, DOA Bangkok	NCSU 2 weeks 1984 NCSU 3 weeks 1987 1 week in 1988 to Indonesia Workshop.
22. Nantakorn Boonkerd	Thailand	NCS/SM/TP	CRSP Rhizobia PI, DOA/Bangkok	NCSU 4 weeks 1985
23. Banyong Toomsan	Thailand	NCS/SM/TP	CRSP Rhizobia Co-PI, Khon Kaen University	NCSU 4 weeks 1985
24. Yenchai Vasuvat	Thailand	NCS/SM/TP	CRSP Rhizobia Co-PI, DOA/Bangkok	NCSU 4 weeks 1984
25. Sonia Rubico	Philip-pines	GA/FT/TP	Research Assistant, UPLB	One year 1986/87 at University of Georgia, research training.
26. Penkwan Chompreeda	Thailand	GA/FT/TP	Co-PI, KU	6 months - Aug 1986/Feb 1987 at University of Georgia, Research and Computer training. Sept. 27-Oct. 5, 1987 - Singapore International Food Technology Conference
27. Virgilio Garcia	Philippines	GA/FT/TP	PI/UPLB	June 10-20, 1987 - University of Georgia Sept. 27-Oct. 5, 1987 - Singapore International Food Technology Conference

SHORT-TERM TRAINEES

NAME	COUNTRY	PROJECT	STATUS	DATE OF TRAINING
28. Reynaldo Mabesa	Philippines	GA/FT/TP	Co-PI/UPLB	Sept. 27-Oct. 5, 1987 - Singapore International Food Technology Conference June 24-July 3, 1989 - University of Georgia and Annual Meeting of Institute of Food Technologists, Chicago.
29. Ricardo R. del Rosario	Philippines	GA/FT/TP	Co-PI	Sept. 27-Oct. 5, 1987 - Singapore International Food Technology Conference June 15-25, 1988 - University of Georgia Planning, review of progress, Annual Mtg., Institute of Food Technologists, New Orleans.
30. Chintana Oupadissakoon	Thailand	GA/FT/TP	PI/Kasetsart Univ.	June 1985 - University of Georgia July 1986 - University of Georgia Sept. 27-Oct. 5, 1987 - Singapore International Food Technology Conference July 9-27, 1988 - University of Georgia Planning, review of progress Nov. 13-18, 1988 - Indonesia, Peanut Workshop
31. Vichai Haruthaithanasan	Thailand	GA/FT/TP	Co-PI/KU	Sept. 27-Oct. 5, 1987 - Singapore International Food Technology Conference June 24-July 3, 1989 - University of Georgia and Annual Meeting of Institute of Food Technologists, Chicago.
32. Elias E. Escueta	Philippines	GA/FT/TP	PI	June 1985 - University of Georgia Planning, review of progress

SHORT-TERM TRAINEES

NAME	COUNTRY	PROJECT	STATUS	DATE OF TRAINING
33. Bernardita Santos	Philippines	GA/FT/TP	Graduate Student at Univ. of Georgia	Traveled to Philippines to conduct consumer test for four weeks in July 1987.
34. Aminah Abdullah	Malaysia	GA/FT/TP	Professor, Univ. Kebangsaan Malaysia	April 4-Dec. 4, 1989 - Training at University of Georgia; 67% support from USDA/OICD program.
35. Ma. Pia Real	Philippines	GA/FT/TP	Research Assistant UPLB	6 months- May 1-Nov. 1, 1989. Training in methods for aflatoxin analysis; detoxification project.
36. Bachir Sarr	Senegal	TX/MM/S	Co-PI	Oct. 18-Nov. 8, 1984 at Texas A&M Research training.
37. Amadou Ba	Kaolack	TX/MM/S	PI	June 20-September 18, 1984 at TAMU for training May 2-June 7, 1985 at TAMU, training and planning Four months at TAMU 1986, training and planning To Dakar for 6 weeks for computer training - March-April, 1987
38. Omsub Nopamornbodi	Thailand	TX/SM/TP	PI	June 23-July 23, 1984, Texas A&M, planning July 4-9, 1985, Texas A&M, planning, review of research August 24-29, 1986 - To Malaysia, Workshop April 27 - May 7, 1987 North American Conf. on Mycorrhizae, Gainesville, FL May 8-15, 1987, Texas A&M, planning, review of research
39. Yenchai Vasuvat	Thailand	TX/SM/TP	Chief Microbiologist Dept. of Agriculture	June 23-July 23, 1984, Texas A&M, planning, review of research Aug. 24-29, 1986, Malaysia, Workshop May 2-10, 1987, North American Conference on Mycorrhizae

SHORT-TERM TRAINEES

NAME	COUNTRY	PROJECT	STATUS	DATE OF TRAINING
40. Lina Ilag	Philippines	TX/SM/TP	PI at UPLB	July 16-23, 1985, Texas A&M, planning, review of research Aug. 24-29, 1986, Malaysia, Workshop April 27-May 7, 1987 - North American Conf. on Mycorrhizae May 8-15, 1987, Texas A&M, planning, review of research
41. Aly N'diaye	Senegal	TX/BCP/S	Project Coordinator	July 15-Aug. 2, 1984 - APRES Meeting, Texas A&M, planning, review of research May 23-June 7, 1985 - Texas A&M, planning, review of research August 21-25, 1985 to Niger, Workshop July 13-28, 1986 - Texas A&M, planning, review of research and attend APRES meeting.
42. Philippe Sankara	Burkina Faso	TX/BCP/S	PI	March 1986 (two weeks) at Texas A&M, planning, review of research July 14-28, 1987 at Texas A&M, planning, review of research and attend APRES meeting.
		GA/IM/BF	PI at ISP	July 17-28, 1984 - Research review and planning and attended APRES meeting. July 14-28, 1987 - Review peanut research at the Coastal Plain Experiment Station and attended APRES meeting.
43. J. L. Khalfaoui	Senegal	TX/BCP/S	Cooperator	To Niger, Aug. 21-25, 1985, Workshop
44. Amadou Mounkaila	Niger	TX/BCP/S	PI	Two weeks at Texas A&M, March 1986, planning, review of research Eleven weeks at Texas A&M, March-June 1989, Crossing, seed processing, nursery establishment, descriptor applications, research planning
45. Sadio Traore	Mali	TX/BCP/S	Research Assistant	Two weeks at Texas A&M - March 1986, planning, review of research

SHORT-TERM TRAINEES

NAME	COUNTRY	PROJECT	STATUS	DATE OF TRAINING
46. Amangone N'Doye	Senegal	TX/MM/S	Research Assistant	Nov. 10-Dec. 9, 1985 at Texas A&M, planning, review of research
47. Ibra Fall	Senegal	TX/BCP/S	Research Assistant	Two months at Texas, August - September 1984, research planning
48. Solibo Some	Burkina Faso	GA/IM/BF	Co-PI at University of Ouagadougou	3 Months, June 6 - Sept. 4, 1984 Conduct lab and field research on peanuts.
49. Albert Patoin Ouedraogo	Burkina Faso	GA/IM/BF	Co-PI	July 17-28, 1984 - Research review and planning, attended APRES Meeting and attend Peanut CRSP planning session.. Review research at the IBPMRL on peanut. July 14-28, 1987 - Research review and planning, training in rating peanut for insect damage, and attended APRES Meeting. August 21-26, 1985 - Participate in the Agrometeorology of Groundnut Symposium in Niamey, Niger and discuss peanut research with other SAT colleagues. Sept. 13-16, 1988 - Participate in the Groundnut Production in West Africa Symposium, attend Peanut CRSP planning session, and discuss research with SAT colleagues.
50. Steve Misari	Nigeria	GA/PV/N	PI at IAR	University of Georgia - May 1983 Nigeria to Cambridge, England-April 10-14, 1985 To Malawi-March 8-10, 1987 University of Georgia July 8-29, 1987 England April 7-11, 1988 Niamey, Niger, September 12-18, 1988

SHORT-TERM TRAINEES

NAME	COUNTRY	PROJECT	STATUS	DATE OF TRAINING
51. Okon Ansa	Nigeria	GA/PV/N	Co-PI at IAR	Scottish Crops Research Institute March 15-April 16, 1984. Cambridge, England April 10-14, 1985 Malawi March 5-13, 1987 Nigeria to West Germany April 28-May 29, 1987 England April 7-11, 1988 Niamey, Niger Sept. 12-18, 1988
52. Phindile Olorunju	Nigeria	GA/PV/N	Ph.D. Student	Niamey, Niger Sept. 12-18, 1988
53. Duangchai Choopanya	Thailand	GA/PV/N	Cooperator/Dept. of Agriculture	Indonesia/Workshop June 8-13, 1987
54. Candida Adalla	Philip-pines	GA/PV/N	Pathologist/ Cooperator	Indonesia/Workshop June 8-13, 1987
55. Sopone Wongkaew	Thailand	GA/PV/N	PI at Khon Kaen University	Indonesia/Workshop June 8-13, 1987 Indonesia/Workshop Aug. 11-26, 1988 Indonesia/Workshop Nov. 13-18, 1988 Montpellier, France, January-June, 1989
56. Marina Natural	Philip-pines	GA/PV/N	PI-Inst. of Plant Breeding	Indonesia/Workshop Nov. 13-18, 1988 University of Georgia April 29-May 4, 1989
57. D. V. R. Reddy	ICRISAT	GA/PV/N	Visiting Professor	Cambridge, England, April 10-14, 1985 Rosette virus conference/workshop
58. P. Sreenivasulu	India	GA/PV/N	Visiting Professor	University of Ga. 18 months- March 1987 - Sept. 1988.
59. Imbrihim Wayo	Nigeria	GA/PV/N	Technician	1 week of training 1983 - 1985.
60. Seidu Sule	Nigeria	GA/PV/N	Technician	1 week of training 1985.
61. Rudolph Casper	West Germany	GA/PV/N	Professor at Virus Institute in West Germany	Cambridge, Eng. April 1-14, 1985 Attended Rosette virus conference/workshop

SHORT-TERM TRAINEES

NAME	COUNTRY	PROJECT	STATUS	DATE OF TRAINING
62. Erich Breyel	West Germany	GA/PV/N	Professor at Virus Institute in West Germany	Cambridge, Eng. April 10-14, 1985-Attended Rosette virus conference/workshop Visited Athens, GA July 3-4, 1985 to review progress.
63. Joscelyn E. Grant	Jamaica	GA/PH/CAR	PI	April 1988, 10 days, Planning, equipment fabrication
64. Ishwar Garg	India	GA/PH/CAR	Research Engineer Panjab Agricultural Ludhiana, India	May 1988-August 1988, Design concept and testing of peanut shelling equipment.
65. Yehia Heikal	Egypt	GA/PH/CAR	Asst. Professor of Food Engineering, Ain Shams Univ. Cairo. Fulbright Comm. Supported by CRSP 1 month.	July - November, 1988, Design of peanut drying systems of various capacities.
66. Hope Kerr	Jamaica	AAM/FT/CAR	Acting Director Food Technology Institute	Two months training at Alabama A&M June/July 1986 Two weeks training at ALA A&M/June 1987.
67. Althea Townsend	Jamaica	AAM/FT/CAR	Director of Food Technology Institute	Two months training at Alabama A&M December 1985-January 1986.
68. B. K. Rai	Belize, C. A.	AAM/FT/CAR	PI at Belize	Two weeks at Alabama A&M & UGA July 1985 Two weeks at Alabama A&M & UGA September 1986
69. Brian Cooper	Antigua	AAM/FT/CAR	PI at Antigua and Principal Coordinator for all CARDI locations	Two weeks at Alabama A&M & UGA Sept. 1986.

SHORT-TERM TRAINEES

NAME	COUNTRY	PROJECT	STATUS	DATE OF TRAINING
70. Laxman Singh	Antigua	AAM/FT/CAR	PI at Antigua	Two weeks at Alabama A&M & UGA July 1985
71. Horace Payne	Jamaica	AAM/FT/CAR	PI at Jamaica (deceased)	Two weeks at Alabama A&M & UGA July 1985
72. H. Ishag	Sudan	AAM/FT/S	Project Coordinator	Two weeks/July 1985 at Alabama A&M
73. Margaret Hinds	Caribbean	AAM/FT/CAR	Ph.D. student at St. Augustine, Trinidad	Two months at Alabama A&M 1987
74. Alfred Traore	Burkina Faso	AAM/FT/BF	PI	Two weeks at Alabama A&M/UGA/ICRISAT, Niger August - September 1988.

U.S. Principal Investigators Trips to Host-Country

NAME	COUNTRY	PROJECT	DATE	PURPOSE
1. Gerald Elkan	Philippines	NCS/SM/TP	Feb. 22-Mar. 1, 1983	Establishment of project
	Philippines		Oct. 25-Nov.2, 1983	Establishment of project
	Thailand			
	Philippines		April 8-28, 1984	Research planning
	Thailand		Feb. 4-24, 1985	Research planning
	India		Feb. 12-15, 1986	Research planning
	Thailand		Feb. 15-22, 1986	Research planning
	Philippines		Feb. 22-28, 1986	Research planning
	Thailand		August 14-23, 1986	Planning, project review, Workshop
	Malaysia		August 24-Sept. 1, 1986	Workshop
2. W. V. Campbell	Philippines	NCS/IM/TP	April 8-28, 1984	Research planning
	Thailand			
	Thailand		Jan. 22-28, 1985	Research planning
	Philippines		Jan. 31-Feb. 6, 1985	Research planning
	Burma		Jan. 28-31, 1985	Technical assistance

U.S. Principal Investigators Trips to Host-Country

NAME	COUNTRY	PROJECT	DATE	PURPOSE
2. W. V. Campbell cont'd	Philippines		Feb. 6-15, 1985	Research planning and review project
	Thailand		Jan. 11-Feb. 2, 1986	Research planning and review project
	Philippines		Feb. 2-8, 1986	Research planning and review project
	Philippines		April 6-15, 1986	Research planning
	Thailand		Aug. 10-22, 1986	Sabbatical study from August 10, 1986 to March 2, 1987
	Philippines		Aug. 23-29, 1986	
	Thailand		Aug. 30-Sept. 21, 1986	
	Philippines		Sept. 22-Oct. 11, 1986	
	Thailand		Oct. 12 - Dec. 27, 1986	
	Philippines		Dec. 28 - Jan. 8, 1987	
	Thailand		Jan. 9 - Jan. 26, 1987	
	Philippines		Jan. 27 - Feb. 8, 1987	
	Thailand		Feb. 9 - Mar.2, 1987	
	Thailand		Jan. 4-Feb. 6, 1988	Research planning, review
	Philippines		Mar. 3-Mar. 14, 1989	Research planning, review
	Thailand		Mar. 14-Apr. 9, 1989	Research planning, review
3. M. K. Beute	Philippines	NCS/BCP/TP	April 8-28, 1984	Research planning
	Thailand			
	Thailand		Jan. 31-Feb. 6, 1985	Project review, planning
	Philippines		Feb. 6-15, 1985	Project review, planning
	Thailand		Mar. 26-April 10, 1988	Project review, planning
4. J. C. Wynne	Philippines	NCS/BCP/TP	Feb. 22, March 1, 1983	Establishment of project
	Thailand			
	Philippines		March 26-April 7,'83	Research planning
	Thailand			
	Philippines		April 8-28, 1984	Research planning
	Thailand			
	Burma		Jan. 28-31, 1985	Technical assistance
	Thailand		Jan. 31-Feb. 6, 1985	Project review, planning
	Philippines		Feb. 6-15, 1985	Project review, planning
	Thailand		August 14-28, 1986	Planning, project review, Workshop
	Egypt		June 22-27, 1987	Potential project site

U.S. Principal Investigators Trips to Host-Country

NAME	COUNTRY	PROJECT	DATE	PURPOSE
5. T. J. Schneeweis	Cameroon	NCS/BCP/TP	May 21-June 12, 1984	Technical assistance
			May 17-30, 1985	Technical assistance
6. H. T. Stalker	Thailand	NCS/BCP/TP	March 26-April 7, 1983	Research planning
	Philippines			
	India		Feb. 12-15, 1986	Discuss interspecific hybridization and tissue culture programs with researchers at ICRISAT
	Thailand		Feb. 15-22, 1986	Research planning
	Philippines		Feb. 22-28, 1986	Research planning and Workshop
	Thailand		August 14-26, 1986	Planning, review of progress, Workshop
7. Barbara B. Shew	Thailand	NCS/BCP/TP	August 14-26, 1986	Planning, review of progress, Workshop
8. William F. Anderson	Thailand	NCS/BCP/TP	April 6, 1985 - June 5, 1986	Research
9. Michael S. Fitzner	Philippines	NCS/BCP/TP	June 25, 1985 - June 21, 1986	Research
10. Tommy Nakayama	India	GA/FT/TP	Feb. 14-21, 1983	Research planning, Food Rsch Inst. at Mysore
	Thailand		Feb. 22-25, 1983	Planning and establishing project
	Philippines		Feb. 26-March 1, 1983	Planning and establishing project
	Philipppines		April 15-20, 1985	Planning, review of progress
	Thailand		April 20-26, 1985	
11. Bob Raunikar	Philippines	GA/FT/TP	May 13-28, 1983	Food Consumption Survey
	Thailand			
12. Earl Worthington	Philippines	GA/FT/TP	April 10-13, 1984	Food Consumption Survey
	Thailand		April 13-19, 1984	
13. Larry Beuchat	Thailand	GA/FT/TP	May 3-9, 1986	Planning, review of progress
	Philippines		May 9-17, 1986	Planning, review of progress
	Philippines		Feb. 1-7, 1987	Planning, review of progress

U.S. Collaborators' Trips to Host-Country

NAME	COUNTRY	PROJECT	DATE	PURPOSE
13. Larry Beuchat cont'd	Thailand	GA/FT/TP	Feb. 7-14, 1987	Planning, review of progress
	Singapore		Sept. 28-Oct. 5,'87	International Food Technology Conference
	Philippines		April 14-16, 1988	Planning, review of progress
	Thailand		April 17-19, 1988	Planning, review of progress
	Indonesia		Nov. 12-17, 1988	Workshop on Peanut in Asia
14. Anna Resurreccion	Thailand	GA/FT/TP	May 3-9, 1986	Planning, review of progress
	Philippines		May 9-17, 1986	Planning, review of progress
	Singapore		Sept. 27-Oct. 5, 1987	International Food Technology Conference
	Philippines		Oct. 2-11, 1987	Planning, review of progress, ASEAN Food Conference
	Thailand		Oct 22-27, 1988	Planning, review of progress
	Philippines		Oct. 27-Nov. 9, 1988	Planning, review of progress
15. Bob Brackett	Thailand	GA/FT/TP	Sept. 21-26, 1987	Planning, review of progress
	Singapore		Sept. 27-Oct. 5, 1987	International Food Technology Conference
16. Olin Smith	Senegal	TX/BCP/S	November 7-17, 1983	Organization of project
	Senegal		May 28-June 3, 1984	Planning, review of research
	Senegal		April 22-30, 1985	Planning, review of research
	Niger, Burkina Faso and Senegal		Aug. 17-Sept. 5, 1985	Planning, review of research and Workshop
	Senegal		Oct. 2-11, 1986	Planning, review of research
	Burkina Faso		Oct. 11-16, 1986	Planning, review of research
	Niger		Oct. 16-23, 1986	Planning, review of research
	Niger, Senegal, and Burkina Faso		Aug. 23-Sept. 10, 1987	Planning, review of research
	Burkina Faso		Sept. 7-11, 1988	Planning, review of research
	Niger		Sept. 11-16, 1988	Planning, review of research and Workshop
	Senegal		Sept. 16-20, 1988	Planning, review of research
17. Donald H. Smith	Senegal	TX/BCP/S,BF,N	November 7-17, 1983	Planning, review of research
	Senegal		Aug. 30-Sept. 12, 1984	Disease survey, review of research
	Niger, Burkina Faso and Senegal		Aug. 12- Sept. 5, 1985	Planning, review of research and Workshop

U.S. Collaborators' Trips to Host-Country

NAME	COUNTRY	PROJECT	DATE	PURPOSE
17. Donald Smith cont'd	Philippines, India, Thailand	TX/BCP/S	Feb. 24-March 23, 1986	Planning, review of research
	Senegal		October 2-11, 1986	Planning, review of research
	Burkina Faso		October 11-16, 1986	Planning, review of research
	Niger		October 16-23, 1986	Planning, review of research
	Niger and Burkina Faso		Sept. 9-26, 1988	Collaborative disease surveys
18. W. J. Grichar	Burkina Faso, Niger and Senegal	TX/BCP/S,BF,N	Aug. 23-Sept. 10, 1987	Assist in evaluation of field experiments
	Niger		Aug. 27-Sept. 2, 1988	Assist in evaluation of field experiments
	Burkina Faso		Sept. 2-6, 1988	Assist in evaluation of field experiments
	Senegal		Sept. 6-13, 1988	Assist in evaluation of field experiments
19. Robert Pettit	Senegal	TX/MM/S	Feb. 18-26, 1982	Planning for project.
	Senegal		Jan. 3-13, 1983	Organization of project
	Philippines, Thailand		August 4-14, 1983	Research planning and review
	Senegal and France		Oct. 8-23, 1983	Research planning and review
	Senegal		May 28-June 3, 1984	Research planning and review
	Senegal and Niger		Aug. 17-Sept. 1,'85	Research planning and Workshop
	Senegal		June 24-July 5,'87	Research planning and review
	India		Oct. 1-10, 1987	Aflatoxin Workshop
	Burkina Faso		Sept. 7-11, 1988	Research planning and review
	Niger		Sept. 11-16, 1988	Research planning and review
	Senegal		Sept. 16-20, 1988	Research planning and review
	Senegal		April 9-14, 1989	Accompany External Evaluation Panel
20. Ruth Ann Taber	Senegal and France	TX/MM/S	Oct. 8-23, 1983	Research planning
	Philippines	TX/SM/TP	Aug. 4-10, 1983	Research planning
	Thailand		Aug. 10-14, 1983	Research planning
	Philippines		March 31-April 14, 1984	Research planning and review
	Thailand	TX/SM/TP	April 14-29, 1984	Research planning and review

U.S. Collaborators' Trips to Host-Country

NAME	COUNTRY	PROJECT	DATE	PURPOSE
20. Ruth Ann Taber cont'd	Philippines and Thailand	TX/SM/TP	March 2-15, 1985	Research planning and review
	Philippines, Thailand & India		Feb. 24-March 23,'86	Research planning and review
	Thailand		Aug. 14-21, 1986	Research planning and review and Workshop
	Malaysia		Aug. 24-29, 1986	Research planning and Workshop
	Philippines		Aug. 30-Sept. 5,'86	Research planning and review, Seminar at IRRI
	Senegal	TX/MM/S	June 24-July 5,'87	Research planning and review
	Philippines	TX/SM/TP	Aug. 30-Sept. 3,'88	Research planning and review
	Thailand		Sept. 3-10, 1988	Research planning and review
21. A. M. Schubert	Senegal and Burkina Faso	TX/BCP/S	April 22-30, 1985	Research planning and review
	Senegal		May 24-June 1, 1987	Research planning and review
22. Tim Philipps	Senegal	TX/MM/S	Jan. 3-13, 1983	Research planning and review
	Senegal		Feb. 4-18, 1985	Research planning and review
23. C. E. Simpson	Niger, Senegal and Burkina Faso	TX/BCP/S	Aug. 17-Sept. 5,'85	Research planning and review
24. Thurman Boswell	Senegal	TX/BCP/S	Nov. 7-17, 1983	Research planning and review
25. James Stack	Senegal	TX/MM/S	Sept. 17-Oct. 4,'84	Assist in research methodology
			June 6-27, 1985	Assist in research methodology
26. Barbara Richardson	Senegal	TX/MM/S	Feb. 4-18, 1985	Survey on aflatoxin contamination in food in selected villages.
			April 3-27, 1985	Survey on aflatoxin contamination
27. Eric Shepherd	Senegal	TX/MM/S	Feb. 4-18, 1985	Set up and assist in initial operation of HPLC analyzer.

U. S. PRINCIPAL INVESTIGATORS' TRIP TO HOST COUNTRY

NAME	COUNTRY	PROJECT	DATE	PURPOSE
28. Robert E. Lynch	Cameroon and Senegal	GA/IM/BF	February 12-26, 1982	Review need for entomology research in SAT Africa.
	Burkina Faso		July 22-Aug. 7, 1983	Organize and establish project with the Univ. of Ouagadougou, obtain signatures on work agreement, and discuss research plans and budget for the first year.
	Burkina Faso		June 22-July 6, 1984	Plan research and assist in design and planting of field plots.
	Burkina Faso		Nov. 18-27, 1984	Review research and assist in research plans for the coming year.
	Burkina Faso,		Aug. 11-27, 1985	Observe research plots, discuss plans, and assist in plans for the coming year. Attend Agrometeorology of Groundnut Symposium, present paper, and consult with ICRISAT scientists.
	Burkina Fasc	GA/IM/BF	Nov. 10-24, 1986	Review research and assist in research plans for the coming year.
	Burkina Faso		Sept. 6-16, 1988	Observe research plots, discuss plans, and assist in plans for the coming year. Attend Groundnut Production in West Africa Symposium, present paper, consult with ICRISAT scientists, and attend Peanut CRSP planning session.
29. Jim Demski	Nigeria	GA/PV/N	February 1982	Discuss plans and objectives of project.
	Nigeria		July 17-Aug.17, 1982	Plan research
	West Germany Virus Institute		August 18-20, 1982	Laboratory work
	Nigeria		July 16-Aug. 3, 1983	Planning research, review of progress
	West Germany		August 3-5, 1983	Planning research
	Nigeria		Oct. 22-Nov. 6, 1983	Planning research, review of progress
	Nigeria		Sept. 8-26, 1984	Planning research, review of progress
	West Germany		Sept. 26-29, 1984	Laboratory work
	Cambridge, Eng.		April 10-14, 1985*	Rosette virus conference/workshop
	Nigeria		August 3-17, 1985	Planning research, review of progress
	West Germany		August 18-20, 1985	Laboratory work

U. S. PRINCIPAL INVESTIGATORS' TRIP TO HOST COUNTRY

NAME	COUNTRY	PROJECT	DATE	PURPOSE
29. Jim Demski cont'd	Thailand, India Nigeria	GA/PV/N	Aug. 16-Sept. 5, 1986	S. E. Asia Workshop in Thailand; Discuss cooperative work with D. V. R. Reddy in India; review progress in Nigeria
	Malawi		March 4-13, 1987	Rosette workshop
	Indonesia		June 5-16, 1987	Workshop
	Nigeria		August 9-17, 1988	Review of progress and confer with Ph.D. graduate student.
	Thailand, Philippines, and Indonesia		Nov. 6-19, 1988	Planning research and Workshop
30. Cedric Kuhn	Nigeria	GA/PV/N	August 28-Sept. 22, 1982	Planning research
	West Germany		Sept. 22-24, 1982	Laboratory work
	West Germany		October 8-23, 1983	Laboratory work
	Nigeria		Oct. 23-Nov. 1, 1983	Planning research, review of progress
	Cambridge, Eng.		April 10-14, 1985	Rosette virus conference/workshop
	Nigeria		August 3-17, 1985	Planning research, review of progress
	West Germany		August 18-20, 1985	Laboratory work
	Nigeria		Aug. 26-Sept. 4, 1986	Planning research, review of progress
	West Germany		Sept. 5-Sept. 7,'86	Laboratory work
	Malawi		March 4-13, 1987	Rosette virus conference/workshop
	Nigeria		August 9-17, 1988	Planning research, review of progress
	West Germany		August 18-20, 1988	Laboratory work
	Nigeria		April 19-27, 1989	Plan Ph.D. degree program for graduate student
31. James Chalkley Technician	Nigeria	GA/PV/N	Aug. 14-Sept. 3, 1982	Provide technical training in laboratory procedures.
32. Manjeet Chinnan	Antigua	GA/PH/CAR	May 24-27, 1987	Planning, review of progress
	Jamaica, St. Vincent, and Port of Spain		Dec. 6-11, 1987	Planning, review of progress
	Belize		Feb. 11-14, 1988	Planning, review of progress
	Jamaica		May 24-27, 1988	Planning, review of progress
	Trinidad		March 12-15, 1989	Planning, review of progress

U. S. PRINCIPAL INVESTIGATORS' TRIP TO HOST COUNTRY

NAME	COUNTRY	PROJECT	DATE	PURPOSE
33. Tal Oz-Ari	Jamaica	GA/PH/CAR	August 1-13, 1988	Assist in field research
	Belize		March 16-27, 1989	Assist in field research
34. Bharat Singh	Sudan	ALA/FT/S	May 26-June 7, 1983	Research planning, Food consumption survey
	Caribbean		May 15-28, 1984	Research planning
	Caribbean	ALA/FT/CAR	Aug. 5-13, 1984	Research planning
	Caribbean		August 25-28, 1985	Research planning and review progress
	Caribbean		March 23-29, 1986	Research planning and review progress
	Caribbean		June 18-21, 1986	Research planning and review progress
	Senegal	AAM/FT/S	May 24-June 27, 1987	Surveying for potential new host country site
	Burkina Faso	AAM/FT/Su	May 24-June 27,1987	Surveying for new host country site.
	Niger			"
	Nigeria			"
	Mali			"
	India	AAM/FT/S	October 3-14, 1987	Attend Aflatoxin Workshop at ICRISAT
	Burkina Faso	AAM/FT/S	Sept. 6-22, 1988	Research planning and review progress
	Niger			Attended West African Peanut Researcher's Meeting/ISC, Niamey
	India	AAM/FT/S	March 26-31, 1989	Participate in Workshop/ICRISAT.
35. Gerald Wheelock	Sudan	AAM/FT/S	May 26-June 7, 1983	Conduct food consumption survey
	Sudan	AAM/FT/S	Aug. 5-13, 1984	Research planning
	Caribbean	AAM/FT/CAR	May 15-28, 1984	Conduct food consumption survey
36. Hezekiah Jones	Sudan	AAM/FT/S	May 26-June 7, 1983	Conduct food consumption survey
	Caribbean	AAM/FT/CAR	May 15-28, 1984	Conduct food consumption survey
37. Virginia Caples	Sudan	AAM/FT/S	May 26-June 7, 1983	Conduct food consumption survey
	Caribbean	AAM/FT/CAR	May 15-28, 1984	Conduct food consumption survey
38. B. Onuma Okezie	Caribbean	AAM/FT/CAR	Sept. 19-24, 1983	Planning and establishing project
			Dec. 10-22, 1983	Planning and establishing project
			May 15-28, 1984	Planning and reviewing progress
			Dec. 10-15, 1984	Planning and review progress
			Jan. 9-12, 1985	Planning and review progress

U. S. PRINCIPAL INVESTIGATORS' TRIP TO HOST COUNTRY

NAME	COUNTRY	PROJECT	DATE	PURPOSE
39. E. M. Ahmed	Caribbean	AAM/FT/CAR	Sept. 19-24, 1983	Planning research
			Dec. 1-15, 1984	Planning research
			August 25-28, 1985	Reviewing progress
			March 23-29, 1986	Reviewing progress
40. John Anderson	Sudan	AAM/FT/S	Aug. 5-13, 1984	Research planning
	Caribbean		March 23-29, 1986	Research related to Everell Miller's thesis
41. Everal Miller (Graduate Student)	Caribbean	AAM/FT/CAR	March 23-29, 1986	Research related to thesis for M.S.
42. Ray Hammons	Caribbean	GA/INPEP	May 2-6, 1983	Establishment of project
43. W. D. Branch	Niger, Burkina Faso, and Senegal		April 8-22, 1983	Establishment of project
	Jamaica		Jan. 9-12, 1985	Planning and review of progress
44. Craig Kvien	Belize, Jamaica	GA/FS/CAR (formerly INPEP)	June 18-26, 1986	Planning research and review of progress INPEP)
	Antigua, Trinidad, Jamaica		Sept. 14-18, 1986	Planning research and review of progress
			Oct. 20-25, 1986	Planning research and review of progress
	Antigua		May 24-27, 1987	Planning of research and review of progress
45. Corley Holbrook	Belize, Jamaica	GA/FS/CAR	June 18-26, 1986	Planning of research and review of progress
46. Alex Csinos	Antigua, Belize Trinidad, Jamaica		Sept. 14-18, 1986	Planning of research and review of progress
	Belize			Oct. 20-25, 1986
				March 19-28, 1989

MANAGEMENT ENTITY TRAVELS

NAME	COUNTRY	DATE	PURPOSE
1. David Cummins	Sudan, Cameroon	Nov. 11-23, 1982	Establishment of projects
	Philippines	Feb. 22-25, 1983	Establishment of projects
	Thailand	Feb. 26-March 1, 1983	Establishment of projects
	Niger, Burkina, Mali, Senegal	April 8-22, 1983	Establishing projects and signing of documents.
	Trinidad and Barbados	May 2-6, 1983	Establishing projects and signing of documents.
	Philippines, Thailand, India	Nov. 23-Dec. 17, 1983	Project review, Workshop
	Trinidad, Barbados	April 23-27, 1984	Project review
	Senegal	May 28-June 3, 1984	Project review
	Mali	Sept. 20-28, 1984	Establishment of project and signing of documents.
	Jamaica, Trinidad, Barbados	Dec. 10-15, 1984	Project review and establishment of projects
	Jamaica	Jan. 9-12, 1985	Project establishment
	India	Jan. 30-31, 1985	Workshop
	Thailand	Jan. 31-Feb. 5, 1985	Triennial Review
	Philippines	Feb. 5-13, 1985	Triennial Review
	Jamaica, Trinidad, Antigua	Sept. 1-7, 1985	Triennial Review
	Niger	Aug. 19-28, 1985	Workshop
	Burkina Faso, Niger, Senegal	Sept. 6-22, 1988	Project review, Workshop
	Thailand, Philippines, Indonesia	Nov. 6-19, 1988	Project review, Workshop
	Thailand, Philippines	March 10-22, 1989	Triennial Review
	Burkina Faso, Niger	April 10-17, 1989	Triennial Review
2. Tommy Nakayama	Thailand, Taiwan, Singapore Philippines	Aug. 15-Sept. 8, 1986	Reviewing projects and visit Singapore to make arrangements for a Food Technology Symposium.
	Belize, Kingston, Jamaica Antigua	June 18-26, 1986	Reviewing projects and visiting Administrators.
	France, Senegal, Burkina Faso Niger, Nigeria, Egypt, Mali	May 24-June 27, 1987	Viewing potential sites for AA&M Africa project.
	Korea, Philippines, Thailand Singapore, India	Sept. 11-Oct. 17, 1987	Reviewing projects and attending Food Technology Symposium in Singapore.

APPENDIX III
PEANUT CRSP PUBLICATIONS

Journal Articles 1983

1. Demski, J. W. 1983. A new virus infects peanuts in the U.S. Peanut Res. (Issue 88) 21:2-3.

2. Casper, R., S. Meyer, D.E. Lesemann, D. V. R. Reddy, R. Rajeshwari, S.M. Misari and S.S. Subbarayudu. 1983. Detection of a Luteovirus in Groundnut Rosette Diseased Groundnuts (Arachis hypogaea) by Enzyme-linked Immunosorbent Assay and Immunoelectron Microscopy. Phytopath. Z. 108:12-17.*

3. Pettit, R. E. 1983. Aspergillus yellow-mold and aflatoxin contamination. In Compendium of Peanut Diseases. Amer. Phytopathological Soc. Pages 33-34.

4. Thomas, R. J., R. E. Pettit, R. A. Taber, and B. L. Jones. 1983. Peanut peg strength: Force required for pod detachment in relation to peg structure. Peanut Science 10:97-101.

5. Ball, S. T., J. C. Wynne, G. H. Elkan and T. J. Schneeweis. 1983. Effect of inoculum and nitrogen on yield, growth and nitrogen fixation of peanut cultivars. Field Crops Research. 6:85-91.

6. Stowers, M. D. and G. H. Elkan. 1983. Gluconate catabolism in cowpea rhizobia: evidence for the ketogluconate pathway. Arch. Microbiol. 137:3-9.

7. Osman, A. K., J. C. Wynne, G. H. Elkan and T. J. Schneeweis. 1983. The effect of leaf removal on symbiotic nitrogen fixation in peanuts. Peanut Sci. 10:107-110.

8. Wynne, J. C., G. H. Elkan, T. G. Isleib and T. J. Schneeweis. 1983. Effect of host plant, Rhizobium strain and host x strain interactions on symbiotic variability in peanuts. Peanut Science. 10:110-114.

9. Stalker, H. T. and W. V. Campbell. 1983. Resistance of wild species of peanuts to an insect complex. Peanut Sci. 10:30-33.

Journal Articles 1984

10. Lynch, R. E., J. W. Garner, and L. W. Morgan. 1984. Influence of systemic insecticides on thrips damage and yield of Florunner peanuts in Georgia. J. Agric. Entomol. 1:33-42.

11. Demski, J. W., D.V.R. Reddy, and G. Sowell. 1984. Stripe disease of groundnuts. FAO Plant Prod. Bull. 32:114-115.*
12. Demski, J. W., D.V.R. Reddy, G. Sowell, Jr. and D. Bays. 1984. Peanut stripe virus - a new seed-borne potyvirus from China infecting groundnut (Arachis hypogaea). Ann. appl. Biol. 105:495-501.*

13. Boykin, L. S. and W. V. Campbell. 1984. Wind dispersal of the two spotted spider mite (Acari: Tetranychidae) in North Carolina peanut fields. Environ. Entomol. 13:221-227.

14. Boykin, L. S., W. V. Campbell and M. K. Beute. 1984. Effect of pesticides on Neozygites floridana (Entomophtorales: Entomophthoraceae) and arthropod predators attacking the twospotted spider mite (Acari: Tetranychidae) in North Carolina peanut fields. J. Econ. Entomol. 77:969-975.

15. Boykin, L. S., W. V. Campbell and L. A. Nelson. 1984. Effect of barren soil border treatments on movement of the twospotted spider mite into peanut fields. Peanut Sci. 11:52-55.

16. Powell, G. S. and W. V. Campbell. 1984. Seasonal aspects of the reproductive biology of Sitona hispidulus (Coleoptera: Curculionidae) in North Carolina. Ann. Entomol. Soc. Am. 77:108-114.

17. Stalker, H. T., W. V. Campbell and J. C. Wynne. 1984. Evaluation of cultivated and wild peanut species for resistance to the lesser cornstalk borer (Lepiodoptera: Pyralidae). J. Econ. Entomol. 77:53-57.

18. Kuhn, C. W., J.W. Demski, D.V.R. Reddy, C.P. Benner, and Mandhana Bijaisoradat. 1984. Identification and Incidence of Peanut Viruses in Georgia. Peanut Science 11:67-69.*

19. Bays, D. C., J. W. Demski, and A. M. Schubert. 1984. A potyvirus from clover that infects peanuts. Phytopathology 74:844.

20. Stalker, H.T. 1984. Utilizing Arachis cardenasii as a source of Cercospora leafspot resistance for peanut improvement. Euphytica 33: 529-538.*

21. Lynch, R. E. J. A. Klun, B. A. Leonhardt, M. Schwarz, and J. W. Garner. 1984. Female sex pheromone of the lesser cornstalk borer, Elasmopalpus lignosellus (Lepidoptera: Pyralidae). Environmental Entomology Vol. 13: 121-126.*

22. Lynch, Robert E. 1984. Damage and preference of lesser cornstalk borer (Lepidoptera: Pyalidae) larvae for peanut pods in different stages of maturity. Journal of Economic Entomology. Vol 77: 360-363.*

23. Holley, R. N., W. W. Weeks, J. C. Wynne and W. V. Campbell. 1984. Screening peanut germplasm for resistance to corn earworm. Peanut Sci. 11:105-108.
24. Jones, R. W., R. E. Pettit, and R. A. Taber. 1984. Lignite and Stillage: Carrier and substrate for application of biocontrol agents to the soil. Phytopathology 74:1167-1170.

25. Reddy, D. V. R., A. F. Murant, G. H. Duncan, O. A. Ansa, J. W. Demski, and C. W. Kuhn. 1985. Viruses associated with chlorotic rosette and green rosette diseases of groundnut in Nigeria. Ann. appl. Biol 107: 57-64.*

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26. Reddy, D.V.R., A.F. Murant, J.H. Raschke, M.A. Mayo, and O.A. Ansa. 1985. Properties and partial purification of infective material from plants containing groundnut rosette virus. Annals of Applied Biology 107:65-78.

27. Demski, J. W., and G. R. Lovell. 1985. Peanut stripe virus and the distribution of peanut seed. Plant Disease 69:734-738.

28. Kisyombe, C. T., M.K. Beute and G. A. Payne. 1985. Field evaluation of peanut genotypes for resistance to infection by Aspergillus parasiticus Peanut Sci. 12:12-17*

29. Schaffner, D. W., L. R. Beuchat, and R.Y.-Y. Chiou. 1985. Fermentation of aqueous extract of peanuts with Lactobacillus bulgaricus in a semi-continuous stirred tank reactor. Food Microbiology 2:249-254.*

30. Beuchat, L. R., T. Nakayama, R. D. Phillips, and R. E. Worthington. 1985. Comparison of Soybeans, Peanuts and Cowpeas as Substrates for Preparing Natto. J. Ferment. Technol. 63 (4): 319-324.*

31. Walls, S. B., J. C. Wynne. 1985. Combining ability for resistance to Cercosporidium personatum for five late leafspot-resistant peanut germplasm lines. Oleagineux 40:389-396.*

32. Wheelock, Gerald, 1985. Organizing for serendipity in the Peanut CRSP. The Rural Sociologist 5:4:296-99.*

33. Campbell, W. V. and J. C. Wynne. 1985. Influence of insect-resistant peanut cultivar NC 6 on performance of soil-applied insecticides. J. Econ. Entomol. 78:113-116.

34. Holley, R. N., J. C. Wynne, W. V. Campbell and T. G. Isleib. 1985. Combining ability for insect resistance in peanuts.

Oleogineux. 40:203-207.

35. Rogers, D. D., D. S. Chamblee, J. P. Mueller and W. V. Campbell. 1985. Fall no-till seeding of alfalfa into tall fescue as influenced by time of seeding and grass and insect suppression. Agron. J. 77:150-157.

36. Rogers, D. D., D. S. Chamblee, J. P. Mueller and W. V. Campbell. 1985. Conventional and no-till establishment of ladino clover as influenced by time of seeding and insect and grass suppression. Agron. J. 77:531-538.

37. Shew, B. B., M. K. Beute and J. E. Bailey. 1985. Potential for improved control of southern stem rot of peanut with resistance and fungicides. Peanut Sci. 12:4-7.

38. Lynch Robert E., and Tim Reed, 1985. Rearing the lesser cornstalk borer fungicides for control of Aspergillus niger. J. Entomol. Sci. 20 (1): 26-33.*

39. Johnson, C. S., P. M. Phipps and M. K. Beute. 1985. Cercospora leafspot management decisions: An economic analysis of a weatherbased strategy for timing fungicide applications. Peanut Sci. 12:82-85.

40. Ricker, M. D., M. K. Beute and C. L. Campbell. 1985. Components of resistance in peanut to Cercospora arachidicola. Plant Dis. 69: 1059-1064.

41. Arrendell, S., J. C. Wynne and G. H. Elkan. 1985. Variation for nitrogen fixation among progenies of a virginia x spanish peanut cross. Crop Science 25:865-869.

Journal Articles 1986

42. Anderson, W. F., J. C. Wynne, C. C. Green, and M. K. Beute. 1986. Combining ability and heritability of resistance to early and late leafspot of peanut. Peanut Science 13:10-14.* (added 9-5-86)

43. Sommartya, Tharmmasak and M. K. Beute. 1986. Temperature Effects on Germination and Comparative Morphology of Conidia for Thai and USA Isolates of Cercosporidium personatum. Peanut Science 13:67-70.*

44. Green, C. C. and J. C. Wynne. 1986. Diallel and generation means analyses for the components of resistance to Cercospora arachidicola in peanut. Theor. Appl. Genet. 73:228-235.*.

45. Bays, D. C. and J. W. Demski. 1986. Bean yellow mosaic virus isolate that infects peanut (Arachis hypogaea). Plant Disease 70:667-669.*

46. Demski, J. W. and D. Warwick. 1986. Testing peanut seeds for peanut stripe virus. Peanut Science 13:38-40.*

47. Schaffner, D. W., and L. R. Beuchat. 1986. Functional properties of freeze-dried powders of unfermented and fermented aqueous extracts of legume seeds. J. Food Sci. 51:629-633, 636.*

48. Schaffner, D. W., and L. R. Beuchat. 1986. Fermentation of aqueous plant seed extracts by lactic acid bacteria. Appl. Environ. Microbiol. 51:1072-1076.*

49. Chiou, R. Y.-Y, and L. R. Beuchat. 1986. Characteristics and applications of immobilized papain in a continuous-flow reactor. Biotechnol. Appl. Biochem. 8:529-536.*

50. Johnson, C. S., M. K. Beute, and M. D. Ricker. 1986. Relationship between components of resistance and disease progress of early leaf spot on Virginia-type peanut. Phytopathological 76:495-499.*

51. Johnson, C. S. and M. K. Beute. 1986. The role of partial resistance in the management of Cercospora leafspot of peanut in North Carolina. Phytopathology 76:468-472.*

52. Alderman, S. C. and M. K. Beute. 1986. Influence of temperature and moisture on germination and germ tube elongation of Cercospora arachidicola. Phytopathology 76:715-719.*

53. Anderson, W. F., J. C. Wynne and C. C. Green. 1986. Potential for incorporation of early and late leafspot resistance in peanut. Zeitschrift fur Pflanzenzuchtung (Plant Breeding) 97:163-170.*

54. Cline, W. O. and M. K. Beute. 1986. Effect of metam sodium, peanut genotype and inoculum density on incidence of Cylindrocladium black rot. Peanut Sci. 13:41-45.

55. Green, C. C. and J. C. Wynne. 1986. Field and greenhouse evaluation of the components of partial resistance to early leafspot in peanut. Euphytica 35:561-574.*

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APPENDIX IV

Meetings, Workshops, Symposia Sponsored or Co-sponsored by the Peanut CRSP.

1. Thailand Groundnut Research Workshop. First held on October 28-30, 1981 at Khon Kaen University, Khon Kaen, Thailand. Meeting of Thai researchers, and often includes U.S. researchers to determine research needs, and made possible by Peanut CRSP. Eighth annual workshop held in 1989. Host location changes each year.

2. Training course for Research and Extension Technicians in Biological Nitrogen fixation Technology, May 1-13, 1983, Bangkok, Thailand. Training led by Dr. Gerald Elkan, North Carolina State University, CRSP PI for Thailand participants.

3. Consultative Group Meeting to discuss Collaborative Research on Groundnut Rosette Virus Disease, May, 1983, Experiment, Georgia. Representatives from Georgia, Nigeria, West Germany, and ICRISAT.

4. American Peanut Research and Education Society, Annual Meeting. Each year since 1983, the Peanut CRSP has been actively involved at this major scientific meeting on all aspects of peanut research and education (technology transfer). Both host country and U.S. participants present research done under the CRSP. A special CRSP meeting is held during the Society meetings.

5. Consultative Group Meeting for Asian Regional Research on Grain Legumes, ICRISAT, India, December 11-15, 1983. Meeting of researchers and research managers to discuss the coordination of Asian grain legume research.

6. North American Conference on Mycorrhizae, June, 1984, Corvallis, Oregon. CRSP participants from Texas, Thailand, and the Philippines.

7. Consultative Group Meeting to discuss Collaborative Research on Groundnut Rosette Virus Disease, April 13-14, 1985, Cambridge, England. Assembled researchers from Peanut CRSP (U.S., Nigeria), ICRISAT, Australia, Scotland, and West Germany to discuss needs and plans for collaborative research.

8. Training Course for Research and Extension Technicians in Biological Nitrogen Fixation Technology, February 11-21, 1985, University of the Philippines at Los Banos. Philippine participants; training led by Dr. Gerald Elkan, North Carolina State University, CRSP PI.

9. Agrometerology of Groundnut, an International Symposium, ICRISAT Sahelian Center, Niamey, Niger, August 21-26, 1985. Assembly of an international group to consider agrometerological implications in groundnut production. Jointly sponsored by ICRISAT, World Meterological Organization, Food and Agriculture Organization of the United Nations, and the Peanut CRSP.

10. Workshop on Storage, Utilization, and Nutritional Aspects of Grain Legumes and Grains, June 13, 1985, Georgia Experiment Station, Griffin, Georgia. Meeting of researchers from Bean/Cowpea CRSP, International Soybean Program, Nutrition CRSP, Peanut CRSP, and Sorghum Millet CRSP to discuss areas of mutual interest in post-harvest problems. Coordinated by Peanut CRSP and Bean/Cowpea investigators.

11. First National Peanut Consultation and Peanut CRSP review, February 7-8, 1985, PCARRD, Los Banos, Laguna, Philippines. Assembled researchers, extension specialists, and farmers to review research and determine future research needs. Reviews are held annually; a second major consultation scheduled for 1989.

12. Peanut CRSP Workshop, Khon Kaen, Thailand, August 19-21, 1986. Included researchers from the Philippines, Thailand, and the United States to review present research and outline a consensus of ideas for future program directions.

13. Symposium on Biotechnology of N_2 Fixation in the Tropics, August 25-28, 1986, Kuala Zumpur, Indonesia. CRSP participants from Texas, North Carolina, Philippines, and Thailand.

14. Cross CRSP conference, "Bringing People In: Social Research in International Agricultural Development," October 2-4, 1986, University of Missouri, Columbia. Peanut CRSP participation from Alabama and Georgia.

15. Consultative Group Meeting to discuss Collaborative Research on Groundnut Rosette Virus Disease, March 8-10, 1987, Lilongwe, Malawi. Added representatives from England and France to Cambridge (preceeding no. 7) meeting to evaluate progress and plan future research.

16. North American Conference on Mycorrhizae, May 2-7, 1987, Gainesville, Florida. CRSP participants from Thailand, Philippines, and Texas.

17. Consultative Group Meeting to discuss Research Needs on Peanut Stripe Virus in Southeast Asia, June 9-13, 1987, Malang, Indonesia. Planning meeting with CRSP representatives from Georgia, Thailand (later involved in CRSP) and Philippines (later involved in CRSP), and researchers from Australia,

Indonesia, ICRISAT, and Japan.

18. XIIth American Rhizobium Conference, August 9-15, 1987, Quebec, Canada. Peanut CRSP PI, Co-PI, and graduate student participation and paper presentations from North Carolina State University.

19. 7th World Congress of Food Science and Technology: Workshop on Peanut Utilization, September 28-October 2, 1987, Singapore. Symposium sponsored by Peanut CRSP, with participation from Georgia, Philippines, and Thailand.

20. International Workshop on Aflatoxin Contamination of Groundnut. October 8-9, 1987, ICRISAT Center, Hyderabad, India. Peanut CRSP participants included representatives from Nigeria, Georgia, Alabama, Sudan, and Texas.

21. West African Region Groundnut Scientists Meeting, September 14-17, 1988, Niamey, Niger. Peanut CRSP researchers from the United States, Burkina Faso, Niger, Nigeria, Senegal and scientists from Benin, Cameroon, Gambia, Ghana, Guinee, Mali, Tchad, Togo, FAO (Rome), ORSTROM (France), and IRHO (France) participated in the meeting to discuss present research and establish goals for regional research.

22. Asian Region Groundnut Scientists Meeting; November 14-17, 1988, Malang, Indonesia. Peanut CRSP scientists from the United States, Philippines, Thailand and scientists from India, Indonesia, Korea, Malaysia, Nepal, China, Vietnam, Australia (ACIAR), and ICRISAT participated in the meeting to discuss present research and establish goals for regional research.

23. Institute of Food Technologists Annual Meeting, Chicago, Illinois, June 25-29, 1989. An informal meeting of scientists involved in the Peanut and Bean/Cowpea CRSPs was held. Thirty-five participants from Thailand, The Philippines, Nigeria, Burkina Faso, Guatamala, Brazil, Malaysia, Taiwan and the U.S.A. attended.

APPENDIX V

Linkages and networks developed by the Peanut CRSP with other International or Regional Research Institutions.

1. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, Andhra Pradesh 502 324, India. Mutual interest in peanut research in the semi-arid tropics; formal Memorandum of Understanding, cooperatively publish International Arachis Newsletter, co-sponsor workshops, etc., co-plan research.

2. ICRISAT Sahelian Center, Niamey, Niger. Center for mutual research interests on peanut for West Africa. Center Director, Dr. Ron Gibbons is on Peanut CRSP Board of Directors.

3. Institute for Oilseeds Research (IRHO), Paris, France. IRHO scientists serve as CRSP cooperators in Senegal and Burkina Faso. Coordinated planning of West African program with IRHO. Former IRHO Oilseed Department Director Pierre Gillier served on Planning Grant Advisory Panel and later on the External Evaluation Panel.

4. Caribbean Agricultural Research and Development Institute (CARDI). Former Director of Research, Dr. St. Clair Forde served on CRSP Planning Grant Advisory Panel. CARDI is presently a participating institution in the CRSP in its role as research institution for some 13 English speaking countries in the Caribbean Region.

5. International Development Research Centre-Canada (IDRC). Joint support of peanut research in Thailand for several years. A coordinated effort with two universities and the Department of Agriculture was developed.

6. Australian Centre for International Agricultural Research (ACIAR). ACIAR supported research in Indonesia has linked with CRSP peanut stripe virus research in the Philippines and Thailand, and should lead to cooperation in breeding for acid-soil and shade tolerant cultivars.

7. Aflatoxin research in the CRSP has fostered an informal network involving the CRSP, ICRISAT and several interested countries.

8. 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 CRSP research on rosette virus at the University of Georgia and Ahmadu Bello University in Nigeria with researchers at ICRISAT in India and

Malawi, the Scottish Crops Research Institute, and the West German Virus Institute.

9. International Rice Research Institute (IRRI), Los Banos, Laguna, Philippines. Mutually supported peanut breeding research at the Institute of Plant Breeding, UPLB for use in farming systems.

10. Food and Agricultural Organization of the United Nations, Rome, Italy. Linkages through co-sponsorship of workshops on Agrometeorology and viruses.

11. World Meteorological Organization, Geneva, Switzerland. Linkage through co-sponsorship of a workshop on agrometeorology.

12. African Groundnut Council, Lagos, Nigeria. Linked through co-planning of research and workshops.

13. Conference des Responsables Africians et Francais de la Recherche Agronomique (CORAF). Newly organized group to coordinate French/African cooperative research on peanut, maize, rice and manioc. Common countries and researchers will necessitate close coordination between Peanut CRSP and CORAF. Peanut CRSP PI in Senegal for mycotoxin project is the African coordinator for CORAF.

CORAF: BP5305
34032 Montpellier, Cedex 1 France

APPENDIX VI

EQUIPMENT PROVIDED BY THE PEANUT CRSP

Country	Year	Description	Cost
Burkina Faso	1984	Peugeot 1500 pickup truck	$7,000
	1986	Motorcycle	1,000
	TOTAL		$8,000
Caribbean			
Antigua	1986	Fluorotoxin meter	2,800
	1986	Air conditioner (seed storage)	500
Belize	1988	Whole-nut blancher	2,700
Jamaica	1985	Microkjeldald unit	4,100
	1985	Fume hood	1,200
	1985	Viscometer	1,000
	1986	Fluorotoxin meter	2,800
	TOTAL		$11,800
Nigeria	1984	Refrigerated centrifuge	$11,000
	1984	Density gradient fractionator	3,900
	1984	Camera for microscope	2,500
	1985	Weather recording equipment	3,300
	1985	Controlled atmosphere oven	1,800
	1985	Seed moisture tester	1,600
	1985	Infrared drying accessory for mettler balance	1,000
	1985	Glassware sterilizer	1,600
	1985	IBM-PC microcomputer	4,300
	1985	Spectrophotometer	6,700
	TOTAL		$37,700
Philippines	1983	Mettler balance	1,600
	1984	Gas chromatograph	15,000
	1984	Refrigerator	500
	1984	Binocular type microscope	3,000
	1984	Typewrriter	1,000
	1984	High pressure liquid chromatograph	20,000
	1984	Motorcycle	1,100
	1985	Evaporator	800
	1985	Miniblender	900
	1985	Microcomputer	5,000
	1985	Variable speed electric motor	1,500
	1985	Peanut plot thresher	2,200

	1985	Pickup truck	10,000

Country	Year	Description	Cost
Philippines	1985	Sterostar zoom microscope	1,300
	1985	Laminar flow table top	2,500
	1985	Porometer	6,000
	1985	Soil moisture pressure bomb	1,700
	1985	Centrifuge	2,300
	1985	Typewriter	900
	1986	Microcomputer	2,500
	1986	Hand tractor	2,000
	1986	Microcomputer	2,400
	1986	Freeze dryer	4,100
	TOTAL		$88,300
Senegal	1984	Prormeter (plant-water)	6,000
	1984	Soxhlet distillation unit	2,500
	1984	Vacuum pump	1,100
	1984	Light microscope	5,000
	1984	Evaporative coolers (greenhouse)	1,400
	1984	High pressure liquid chomatograph	14,000
	1984	Infrared gun (leaf-temperature)	2,500
	1984	Water purification system	4,500
	1984	Vent hood	4,000
	1984	Seed moisture meter	1,300
	1985	Peugeot 505 station wagon	9,000
	1985	Electronic balance (macro)	2,000
	1985	Electronic balance (micro)	2,000
	TOTAL		$55,300
Sudan	1982	Wileymill	1,100
	1982	Soxhlet extractor	2,200
	1982	Hot water bath	1,700
	1982	Table-type shaker	600
	1982	Explosion proof blender	1,300
	1982	Thin-liquid chromatography accessories	1,100
	1982	Fluorometer	3,000
	1982	Apple II microcomputer	3,000
	1984	Kjeldahl unit	8,100
	1984	Crude fiber appartus	3,000
	1984	Fat-oil extractor	3,600
	1985	Fluorometer recorder	2,200
	1985	Heating unit	1,800
	TOTAL		$32,700

Thailand	1984	Gas chromatograph	$12,000
	1985	Thai-English typewriter	1,800
	1985	Air conditioner	1,000
Country	Year	Description	Cost

Thailand	1985	Two-wheel tractor	2,000
	1985	Printer for Apple II	
microcomputer		1,400	
	1985	Typewriter	500
	1985	Packing machine	7,000
	1985	Microcomputer	5,000
	1986	Motorcycle	1,400
	1986	Air conditioner	2,200
	1989	Microcomputer	1,800
	TOTAL		$36,100
	GRAND TOTAL - HOST COUNTRIES		$269,900

University	Year	Description	Cost
AAMU	1985	Fluorotoximeter	$ 3,600
	1986	Whole nut blancher	2,600
UFL (subgrant from AAMU)	1985	Microwave generator	15,000
	TOTAL		$21,200
UGA	1984	Hygrotheromographs (2)	2,000
	1984	Seed counter	900
	1984	Plot planter	2,000
	1984	Plot planter	1,500
	1984	Thresher	6,000
	1984	Seed storage room	14,000
	1984	Ultracentrifuge	27,000
	1985	Ultracentrifuge ($13,000 additional from UGA)	16,000
	1985	HPLC pump ($3,500 from UGA)	2,500
	1985	Microcomputer	5,000
	1985	Microcomputer	5,000
	1985	Vacuum can closing machine	8,500
	1986	ELISA Reader	1,000
	1986	Centrifuge roter	4,000
UGA	1986	Centrifuge roter ($2,000 from UGA)	5,000
	1986	Programmable peristaltic dispenser	2,000

	1986	Automatic sterilizer	7,900
UGA	1986	Media dispenser	8,500
	1986	Seed counter	3,800
	1986	Microelisa titration reader	8,500
	TOTAL		$131,100

University	Year	Description	Cost
UGA (ME)	1989	Desk top computer/printer	6,000
	1989	Laptop computer	2,000
	TOTAL		$ 8,000
NCSU	1984	TRS 80 microcomputer	2,800
	1986	ELISA Reader	4,000
	TOTAL		$6,800
TAMU	1984	Soil temperature sensor and recorder	6,000
	1985	Peanut plot thresher	3,500
	TOTAL		$ 9,500
	GRAND TOTAL - UNIVERSITIES		$176,600

TOTAL EQUIPMENT FOR HOST COUNTRIES AND UNIVERSITIES $446,500