Peanut Collaborative Research Support Program

Five-Year Program Plan
1985-1989

Prepared by
Peanut CRSP
The University of Georgia
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Experiment, Georgia 30212
U.S.A

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EXECUTIVE SUMMARY

The Peanut Collaborative Research Support Program was based on the perception of constraints that could be addressed through research. The importance of peanut to assist in the fulfillment of the goals of "Title XII-Famine Prevention and Freedom from Hunger" had been established. The implementation order was issued 1 July 1982. The Peanut CRSP featured a targeted effort on identified constraints and collaborators at the time of implementation, an efficient design of four universities to maximize program expenditure, and a global impact in three regions and eight countries.

Features of the Peanut CRSP:

Goals: Are focused on mobilization of resources

1. Develop and expand the research base and technological capability in both the U.S. and host countries for peanut.

2. Focus the resources of both developing country and U.S. research institutions into a long term collaborative research program to relieve constraints to peanut production and utilization.

Objectives: (Common to all projects) Are focused on constraints

1. Enhance research programs in the U.S. and host country institutions through

   - Development of cultivars, management practices, and utilization processes that would improve yields and production stability, lower costs, and enhance peanut use
   - Support programs in terms of equipment, supplies, travel, and personnel.

2. Improve the research capability of host country institutions by

   - Scientist to scientist collaboration on mutual research program problems
   - Offering short term and degree oriented training programs for host-country staff at U.S. institutions, workshops and Centers
   - Providing on-site consultation in the host countries by U.S. scientists

Global Plan

The Peanut CRSP is global in nature, 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 - Senegal, Burkina Faso, Niger, Nigeria, Sudan

Breeding peanut for resistance to foliar and soil-borne diseases in Senegal with linkages to Burkina Faso and Niger by Texas A&M University.

Mycotoxin management in peanut by prevention of contamination in Senegal by Texas A&M University.

Peanut viruses: etiology, epidemiology, and nature of resistance in Nigeria by University of Georgia.

IPM strategies for groundnut insects in Burkina Faso by University of Georgia.

An interdisciplinary approach to optimum food utility of peanut in Sudan by Alabama A&M University.

Southeast Asia - Philippines, Thailand

Peanut varietal improvement for Thailand and Philippines by North Carolina State University.

Management of arthropods on peanut in Thailand and Philippines by North Carolina State University.

Rhizobia influence on nitrogen fixation and growth of peanut in Thailand and Philippines by North Carolina State University.

Mycorrhizal fungi influence on growth of peanut in Thailand and Philippines by Texas A&M University.

Consumption of peanut as food and appropriate technology for storage/utilization in Thailand and Philippines by University of Georgia.

Caribbean - Trinidad, Jamaica, Belize, Antigua, St. Vincents, St. Kitts.

Peanut improvement for the Caribbean by University of Georgia.

Peanut utilization in food systems in the Caribbean by Alabama A&M University and University of Florida.

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 conprising 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 a 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.

INTRODUCTION

The peanut (Arachis hypogaea L.), is an ideal crop to help fulfill the goals of "Title XII - Famine Prevention and Freedom from Hunger" because of its worldwide importance. Peanut is an annual legume native to South America. Following discovery of the new world, early traders carried the crop throughout southern Europe, Africa, the Pacific, south and southeast Asia and later to the United States from Africa. It is now grown in most tropical, subtropical, and temperate countries between 40 degrees north and 40 degrees south latitudes. Estimated annual production of peanut is about 18 million metric tons and 18 million hectares.

More than half of the world's peanut production is in developing countries, usually by subsistence farmers where yields are often much lower and more variable than the rest of the world. Our collaborative research is targeted to assist these producers in stabilizing annual production and enhancing the use and quality of the peanut in human diets.

The Peanut Collaborative Research Support Program (CRSP) is based on specific constraints addressed through research. In the 1979 USAID summary, involving Missions, peanut research was rated highest priority (along with small ruminants, sorghum and millet, and bean/cowpea) to improve the well being of the small farmer. In implementing the Peanut CRSP, the BIFAD Joint Research Committee recognized the essential role of research to relieve constraints and realize the great potential to provide food and improve human well-being.

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   - Development of cultivars, management practices, and utilization processes that would improve yields and production stability, lower costs, and enhance peanut use
   - Support programs in terms of equipment, supplies, travel, and personnel

2. Improve the research capability of host country institutions by
   - Scientist to scientist collaboration on mutual research program problems
   - Offering short term and degree oriented training programs for host-country staff at U.S. institutions, workshops and Centers
   - Providing on-site consultation in the host countries by U.S. scientists.

Approach and General Methodology

1. Targeted effort - Constraints were identified and targeted research objectives were established for each host country and U.S. institution. Collaborators were identified or described in the planning process.

2. Efficient design - Four U.S. universities established a manageable CRSP, with minimum management expenditure and maximum investment in programs. Universities are: Alabama A&M, Georgia, North Carolina State, and Texas A&M.

3. Global impact - Collaboration with 8 host countries for impact across 3 major regions; Semiarid Tropical (SAT) Africa, Southeast Asia, and the Caribbean. Specific countries are: Senegal, Burkina Faso, Niger, Nigeria, Sudan, Thailand, Philippines, and the English speaking Caribbean Countries through the Caribbean Agricultural Research and Development Institute (CARDI) and the University of the West Indies.

MANAGEMENT AND ORGANIZATION

The University of Georgia is the Management Entity for the Peanut CRSP and received the grant from AID. Georgia subgrants to the participating U.S. universities, Alabama A&M, Georgia, North Carolina State, and Texas A&M (Florida has a subgrantee relationship with Alabama A&M), for the research projects in collaboration with the host countries. A Board of Directors, Technical Committee, External Evaluation Panel, and AID personnel advise and guide the Management Entity in areas of policy, technical aspects, budget management, and review.

Management Entity

Responsibilities: The University of Georgia Management Entity office is located in the College of Agriculture at the Georgia Station, Experiment, Georgia. The major role is responsibility to AID for technical and administrative matters for the CRSP. Duties include negotiating agreements, fiscal management, progress reports, and project modification.

Organization: The Management Entity staff (CRSP financed) is comprised of:

Dr. David G. Cummins, Program Director
Mrs. Barbara Donehoo, Administrative Secretary
Mrs. Phyllis Brewer, Accounting Assistant

Supportive Management staff (non CRSP financed):
Mr. Ted Proffer, Business Manager, University of Georgia College of Agriculture
Dr. Darl Snyder, Director of International Development and Title XII Representative, University of Georgia.

Board of Directors

Responsibilities: The Board of Directors serves in an advisory role to the Management Entity and provides liaison to their respective institutions. The duties of the Board of Directors are to establish policy for the CRSP, approve annual budgets, approve recommendations on programs, and review accomplishments of the CRSP.

Organization: The Board consists of one administrative representative from each of the participating U.S. institutions and from ICRISAT for a total of 5 members. The length of term of members is at the discretion of the individual institutions. A chairman and secretary are elected.

The present Board members are:

Dr. Dudley T. Smith, (Board Chairman), Texas A&M University
Dr. Billy E. Caldwell, (Board Secretary), North Carolina State University
Dr. B. Onuma Okezie, Alabama A&M University
Dr. Charles W. Laughlin, University of Georgia
Dr. Ron W. Gibbons, ICRISAT

Technical Committee

Responsibilities: The Technical Committee acts in an advisory role to the Board of Directors and Management Entity. Primary duties are to review and recommend plans for research, training, and budgetary components of the projects, establish mechanisms for program coordination in host countries, and assist in planning annual reviews.

Organization: The committee consists of one principal investigator from each participating U.S. institution.

The present Technical Committee members are:

Dr. Johnny C. Wynne, (Chairman), North Carolina State University
Dr. Bharat Singh, Alabama A&M University
Dr. James W. Demski, University of Georgia
Dr. Olin D. Smith, Texas A&M University

The Program Director/Administrative Secretary of the Management Entity serves as secretary to the committee.

External Evaluation Panel

The External Evaluation Panel was described in the CRSP Plan to consist of three to five eminent scientists recommended by the Management Entity for review and approval by AID. Their role is to monitor and evaluate program direction and accomplishments. Duties include a review of projects and programs of the CRSP and provide written evaluation, and recommendation for addition, elimination, or modification of component projects and overall objectives to include retention, elimination, or addition of new overseas sites. A five member Panel has been appointed.

The five member panel is composed of:

Mr. Donald C. Pickering, Assistant Director
Agriculture and Rural Development Department
World Bank, Washington, DC 20523

Dr. Arthur Hugh Bunting, CMG 1971
Professor Emeritus of Agricultural Development
Overseas
University of Reading
Reading, Berkshire
England RG6 2AR

Dr. Pierre Gillier
Head of Annual Oil Crops Department
of the IRHO, Paris (retired).
17 Allee du clos de Tourvoie
at Fresnes (Val de Maine)
94260 Fresnes
France

Dr. Kenneth H. Garren (retired)
Peanut Production and Harvesting Research, USDA/ARS,
Suffolk, VA 23437

Dr. Max Milner
Executive Officer
American Institute of Nutrition (retired).
Rockville, MD 20852

Coordination with AID and BIFAD

AID - Liaison is maintained with AID on a continuing basis for advice in program direction and development, securing travel approval, clearances for equipment purchases, coordination with mission programs, and submittal and approval of various reports.

Dr. Loren Schulze is the AID Peanut CRSP Project Manager.

BIFAD - Advice is provided by BIFAD in various areas of concern in program development and management. The CRSP maintains a liaison with BIFAD.

Mr. William Fred Johnson is the BIFAD liaison to the CRSP.

GLOBAL PLAN

The Peanut CRSP is global in nature, 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.

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 is for oil, but the high protein content of peanut makes it an important source of food where protein is inadequate in most diets. 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. 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 east to west and have a maximum of two 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
- Nigeria
- Sudan

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 a some whole peanut and imports some oil and oilcake with a slight balance of trade to the export side. A major research site is Northeast Thailand, 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 consume considerable quantities of peanut directly, both 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 faams 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

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 (1,500 tons annually), 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 large amount of peanut (6,500 tons annually) 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 Anerican Countries.

Key countries are:
- Trinidad
- Jamaica
- Belize
- Antigua
- St. Vincents
- St. Kitts

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; 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 six 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 varieties and lack of varietal resistance to diseases, insects, and drought;
b. health hazards and economic losses due to mycotoxin contamination;
c. yield losses due to infestations of weeds, insects, diseases, and nemotades;
d. food supplies inadequate and peanut is not generally considered a primary food source;
e. economic and sociological problems preventing efficient production and utilization;
f. 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/Se, BF, Nr - Breeding peanut for resistance to foliar and soil-borne diseases in Senegal with linkages to Burkina Faso and Niger by TAMU
(2) TX/MM/Se - Mycotoxin management in peanut by prevention of contamination in Senegal by TAMU.
(3) GA/PV/Na - Peanut viruses: etiology, epidemiology, and nature of resistance in Nigeria by UGA.
(4) GA/IM/BF - IPM strategies for groundnut insects in Burkina Faso by UGA.
(5) AAM/FS/Su - An interdisciplinary approach to optimum food utility of peanut in Sudan by AAMU.
(6) NCS/BCP/TP - Peanut varietal improvement for Thailand and Philippines by NCSU.
(7) NCS/IM/TP - Management of arthropods on peanut in Thailand and Philippines by NCSU.
(8) NCS/SM/TP - Rhizobia influence on nitrogen fixation and growth of peanut in Thailand and Philippines by NCSU.
(9) TX/SM/TP - Mycorrhizal fungi influence on growth of peanut in Thailand and Philippines by TAMU.
(10) GA/FT/TP - Consumption of peanut as food and appropriate technology for storage/utilization in Thailand and Philippines by UGA.
(11) GA/BCP/CAR - Peanut Improvement for the Caribbean.
(12) AAM(FL)/FT/CAR - Peanut utilization in food systems in the Caribbean by AAMU/UFL.

SUMMARY - PEANUT CRSP PROJECTS AND CONSTRAINTS
IN THREE GEOGRAPHIC REGIONS

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

1 - Primary Project Objective 2 - Secondary Project Objective

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 conprising 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 a 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.

Details of each of the projects as specific goals, objectives, and U.S. and host country institutions and collaborators are given in the project outlines that follow.

SEMIARID TROPICAL AFRICA

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Project Outlines

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Disease Resistant Peanut Varieties for Semiarid Environments

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Mycotoxin Management in Peanut by Prevention of Contamination and Monitoring

GA/PV/Na 35
Peanut Viruses: Etiology, Epidemiology, and Nature of Resistance

GA/IM/BF 44
IPM Strategies for Peanut Insects in SAT Africa

AAM/FT/Su 48
An Interdisciplinary Approach to Optimum Food Utility of Peanut in SAT Africa

Project Code: TX/BCP/Se, BF, Nr

Country-Site: Senegal (Burkina Faso, Niger linkage countries).

Priority Constraint: Low yields due to drought and diseases.

Research Needed: Breeding and cultural practices research to develop disease and drought resistant varieties and cultural practices which utilize to a maximum the yield potentials of the varieties.

Rationale for Site Selection and Research to be conducted:

A. USAID mission and country interest is high in Senegal, Burkina Faso, and Niger.
B. Location is accessible for travel from U. S. and will minimize travel costs, which is important since this project by nature has a number of co-investigators.
C. Amount of rainfall decreases rapidly over a relatively short distance from south to north in Senegal providing test locations in different ecological zones.
D. Germplasm developed here should be adaptable to the linkage countries and other areas of SAT Africa.
E. Research would complement and could cooperate with country programs in West Africa.

Benefits Expected: Development and introduction to farmers of better varieties of peanut should increase yields 10-15% which should add to both food supply and cash income. Production practices and yields of other major crops (sorghum and millet) should improve because of the nitrogen contribution in the system and more available cash for inputs. High potential for program success is expected from cooperative mission and CRSP efforts.

Host Country Lead Institution: ISRA, Bambey.

Linkage Institutions: University of Ouagadougou in Burkina Faso, and the INRAN in Niger.

U. S. Lead Institution: Texas A & M University.

U. S. Principal Investigator: Dr. O. D. Smith.

Project Title: Disease Resistant Peanut Varieties for Semi-Arid Environments.

Objectives:

A. Identify the major pathogens associated with soil-borne diseases and the conditions under which they develop.
B. Determine the seasonal development and relative abundance of foliar disease epidemics to maximize the effectiveness of field screening.
C. Evaluate Texas breeding lines for adaptability, disease reactions, drought tolerance, and acceptability for use as cultivars in Senegal.
D. Provide opportunity for training Senegalese staff and students.

E. Develop new populations by hybridization, select, and evaluate lines of potential benefit under Senegal and Texas growing conditions of disease and drought stress.
F. Increase seed of select lines for distribution and production.

Project Code: TX/MM/S

Host Country: Senegal

Priority constraint: Toxicity of peanuts lead to human and animal health hazards and reduced market value due to mycotoxin contamination.

Research Needed: Research to develop simple mycotoxin (primarily aflatoxin) detection and monitoring procedures, measures to minimize field and storage contamination, and decontamination processes.

Rationale for Site Selection and Research to be Conducted:

A. Strong country interest evidenced by breeding for mycotoxin resistance project and establishment of peanut meal detoxification pilot plant.
B. Objective of this field-oriented research is to minimize toxicity of peanuts during production and village storage thus improving on farm and village peanut food quality and to develop simple village-level detoxification procedures.
C. Results highly transferable across SAT Africa for rainfed peanut culture.
D. Possible strong linkages with country breeding and insect projects.
E. Reduction of mycotoxin levels must be achieved as peanut become more of a major dietary component.

Benefits Expected:

Improved mycotoxin prevention practices will result in significant reduction of mycotoxigenic diseases, such as hepatoma, of people who use peanuts as a regular part of their diet. Accurate statistics do not exist for present morbidity due to these toxic influences. Benefits are difficult to estimate but high levels of aflatoxin are known to exist across Africa and Asia.

The market value of peanut is directly dependent on aflatoxin content. Country-wide reduction of aflatoxin and associated kernel damage can be expected to improve peanut prices to the farmer; preserve the quality of food; and greatly increase the edible percentage of the crop.

Host Country Lead Institution: ISRA, Bambey and Kaolack; ITA, Dakar..

U. S. Lead Institution: Texas A & M University.

U. S. Principal Investigator: Dr. Robert E. Pettit.

Project Title: Mycotoxin Management in Peanut by Prevention of Contamination.

Objectives:

A. Determine when peanut is invaded by mycotoxin producing fungi and identify the fungi capable of producing mycotoxins.
B. To develop rapid, accurate analytical procedures for detection of mycotoxins in peanut, peanut products, and tissues and biological fluids from animals.
C. To develop interdisciplinary efforts to discover production, harvesting, and curing practices which can minimize mycotoxin contamination of peanut.
D. To develop inspection procedures for rapid detection and diversion of mycotoxin contaminated peanut into processing for cleanup and/or detoxification.
E. To set up training programs within the LDC and in Texas to train staff, producers, inspectors, and processors in detection methodology, fungal identification, and mycotoxin prevention programs.

Project Code: GA/PV/Na

Host Country: Nigeria

Priority Constraint: Low yields and high plant death caused by rosette, peanut mottle virus and other endemic viral diseases.

Research Needed: Determine the etiology of groundnut rosette and provide knowledge of specific causal agents for use in breeding and cultural control programs; to identify variants of peanut mottle virus and implement control strategies against the disease it causes; and provide methods of rapid identification of peanut mottle virus, agents causing groundnut rosette, and other peanut viruses.

Rationale for Site Selection and Research to be Conducted:

A. Rosette is very damaging (up to 100% loss) and endemic; a principal production problem in Nigeria, and surrounding SAT countries.
B. Worldwide peanut mottle virus reduces yield 10-35% each year; seed-and-insect borne.
C. Etiology of rosette and PMV poorly understood thus hampering breeding and cultural control efforts.
D. Host and linkage country expertise favorable for linkage; country interests high. Despite progress in breeding for resistance, few resistant varieties are available.
E. Results will be highly transferrable across SAT and SE Africa.
F. Linkages with West Germany, Scottish, and ICRISAT accelerate research.

Benefits Expected: Decrease losses in peanut production due to viral disease infestations. Losses due to peanut mottle, clump, and bud necrosis viral diseases range from 30 to 50% of the expected production. Rosette reduces yields every year and epidemics have caused essentially 100% yield losses.

Host Country Institution: IAR, Zaria/Samaru, Nigeria.

Linkage Country Institutions: ICRISAT, Virus Institute in West Germany, and Scottish Crops Research Institute.

U. S. Lead Institution: University of Georgia.

U. S. Principal Investigator: Dr. James W. Demski.

Project Title: Peanut Viruses: Etiology, Epidemiology, and Nature of Resistance.

Objectives:

A. Determine the etiology of groundnut (peanut) rosette.
B. Determine the epidemiological factors of groundnut rosette.
C. Select and determine the nature of resistance in groundnut to groundnut rosette.
D. Identify other peanut viruses, determine the variants of these agents, and develop means of rapid identification.

Project Code: GA/IM/BF

Country Site: Burkina Faso

Linkage Countries: Possible linkages with Niger, Nigeria, and Senegal.

Priority Constraint: The attack on peanut by a complex of foliage and soil insect pests that reduce yields, provide entry for pod rotting organisms, transmit virus diseases, and destroy peanuts is a major constraint in production stability in SAT Africa.

Research Needed: Determination of major insect pests, determination of economic injury levels for these pests, and development of inexpensive, integrated pest management practices that would emphasize cultural control practices.

Rationale for site selection and research to be conducted:

A. USAID mission and country interest high.
B. Relates to USAID and Peanut CRSP coordinated efforts with advanced line and variety testing to further delineate yield constraints.
C. Central location in SAT region for linkage and outreach efforts.
D. Insect problems are high in region but research efforts are minimal.

Benefits Expected: Stabilized and increased production of peanut, which should increase food supply and farm income.

Host Country Lead Institution: University of Ouagadougou, Institute Superior Polytechnique, Burkina Faso.

U. S. Lead Institution: University of Georgia.

U. S. Principal Investigators: Dr. Robert E. Lynch.

Project Title: IPM Strategies for Groundnut Insects in SAT Africa.

Objectives:

A. Identify the major economic pests of groundnut.
B. Develop economic-injury levels for the major economic pests by quantifying the relationship between pest density and groundnut yields.
C. Develop reliable sampling procedures for the major pests to estimate population density.
D. Determine arthropod abundance as related to peanut season and developmental phenology.

E. Develop bail attractants or other control strategies for major insect pests.

F. Evaluate promising breeding lines, developed by the Breeding CRSP or from ICRISAT, for resistance-susceptibility to major arthropod pests.

G. Develop IPM strategies for control of the major insect pests and evaluate these strategies in farmer's fields throughout the growing season.

Project Code: AAM/FT/Su

Host Country: Sudan

Priority Constraint: Under-utilization of peanut as a direct food product.

Research Needed: Food consumption survey to determine the role of peanut as food item in diets; improvement of current practices of postharvest handling of peanut; improve existing peanut foods; develop new peanut foods.

Rationale for Site Selection and Research to be Conducted:

A. Peanut is important as food but utilization is hindered by lack of knowledge of low cost post-harvest handling and storage methods, alternative food preparations and nutritive value of peanut.
B. Mission and country interest high.
C. Excellent expertise at Food Research Center, ARC, but peanut utilization research negligible prior to Peanut CRSP.
D. AID sponsored Western Sudan project, which includes peanut, will facilitate very wide distribution of research results.
E. U.S. institution has high expertise in this women-related effort.

Benefits Expected: Increased food intake of protein and calories due to an increase in the use of peanut as a basic food component. Improved peanut processing and foods will allow increased efficiency of women in food preparation; and/or allow alternative income generation via cottage industries.

Host Country Lead Institution: Agricultural Research Corporation, Food Research Center, Khartoum.

U. S. Lead Institution: Alabama A & M University.

U. S. Principal Investigator: Dr. Bharat Singh.

Project Title: An Interdisciplinary Approach to Optimum Food Utility of Peanuts in SAT Africa.

Objectives

Design and implement a research program to determine the food utility of the peanut for the semi-arid tropics (SAT) of Africa via:

A. Description and understanding of variations in environment, socioeconomics, and food technologies as they constrain the preservation and utilization of peanut supplies;
B. Analysis of the current and potential dietary role of existing peanut products;
C. Research on the improvement of existing peanut products and the development of new peanut products with suitable energy density, nutrient concentrations and preferred tastes at acceptable cost.
D. Assurance of safety of the products with particular reference to mycotoxins in the raw and finished products.
E. Exchange of peanut germplasm for breeding resistant varieties to aflatoxin.

"Disease Resistant Peanut Varieties for Semi-Arid Environments"

Texas A&M University - Senegal, Burkina Faso, and Niger

O.D. Smith, Principal Investigator, TAMU

INTRODUCTION

Peanut is an important and widely grown crop in many areas of West Africa. Yields are very low, in general, because of drought, diseases, low soil fertility, arthropod damage, and management. The rainy season is short, especially in the more northern zones of the groundnut production regions of the Sahel, and the earliest maturing cultivars often do not mature. Mycotoxin producing fungi, commonly found in field and stored peanut, is an important constraint to good peanut quality. The constraints cited for Senegal are also important factors in peanut production in Texas, especially for that which is not irrigated. Thus, the research of this project has potential benefit for West African and U.S. peanut production.

Host Countries: The collaborative project was established with the Senegalese Institute of Agricultural Research which answers to the Senegal Ministry of Agriculture. Research was anticipated over a range of environments with annual rainfall from less than 400 mm to more than 1200 mm which would typlify much of West Africa peanut agriculture. Tests in the Casamance region of South Senegal were not approved, and rainfall has been extremely low north of Gambia. In 1985 agreements were signed for collaborative disease evaluation tests in southwest Burkina Faso where the annual rainfall approximates that of the Casamance region of Senegal. This research is in collaboration with the University of Ouagadougou. Additional expansion of the project to include agronomic evaluations in Burkina Faso and Niger has been authorized by the Peanut CRSP Directors and is being planned for 1986.

MAJOR ACCOMPLISHMENTS

Establishment of Project

Funds for the project became available in Texas in February 1983 and in Senegal in May, 1984. Resignation and subsequent replacement of the original host country principal investigator in Senegal caused some delay in project implementation. Collaborative research in Burkina Faso was initiated in June, 1985.

Research Results

A limited 1983 and more comprehensive 1984 survey of Senegalese peanut production constraints revealed that foliar and soil-borne diseases were present but drought was the dominant production constraint in those two seasons.

Selected germplasm with earliness, and resistance to leafspot, pod rot, southern blight, and lesion nematode have been increased in Senegal and are being evaluated for adaptation and usefulness in those climates.

The abnormally dry seasons have resulted in complete loss of some tests and reduced the effectiveness of others. Results indicate reasonable adaptation of Texas breeding lines and cultivars in Senegal; the best entries equaling but not exceeding Senegal cultivars in productivity. Leafspot reactions of Texas lines in Senegal, and Senegal lines in Texas, are within the same range as local checks.

Pod disease evaluations of Senegal cultivars and breeding lines show a wide range of pod disease susceptibility in Texas field tests with high disease pressure. Some Senegal cultivars show reasonable resistance while others are more susceptible to Pythium and Rhizoctonia than U.S. check cultivar.

Leafspot severity classifications utilizing varied evaluation techniques employed in leafspot resistance programs were made and correlations among classifications have varied. Measurement of differing leafspot responses or misdirected classification methods are suggested.

Crosses of adapted U.S. and Senegal cultivars and lines with sources of earliness and resistance to disease, including A. flavus, and drought have been effected and F_1 and F_2 populations are under increase. Modified bulk, pedigree, modified pedigree, and backcross breeding methods will be employed.

Training

Short term training has been provided one Senegalese technician. A University of Dakar graduate is in M.S. level training in plant breeding at Texas A&M University. Several short term exchange visits of Texas & Host Country Collaborators have been effected for planning, consultation, and conduct of research.

EXPECTED IMPACT OF PROJECT

The potential impact of the project on peanut production in Senegal and West Africa is contingent upon the adaptation of the Texas germplasm to those production conditions, and its resistance to the production constraints of that region. Preliminary seed increases and tests have been conducted under a typical, water-supplemented, or extremely dry and short season conditions. The adaptation appeared reasonable but tests under more typical production conditions will be required.

The identification and recognition of the relative importance of soilborne diseases in Senegal is important. Although soilborne diseases were readily apparent in collections made to date in Senegal; drought has been an over-riding and dominant constraint. The constraint of soilborne disease, obviously present, under more "normal" conditions is in question. Interaction of disease and drought so as to amplify drought symptoms because of disease and weakened roots is a realistic possibility. If soilborne diseases are causing significant production losses, the Texas germplasm could be quite beneficial. Parents and breeding lines selected originally for resistance to Pythium and Rhizoctonia spp. have been found to resist Sclerotium rolfsii, Sclerotinia minor, and to some extent, Cylindrocladium crotalariae. Thus, it seems reasonable to expect that it could be useful for reducing

losses to soilborne diseases in Senegal. Reliable evaluations on the utility of this germplasm in different ecological areas of peanut production in Senegal is urgently needed.

The impact of the project to Texas will include access to new germplasm, especially that developed for drought resistance and early maturity, evaluation of Texas breeding materials under a broader range of environments, the development of new germplasm pools with a broader base, new selection criteria, and broadened experience by the Texas researchers.

GOAL

To develop peanut lines adapted to non and suboptimal-irrigated production in drought prone environments that have resistance to pathogens causing economic loss, and to identify cultural practices that will maximize the yield potential of cultivars fitted to these environments.

OBJECTIVES

A. Identify the major pathogens associated with soilborne diseases and the conditions under which they develop.

B. Determine the seasonal development and relative abundance of foliar disease epidemics to maximize the effectiveness of field screening.

C. Ascertain the usefulness and acceptability of Texas breeding lines for use as cultivars in West Africa.

D. Develop effective screening procedures for the selection of drought tolerant genotypes adapted to West Africa and Texas.

E. Develop new populations by hybridization, select, and evaluate lines of potential benefit under West African and Texas growing conditions.

F. Increase seed of select lines for distribution and production.

ORGANIZATION

TEXAS A&M UNIVERSITY

Dr. O.D. Smith, Principal Investigator, Dept. of Soil & Crop Sciences,
College Station, Breeder
Dr. C.E. Simpson, Cooperator, TAMU Research & Extension Center at Stephenville, Breeder
Dr. D.H. Smith, Mr. W.J. Grichar, and Dr. A.M. Schubert, Cooperators, TAMU Plant Disease Research Station at Yoakum, Plant Pathologists and Plant Physiologist, respectively.
Dr. R.E. Pettit, & Mrs. R.A. Taber, Cooperators, Dept. of Plant Pathology, College Station, Plant Pathologists

Institut Senegalais De Recherches Agricoles (ISRA), Senegal

Dr. M. Niang, Le Director General, ISRA Dakar
Dr. N. N'Doye, Director du Departement Production: Vegetales, CNRA/ISRA, Bambey
Dr. Aly N'Diaye, Physiologiste, CNRA/ISRA, Bambey
Dr. J.C. Mortreuil, CNRA/ISRA, Bambey.
Dr. Danielle Annerose, CNRA/ISRA, Bambey
Dr. J. L. Khalfoui, CNRA/ISRA, Bambey

Universite of Ouagadougou Institut de Scientifique Polytechnique (ISP), Burkina Faso

Dr. Alain Savadogo, L'Directeur, ISP, Univ. of Ouagadougou, Ouagadougou
Dr. Philippe Sankara, Phytopathologiste, Ouagadougou

Institut Nationale de Recherches Agronomique du Niger (INRAN)

Dr. Moussa Saley, L'Directeur Generale, INRAN, Niamey
Mr. Amadou Mounkaila, Agronomiste, Maradi

Approach

1. Texas and other germplasm available from ICRISAT and other institutions will be evaluated with local cultivars in West African environments to determinme adaptation and suitability for use as varieties or germplasm.

2. Germplasm from West Africa and other sources will be evaluated in Texas under rainfed, irrigated, and disease prone conditions to determine adaptability to U.S. conditions and to establish a basis for making appropriate selections.

3. Breeding stocks and segregating populations will be evaluated under field, greenhouse and laboratory conditions where feasible, for reactions to important foliar and soilborne diseases.

4. Progenies of fertile hybrids from bridge crosses involving *Arachis hypogaea*, *A. cardenasii*, *A. chacoensis*, and *A. batizocoi* have been found to segregate for pollen fertility and for resistance to early and late leafspot resistance. Six cycles of backcrossing to *A. hypogaea* have been completed. Early generation progenies were evaluated for resistance to the leafspots under field conditions. More recent backcross progenies have been screened using laboratory techniques. Field and laboratory evaluations for disease reaction and agronomic traits will be made and select progenies will be tested underdiverse environments in Texas and West Africa. Response of advanced lines to other foliar diseases will be noted as the three parental wild species also resist infection by rust and/or web blotch.

5. Evaluate and utilize peanut germplasm including wild species, discovered and collected in recent expeditions to South America through sponsorship of IBPGR, Texas A&M University, EMBRAPA CENARGEN, ICRISAT, USDA and other agencies. Cross-compatibility of new collections will be examined, and efforts to introgress useful gene sources into acceptable A. hypogaea populations will be strengthened.

6. Conduct laboratory, greenhouse, and field studies to determine critical stress periods, mechanisms of resistance, and effective selection criteria. Lysimeters for greenhouse and natural environment studies will be used to analyze water requirements for different growth stages of various genotypes. Seedling and adult plant rooting patterns, identification of critical water extraction zones, enzymatic changes resulting from moisture stress, and visible indicators of drought tolerance (e.g. seed abortion, one-seeded pod production, border effects) will be evaluated. Simultaneous field studies will be conducted for preliminary germplasm evaluation and association with greenhouse and laboratory results.

7. Select parental lines and make crosses to combine desirable traits such as earliness, yield, disease resistance, and fruiting characteristics. Preliminary selection will be made in Texas. More advanced populations and breeding lines will be tested and selected in Senegal, Burkina Faso, and Niger.

8. Develop evaluation techniques, screening procedures, and genotype standards that will facilitate communication and enhance national and international collaborative research.

9. Provide educational and training opportunities for host country collaborators and support personnel.

"Mycotoxin Management in Peanut by Prevention of Contamination and Monitoring"

Texas A&M University - Institut Senegalais De Recherches Agricoles

Robert E. Pettit, Principal Investigator, TAMU

INTRODUCTION

There is an urgent need to reduce the severity of mycotoxin (e.g. aflatoxin) contamination of peanut and peanut products produced in the United States, Senegal, and other peanut producing countries of the world. This project is designed to discover improved management procedures for reducing the mycotoxin problems through prevention of contamination, monitoring of peanut in trade channels for diversion of contaminated lots into either clean up or detoxification processes, and the development of improved detoxification procedures. Research activities have been designed to determine when peanut is invaded by the mycotoxin producing fungi in relation to peanut cultivar susceptibility; environmental conditions; and various production, harvest and storage procedures. Experiments have also been designed to develop improved mycotoxin detection procedures, improved inspection and diversion procedures, and methods of removing aflatoxin from crude peanut oil and other peanut products. These research projects will require that the staff utilize the "state of the art" procedures, modern equipment, and dedication to the task. In addition, training of graduate students and technical staff should provide a basis for continued research and education programs for many years in the future.

MAJOR ACCOMPLISHMENTS

Establishment of project

A collaborative mycotoxin research project has been developed between four research groups in Senegal: Centre National De Recherches Agronomiques in Bambey, Secteur Centre - Sud in Kaolack, and Laboratorie National d'Elevage in Dakar, all within the Institut Senegalais de Recherches Agricoles and the Institut de Technologie Alimentaire, in Dakar. A Memorandum of Understanding between Texas A&M University and Institut Senegalais de Recherches Agricoles has been completed as of 7 March 1984.

Training

A Senegalese scientist, Mr. Bashir Sarr, Director of the mycotoxin laboratory at ITA (Institut de Technologie Alimentaire) in Dakar, Senegal traveled to Texas A&M University in October, 1984 and trained in the Department of Veterinary Public Health. His training (over a 4 week period) was under the direction of Dr. Timothy D. Phillips and Dr. Eric C. Shepherd. Training covered detailed instruction in fundamental and advanced concepts of thin-layer, high pressure liquid and gas-liquid chromatographic analyses of mycotoxins (i.e. aflatoxins, ochratoxin A, zearalenone, and citrinin) and applications of these techniques in a variety of commodities. Emphasis was placed on "state of the art"

protocols that could be realistically adapted for use in Senegal, given limitations in support equipment and availability of critical supplies. Mr. Sarr was given "hands on" training in HPLC operation, sample preparation, handling and manipulation, data analysis and interpretation, electrical and mechanical troubleshooting, and laboratory safety.

A second Senegalese scientist, Dr. Amadou Ba, Director of the SR/Techno-Arachide Laboratory, ISRA Secteur Centre-Sud in Kaolack, Senegal traveled to Texas A&M in May, 1985 to train in the Departments of Plant Pathology and Microbiology and Veterinary Public Health. While in the Plant Pathology laboratories he worked under the leadership of Mrs. Ruth Ann Taber and Dr. James P. Stack. He studied detailed features of soil-borne fungi in terms of their identification and in experimental design. While in the Veterinary laboratories he worked under the leadership of Dr. Timothy D. Phillips and Dr. Eric C. Shepherd on fundamental procedures of mycotoxin analysis in peanut employing thin-layer and high pressure liquid chromatography and was introduced to concepts of lipid analysis using gas-liquid chromatography. Sample handling and safety precautions were emphasized.

A third Senegalese scientist, Mr. Amangone Ndoye N'Doye, director of Chemical Laboratories at ISRA Department de Recherches sur les Productions et la Sante Animales, will be at Texas A&M in November-December, 1985 to train in the Department of Veterinary Public Health. Mr. N'Doye will study experimental design and set up animal feeding studies designed to assess the distribution, elimination and metabolism of aflatoxin.

Mr. Bashir Sarr from the Institut de Technologie Alimentaire in Dakar has received verbal permission from the Director, Dr. Ousmane Kane, to come to Texas A&M in 1986 to begin studying for a Masters of Science degree.

Equipment Installation

A high pressure liquid chromatograph (HPLC) with radial compression capabilities has been installed in the mycotoxin laboratory at the Institute de Technologie Alimentaire (ITA) Dakar, Senegal. This instrument will greatly expand the current capabilities of the laboratory and will facilitate the identification of mycotoxins in agricultural commodities and biological samples. In addition it will provide analytical support to staff within the Laboratoire National de E'elevage et de Recherches Veterinaires for associated nutritional and biochemical studies.

Research Results

The incidence of *A. flavus* in immature pods collected from several geographical regions in Senegal revealed that up to 24% of the pods and 15% of the surface disinfested kernels contained viable propagules. Similar studies in Texas have revealed that up to 5% of the pegs and immature pods of the cultivar Starr, contain viabale *A. flavus*.

Peanut kernels from Senegalese farm fields and stored peanut piles contained fungi classified as: Aspergillus flavus, A. parasiticus, Macrophomina phaseolina, Pencillium spp., Fusarium spp, A. fumigatus, and Mucor spp. In addition, thermotolerant fungi (e.g. Mucor pusillus, Paecilomyces variotii, Actinomycete sp. and Chaetomiim sp.) and a thermotolerant bacterium, Bacillus sp. have been isolated. The Paecilomyces isolate grew at 35-50 C, has the ability to grow on a lignite-stillage carrier nutrient medium and is being studied for its ability to function as an antagonist of the Aspergilli and other soil borne pathogens.

Survival of the Aspergilli within the soil has been correlated with the type of organic matter present, occurrence of sclerotia, and potential colonizers of these sclerotia. Studies on peanut pod structure has revealed that the pods of some cultivars reduce the degree of A. parasiticus penetration, however immature pods are easily parasitized at relative humidities in the range of 90-97%. Peanut kernels from different breeding lines with varying structural features, which relate to the ability of the fungus to invade the seed, are invaded through the hila provided adequate moisture is available and sufficient time occurs for growth and penetration. Kernels from all breeding lines were contaminated with aflatoxin following 10-25 days incubation.

Sclerotia produced by many isolates of A. flavus germinate in soils over a range of soil moisture levels (-0.1 to -10.0 bars matric potential) and temperatures (20-35C). Following germination of a single sclerotium sufficient energy is available to produce up to 50-75 conidiophores on which up to 0.8 X 10^4 conidia are borne. Each conidium can act as a source of inoculum for future colonization of organic matter or peanut plant parts.

Two potential biocontrol agents of A. flavus sclerotia, Gliocladium roseum and Chaetonium globosum have been found capable of suppressing germination and reducing propagule viability at -0.1 and 1.0 bars matric potential. In addition the thermophilic fungus Paecilomyces varioti can colonize A. flavus sclerotia over a soil matric potential of -0.1 to -10.0 bars and at temperatures in the range of 45-50C.

An examination of peanut from 22 areas within three major peanut growing regions of Senegal, previous to harvest, revealed that A. flavus inhabited from 39-63% of the shells and from 7-25% of the kernels. The incidence of A. niger was higher with 70-95% of the shells and 48-73% of the kernels inhabited.

Examination of 14 randomly selected peanut samples (from storage piles adjacent to the oil mill at Diorbel, Senegal) revealed that A. flavus was isolated from 21% of surface sterilized shells and 30% of the surface sterilized kernels. In addition A. niger was isolated from 46% of the shells and 19% of the kernels, and Macrophomina grew from 44% of the shells and 8% of the kernels. Extensive insect damage may have in part attributed to the high incidence of fungi detected in the kernels.

Screening peanut cultivars for resistance to A. flavus at Texas A&M has revealed that cultivars differ in their susceptibility. The pod-rot resistant cultivar, Plant Inventory 365553, has been found to be highly susceptible to A. flavus invasion in laboratory and field trials. In greenhouse screening studies it has been noted that when peanut plants with seed coat resistance are drought stressed for several days then provided normal irrigations their susceptibility to A. flavus and aflatoxin contamination increases over control plants.

Laboratory evaluation of seed coat permeability for 24 peanut varieties grown at Nero, Senegal (in Kaolack) by measuring the electrical conductivity of bathing solutions of the seed and comparing these results with A. flavus colonization indicated a lack of direct correlation.

Comparative studies on peanut drying methods in Senegal, following digging, indicated that drying on a raised mat with an awning accelerated the drying process over windrow and raised mat treatments. The degree of A. flavus infestation was slightly lower in kernels from the windrow treatment. No direct relationships were noted between oil acidity and A. flavus activity.

Parallel analyses of peanut oil samples from Senegal (conducted at ITA and in the Veterinary Public Health laboratories) have demonstrated the potential for high level aflatoxin contamination. Raw peanut oil contained up to 381 ppb aflatoxin. Since only 5-10% of the aflatoxin in normally retained in the oil, the original peanut would have contained 1500 to 3000 ppb aflatoxin. Our data indicated that one of the commercial detoxification procedures currently used to degrade aflatoxins (within the peanut meal) did reduce the total aflatoxin content, mainly by reducing the level of nontoxic congeners (aflatoxins B_2 and G_2); while, the toxic congeners (aflatoxins B_1 and G_1) were detected at concentrations of 59 and 102 ppb.

Certain types of aluminosilicates have been found to be very effective in removing aflatoxins B_1, B_2, G_1, and G_2 from raw peanut oil. From 90 to 94% of the aflatoxins present were absorbed to bentonite clays following a short period of mixing. Attapulgite (a common clay from Senegal) absorbs up to 75% of the aflatoxin present. Kaolins and zeolites were much less effective in removing aflatoxins from peanut oil. Based on these results, a simple and inexpensive method for detoxification of raw peanut oil has been developed for use in Senegalese villages.

An improved mini-column method for detecting mycotoxins has been developed. The new column employs a benonite-type processed clay and other adsorbants, which enhance the resolution and limits of detection of aflatoxins from extracted peanut and peanut oil.

A new procedure for the extraction of mycotoxins from contaminated peanut products has been developed. The new procedure reduces costs and the amount of time required to prepare samples for the semi-automatic HPLC.

During the past year a dietary questionnaire was developed and used in the Senegalese village of Fayil in order to obtain a baseline level of aflatoxin intake by the village inhabitants. An analysis of 500 questionnaires is in progress. Forty food samples collected from individual families in the village have been analyzed for aflatoxin and all samples were negative with the exception of two peanut samples which contained 14 and 320 ppb aflatoxin.

Research has been targeted at determining the potential for toxic interaction of frequently occurring mycotoxins such as aflatoxin, ochratoxin A, and citrinin. Studies on the interactions of mycotoxins with other environmental chemicals of concern are also underway. The discovery has been made that polyhalogenated biphenyls can influence aflatoxin metabolism resulting in an increase in the production of aflatoxin M, in milk.

Results from studies on the dielectric characteristics of A. parasiticus invaded peanut kernels indicated that the real permittivity is only slightly affected by the fungus whereas the loss tangent of the dielectric properties is greatly affected. Differences in the loss tangent of the cielectric constant (between healthy and moldy kernels) are greatest at frequencies below 30 kilohertz. The greatest differences in the real permittivity are in the frequency range of 200 to 5,000 kilohertz. Differences in the loss tangent have been correlated with the degree of mold damage.

Experiments designed to quantify the interrelationships of mold damage, aflatoxin contamination, and moisture content of peanut kernels in statistically meaningful sense has necessitated the development of additional equipment. An electronically controlled inoculation chamber has been constructed for accurate programming of temperature and relative humidities, a computer program for a PH 9845 computer has been designed and is functional, and a new rectangular capacitive test cell has been constructed. The new test cell will replace the two concentric cylindrical cells and provide additional safety to the technical staff.

EXPECTED IMPACT OF PROJECT

In Senegal - Reducing the levels of aflatoxin within Senegalese grown peanut will help improve the health of the local population and greatly improve the quality of the peanut meal used in export trade. New methods of electrical or chemical detection of aflatoxin should aid in the diversion of mycotoxin contaminated peanut into processing for clean up and/or detoxification. Development of a marketing procedure which provides an incentive for producing aflatoxin free peanut will help encourage implementation of preventive measures for reducing mold damage. Newly developed aflatoxin sorption methodologies will allow local villagers to treat peanut oil to reduce aflatoxin levels to a safe level for consumption. Future development of peanut varieties with some resistance to penetration by the mycotoxin producing fungi will further reduce contamination once such varieties have been developed and grown in Senegal.

In United States - Research results from efforts on this project will lessen the impact of the aflatoxin problem to the peanut industry in the U.S. Newly developed peanut varieties adapted to the peanut growing regions could greatly reduce the number of Segregation III peanut marketed within the country. Electronic detection of aflatoxin contaminated peanut and improved chemical detection techniques should increase the speed and accuracy of analyses and reduce the cost related to diversions of contaminated peanut lots. Future discoveries related to the diversion and detoxification of aflatoxin in peanut, peanut products and other commodities will lessen the potential health hazard which contaminated products currently impose on the American public.

GOAL

The goals of the mycotoxin peanut CRSP research project are to enhance mycotoxin management within the LDC's and the United States through prevention of contamination in foods and feeds; development of improved inspection and diversion procedures, and the discovery of cleanup and detoxification procedures which will render contaminated products safe for consumption.

OBJECTIVES

A. Determine when peanut is invaded by mycotoxin producing fungi and identify the fungi capable of producing mycotoxins.

B. To develop rapid and accurate analytical procedures for detection of mycotoxins in peanut, peanut products, and tissues and biological fluids from animals.

C. To develop interdisciplinary efforts to discover production, harvesting, and curing practices which can minimize mycotoxin contamination of peanut.

D. To develop inspection procedures for rapid detection and diversion of mycotoxin contaminated peanut into processing for cleanup and/or detoxification.

E. Develop safe and efficacious detoxification methodologies for aflatoxin-contaminated crude peanut oil and peanut products in Senegal.

ORGANIZATION

Senegal

Institut Senegalais de Recherches Agricoles

Dr. Mbaye N'Doye, Directeur, Department des Productions Vegetales. BP 51, Bambey, Senegal
Dr. Aly N'Diaye, Physiologiste, Centre National de Recherches Agronomiques, BP 51, Bambey, Senegal
Dr. Amadou Ba, Technologist, Secteur Centre - Sud, BP 199, Kaolack, Senegal

Mr. Andre Rouziere, Coordinateur du Programe Arachide, Secteur Centre - Sud, BP 199, Kaolack, Senegal
Mr. Jean Claude Mortreuil, Selectionneur, Centre National de Recherches Agronomiques, BP 51, Bambey, Senegal
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Mr. Amangone N'Doye, Directur Service Alimentation - Nutrition Laboratoire National d'Elevage, BP 2057, Dakar - Hann, Senegal.

Institut de Technologie Alimentaire

Dr. Ousamane Kane, Directeur, BP 2765, Dakar - Hann, Senegal
Mr. Mouhamadou Diop, Directeur Technique, BP 2765, Dakar - Hann, Senegal
Mr. Amadou Kane, Directeur Laboratoire Mycotoxines, BP 2765, Dakar - Hann, Senegal
Mr. Bashir Sarr, Directeur Laboratoire Mycotoxins, BP 2765, Dakar-Hann, Senegal

Texas A&M University

Dr. Robert E. Pettit, Plant Pathologist (Principal Investigator), College Station, TX 77843
Mrs.Ruth Ann Taber, Mycologist, College Station, TX 77843
Dr. Olin D. Smith, Plant Breeder, College Station, TX 77843
Dr. James P. Stack, Plant Pathologist, College Station, TX 77843
Mr. Charles L. Martin, Technician, College Station, TX 77843
Mr. Hassan A. Azaizeh, Graduate Student, College Station, TX 77843
Ms. Russelyn Henson, Graduate Student, College Station, TX 77843

Department of Electrical Engineering

Dr. Randall L. Geiger, Electrical Engineer, College Station, TX 77843

Department of Veterinary Public Health

Dr.Timothy D. Phillips, Mycotoxicologist, College Station, TX 77843
Dr. Eric C. Shepherd, Mycotoxicologist, College Station, TX 77843
Mrs. Barbara Richardson, Epidemiologist, College Station, TX 77843

Approach

Peanut plant parts from different regions of Senegal and Texas will be collected, surface disinfested and the fungi present isolated on specialized nutrient media. Peanut stems, pegs, pods, and kernels will be examined from different peanut cultivars. Results from periodic samplings during the growing season should provide needed information on when *A. flavus* and *A. parasiticus* invade the peanut plant. Differences in cultivar susceptibility, variations in environmental conditions and knowledge of the associated soil microflora should help establish a basis for future experiments designed to limit the activity of the Aspergilli.

Studies on the growth and survival of Aspergilli reproductive units in soil, peanut plant parts, and other types of organic matter will be determined. Sclerotial germination, hyphal growth and sporulation of these fungi will be examined for fungal isolates from Senegal and Texas. Tests will be conducted in artificial media, pasturized soil, and natural field soils at different soil moisture potentials.

In order to access the feasibility for biological control of the A. flavus group fungi in the soil and on peanut plant parts the ecological relationships of A. flavus with other soil borne microorganisms has been initiated. Several fungi have been isolated and screened as potential biocontrol agents. Attempts to improve their performance in soils, with different moisture levels, has lead to a study on the influence of carrier substrate on propagule development. To more accurately access the activity of A. flavus in soils, different morphologically varients (e.g. those with color markers) will be used.

Continued efforts will be undertaken in the Plant Pathology facilities at Texas A&M to develop procedures for screening peanut cultivars for resistance to the A. flavus group fungi. Peanut cultivars with differing shell and seed coat features will be grown under greenhouse, boxplot, and field conditions. Plant parts will be recovered periodically to determine when the Aspergilli enter the plant and to determine if some of the cultivars exhibit differences in susceptibility.

Dr. Amadou Ba will continue his experiments which are designed to develop an evaluation technique which could aid in determining the extent to which peanut seed coats restrict the invasion of A. flavus. These studies are based on the hypothesis that seed coat permeability, as measured by electrolytic leakage, is correlated with susceptibility to A. flavus colonization. The procedure involves taking ten grams of seed from several peanut varieties and soaking these in 100 ml of distilled water for 10, 20, 30, 40, 50, and 60 minutes and taking electrical conductance readings. The readings are then corrected for any temperature difference during the soaking process and the final values converted to conductances per 100 cm^2 of seed coat surface. In a related experiment kernels of the same varieties are inoculated with a suspension of A. flavus conidia (3.7×10^6), placed in a humidity chamber for 8 days, and the percentage of kernels invaded by A. flavus recorded. Statistical comparisons will be made between the conductances and degree of seed colonization.

Dr. Amadou Ba will continue to conduct field plot experiments at the research station near Nero, Senegal. The experimental plots will contain a sequence of experiments designed to test various peanut cultivars for their susceptibility to A. flavus invasion, cultural practices capable of reducing the incidence of A. flavus within peanut soils, and various harvest and curing practices which could reduce the activity of the aflatoxin producing fungi during this period. During these studies the climatic conditions will be closely monitored and the harvested peanut will be examined for the incidence of Aspergillus, their aflatoxin content, and oil acidity. Mr. Bashir Sarr and Mr. Amadou Kane will assist in the analysis of these samples for aflatoxin and other mycotoxins at the Institut de Technlogie Alimentaire in Dakar, Senegal.

Experiments designed for detoxification of raw peanut oil, produced in Senegalese villages with oil presses, will continue. Crude peanut oil will be mixed with different clays secured from commercial sources within the United States and from clay deposits in Senegal and the extent of aflatoxin binding determined. Clay will be added to aflatoxin contaminated oil, the mixture stirred for 1 hour, the clay allowed to settle, and the clarified oil decanted into a filtration unit to remove any remaining clay particles. Treated and untreated oils will then be analyzed for aflatoxin content and tested for toxicity employing a battery of short-term in vitro assays for mutagenicity (in order to assess the "effiancy" and "predict" the "safety" of the procedure).

Development of chemical methods for the detection and detoxification of mycotoxins from peanut, and peanut products will be based on the premis that the methods must be inexpensive, easy to perform, and give consistent results in both Senegal and the United States. Procedures will involve a continued survey of adsorbants to determine their ability to bind aflatoxins and other mycotoxins. Selectivity and affinity will be modified via chemical derivatization.

The newly developed minicolumn will be tested for its ability to detect mycotoxins other than aflatoxin in Senagalese commodities and prepared foods.

Preliminary evidence indicates that peanut products contain potentially synergistic combinations of mycotoxins. In order to resolve the significance of this finding, peanut, peanut oil, and peanut meal will be collected in Senegal and will be analyzed for aflatoxin, ochratoxin A, citrinin and sterigmatocystin.

Research will continue to focus on the development of an aflatoxin detoxification program in Senegal. This research initiative will be expanded to include testing of "detoxified" commodities using short-term assays for mutagenicity and whole embryo tissue culture assays for teratogenicity.

Work will continue on the development of procedures for extraction of aflatoxin from plant and animal products for use with an automated high liquid chromatograph in Senegal and other countries.

Dielectric measurements of healthy and fungal damage peanut kernels will be continued using a Hewlett Packard LF 4192 analyzer and 9845 computer over a frequency range of 10 Kilohertz to 10 Megahertz. Correlations will be made with the dielectric constants, degree of mold damage, and moisture content of the kernels. These studies will utilize the recently constructed electronical controlled inoculation chamber for accurate programming of temperature and relative humidity. In addition, tests will be conducted in a rectangular capacitive test cell to minimize replicate variation and provide additional safety.

Mr. Amagone N'Doye will continue animal feeding studies designed to test the efficacy of currently employed chemical detoxification procedures for aflatoxin contaminated peanut meal in Senegal. Mr. N'Doye will be involved in a technical training program in November - December, 1985 within the Department of Veterinary Public Health at Texas A&M University. He will obtain training in experimental design and laboratory procedures necessary to assess the toxicokinetics of distribution elimination and metabolism of aflatoxin in animals. Sample analysis will be carried out at the ITA laboratories by Mr. Bachir Sarr and Mr. Amadou Kane.

"PEANUT VIRUSES: ETIOLOGY, EPIDEMIOLOGY, AND NATURE OF RESISTANCE"

University of Georgia - Institute for Agricultural Research
at Ahmadu Bello University, Nigeria

James W. Demski, Principal Investigator, UGA

INTRODUCTION

Groundnut (peanut) rosette is a major constraint in the production of peanut in Africa and along with other viruses cause significant yield losses. Groundnut rosette has been known since 1907, but the etiologic agent(s) has not been clearly defined. Before control measures can be implemented the etiologic agents must be defined, a rapid method of identifcation developed, the source of virus found and the nature of resistance elucidated.

Currently a new virus infecting peanut in the U.S. is being identified and characterized. Preliminary data indicate this new virus, if established in peanut in the U.S. and other areas of the world, has the potential to become a damaging virus of peanut because of its high frequency of seed transmission, rapid dissemination in the field where the crop often takes over four months for maturity, and the yield loss it induces.

MAJOR ACCOMPLISHMENTS

Establishment of project

This project was established when Dave Cummins and James Demski went to the Institute of Agricultural Research (Nigeria) in February 1982 to discuss goals, research objectives, and collaborative work with Director John Davies, Dr. Colin Harkness and Dr. Steve Misari. Mutual interests were confirmed and a Memorandum of Understanding and Plan of Work was signed.

In 1983, Cedric Kuhn worked at the Virus Institute, Braunschweig, W. Germany (October 9, 1983 to October 23, 1983) and Nigeria (October 24, 1983 to November 2, 1983). James Demski worked in Nigeria from 7/16/83 to 8/5/83 (last 2 days in Germany) and again from 10/22/83 to 11/7/83. Okon Ansa left Nigeria and worked in the Scottish Crops Research Institute from March 15, 1984 to April 16, 1984. Additionally, other cooperating scientists worked on groundnut rosette in 1983-1984. Dr. D.V.R. Reddy from ICRISAT worked at the Scottish Crops Research Institute from November 1983 to the end of April 1984. Sylke Meyer from Germany worked in Nigeria from 10/23/83 to 11/7/83.

Research results

In Africa mechanical transmission of chlorotic rosette was increased to 80 percent efficiency from peanut to peanut. The key component in the inoculation buffer appeared to be the addition of magnesium bentonite.

With Mg bentonite, over 80 percent of the plants became infected, without Mg bentonite 10 percent or less.

Field spread of both green and chlorotic rosette was monitered on a weekly basis in 1983. Disease spread (from previously infected plants) occurred more within a row than between rows. Since the distance between plants in a row is 10 to 20 cm and between rows 80 to 120 cm, this may indicate that non-winged aphids play a major role in the secondary spread.

The occurrence of cowpea mild mottle virus naturally infecting peanut in Nigeria was confirmed in 1983. In several cases it was found in plants infected with chlorotic rosette. The significance of this dual infection is being studied.

Nucleic acid extracted from groundnut rosetted plants was infectious and sensitive to ribonuclease. Furthermore, virus specific double-stranded ribonucleic acid could be isolated from rosetted plants. Several species of plants appeared to be susceptible to groundnut rosette, one or more of which may be important in viral nucleic acid studies.

In the U.S., the new virus derived from contaminated seed from the Peoples Republic of China, and now infecting peanut in all major peanut producing states has been named peanut stripe virus (PStV). The virus has been partially characterized (publication in press - Annals of Applied Biology) and identification procedures worked out. A test to detect PstV directly in individual peanut seed without harming the germination of the seed has been developed. Healthy bait plants, grown in areas where PstV infected peanut was grown the previous year in Georgia, did not become infected with PStV. Thus control measures aimed to excluding the source of virus in contaminated seed lots may prove effective. Although resistance to PStV has not been found in peanut, control programs consist of identifying all plantings of peanut that are contaminated with PStV and recommending that the harvested seed be used for processing and not for planting. Seed lots of unknown contamination are being tested and only healthy seed are being planted.

EXPECTED IMPACT OF PROJECT

In host-country. Because of the epidemic of rosette in Nigeria in 1975, many growers have reduced or eliminated peanut production in their farming operations. After initial research efforts have defined the basic epidemiological aspects, and the causal agents can be readily identified and manipulated, then this will open the way for numerous research opportunities. Breeding programs and ecological studies can be instituted, control strategies can then be made available for use by peanut breeders. The biological nature of resistance and genes conferring resistance will be established. Studies on epidemiology will provide a variety of approaches which can be used in control. All approaches may be used in an integrated control program or specific approaches may be adapted to disease and environmental conditions in a given geographical area. Control of rosette disease should permit growers to produce peanut profitably and thus reverse the declining production trends and raise the per capita production.

In U.S. The CRSP virus project has lead to the discovery of a new virus infecting peanut in the United States. This virus has the potential to be the most devastating virus in U.S. peanut production if not controlled. Programs are underway to eliminate this seed borne virus before it becomes endemic in other hosts that could serve as new sources of inoculum.

The University of Georgia will maintain an antisera bank and a seed bank of virus free seed. It will be possible to achieve rapid diagnosis of the peanut virus diseases in any part of the world without sophisticated facilities by serological tests and host reactions. These tools will be available on a world basis. If written instructions for diagnosis are inadequate, a short course will be developed for presentation wherever needed.

GOAL

Virus diseases, in epidemic proportion, are limiting factors in peanut production. The three most destructive virus infecting peanut, on a worldwide basis, are peanut mottle (PMV), groundnut rosette (GR), and bud necrosis (BN). BN is especially damaging in India where major research efforts at ICRISAT are directed towards the problem. PMV is worldwide in distribution but except for identification and yield loss documentation, little research has been done outside the USA and ICRISAT in India. GR although restricted to Africa, is extremely important because of the serious losses it induces and the large quantity of peanut produced in the African countries. We propose in-depth research on GR, some epidemiological and resistance studies on PMV, and the identification of other viruses of peanut that occur in Africa and the U.S. Therefore, the major goal of this project is through research efforts to attain a better understanding of the causal agent of GR and the disease so that some methods of control can be developed for GR and other viruses.

OBJECTIVES

A. Determine the etiology of groundnut (peanut) rosette.

B. Determine the epidemiological factors of groundnut rosette.

C. Select and determine the nature of resistance in groundnut to groundnut rosette.

D. Identify other peanut viruses, determine the variants of these agents, and develop means of rapid identification.

ORGANIZATION

University of Georgia

Dr. James W. Demski, Principal Investigator, Dept. of Plant Pathology, Georgia Experiment Station, Virologist
Dr. Cedric Kuhn, Cooperator, Dept. of Plant Pathology, Athens, Virologist

Istitute for Agricultural Research (IAR)

Dr. Steve Misari, Dept. of Crop Protection, Ahamadu Bello University, Samaru-Zaria, Nigeria, Vector entomologist
Dr. Okon Ansa, Virologist

Informal cooperation exists with ICRISAT with D.V.R. Reddy cooperating. Dr. Reddy's address is: Dr. D.V.R. Reddy, Principal Virologist, International Crops Research Institute for Semi-Arid Tropics, Patancheru P.O., Andhra Pradesh 502324, India.

Informal cooperation also exists with the Virus Institute in W. Germany with Dr. Rudolf Casper cooperating. Dr. Casper's address is: Dr. Rudolf Casper, Biologische Bundesanstalt Fur Land-und Forstwirtschaft, Institute Fur Viruskrankheiten der Pflanzer, Messeweg 11/12, 3300 Braunschweig, West Germany.

Because the U.S. and India have peanut production, but do not have groundnut rosette, those phases of the work that are difficult to complete in Africa are done in Germany. Germany does not have peanut production so fresh tissue can be studied in the laboratory having modern facilities.

Also, for a four month period (Nov. 1983 through Feb. 1984) Dr. Reddy worked on the chemical characterization of the mechanical transmissible component of groundnut rosette and its relationship to the aphid transmissible component in Dr. Tony Murants laboratory in Dundee, Scotland. Dr. Ansa from Nigeria took tissue to Scotland from Nigeria (that Dr. Demski and Kuhn inoculated) and spent two weeks working on nucleic acid extraction techniques. This will enable Dr. Ansa to do extensive studies in Nigeria on the etiology of groundnut rosette.

Methodology

In May 1983, a planning conference was held at the Georgia Experiment Station for the purpose of determining the approach to the various facets of the research problem. The various cooperators have special skills that should help bring the project to a successful conclusion.

Dr. Steve Misari in Nigeria is a specialist in insect vectors and will develop those facets of the program related to aphid transmission. He also works closely with Dr. Demski on the epidemiology phases.

Dr. Okon Ansa has a background in molecular biology and serology. He will work on virus purification, nucleic acid extraction, and serology to the extent that can be completed in Nigeria, but may also go to European labs.

Dr. D.V.R. Reddy has worked extensively with ELISA serology and has many antisera to different peanut viruses which are available to all workers. He will also work on the chemical characterization of rosette components. Dr. Reddy has spent one month of a years sabbatical leave in Dr. Demski's lab in the U.S. and Dr. Murrant's lab in Scotland.

Dr. Rudolf Casper has an excellent facility including the use of an electron microscope. Components that have been separated in Nigeria are being taken to his lab for various assays including serology and nucleic extraction. In addition, a graduate student (Sylke Meyer) may go to Nigeria to do serological tests for different peanut viruses. She is trying to produce an antiserum specific to the luteo virus in groundnut rosette. Dr. Breyel has recently started work in the German lab. He is working on the molecular basis of groundnut rosette.

Dr. Cedric Kuhn has extensive experience with virus manipulation (transmission, separation, isolation), nucleic acid extraction, serological testing and studying the nature of resistance. He will work both in Germany and Nigeria on these facets.

Dr. James Demski will work on the epidemiology aspects, separation of components in Nigeria and in general coordinate the project.

RESEARCH PLAN, 1982 to 1989

Stage I - years 1 to 3 - Research completed

1. Improved method to mechanically inoculate peanut with groundnut rosette virus - chlorotic strain (Demski, Misari, Ansa, Kuhn-Nigeria).

2. Serological identification of a luteovirus associated with groundnut rosette (Casper, Reddy - Germany).

3. Association of an infectious nucleic acid with the symptom inducing agent which causes the groundnut chlorotic rosette (Reddy, Murant, Ansa - Scotland; Kuhn, Casper - Germany).

4. Confirmed the requirement of the presence of the luteovirus for aphid transmission of groundnut rosette; also the failure of aphids to transmit groundnut rosette from infected mechanically inoculated plants (Misari, Demski, Ansa, Reddy, Casper - Nigeria, Germany, Scotland).

5. Identification of more desirable hosts than peanut to culture groundnut rosette virus for nucleic acid studies (Demski, Ansa - Nigeria; Reddy - Scotland; Casper, Kuhn - Germany).

6. Isolation and characterization of peanut stripe virus (PStV), a new virus in the southeastern United States introduced from the People's Republic of China (Demski, Reddy - Georgia).

7. Extensive survey of peanut viruses in Georgia (Demski, Kuhn, Reddy - Georgia).

8. Identification of peanut stripe virus in peanut researcher's experimental fields (Demski, Reddy - Georgia).

9. Development of a serological technique to identify peanut stripe virus in infected peanut seeds (Demski, Reddy - Georgia).

Stage II - years 4 to 6

Purification and characterization of the groundnut rosette luteovirus (Casper, Breyel - Germany).

Isolation and characterization of the nucleic acid of the groundnut rosette luteovirus (Casper, Breyel - Germany).

Production of antiserum specific for the groundnut rosette luteovirus (Casper, Breyel - Germany).

Isolation and characterization of the single-stranded (ss) and double-stranded (ds) nucleic acids associated with the symptom-inducing-agent of groundnut rosette (Casper, Breyel, Kuhn-Germany).

Preparation of complementary (c) deoxyribonucleic acid (DNA) to the nucleic acids of the luteovirus and the symptom-inducing-agent (Casper, Breyel, Kuhn - Germany).

Development of a differential host range to identify strains of peanut mottle virus (PMV) (Kuhn - Georgia).

Preparation of cDNA to the nucleic acids of eight strains of PMV and other potyviruses infecting peanut (Sukorndhaman, Kuhn - Georgia).

Development of a cDNA dot blotting hybridization method to assay peanut plants for four viruses: (i) groundnut rosette luteovirus, (ii) groundnut rosette symptom-inducing-agent, (iii) PMV, (iv) peanut stripe virus (Casper, Breyel, Sukorndhaman, Kuhn, Ansa - Germany, Georgia, Nigeria).

Determination of properties of a new strain of PMV (chlorotic stunt): (i) physicochemical properties, (ii) seed transmission, (iii) effect on yield, (iv) epidemiology (Demski, Kuhn, Warwick - Georgia).

Studies of resistance to groundnut rosette: (i) compare the effect of mechanical and aphid inoculation on susceptible and resistant peanut cultivars, (ii) compare the spread of groundnut rosette in fields with susceptible and resistant peanut cultivars, (iii) compare field spread of groundnut rosette specifically resistant to mechanical and aphid inoculation (Misari, Demski, Ansa, Kuhn - Nigeria).

Initiate inheritance of resistance studies by making crosses among appropriate susceptible and resistant peanut cultivars (Misari, Demski, Kuhn, Ansa - Nigeria).

Search for resistance in peanut to PStV (i) resistance to infection, and (ii) resistance to seed transmission (Demski, Warwick - Georgia).

Identify susceptible and resistant cultivars of legumes to PStV (primarily soybeans and cowpeas) since they may play a role in the disease cycle of PStV (Demski, Warwick - Georgia).

Stage III - years 4 to 8 - research will overlap with and be coordinated with studies in stage II

A. The following research will be initiated as soon as two potent diagnostic research tools are available, cDNA prepared for the nucleic acids of the groundnut rosette symptom-inducing-agent (SIA) and the luteovirus (LV) and ELISA conjugates for the luteovirus:

1. Survey in Nigeria, and perhaps other African countries, for the presence of single and mixed infections of SIA and LV in peanut (Misari, Ansa, Demski, Kuhn, Reddy).

2. Survey in the United States for LV in symptomless peanut (Demski, Kuhn).

3. Survey for sources of inoculum of SIA and LV in natural hosts other than peanut (Misari, Ansa, Demski, Kuhn - Nigeria).

4. Analysis of purified virions of luteovirus to determine if the SIA nucleic acid is encapsidated by the LV coat protein (Ansa, Kuhn - Nigeria/Germany).

5. Comparison (dot blot hybridization of the nucleic acids of variants of SIA (such as chlorotic rosette, green rosette, and mosaic rosette) (Ansa, Kuhn, Casper - Nigeria/Germany).

6. Determine nature of resistance to groundnut rosette by critcal studies of the SIA and LV nucleic acid replication cycles and dsRNAs and subgenomic RNAs (Kuhn, Ansa - Nigeria/Germany).

7. In inheritance studies, evaluate F_1,F_2, and F_3 populations for reaction to SIA alone, and a mixture of SIA and LV; criteria for evaluation will include symptomatology, field performance, and factors related to the nature of resistance (item 6 above) (Misari, Ansa, Kuhn, Demski - Nigeria).

8. Epidemiological studies will include monitoring field spread under a variety of conditions of single and mixed infections (Misari, Demski, Ansa - Nigeria).

9. Aphids will be collected from a variety of sources and at different times of the year to detect the presence of SIA, LV or both (Misari, Demski, Ansa - Nigeria).

B. In the United States, studies will be conducted with peanut mottle virus (PMV) and peanut stripe virus (PStV). The production of cDNA to the viral nucleic acids will be necessary for some of the studies.

1. Nature of resistance studies to determine the PMV and PStV viral nucleic acid replication cycle in peanut; compare plants with different levels of resistance to one or more strains of the viruses (Kuhn - Georgia).

2. Attempt inheritance of resistance studies between susceptible *Arachis hypogaea* and other *Arachis* species which are resistant to PMV and PStV (Demski, Kuhn, Sukorndhaman - Georgia).

3. Determine the nature of resistance to PMV in soybean; potential for gene transfer from soybean to peanut (Kuhn, Sukorndhaman - Georgia).

4. Compare the effects of PStV alone and in combination with other viruses infecting peanut on (i) yield, (ii) total oil and protein, and (iii) fatty acid composition (Demski - Georgia).

5. Identify, determine incidence and formulate yield loss models for the viruses infecting peanut in the southeast (Kuhn, Demki - Georgia).

Presentations to Professional Groups

1983 J.W. Demski to Directors and other professionals working with peanut (in Atlanta, GA) on peanut stripe virus.

1983 J.W. Demski to regulatory personnel (in Washington, D.C.) on peanut stripe virus.

1983 C.W. Kuhn and J.W. Demski to the faculty at Ahmadu Bello Universtiy (in Nigeria) on the production of peanut in the U.S.

1984 J.W. Demski to the Southern Division of the American Phytopathological Society on Groundnut Rosette.

1984 J.W. Demski to the Southern Division of the American Phytopathological Society on peanut stripe virus.

1984 J.W. Demski to the Georgia Association of Plant Pathologists on peanut stripe virus.

1984 D.V.R. Reddy to the University of Georgia Division of Plant Pathology on International Programs and groundnut virology.

1984 C.W. Kuhn to the Society for International Development on virus studies in Nigeria.

1984 J.W. Demski to the International Seed Testing Association on testing peanut seed for viruses.

1984 J.W. Demski to the American Peanut Research and Education Society; organizer and chairman of a panel discussion on peanut stripe virus.

Publications

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BAYS, D. C., J. W. DEMSKI, and A. M. Schubert. 1984. A potyvirus from clover that infects peanuts. Phytopathology (ABSTR.). (In Press).

"IPM STRATEGIES FOR PEANUT INSECTS IN SAT AFRICA"

University of Georgia - University of Ouagadougou, Burkina Faso

Robert E. Lynch, Principal Investigator, UGA

INTRODUCTION

Developing countries in SAT Africa offer great promise for expanded food production with their vast arabale lands suitable for agricultural production. At present, the primary goal of these SAT countries is to stabilize crop production. Often insects and insect borne diseases are associated with the unstable crop production. Research on the insects associated with peanut production and development of IPM strategies will aid in stabilizing crop production in these countries.

MAJOR ACCOMPLISHMENTS

Establishment of Project

Dr. Robert Lynch traveled to Ouagadougou, Burkina Faso in July, 1983 to establish a collaborative peanut research support program with the Institute Superior Polytechnique at the University of Ouagadougou, obtain signatures for the Work Agreement, and to discuss research plans and budget for the first year of the project. Collaboration was established with Dr. Albert Pation Quedrago, entomologist, at the University of Ouagadougou with assistance from Dr. Idrissa Dicko, plant pathologist.

In November, 1983 a detailed outline of the first years research was sent to Drs. Ouedrago and Idrissa which received their approval. Three major objectives were addressed in the first years research:

(1) survey the insects of Arachis throughout the growing season to determine population densities and damage
(2) determine the influence of different seed bed preparations and local peanut varieties on insect damage
(3) evaluate U.S. germplasm and local varieties for susceptibility to insect damage.

Equipment and supplies necessary to accomplish these objectives were ordered in the U.S. and are being shipped to Burkina Faso. Dr. Lynch traveled to Quagadougou in June, 1984 to assist in the initiation of this research.

Research Results

The first year's research on insects associated with peanut was initiated in Burkina Faso in 1984. Three major objectives were addressed: 1) Survey the arthropods associated with peanut production throughout the major peanut growing areas in Burkina Faso and determine their relative abundance in relation to plant phenology; 2) determine the

influence of different local seed-bed preparations on arthropod damage to peanut; and 3) evaluate U.S. and local germplasm for susceptibility to insects. During 3 survey trips, 10 orders of arthropods were collected on peanut. These arthropods are presently being identified by taxonomic specialists. Four groups of insects were classified as potentially of economic importance. These include thrips, jassids, millipedes, and termites. The most severe damage was caused by termites during the latter part of the growing season. Preliminary results should higher termite populations when peanut was planted on ridges compared to flat seedbeds.

Training

Mr. Idrissa Ousmane Dicko of the University of Ouagadougou attended the American Peanut Research and Education Society Annual Meeting and the Peanut CRSP Research Meeting. Mr. Dicko also visited the Coastal Plain Experiment Station, Tifton, Georgia, to observe peanut research.

Mr. J. Arsene Some Solibo worked at the Insect Biology and Population Management Research Laboratory, Tifton, GA., for 3 months before continuing work on his M.S. degree in entomology at the University of Georgia. Mr. Solibo assisted in all phases of peanut research, gaining valuable experience in both laboratory and field plot techniques. In April, he will complete his M.S. degree and return to Burkina Faso, where he will assist Dr. Ouedrago with the Peanut CRSP Entomology Project.

EXPECTED IMPACT OF PROJECT

Research to define the major economic insects of peanut and development of IPM strategies within the socio-economic frame of the host country will reduce this direct threat to stability in peanut production.

GOAL

Identify the major arthropod pests of peanut, determine their relationship with aflatoxin contamination, develop economic thresholds for these pests, and develop IPM strategies and control measures to reduce losses to these pest.

OBJECTIVES

A. Identify the major economic pests of peanut.

B. Determine the relationship between level and type o. arthropod damage with aflatoxin contamination in both preharvest and postharvest peanut.

C. Develop economic injury levels for the major arthropod pests by quantifying pest density with peanut yield.

D. Develop reliable sampling procedures to estimate population density of the major pests.

E. Determine arthropod abundance as related to peanut season and developmental phenology.

F. Provide opportunity for training for Burkina Faso students.

G. Develop bait attractants or other control strategies for major insect pests.

H. Evaluate promising breeding lines, developed by the Breeding CRSP or from ICRISAT, for resistance-susceptibility to major arthropod pests.

I. Develop IPM strategies for control of the major insect pests and evaluate these strategies in farmer's fields throughout the growing season.

ORGANIZATION

University of Georgia

Dr. Robert E. Lynch, Principal Investigator, Southern Grain Insect Research Lab, Tifton, Entomologist

Institute Superior Polytechnique (ISP)

Dr. Albert Pation Ouedrago, Collaborating Scientist, University of Ouagadougou.

Approach

During the first phase of the Peanut CRSP, focus will be placed on three main objectives.

1. Survey the insect problems of peanut at six locations in Upper Volta to relate arthropod densities with peanut developmental phenology.

2. Evaluate local peanut varieties for arthropod damage using two different cultural practices common in Burkina Faso.

3. Evaluate advanced breeding lines in the Breeding CRSP program along with local varieties for arthropod damage at the Gampala Research Station.

Collaborative research has been established with the Institute Superior Polytechnique, University of Ouagadougou, Burkina Faso with Drs. Albert P. Ouedrago and Idrissa Dicko as collaborating scientists. In 1983 the Memorandum of Understanding and Plan of Work were signed and returned, and initial plans were made for the entomology research. In September, 1983, $10,000 was transferred to the University of Ouagadougou for the Peanut CRSP-Entomology project. A detailed research plan covering objectives and

procedures for the first years research was forwarded to the collaborating scientists in Burkina Faso and approved. Supplies for this research were purchased in the U.S. and mailed to Burkina Faso. Dr. Idrissa Dicko obtained cooperation from farmers in six areas of south or southwest Burkina Faso to conduct insect surveys on peanut. Dr. Robert Lynch traveled to Burkina Faso in June, 1984 to assist in initiating the pre-harvest research and in November, 1984 to assist in initiating the post-harvest research.

During the second phase of the CRSP, research will focus on:

1. Continue the survey for arthropods with peanuts throughout the major peanut growing regions.

2. Continue to evaluate the different seed-bed preparations common to Burkina Faso for their influence on insect damage to peanuts.

3. Evaluate the most promising breeding lines and local cultivars for susceptibility to arthroped damage.

4. Utilize insecticides for control of thrips and jassids during the early part of the growing season, and termites and millipede during the latter part of the growing season in comparison to untreated check plots to determine the effect of thses arthropods on yield loss.

5. Evaluate the effect of harvest date on yield, termite damage, and aflatoxin contamination in peanut. Pre- and post-harvest aflatoxin contamination and buildup will be evaluated.

"An Interdisciplinary Approach to Optimum Food Utility of Peanut in SAT Africa"

Alabama A&M University - Democratic Republic of the Sudan

Bharat Singh, Principal Investigator, AAMU

INTRODUCTION

Recent events clearly indicate that there is an urgent need to reduce food shortage and combat malnutrition in SAT Africa, especially in the Sudan. Even though Sudan is the fourth leading country in peanut production, the amount of peanut used per capita is relatively small. While some of the peanut produced is crushed for domestic oil consumption, most of the peanut meal is exported rather than used within the country. The data from a recently conducted survey indicate that peanut consumption in the Sudan has been limited by various constraints, most importantly lack of appropriate food preservation and preparation technology, as well as socioeconomic problems. There are just not enough peanut products available at an affordable price for most Sudanese. Understanding of the environmental and socioeconomic contraints, as well as those of food preservation and preparation technology are needed if sufficient cost-effective, tasty, nutritious and aflatoxin-free peanut is to be made available. In addition to production technology, cultural practices impacting the supply of peanut include storage techniques and inventory management stystems.

In Sudanese populations, the change most desired in food consumption is to have a reliable and adequate supply of the traditional diet. This emphasis should reflect in development of research capabilities sensitive to research needs of the region, specifically, research on optimizing food utility of te peanut. The first phase of the study included a consumption survey to assess (at different income levels and in contrasting markets) the current and potential dietary role of existing peanut products. Further, a survey was conducted to assess post-harvest practices that impact upon the supply of peanut, including storage techniques and inventory management techniques.

MAJOR ACCOMPLISHMENTS

Establishment of Project

The project was reviewed and approved by the Directorate of Agriculture and the Ministry of Agriculture in the Sudan in June, 1983. The linkage with the Agricultural Research Corporation and Food Research Centre of the Sudan and Alabama A&M University and the Management Entity of the Peanut CRSP was formalized through a Memorandum of Understanding.

Research Results

Collaborative work at Alabama A & M University and Food Research Centre: A team consisting of Alabama A & M scientists (Singh, Wheelock,

Jones, and Caples), and Food Research Centre scientists (Bashir, Magboul, Khalid, and Zakaria) completed proposed surveys on consumption and post-harvest handling of peanut in the Sudan in January, 1984. The data analysis has been completed at Alabama A & M University on consumption of peanut in urban and rural populations in Sudan and post-harvest survey in the Wad Medani area.

Results of the consumption survey indicate that peanut is used in the Sudan in various forms including roasted, ground (or pastes), peanut oil, boiled, and raw. The most commonly utilized form is the roasted peanut followed by ground peanut (or paste). Peanut paste as an ingredient in salads, soups, and various household preparations, was rated higher in preference than any other peanut product. The data on peanut purchases per month indicate that a Sudanese family buys, on an average, from 2.13 kg to 3.13 kg. of whole peanut and 1.53 to 7.45 kg of peanut paste, depending upon household budget class. In general, more peanut is used in rural areas than in urban areas. Boiled peanut is used primarily in rural areas. A significant number of respondents indicated that cost of peanut was the reason for their not consuming more peanut. In the Wad Medani area, a household may have approximately (average) 300 lbs of peanut stored for consumption, 4,000 lbs for sale, and 400 lbs for seed. Most rural respondents were not aware of the storage problems (59%), while few (3%) reported insects as a problem, and a significantly greater number (28%) reported rodents as a problem. None were aware of mold or aflatoxin contamination.

Alabama A & M University

B. Singh and Esmond W. Joseph completed a study on evaluation of nutritional quality, rheological and baking characteristics of a blend of wheat, peanut, and black-eye pea flours. Acceptable cookies were made from composites containing 50% wheat, 35% peanut, and 15% black-eye pea flours. Acceptable breads prepared using 70% wheat, 20% partially defatted peanut, and 10% black-eye pea flours had 70% more protein compared to breads prepared with wheat alone. The rheological data indicated that the composites were better suited for cookie baking rather than bread baking. Composites contained significantly lower contents of tannins but higher levels of phytic acid and trypsin inhibitor activities than wheat flour. No detectable amounts of aflatoxins were found.

D.R. Rao and W.K. Kelker completed a study in supplementation of "gari" (a traditional Nigerian food) with peanut, cowpea, and soy flours. The objective of this research was to develop a high-protein "gari" without significantly altering its organoleptic characteristics. Taste panel studies conducted at Alabama A & M University revealed that addition of untoasted partially defatted peanut flour was acceptable to a 20% substitution level. A distincitive peanut flavor was detected in products enriched with partially toasted and defatted peanut flour.

Food Research Centre

Scientists at Food Research Centre completed chemical analysis of peanut collected from rural areas near Wad Medani and El Obeid. The data indicate presence of small amounts (less than 20 ppb) of aflatoxins in almost all samples.

The analysis of data from El Obeid is also completed. The data indicate that only 12.5% of the surveyed households in the El Obeid area stored peanut for sale and 28% for seed compared to 83% for sale and 82% for seed in the Wad Medani area. The smaller percentage of households storing peanut for sale in the El Obeid area may be explained, among other things, by (a) the fact that peanut are usually sold immediately after harvest because of the need for immediate cash, (b) general inefficiency and unavailability of storage facilities.

EXPECTED IMPACT OF PROJECT

Impact of Project in Sudan

(1) The project has established a linkage between Alabama A&M University and the Sudanese scientists at the Agricultural Research Corporation and Food Research Centre. This will lead to long-term collaborative research studies, and development of peanut-based food products. Since the establishment of the project, the Food Research Centre has enhanced its capability to conduct research on peanut and peanut products, including analysis of peanut for aflatoxin contamination, proximate composition and other constraints.

(2) The data from the consumption and post-harvest survey have provided a basis for research on improvement of peanut products. Also, theneed for further studies on post-harvest handling of peanut in the Sudan is suggested.

(3) The most vulnerable Sudanese populations (rural/urban) may have increased and prolonged opportunities to benefit from peanut consumption.

(4) To impact favorably the status of women, techniques will be designed to utilize and reward women's indigenous means of production. The project aims to identify improved and innovative peanut processing technologies to allow increased efficiency of women in family food preparation and/or alternative income generating activities, e.g., peanut-based foods as a cottage industry product for sale.

(5) More specifically, the project will enhance the capability of the Agricultural Research Corporation to analyze peanut, peanut products and other food products for aflatoxin and other contaminants and to analyze the socio-economic impact of peanut utilization.

Impact of Project in U.S.

(1) The project has provided an opportunity to Alabama A&M University to develop capability in solving world problems and to further strengthen programs in international food and agriculture.

(2) Since the establishment of the project, the School of Agriculture at Alabama A&M University has started a project on evaluation of toxic components of peanut flour and meal including protease inhibitors, phytic acid and aflatoxins. It certainly will enhance the program on utilization of peanut.

(3) Also since initiation of the project, an Alabama A&M farming systems project for North Alabama has been proposed and is expected to be funded by O.I.C.D. It will benefit from the experience with the post-harvest survey and on farm research in Sudan.

(4) The result on breeding and selection of aflatoxin resistent varieties of peanut in the Sudan and other Peanut CRSP host countries will be of significance to the farmers of Alabama and other peanut growing states.

(5) The State of Alabama will further derive benefits through the transfer of technologies of peanut processing and utilization to the Sudan.

GOALS

General Goal

To foster interdisplinary (nutrition, food science, social and economic) institutional-based linkages between U.S. and LDC scientists serving major peanut producing and consuming populations of the Semi-Arid Tropic region of Africa for the purpose of optimizing the food utility of the peanut.

Specific Goals

Specific goals of the project are consistent with the general goal of the Peanut CRSP to develop collaborative research and development programs on the peanut between social scientists and food scientists at Alabama A&M University and the Agricultural Research Corporation of the Sudan.

OBJECTIVES

A. Description and understanding of variations in environment, socioeconomics, and food technologies as they constrain the preservation and utilization of peanut supplies.

B. Analysis of the current and potential dietary role of existing peanut products.

C. Research on the improvement of existing peanut products and the development of new products with suitable energy density, nutrient concentrations and preferred tastes at acceptable cost.

D. Research on appropriate post-harvest handling and storage technology.

E. Assurance of safety of the products with particular reference to mycotoxins in raw and finished products, and

F. Exchange of peanut germplasm for breeding resistent varieties to aflatoxin.

ORGANIZATION

Alabama A&M University

Dr. Bharat Singh, Principal Investigator, Department of Food Science, Normal, Food Scientist
Dr. John C. Anderson, Cooperator, Department of Food Science, Normal, Food Scientist
Dr. Virginia Caples, Cooperator, Division of Home Economics, Normal, Home Economist
Dr. Hezekiah Jones, Cooperator, Department of Agribusiness, Normal, Rural Economist
Dr. D. R. Rao, Cooperator, Department of Food Science, Normal, Nutritionist
Dr. G.C. Wheelock, Cooperator, Department of Agribusiness, Normal, Rural Sociologist.

Sudan

Agricultural Research Corporation and Food Research Centre
Dr. H.M. Ishag, Principal Investigator, National Coordinator, Groundnut Research
Dr. B. Bashir, Deputy Principal Investigator, Food Research Centre
Dr. A.B. Ahmadi, Plant Breeder, ARC
Dr. S.M. Badi, Cereal Chemist, FRC
Dr. A.S. Khalid, Microbiologist, FRC
Dr. B.I. Magboul, Nutritionist, FRC
Dr. A.G. Tayeb, Chemist, ARC
Mr. Asha El Karib, Rural Economist, FRC

Graduate Students and Research Projects for Thesis

Mr. Obie Warren (Started Fall, 1984). A survey of nutrient contents and aflatoxins in peanut products available in Alabama market channels.

Mr. Ahmed El Murtada Ahmed (Started Fall, 1985). Utilization of peanut cake in a sorghum-based product - Kishara.

Mr. Ismeldin Hashim (Started Fall, 1985). Effects of blanching, carbon dioxide and packaging materials on storageability of shelled and unshelled peanut.

Relationship with International Agencies

The A&M team members have discussed the project objectives with members of the Nutrition Division of the FAO. There is a possibility of collaboration in aflatoxin area in the Sudan. Similar relationships will be developed with Tropical Products Institute in London and ICRISAT and CFTRI, India in the future.

Research Plan and Approach 1985-1989

A., B. The first phase of the plan of work (1982-1985) included a consumption and post-harvest survey in the Sudan. These surveys have been completed. Based on the survey results in two rural areas and two urban areas of the Sudan and discussions with Sudanese scientists and administrators,the following research objectives have been planned or are in progress.

C. Improvements or Modifications in Peanut Processing

(i) Roasted peanut: The survey data indicated that the most utilized form of peanut product is roasted peanut. Roasted peanut is used primarily outside the home either roasted in-shell or "ashed" shelled peanut. The proposed research plan during 1985-1989 include both development of methods for roasting shelled peanut and unshelled peanut. Currently peanut are roasted by vendors generally in small batches using traditional methods. Attempts will be made to introduce a simple roaster that could be made accessible to small entrepreneurs. Increased efficiency in roasting will lead to increased availability of roasted peanut. Further, the roasted peanut will be packaged for longer periods of storage in homes, especially in urban areas. Variety will be created using salt and special flavorings or spices acceptable to Sudanese populations. This part of the research will be conducted mainly at the Food Research Centre in Sudan.

(ii) Peanut paste: The second most utilized form of peanut products is the peanut paste. This product is prepared by certain groups of Sudanese in homes using the traditional method of roasting on hot sand, size reduction by mortar and pestle (wooden) and then further grinding on a stone slab by bottles. The product is sold in the market wrapped in newspaper or plastic bags. The work is planned for improvement of the grinding process; then on packaging and marketing of the packaged product. This part of the research will be conducted at Food Research Centre. Alabama A & M scientists will assist this research on process development, evaluation of the product using nutritional studies, chemical, and microbiological analyses. The research is already in progress on (a) description of the production (proximate and other nutrient compositions, texture, color); (b) survey of the current methods of preparation: acquisition of raw materials, shelling, sorting, roasting, skin removal, grinding and packaging; (c) identification of contaminants: sand, silica, insect and animal residues; (d) naturallyoccurring toxin substances: protease inhibitors, phytic acid, goiterogenic substances; (e) microbiological contaminants: molds, bacteria, microbial toxins.

(iii) Research on incorporation of peanut flour or protein in existing Sudanese dishes: Research has been planned to incorporate peanut proteins from the peanut meal (after extraction of oil) in breads and in "Kishara". "Kishara" is a sorghum-based product. A graduate student from Sudan has already started preliminary work on incorporation of peanut meal in "Kishara". Promotion of peanut fortified products in the Sudan will be suggested only if the approaches are deemed acceptable and technologically and economically advantageous after trial with model families who will be engaged to aid the evaluation of the products.

(iv) Research Production of New Acceptable Foods: It is desirable to produce foods where shelf life is considerably increased. However, the new product should resemble local products and should not contain unusual flavor or taste. For example, lactic cultures or other fermentation processes may be used with peanut products to improve shelf life. This may also lead to inactivation of aflatoxin. It is proposed that considerable effort be made to produce economical, acceptable, and

marketable products. Any concept using technology which can be easily transferable to village economies will be explored, e.g., village texturizer. The research on these products will be done at Alabama A & M University as well as at the Food Research Centre.

(v) Socioeconomic impact: Socioeconomic impact of improvement in product will be determined. This will include studies on: (a) traditional processing industry vs improved processing, (b) street foods and vendors vs sales in stores. Studies on the socio-economic impact of post-harvest handling and storage will include comparisons of the improved system with traditional methods.

(vi) Assessment of the Role of Women: Assess the role and activities of women in peanut processing and utilization. This will include assessment of the role of women in post-harvest handling, processing, and marketing of peanut and peanut products.

D. Improvement of Post-Harvest Handling and Storage: Results from the post-harvest survey indicated that additional information is needed to plan improved post-harvest handling and storage systems, especially in peanut producing areas of the Sudan. Research is in progress to collect additional information on maturity index and changes in nutrient compositions during storage in homes. It is expected that a model storage facility will be established to reduce losses and to avoid contamination of aflatoxins during post-harvest handling and storage. A variety of appropriate structures will be considered and evaluated. If possible, efforts will be made to establish common controlled atmosphere facilities for common storage, probably on a cooperative basis, or by small entrepreneurs.

E. It was determined in the early phases of the collaborative effort that aflatoxin must be managed to assure food products with low health hazards from aflatoxin. Basic equipment for an analytical lab was provided. Samples taken in the survey have been analyzed. The Sudan lab will continue research throughout the product development phase to identify and minimize aflatoxin in peanut food products.

F. The CRSP management arranged for the Sudan breeding project to collaborate with an ICRISAT coordinated program to participate in cultivar testing program on aflatoxin resistance. This assistance was provided at the request of the Sudan administrative group, because they recognized the great problem of aflatoxins.

G. Training Plan: Two graduate students from Sudan have started their MS degree program in Food Science at Alabama A & M University. These students will be completing their program in June, 1987 and returning to the Food Research Centre. Sudanese scientists have visited Alabama A & M University and other parts of the US to attend meetings and exchange information. Further plans have been made for other Sudanese scientists to visit the US. Alabama A & M scientists have visited Sudan and have worked with Sudanese scientists at the Food Research Centre in planning research, training, and in collection of data. Plans have been made for the principal investigator and other collaborators to visit Sudan at least twice per year for durations of 10 - 20 days. Currently, one US graduate student is working on his MS thesis on problems related to the Peanut CRSP project. Further modification will be made in the plan on the basis of progress in research in 1985-86.

SOUTHEAST ASIA

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Consumption of Peanut as Food and Appropriate Technology for Storage/Utilization in Thailand and Philippines

Project Code: NCS/BCP/TP

Host Countries: Thailand and Philippines

Priority Constraint: Low yields due to inherently low yield potential of varieties and lack of resistance to diseases and insects.

Research Needed: Breeding and advanced line-variety testing and cultural practices research to develop adapted disease and insect resistant varieties and cultural practices which utilize to a maximum the yield potentials of the varieties.

Rationale for Site Selection and Research to be Conducted:

A. Country interest very high for improved peanut production in Northeast Thailand and for increased production in Philippines.
B. Good collaborative relationships with scientists at Kasetsart and Khon Kaen Universities and at the Department of Agriculture Field Station at Khon Kaen.
C. Research in Thailand and the Philippines provides a range in environments making research more transferable regionwide.
D. Present peanut cultivars and cultural practices need improvement.

Benefits Expected: Provide needed technology for increased production of peanut in Northeast Thailand. Work will complement the AID sponsored Northeast Rainfed Project. Provide production base for additional production of peanut in Northern Luzon over the amount now grown. Improved prospects for better nutrition of farm people and rural villages in both Thailand and the Philippines.

Host Country Institutions: Kasetsart, Khon Kaen Universities and Department of Agriculture, Thailand; Philippine Council for Agricultural Research, Resources and Development.

U. S. Lead Institution: North Carolina State University.

U. S. Principal Investigator: Dr. Johnny C. Wynne.

Project Title: Peanut Varietal Improvement for Thailand and the Philippines.

Objectives:

A. Establish regional testing programs to identify peanut varieties suitable for use in Thailand and the Philippines.
B. Determine cultural practices used in peanut production and modify either cultural practices or genetic material to increase productivity.
C. Develop high yielding, early maturing, large-seeded peanut varieties tolerant to drought, soil salinity and resistant to leafspsots, rust and leafhoppers.
D. Provide short-term, academic and technical assistance required to establish projects capable of independent research in peanut variety testing and development.

Project Code: NCS/IM/TP

Country Site: Thailand and Philippines.

Linkage Countries: Indonesia and Burma.

Priority Constraint: Attack on peanut by a complex of foliage, soil, and storage insect pests that reduce yields, provide entry for pod rotting organisms, transmit virus diseases and destroy and foul peanuts harvested for food and seeds.

Research Needed: Development of inexpensive pest management practices that would emphasize cultural control practices, and insect resistant peanut cultivarsand action thresholds for insects.

Rationale for site selection and research to be conducted:

A. Country interest is very high for improved peanut production in Thailand and the Philippines.

B. Excellent collaborative research is underway with scientists at Khon Kaen University and at the Department of Agriculture in Thailand and with scientists at the University of Philippines, Los Banos and the Institute of Plant Breeding.

C. Linkage proposed with the Philippines and outreach to Burma and Indonesia extends to environments outside ICRISAT research interests.

D. Present insect management practices need improvement.

E. Project closely coordinated with N. C. State University breeding project at the same location.

Benefits Expected: Provide needed technology for increased production of peanuts in Northeast Thailand. Work will complement the AID sponsored Northeast Rainfed Project. Work will aid in the desired peanut production increase in Northern Luzon, Philippines. Profits from farm production plus income a planned oil mill would generate will be of great economic value to Northern Luzon. Improved prospects for better nutrition of farm and rural village peoples in both Thailand and the Philippines. Benefits to North Carolina include additional financial support to expand peanut insect management technology, reduce production cost and ultimately provide a greater profit to North Carolina peanut farmers.

Host Country Lead Institution: Khon Kaen University and Department of Agriculture. (Philippines program coordinated by Philippines Council for Agricultural Research Resources).

U. S. Lead Institution: North Carolina State University.

U. S. Principal Investigators: Dr. W. V. Campbell.

Project Title: Management of Arthropods on Peanuts in Southeast Asia.

Objectives:

A. To determine importance of specific insect pests of peanuts in rainfed and irrigated production.

B. Determine insect and/or damage thresholds where control measures are feasible.

C. Evaluate breeding lines, cultivars, and wild *Arachis* species for resistance to principal insect pests in cooperation with breeder(s).

Project Code: NCS/SM/TP

Country Site: Thailand and Philippines.

Priority Constraint: Inadequate nitrogen fixation by rhizobia resulting in low peanut yields.

Research Needed: Research to improve the effieiency of biological nitrogen fixation under suboptimum conditions in LDC's.

Rationale for site selection and research to be conducted:

A. Country interest high for improved peanut production in Northeast Thailand and North Luzon, Philippines.
B. Good collabortive arrangements with scientists in the Department of Agriculture Thailand and University of the Philippines at Los Banos.
C. Research proposed in both the Philippines and Thailand is in environments that make results transferable across the region.
D. Present peanut production efficiency needs improvement.
E. Work complements NCSU Breeding project in Thailand and Philippines.

Benefits Expected: Provide needed technology for increased production of peanut in Northeast Thailand. Provide base for planned increase in peanut production in Northern Luzon, Philippines. Improved prospects for better income and nutrition of rural and urban population.

Host Country Lead Institutions: Department of Agriculture, in Thailand. Philippine program coordinated by Philippine Council for Agricultural Research Resources and includes the University of the Philippines at Los Banos.

U.S. Lead Institution: North Carolina State University.

U.S. Principal Investigator: Dr. Gerald Elkan, NCSU.

Project Title: Rhizobia influence on nitrogen fixation and growth of peanut in Thailand and the Philippines.

Objectives:

A. Evaluate the need for inoculation for locally adapted peanut cultivars.
B. Determine the efficiency of inoculanta prepared using strains identified as being effective with local peanut cultivars.
C. Test the nitrogen-fixing capacity and yield potential of peanut germplasm derived from crosses of locally adapted cultivars and cultivars with high nitrogen-fixing ability.
D. Determine the effect of flooding (rice rotation) on survival of rhizobia.
E. Evaluate peanut-*Rhizobium* contribution to the total on intercropped farming systems.

Project Code: TX/SM/TP

Country Site: Thailand and Philippines.

Priority Constraint: Under-utilization of mycorrhizal fungi as accessory roots resulting in low peanut yields.

Research Needed: Research to determine the effectiveness of mycorrhizal fungi in promoting peanut growth.

Rationale for site selection and research to be conducted:

A. Country interest high for improved peanut production in Northeast Thailand and Northern Luzon, Philippines.
B. Good collaborative arrangements with scientists in the Department of Agriculture, Thailand and the University of the Philippines Los Banos.
C. Research in the Philippines and Thailand is in environments that make results transferable across the region.
D. Present peanut production efficiency needs improvement.
E. Proposed work complements NCSU Breeding project in Thailand and Philippines.

Benefits Expected: Provide needed technology for increased production of peanuts in Northeast Thailand. Work will complement the AID sponsored Northeast Rainfed Project. Provide base for planned increase in peanut production in Northern Luzon, Philippines. Improved prospects for better income and nutrition of rural and urban population.

Host Country Lead Institution: Department of Agriculture, Thailand. Philippine program coordinated by Philippine Council for Agricultural Research Resources and includes the University of the Philippines at Los Banos.

U. S. Lead Institution: Texas A & M University.

U. S. Principal Investigators: Ms. Ruth Ann Taber, TAMU.

Project Title: Mucorrhizae influence on the growth of peanut in Thailand and the Philippines.

Objectives:

A. Survey mycorrhizal fungi predominant in the peanut rhizosphere and roots.
B. Compare efficiencies of various mycorrhizal fungi strains to promote plant growth.
C. Determine value of mycorrhizal fungi in relieving various growth stress conditions.
D. Develop efficient inoculation methodology.

Project Code: GA/FT/TP

Country Sites: Thailand and the Philippines

Priority Constraint: Restricted array of peanut food preparations with low sensory values, and general unrecognition of the nutritional value of peanuts.

Research Needed: Work to characterize socio-economic, cultural, and technical factors which act to prevent efficient utilization of peanut and development of products, technology, and policy instruments that would promote the increased efficiency of utilization.

Rationale for site selection and research to be conducted:

A. Peanut is important as food but utilization is hindered by lack of knowledge of appropriate post-harvest handling and storage technology, alternative food preparations and nutritive value of peanut.
B. Mission and country interest is high.
C. Present peanut utilization research is low, but an adequate collaborative situation exists in both countries and awareness of the importance of the research is growing rapidly.

Benefits Expected: Increased intake of protein and calories due to an increased use of peanut as a basic food component. Improved peanut processing and foods will allow increased efficiency of women in food preparation; and/or allow alternative income generation through cottage industries.

Host Country Lead Institutions: Kasetsart University, Thailand; University of the Philippines at Los Banos.

U. S. Lead Institution: University of Georgia

U. S. Principal Investigators: Dr. Tommy Nakayama

Project Title: Appropriate Technology for Storage/Utilization of peanut.

Objectives:

A. Assess patterns of peanut utilization and determine if there are any socio-cultural factors which need to be addressed.
B. Develop a package of appropriate technology adapted specifically to address identified constraints; such as storage to control mold and insects using inexpensive technology, minimizing aflatoxin in food products, improvement of present food products, and development of acceptable new food products.
C. Make a quantitative assessment of the efficiency of the system developed.

"Peanut Varietal Improvement for Thailand and the Philippines"

North Carolina State University - Thailand and Philippines

Johnny C. Wynne, Principal Investigator, NCSU

INTRODUCTION

Peanut yields in Thailand and the Philippines are less than one-half of those in the U.S.A. Major constraints to increased production are inadequate moisture, low soil fertility, diseases, insects, and lack of proper management. The development of improved cultivars resistant to diseases and insects and tolerant to the constraints of the environment suitable for the cropping systems of Thailand and the Philippines could lead to increased productivity

Philippines - The peanut breeding program, including the development of pest-resistant cultivars, is part of the Institute of Plant Breeding (IPB) which is organized under the aegis of the College of Agriculture of the University of the Philippines at Los Banos (UPLB) through a semi-autonomous arrangement. Plans and programs of IPB are reviewed annually by an advisory board composed of the Minister of Agriculture, the Dean of the College of Agriculture, the Director of Research of UPLB, the Director of the Crops Research Division of the Philippine Council for Agriculture and Resources Research (PCARR) and a representative of the private sector. IPB is headed by a director and is composed of crop research groups, support laboratories and service units. Each crop research group consists of plant breeders, plant pathologists, entomologists, agronomists, geneticists and plant physiologists. The peanut program is part of the legume crop research group.

A portion of the peanut breeding research is funded through a grant from the International Development Research Centre (I.D.R.C.) of Canada. The goal of the I.D.R.C. program is to provide peanut cultivars for the Asian Cropping Systems Network which is a cropping-systems testing program for rain-fed rice cropping systems in 11 southeastern Asian countries. The program is conducted by the International Rice Research Institute (IRRI) under the direction of Dr. Virgilio Carangal.

Thailand - Peanut research has primarily been conducted in Thailand by the Department of Agriculture and two agricultural universities: Khon Kaen and Kasetsart. A coordinated program administered by the Department of Agriculture but also involving the two universities was organized in 1981. Both the Canadian I.D.R.C. and the Peanut CRSP are supporting the coordinated program. I.D.R.C. primarily supports Khon Kaen and Kasetsart Universities while the CRSP primarily supports the Department of Agriculture. Breeding research is concentrated on developing cultivars with higher yield and disease resistance. Emphasis is being placed on developing cultivars suitable for a rice cropping system under rain-fed conditions. In addition to assisting in screening germplasm for disease resistance, the plant pathologists are monitoring peanut diseases in

order to develop control practices. Agronomic studies including plant populations and spacings have already been conducted for the main growing season. Additional studies are needed for the rice cropping system which will differ from the main growing season because of limited moisture. Land preparation practices to conserve moisture, ensure good crop establishment and reduce weed populations are being evaluated. Division of responsibilities among the three institutions is given in Table 1. While the Department of Agriculture has responsibility over all ecological zones, emphasis is on the Northeast. Khon Kaen University will also concentrate on the Northeast while Kasetsart University will concentrate on the Central Plain.

MAJOR ACCOMPLISHMENTS

North Carolina. Five advanced breeding lines resistant to *Cylindrocladium crotalariae* (CBR) were selected and increased for final evaluation. The lines were developed to replace the cultivar NC 8C. Inheritance studies of components of partial resistance to both early and late leafspot indicate that breeding lines with resistance to either or both leafspots is possible. Breeding lines resistant to early leafspot were selected for final evaluation.

The role of environmental factors influencing the critical biological phases of infection and disease development were elucidated for *Cercosporidium personatum* and *Cercospora arachidicola*. This information will be useful in current and future studies to improve the efficiency of breeding efforts for leafspot resistance.

Significant progress was made in regenerating plants from callus of both the cultivated peanut and wild species of *Arachis*. Plantlets with both roots and shoots were obtained but have to be established in the greenhouse. Methodology for the rescue of developing embryos was also established.

Thailand. An extensive evaluation program of introduced and selected peanut germplasm for each growing season/condition was continued. Promising selections were made from each test and advanced to the next stage of testing. Moket, released as UPL Pn-2 in the Philippines, gave slightly higher yield than Tainan 9 when compared in farm trials. Lampang and Tainan 9 both gave substantial yield increases in production trials in farmers' fields when Department of Agriculture-recommended practices were used instead of local practices.

Philippines. The introduction and testing of promising introductions and selection of peanut germplasm adapted to the Philippines was continued. Five advanced breeding line were evaluated in the advanced regional yield trials during the wet season. Recommendation for cultivar release will be made based on the regional trials conducted at 12 locations.

EXPECTED IMPACT OF PROJECT

Thailand and Philippines - The yield of peanut in Thailand and the Philippines is about one-half of that in the U.S.A. Many of the factors which limit the yield of peanut can be overcome by the development and proper management of improved varieties. The CRSP project should provide the peanut improvement projects of Thailand and the Philippines training, technical assistance and additional germplasm. This should lead to the establishment of breeding projects that will develop improved peanut varieties adapted to the local environment. The release of improved varieties in conjunction with appropriate management practices should allow small growers to increase yields with little or no additional production inputs. The increased production should increase the food and vegetable oil supply in Thailand and the Philippines helping to alleviate shortages.

U.S. based research - This project should result in the development of early maturing, disease-resistant peanut varieties for use in North Carolina. The utilization of improved varieties with disease resistance will lower the cost of production and increase profits. This will allow the North Carolina peanut grower to compete more favorably in the world market.

GOAL

The goal of this project is to aid in the establishment of peanut breeding-pathology-agronomy programs in Thailand and the Philippines that are capable of developing and utilizing varieties that produce high yields under the cropping systems of Southeast Asia.

OBJECTIVES

Thailand - Objectives:

(1) To develop varieties with:

Desirable agronomic traits of high yields, early maturity and drought tolerance, and

Resistance to rust, Cercospora leafspots and *Aspergillus flavus*.

(2) To develop an agronomic system of production suitable for exploitation of new varieties in cropping systems of northeast Thailand.

Philippines - Objectives:

(1) To develope varieties with:

Desirable agronomic traits of high yields, early maturity and drought tolerance and

Resistance to rust, Cercospora leafspots, Aspergillus flavus, and Sclerotium wilt and insects.

(2) To select germplasm tolerant to low soil acidity

The development of varieties high in nitrogen fixation capacity is to be pursued collaboratively with activities under The rhizobia project (NCS/SM/TP).

ORGANIZATION

North Carolina State University

Dr. J.C. Wynne, Principal Investigator, Department of Crop Science, Raleigh, Breeder
Dr. H.T. Stalker, Co-Principal Investigator, Department of Crop Science, Raleigh, Breeder-Cytogeneticist
Dr. M.K. Beute, Co-Principal Investigator, Department of Plant Pathology, Raleigh, Plant Pathologist
Dr. W.V. Campbell, Cooperator, Department of Entomology, Raleigh, Entomologist
Dr. G.H. Elkan, Cooperator, Department of Microbiology, Raleigh, Microbiologist.
Dr. Jim W. Moyer, Cooperator, Department of Plant Pathology, Raleigh, Virologist.

Philippines

Institute of Plant Breeding (IPB)
Dr. Ricardo Lantican, Coordinator of Project
Dr. Remedios Abilay, Senior Breeder
Mr. Rodante Tabien, Breeder
Mr. Julian Magpantay, Breeder
Dr. Lina Ilag, Senior Pathologist
Ms. Araceli Pau, Pathologist
Dr. Candida Adalla, Entomologist
Dr. Henry Samonte, Soil Scientist
Isabela State University:
Dr. Rustico Santos, Agronomist
Cagayan State University:
Mr. Silvino Tejada, Agronomist
Bureau Plant Industry, Tupi Experiment Station:
Ms. Delia Concepcion, Agronomist

Dr. Virgilio Carangal, Director of the Cropping Systems Network at the International Rice Research Institute, serves as a cooperator on the project. He will test elite germplasm from the project in the Asian Cropping Systems Network.

The CRSP project in Thailand collaborates with a coordinated peanut improvement project administered by the Department of Agriculture but also involving Khon Kaen University and Kasetsart University. The Department of Agriculture has overall responsibility with research areas covering all components of production technology. The Department of Agriculture and the two universities have an informal agreement to coordinate research on peanut. Collaborating personnel are as follow:

Thailand

Department of Agriculture
Dr. Vichitr Benjasil, Coordinator and Peanut Breeder
Dr. Duangchai Choopanya, Plant Pathologist

Kasetsart University
Dr. Aree Waranyuwat, Peanut Breeder
Dr. Tharmmasak Sommartaya, Plant Pathologist

Khon Kaen University
Dr. Aran Patanothai, Peanut Breeder
Dr. Sopone Wongkaew, Plant Pathologist

Dr. Ron Gibbons, Head of the Groundnut Improvement Program at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), will serve as a cooperator for the CRSP program for both countries. ICRISAT will provide technical advice, make germplasm available and assist in the training of both Thai and Filipino scientists.

Approach

Seeds of peanut germplasm from North Carolina, ICRISAT or other institutions with resistance to rust, leafspots, *A. flavus*, and Sclerotium wilt and with drought tolerance or early maturity will be introduced into both Thailand and the Philippines. The introduced germplasm will be grown in unreplicated nurseries. Observations on agronomic potential, disease and insect resistance, maturity and drought tolerance will be made. Selected lines will be grown in preliminary replicated tests to identify lines for further testing at multiple locations within each country. In addition to identifying lines for potential release as new cultivars, the results should also identify parents for hybridization programs.

Crosses between appropriate disease resistant, early maturing, or drought-tolerant germplasm and locally adapted varieties will be made to transfer disease resistance to adapted germplasm. Pedigree and backcrossing breeding procedures will be used to develop improved varieties. Emphasis will change from introduction and testing to hybridization and selection for the host country breeding projects.

Germplasm with both discriminatory (specific) and dilatory (general) resistance to leafspots and rust will be developed at North Carolina State University. As effectiveness of various resistance factors are verified, breeding will be initiated to determine heritability of factors, combining ability of multiple factors and efficacy of combined factors in various combinations.

The current studies with both cercospora leafspot pathogens will be broadened to include evaluation of genetic variability in the fungi as reflected by infectivity on resistant peanut lines. Behavior of pathogen population in all three countries will be analyzed with emphasis on durability of resistant factors (infection efficiency, latent period, lesion size and sporulation characteristics) by multiple-year assessments using detached leaf tests and representative local isolate collections. (Communication has achieved a common technique for assessment of resistant factors. Cyclone spore collectors have been supplied to cooperators.)

Studies will begin on the role of cercospora toxin (cercosporin) in initiation of infection, development of lesions and influence on yield potential in resistant and susceptible peanut lines. Data will be incorporated into ongoing breeding strategies.

Evaluation of *Sclerotium rolfsii* resistance in breeding lines and/or management technique will be intensified in both Thailand and the Philippines. Management studies will focus on the relationship between microenvironmental factors and disease enhancement or inhibition (support of local student suggested for both Thailand and Philippines, jointly directed by collaborating personnel).

Virus disease studies will be initiated cooperatively with selected personnel in both Thailand and the Philippines to reduce infection and yield losses in either or both collaborating countries. Epidemiological studies on host and vector resistance as well as crop management studies will be initiated within the problem areas.

Hybrid populations appropriate to the environments of Thailand and the Philippines will be developed at NCSU. Late generation materials will be evaluated in both countries for potential use.

In addition to research with cultivated peanut, investigations using wild species of *Arachis* will be conducted. Members of the genus have already been identified which are highly resistant or immune to many of the most important disease and insect pests of peanuts. For example, resistances for *Cercospora arachidicola*, *Cercosporidium personatum*, peanut rust, stunt virus, thrips, leafhoppers and lesser cornstalk borer have been found. Most important of the research findings to date are the high levels of disease and insect resistances found in species which are cross-compatible with *A hypogaea*. As additional sources of resistance or variability for physiological traits required for crop improvement are found, species of *Arachis* will be evaluated for desirable germplasm.

Although species of section Arachis will hybridize with A. hypogaea, polyploid differences and genome differentiation makes introgression from wild to cultivated peanut difficult. Pathways for easy and repeatable gene transfers must be found. Arachis hypogaea has already been hybridized with 13 different species of section Arachis and fertility restored at the hexaploid level after colchicine treatments. However, lowering the ploidy to 2n = 40 is difficult and large hybridization programs will be required to obtain a series of tetraploid hybrid derivatives. Cytological analyses of hybrids will be necessary to determine fertility levels and chromosome homologies among species. A method to circumvent sterility in aneuploid and pentaploid progenies is to product 40-chromosome amphidiploids of wild species before they are hybridized with cultivated peanuts. To insure fertile interspecific hybrids with A. hypogaea, a series of A-genome species will first be hybridized with A. batizocoi (B genome). Although F_1's are sterile, colchicine treatments will result in restoration of fertility at the tetraploid level. The project has been initiated, but many F_1 hybrids are difficult to oproduce in reciprocal, and success of colchicine treataments is low. Tetraploid sectors must be cytologically confirmed and then plants hybridized with A. hypogaea. In addition to more quickly introgressing germplasm to A. hypogaea, cytoplasmic lines which are potential sources for new variability in A. hypogaea, including male sterility genes, may result from interspecific hybrids.

During the past four years the number of Arachis species collections has increased from 158 to 250. Additional taxa are still being introduced from South America. The newly introduced plant collections must be characterized botanically, cytologically for pest resistances and agronomic traits. Especially important will be finding new sources of variability for disease resistance to be incorporated into the cultivated genome. Plants will be propagated in seed-increase nurseries to obtain materials to be analyzed in the laboratory or field. New species will be cytologically analyzed to determine genomic relationships and potentials for germplasm introgression. Work to date indicates that at least two previously unknown genomes are present in section Arachis. Taxa are being hybridized to A. duranensis (A genome) and A. batizocoi (B genome) to determine genomic relationships of newly received taxa. When collections with desirable germplasm are found, they will be hybridized with cultivated peanuts, fertility restored by manipulating polyploid levels and 40-chromosome progenies obtained.

To effectively utilize the Arachis germplasm, embryo rescue techniques will be necessary to recover hybrids and manipulate ploidy levels. This is especially true when intersectional hybrids are necessary, but also in section Arachis to obtain several reciprocal hybrids and to make hexaploid x diploid hybrids. Investigations at North Carolina State University and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) indicate several barriers to hybridization are present among species. Progress has been made toward developing embryo rescue techniques, but genotypic differences are present and root development slow, or nonexistent, on in vitro cultured plantlets. Research to develop and apply techniques adapted to the Arachis germplasm used in the hybridization programs at NCSU will be made.

Several 40-chromosome interspecific hybrid populations developed at NCSU have been evaluated for disease and insect resistances in North Carolina and at ICRISAT. Hybrid lines have been selected for high levels of resistance to peanut rust, C. arachidicola, C. personatum and an insect complex. The lines need to be tested at multiple locations to confirm evaluations to date before germplasm is released to peanut breeders. Because of the low yields and poor seed traits of many hybrid lines, backcross programs must be initiated to improve agronomic performance. The germplasm resources will be tested in Thailand and the Philippines as well as in North Carolina and ICRISAT. As additional 40-chromosome hybrid populations are developed, they will be evaluated for disease and insect resistances, agronomic potential and then incorporated into crossing programs for varietal improvement.

Advanced breeding lines from ICRISAT, the U.S. and from IPB will be increased and tested in a testing network developed for the peanut growing region by PCARRD. The project will evaluate introduced lines in the area of production and will expand the area of testing from that of IPB.

Two junior scientists with master of science degrees will be stationed in Thailand and the Philippines (one each) during 1985-86. The research associates will conduct project-related research, coordinate CRSP activities and assist local researchers with their research. The scientist in Thailand will evaluate the agronomic potential of a diallel cross of elite peanut germplasm made and increased by ICRISAT.

Short-term visits of Thai and Filipino collaborators to NCSU or ICRISAT will be made as needed. Candidates for M.S. or Ph.D. degrees will be identified and trained at NCSU. Short visits for technical training at ICRISAT will also be arranged as needed. Journals, books, reprints and other literature will be provided to the collaborators as needed.

In Cooperation with ICRISAT

Efforts will be made to link the current breeding project with variety testing and improvement projects in Burma and Indonseia in order to take advantagve of germplasm developed for Southeast Asia and to provide a regional program for peanut germplasm improvement.

"Management of Arthropods on Peanut in Southeast Asia"

North Carolina State University-Thailand and Philippines

W.V. Campbell - Principal Investigator, NCSU

INTRODUCTION

Arthropods are a major constraint on the yield of peanut. Insects, mites and millipedes form a destructive arthropod complex that defoliates the peanut plant, sucks the plant sap, and tunnels into and destroys the developing pods.

In North Carolina we have nine above ground insects that stunt and defoliate the plant and five soil inhabiting insects that destroy the peanut pegs and pods. In Thailand they list eighteen foliage and stem feeding insects and four soil insects important in peanut. The insect pests of peanut in the Philippines are similar in number and importance to those in Thailand.

Since many of the insects in North Carolina, Thailand and the Philippines belong to a common genera; their damage potential, habits and methods of management may be universal. Several insects in North Carolina and Southeast Asia are the same species.

Insect management practices, therefore, may be developed that should prove mutually useful and beneficial to North Carolina, Thailand and the Philippines.

MAJOR ACCOMPLISHMENTS

Research Results - Experiments for management of insects were established in North Carolina, in Thailand (Khon Kaen, Kalasin, Rayong and Mahasara Kom) and in the Philippines (Los Banos, Tuguegarao, Negros Oriental and Laguna).

International germplasm was screened in North Carolina and lines selected for insect resistance were retested in Thailand and the Philippines. Some selected lines and cultivars exhibited cross resistance to insects in Thailand and the Philippines. A paper on this cooperative research supported by Peanut CRSP was presented at the international peanut meeting of American Peanut Research Education Society (APRES) at Mobile, Alabama in July 1984.

Experiments conducted on the effect of cultural practices on insects in North Carolina, Thailand, and the Phillipines showed that planting date, minimum tillage, seeding rate, and cultivar affected the insect population and damage. This experiment will be repeated and expanded to provide additional information for arthropod management by cultural practices.

Plants were defoliated at different growth stages and percentages to determine damage/growth stage relationship of simulated insect damage on yield. Leaf loss during R-3 to R-5 growth stages resulted in the greatest yield loss. In North Carolina the greatest yield loss occurs between August 1 to September 1 when nut production is at a peak.

Seasonal population peaks for thrips, potato leafhopper, leaf miner and the subterranean ant have been conducted in Thailand. Population/damage thresholds are being investigated in North Carolina for thrips, potato leafhopper and southern corn rootworm. Preliminary results suggest the threshold may be raised, thereby reducing the need for chemical control and reducing the cost of production.

Results from a pilot IPM program (diseases, insects and weeds) show the pest complex may be more economically managed with the aid of pest thresholds for decision making and implementation.

Pests are being more accurately monitored with the use of pheromones and sticky traps in North Carolina, Philippines and Thailand. This method of population monitoring is relatively inexpensive and it provides a standardized procedure for population sampling whereby results from North Carolina and Southeast Asia are interchangeable.

Training - Two technicians from Thailand and one technician from the Philippines were sent to ICRISAT, India for one month for training in peanut production methods, insect identification and damage, and pest management methods in 1983. Two additional technicians from Thailand and one technician from the Philippines were sent to ICRISAT for six weeks training in pest management in 1985.

A collaborator from Thailand, Dr. Manochai Keerati-Kasikorn, and a collaborator from the Philippines Dr. Eliseo P. Cadapan attended the 1983 APRES meeting in Charlotte, NC, visited research plots in North Carolina and Georgia and received training in host plant resistance and pest management in North Carolina for three weeks. Dr. Sathorn Sirisingh, collaborator from Dept. of Agriculture, Thailand attended the APRES meeting in 1984 and received training in host plant resistance and pest management in North Carolina for two weeks. Dr. Eliseo Cadapan, Collaborator from the Philippines attended APRES meeting in 1985. Ms. Turnjit Satayavirut enrolled in a Ph.D program in Entomology at N.C. State University with funds from CRSP project NCS/IM/TP.

EXPECTED IMPACT OF PROJECT

In host country - The project will increase the amount of research on the management of peanut insects; as a result the Peanut CRSP will improve and enhance the present management strategies.

In North Carolina - We will be able to provide information to our peanut producers in a shorter time span than otherwise possible on management of insects on peanut. Some of this additional information will come from graduate students who will be supported by Peanut CRSP and who will be doing a thesis in some area of the Entomology Peanut CRSP.

Too, germplasm with apparent insect resistance can be screened in two crop seasons within a year in Southeast Asia to advance germplasm selection.

GOAL

To provide information for the economical and environmentally sound management of insects and other arthropods on peanut and to enhance the current research that coincides and compliments the objectives of the Peanut CRSP.

OBJECTIVES

1. To evaluate an international collection of peanut germplasm for resistance to a complex of insects and mites in cooperation with Dr. J.C. Wynne (Breeder, North Carolina State University) and entomology collaborators in Thailand and the Philippines and cooperate in the development of high yielding, insect resistant cultivars for use in North Carolina, Thailand and the Philippines.

2. Determine the damage potential of specific insects and the insect damage/plant phenological relationship (population dynamics) of important insects.

3. Determine the effect of cultural practices (planting date, seeding rate, row spacing, no-till, cultivation and intercropping) on the insect population and damage to principal cultivars.

4. To establish insect/damage thresholds for the most important pests in North Carolina, Thailand and the Philippines.

5. Cooperate in the management of post harvest (storage) insects.

6. To develop a pilot pest management system that will incorporate information from the Peanut CRSP into existing peanut management systems.

7. Train extension personnel and growers to recognize pests, their damage and management of pests by means of field demonstrations, training sessions and pamphlets.

8. To provide technical training and assistance and on-the-job training in entomology and pest management. To provide academic training at the MS and Ph.D level in entomology and pest management for qualified host country students contingent upon the availability of funds.

ORGANIZATION

North Carolina State University

W.V. Campbell - Principal Investigator, Dept. of Entomology, Entomologist
J.C. Wynne - Cooperator, Plant Breeder

Thailand

Khon Kaen University
Manochai Keerati-Kasikorn, Collaborator, Entomologist
Aran Patanothai, Cooperator, Plant Breeder

Department of Agriculture
Vichitr Benjasil, Coordinator
Sathorn Sirisingh, Collaborator, Entomologist
Pisit Sepsawardi, Cooperator, Entomologist

Philippines

University of Philippines, Los Banos
Eliseo P. Cadapan, Collaborator, Entomologist

National Crop Protection Center
Fernando Sanchez, Cooperator, Entomologist

Institute of Plant Breeding
Candida Adalla, Cooperator, Entomologist

Approach

Our pest management methodology in North Carolina, Thailand and the Philippines will be to conduct tests in areas where pests are endemic to take advantage of natural insect populations and the natural environmental interactions. This approach will minimize the need for laboratory and greenhouse space. However, some limited research will be conducted in the greenhouse and laboratory at all locations where field insect population pressure is not adequate or where refinement of data is needed and is not possible under natural field conditions. Screening for resistance of peanuts to the leafhopper Empoasca will be conducted in screen cages in the Philippines. Trap crops and artificial infestation of plots with insects will be utilized to augment insect and mite populations.

We will conduct the research in the host countries in as many areas as possible where peanut is grown and for rain-fed and dry-land crops. On-farm demonstrations and training in recognition and management of pests will be conduted in key peanut production areas.

We will concentrate our research effort on the major pests in North Carolina and the host countries.

The NCSU collaborator, Dr. Campbell, is finalizing plans to spend a six month sabbatical leave in Thailand and the Philippines beginning in the fall of 1986. He will conduct a research project to evaluate peanut germplasm resistance to insect damage in Thailand, Philippines, and in North Carolina. He will also serve as general advisor to all the CRSP projects while there.

"Rhizobia Influence on Nitrogen Fixation and Growth of Peanut in Thailand and the Philippines"

North Carolina State University - Thailand and Philippines

G.H. Elkan, Principal Investigator, NCSU

INTRODUCTION

Although a considerable amount of information on both the physiology and agronomy of peanut has been generated, a number of production management strategies remain to be explored. First, the potential of the Rhizobium-legume fixation system as a possible major source of the nitrogen requirement of peanut needs to be explored. Not much research has been conducted on Rhizobium technology so far. At present, certain studies are looking into the selection and identification of genetically compatible peanut variety-Rhizobium combinations capable of fixing N_2 over a wide range of environmental conditions. Others are on the determination of the inoculation requirement of peanut using Rhizobium strains from NCSU and other sources. Other peanut-Rhizobium strains that are effective and ecologically competent over a wide range of environmental conditions will be identified and isolated. Optimizing N_2 fixation in crop rotations (especially in a rice production system) and intercropping to supply sufficient N for the subsequent grain crop needs to be studied further.

Two agricultural realities exist in Southeast Asia which offer great opportunities for the Peanut CRSP, and both of these involve a central research and development role for the biological nitrogen fixation project:

1. Domestic plant protein sources for feed or food are scarce, thus requiring large import expenditures (a major trade-deficit item), and
2. As a result of the 1973 energy crisis, the increased cost of nitrogen fertilizer (i.e., a tenfold increase between 1973-1975 for urea delivered to farms in the Philippines) has limited optimization of crop yields.

MAJOR ACCOMPLISHMENTS

The soil microbiology project was not officially phased into the CRSP until year 2 (1984). Accomplishments are as follows:

1. Trips were made to Thailand and the Philippines by NCSU and TAMU PI's to organize the collaborative groups and outline the proposed research plans.

2. Work plans and Memoranda of Understanding were prepared, approved and signed for Thailand and the Philippines.

3. The first-year and second year research plans were implemented and field studies were begun at the overseas sites and laboratory and field trials were begun at NCSU.

4. The NCSU principal investigator (G. H. Elkan) organized and taught, together with our Thai collaborators, a 2-week-long nitrogen fixation course for 20 Thai technicians so as to prepare more field research workers to help with the CRSP program.

5. We have organized and taught (G.H. Elkan) a two-week short course on BNF Technology (joint effort between NCSU, PCARRD, and our Philippine collaborators) for 24 researchers and extension agents so that they can demonstrate the usefulness of BNF to the farmers.

6. We have continued two projects (at NCSU) with cooperation of R.A. Taber (TAMU) to determine the interaction of mycorrhizae and Rhizobium on BNF in peanut.

7. Multiple site field plots have been established in the Philippines, Thailand, and Cameroon to further screen our Rhizobium isolates and peanut cultivars for enhanced BNF. Included are environmental stress conditions such as soil acidity, flooding (paddy rice rotation), shading, soil type, etc.

8. We have developed and field tested a laboratory protocol for the rapid screening of Rhizobium isolates.

9. We have established a network of cooperators who send us nodules from native tropical cultivars.

10. We have identified and made available to our collaborators some 12 promising Rhizobium strains plus some potentially useful cultivars.

11. We have established some pilot studies in Cameroon as extensions of the Asian project. Although only $10,000 in CRSP technical assistance funds are involved, we are getting promising results.

EXPECTED IMPACT OF PROJECT

Peanut yields in Thailand and the Philippines are about one-half of that in the USA. One major reason is due to the inefficiency of symbiotic nitrogen fixation. Improving available nitrogen levels will result in improved peanut yields. Preliminary experiments in Thailand and Malysia have shown the potential of the Rhizobium-peanut symbiosis as a source of nitrogen in intercropping or crop rotation systems. Optimizing BNF, then, is of considerable importance to the entire food and feed production program of these countries.

The major potential impact of this project is twofold. First, by optimizing peanut production we can alleviate the protein deficits for food and feed in the region served by the CRSP. Secondly, by optimizing nitrogen fixation and developing the growth of peanut as part of a farming systems approach (i e., crop rotation and/or intercropping), we transfer biologically fixed nitrogen to other crops, decreasing the dependence of farmers in this region upon high priced chemical nitrogenous fertilizer.

Research under the project will concurrently lead toward optimizing BNF in U.S. peanut production.

OBJECTIVES

The overall goal of our research is to optimize (or eliminate constraints) biological nitrogen fixation (BNF) to allow improved peanut production; and, then, develop the BNF-peanut symbiosis as part of a "farming systems" approach as a source of transferring nitrogen to subsequent crops using crop rotation and/or intercropping approaches. The overall goals are:

1. Relieve yield constraints due to inherently low or inefficient nitrogen fixation and mineral nutrient availability,
2. Optimize biological nitrogen fixation to allow maximum yield of peanuts as a food and feed crop, and
3. Exploit the biological nitrogen fixation process with peanuts in a farming systems approach (intercropping, crop rotation, etc.) to allow growth of other needed crops without the addition of chemical nitrogen.

ORGANIZATION

North Carolina State University

Dr. G. H. Elkan, Principal Investigator, Department of Microbiology, Raleigh, Microbiologist

Mr. T. J. Schneeweis, Co-Principal Investigator, Department of Microbiology, Raleigh, Microbiologist

Dr. J. C. Wynne, Cooperator, Crop Science Department, Raleigh, Breeder

Texas A&M University

Ruth Ann Taber, Co-Principal Investigator for Mycorrhizae, Department of Plant Pathology, College Station

Philippines

Dr. Erlinda Paterno, Institute of Biotechnology (Rhizobium), University of the Philippines at Los Banos

Dr. Lina Ilag, Institute of Plant Breeding (mycorrhizae, University of the Philippines at Los Banos

Mr. Ridante Tabien, Institute of Plant Breeding (breeding for high BNF), University of the Philippines at Los Banos

Thailand

Mrs. Yenchai Vasuvat, Department of Agriculture (Rhizobium)
Dr. Nantakorn Boonkerd, Department of Agriculture (Rhizobium
Dr. Omsub Nopamornbodi, Department of Agriculture (mycorrhizae)
Dr. Banyoı ` Toomsan, Khon Kaen University (Rhizobium)

The Philippine project is coordinated through the Philippine Council for Agriculture and Resources Research Development (PCARRD) with the Institutes of Biotechnology and Plant Breeding.

The CRSP project in Thailand collaborates with a coordinated peanut improvement project administered by the Department of Agriculture but also involving Khon Kaen University and Kasetsart University. The Department of Agriculture has overall responsibility with research areas covering all components of production technology. The Department of Agriculture and the two universities have an informal agreement to coordinate research on peanut.

Dr. Ron Gibbons, Head of the Groundnut Improvement Program at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), will serve as a cooperator for the CRSP program for both countries. ICRISAT will provide technical advice, make germplasm available and assist in the training of both Thai and Filipino scientists.

APPROACH

The research plan consists of two phases. Phase 1 involves identifying rhizobia and peanut cultivars which show promise for enhanced BNF. This is planned for the first three years of CRSP funding. In phase 2 we propose to begin to look at systems of crop rotation and intercropping to improve yields, in addition to peanuts, in subsequent crops (preliminary promising increases due to transfer of nitrogen from the symbiosis have been shown in rubber trees, citrus, rice, oil palm and corn). Specific objectives are as follows:

Phase 1

1. Identify rhizobia effective with local peanut cultivars.

2. Evaluate need for inoculation for locally adapted peanut cultivar field tests.

3. Develop peanut cultivars for increased nitrogen fixation.

4. Determine efficacy of inoculants from strains effective with local peanut cultivars.

5. Test BNF and yield potential from crosses of locally adapted cultivars and cultivars with high BNF ability.

6. Evaluate BNF capacity and yield potential of peanut germplasm tolerant to acid soil conditions.

Phase 2

1. Determine effect of flooding (rice rotation) on survival of rhizobia.

2. Screen effective rhizobia and peanut germplasm for tolerance to soil acidity, high exchangeable Al and low available P.

3. Screen *Rhizobium* isolates for effectiveness under salt stress, drought and shading.

4. Select cultivar-*Rhizobium* combinations for ability to supply N to other crops in rotation or intercropping.

5. Evaluate peanut-*Rhizobium* contribution to the total N economy of various rotation or intercropped farming systems.

As of 1 July 1984 we received full funding. Briefly, summarizing our current progress:

1. We have developed a laboratory protocol for the rapid screening of *Rhizobium* isolates.

2. We have established a network of cooperators who send us nodules from native tropical cultivars.

3. We have identified and made available to our collaborators some 125 promising *Rhizobium* strains plus some potentially useful cultivars.

4. Multiple site field plots have been established in the Philippines and Thailand to further screen our *Rhizobium* isolates and peanut cultivars for enhanced BNF. Included are environmental stress conditions such as soil acidity, flooding (paddy rice rotation), shading, soil type, etc.

5. We have organized and taught a 2-week short course on BNF technology in Thailand (joint effort between NCSU and our Thai collaborators) for 30 district extension agents so that they can demonstrate the usefulness of BNF to the farmers.

6. We have organized (G.H. Elkan) and taught a two-week short course on BNF technology (joint effort between NCSU, PCARRD, and our Philippine collaborators) for 24 researchers and extension agents so that they can demonstrate the usefulness of BNF to farmers.

7. We have continued two projects (at NCSU) with cooperation of R.A. Taber (TAMU) to determine the interaction of mycorrhizae and *Rhizobium* on BNF in peanut.

8. We have extended some pilot studies to Cameroon as extensions of the Asian project. Although only $10,000 in CRSP technical assistance funds are involved, we are getting promising results and will be turning this work over to the local investigators for continuation.

9. Because we are involved with non-CRSP-funded projects in Indonesia and Malaysia, we have started a network for coordinating our work so we will have a regional impact rather than a two-country project.

Looking toward the future, because of the potential importance of BNF and peanut and, given the high priority that the ASEAN Organization gives to this area of research, we would like to expand our research effort. In Thailand and the Philippines we have excellent collaborators and we could successfully increase our efforts.

The external review panel recommended that additional emphasis be placed on training and education so that additional researchers be available for our HC principal investigators. We are, therefore, giving increased priority to training aspects by sponsoring PhD-level graduate students from the Philippines and Thailand for study in the USA. We have also worked out an arrangement for collaborative graduate work (with both countries) so that students will come to NCSU for perhaps two semesters to take those courses not available at home and to start their CRSP-oriented research. They will then return to their home location and continue the research and course work while on the job. The degree would be awarded by the Thai or Philippine university with the NCSU collaborator serving on the student committee. This would be more cost effecive and enable the student to return more quickly.

We are also planning, in response to the review panel recommendations, to spend more time in Thailand and the Philippines to work with our collaborators and perhaps continue with the short course concept already field tested as an additional training component.

Mycorrhizae Influence on Growth of Peanut in Thailand and the Philippines

Texas A&M University - Thailand and Philippines

Ruth Ann Taber, Principal Investigator, TAMU

INTRODUCTION

Mycorrhizal fungi inhabit the roots of almost all terrestial plants, including important crop plants such as peanut. Mycorrhizal fungi aid plant growth by functioning as accessory roots. In some plant species these fungi have been shown to promote solubility and uptake of minerals (especially phosphorus); protect plant roots from disease; produce growth-promoting hormones; increase salt, drought, and flooding tolerance; and may act synergistically with Rhizobium on legumes. The relative efficiencies of these fungi in peanut are relatively unknown. Endomycorrhizal fungi have been reported in peanut roots - in Texas, five species representing 3 genera (Glomus, Gigaspora, and Sclerocystis) are recognized as associative with peanut, although their value has never been assessed. A better understanding of the various endomycorrhizal fungi present in the roots of peanut both in the LDC's and in Texas and North Carolina is urgently needed.

MAJOR ACCOMPLISHMENTS

Establishment of the project

A coordination trip to Thailand and the Philippines was completed in early 1983. In the Philippines, a field trip was made to the northern part of Luzon (to Tuguegara and Cagayan by airplane) in order to observe peanut in the field and collect samples. Meetings were held with cooperating scientists, directors, and staff at PCARRD/UPLB/SEARCA. The Memorandum of Understanding was signed February 3, 1983. Conferences were held with cooperating scientists in the Philippines and future plans and considerations were discussed.

In Thailand, meetings were held with staff of the Department of Agriculture and Kasetsart University. Conferences were held with the Soil Microbiology group, experimental procedures were outlined, and the Memorandum of Understanding was signed February 8, 1983. On the return trip to the U.S., the Niftal laboratory in Maui, Hawaii was visited and phone contact was made with Dr. Bohool in Honolulu.

A second trip to the Philippines and Thailand was made in August, 1983. Additional contacts were made with cooperating scientists and information concerning our mycorrhizal research progress in Texas was reviewed. Further needs and plans were discussed. In Thailand, a field trip was made to mycorrhizae-inoculated plots north of Bangkok. During the International Plant Pathology Congress in Melbourne Australia,

conversations with Dr. Norman Schenck, University of Florida, have resulted in plans to cooperate on our respective projects in Thailand and mutual agreement was reached on benefits we may derive from our cooperative mycorrhizae research efforts on peanut and rice.

Three graduate students and one technician have been added to our group to further advance research progress.

Research Results

1. Initial surveys of vesicular-arbuscular endomycorrhizal fungi (VAMF) associated with peanut in Thailand and in soils planted to peanut and other crops in the Philippines were made. Information gained from these surveys resulted in documentation of numerous species never reported on peanut or any other crop in these countries. Two posters were presented at the 6th North American Mycorrhizal Conference held in Bend, Oregon (June 25-29), 1984) that summarized these findings. The predominant VAM fungal species are now being multiplied in pot cultures.

2. Greenhouse studies were initiated to test the influence of inoculum potential on peanut root infection in Thailand.

3. In the Philippines, VAMF infections in 9 peanut genotypes were assessed after growth in sterile and non-sterile soil. Infections resulting from growth in an acid soil (pH 4.8) were compared with those in a neutral-slightly alkaline (pH 7.1) soil.

4. The effect of peanut genotype and plot location on root infection by indigenous VAMF in Texas was analyzed, based on microscopic examination of peanut roots at Stephenville, Yoakum, Bryan, and El Paso, Texas (from a preliminary planting in 1983).

5. Further observations were made on the occurrence of VAMF spores in weed seeds in soil. VAMF spores were found in weed seeds in Philippine and Thailand peanut soils. Pot cultures are being established from spores from weed seeds found in Texas. A portion of these results was presented as a poster at the 6th NACOM Conference in Bend, Oregon.

6. Spores extracted from soil or originating from plant roots were obtained from 14 states, Thailand, Philippines, and Australia. Of 14 states (67 sites) positive Sudan grass root infections were obtained from 48 selections. These are being increased in the greenhouse for field inoculation. In addition, known cultures from other investigators are being solicited. Research continued on pot culture techniques.

7. Two weeks (each) were spent in Thailand and Philippines organizing research plans and making microscopic observations on VAMF spores and root infections.

8. Peanut (10 genotypes) were planted again in 1984 at 4 locations in Texas. Influence of drought and it's relation to mycorrhizal cultivar acceptivity are being tested at Stephenville; the influence of high salinity is being tested in plots at El Paso. These plantings are designed to provide information and access to spore types of VAMF able to survive these adverse conditions.

Experimental evidence has now been accumulated to show the beneficial effect of inoculation of peanut with mycorrhizal fungi. The first field trails were attempted. Experience was gained in methodologies appropriate for field testing.

9. In the Philippines, inoculation of three peanut cultivars (UPL Pn-d, NC7, and UPL Pn-4) in greenhouse studies showed that of nine species of mycorrhizal fungi tested, Glomus deserticola gave the most promising results. In general, peanut inoculated with this fungus developed the mycorrhizal association and exhibited generally better plant growth than uninoculated plants. The presence of the fungus enhanced nodulation.

10. Data were accumulated to demonstrate Philippine cultivar differential response to inoculation. UPL Pn-2 generally responded to inoculation better than UPL Pn-4. These results are in agreement with work done in Texas. Glomus fasciculatum and Glomus epigaeum showed promise as inoculants in another test involving three species and 2 cultivars.

11. Seed yields of inoculated UPL Pn-4 were significantly higher than uninoculated controls when inoculated with Glomus fasciculatum. Nodulation was enhanced by inoculation with this fungus and Glomus mosseae.

12. Progress was made in the quest to understand colonization of weed seeds in the soil by mycorrhizal fungi. Glomus epigaeus colonized pigweed seeds on agar in the laboratory.

13. Effects of inoculation of mycorrhizal fungi on one cultivar were more pronounced in peanut watered every day vs. other water regimes. Results on water relationships are preliminary.

14. In Thailand, peanut cultivars inoculated with 10 mycorrhizal fungi responded differently in regard to shoot weight and pod yield. Pod weights were significantly higher from those plants inoculated with mycorrhizal fungi plus Rhizobium than were those from uninoculated plants.

15. In field studies in Thailand, evidence was shown that the application of an efficient mycorrhizal fungus could increase yeilds and that percent root colonization does not necessarily reflect efficiency.

16. Preliminary experiments in Thailand showed that inoculation with a mycorrhizal fungus may enhance nodulation.

17. Potting mixture for pot-culturing mycorrhizal fungi was shown to affect colonization, foliage, and root systems.

18. Seven Tahi isolates were tested on Florunner peqnut. Inoculation produced larger plants.

19. Accessions were made to the pot culture collection. Evaluations are not complete.

20. Inoculation of mycorrhizal fungi on fields in Texas resulted in larger root systems in two peanut cultivars and in some cases the addition of Rhizobium further enhanced root systems early in the growth season.

21. Progress is being made on the study of the ecology of mycorrhizal fungi in saline soil.

22. Addition of commercial Rhizobium to saline soil resulted in good nodulation.

23. Preliminary findings indicate the mycorrhizal condition may provide better water conductivity from the soil to the plant.

COORDINATION AND STUDY TRAVELS

1. The following cooperating scientists made a trip to the United States to coordinate research activities with Texas and North Carolina PI's: Drs. Dely Gapasin and Omub Nopamornbodi and Ms. Yenchai Vasuvat. They also attended the American Peanut Research and Education Society national meeting in Mobile, Alabama and the Peanut CRSP meeting immidiately afterwards. They also traveled to outlying experiment stations and met with cooperating Texas scientists at Stephenville, Yoakum, Bryan, and El Paso. All overseas scientists attended the 6th North American Conference on Mycorrhizae June 25-29, in Bend, Oregon and participated in the presentation of our posters.

2. A trip was made to the University of Florida (Feb. 22-24, 1984) to attend a workshop on "Applications of Mycorrhizal Fungi in Crop Production."

3. A trip to the Philippines and Thailand was made March 28-April 29, 1984. Two weeks were spent at laboratories in each country, with the objective of spending the maximum amount of time collecting specimens, separating VAMF spores, and summarizing results.

4. Plans were made to train a NC state graduate student on VAMF methodology. She is currently a student working on a M.S. degree with Dr. G. Elkan.

5. Three days were spent in J. Trappe's laboratory, Forest Sciences Laboratory, Corvallis, Oregon immediately after the North American Conference on Mycorrhizae. This provided an opportunity to examine herbarium specimens at Oregon State University and to confer with Dr. Trappe and Shannon Berch on classification of the VAMF.

Dr. Amadou Ba, Food Technologist, Senegal Africa, spent one week in our laboratory studying mycorrhizal fungi. He is a cooperating scientist on the Mycotoxin CRSP project and will now be sending representative isolates from rainfall areas of Africa.

A trip to the Philippines and Thailand was made in March, 1985. A week was spent at each location observing greenhouse and field experiments, making observations on spore populations, and planning coordinated research activities.

Ms. Laura Vasquez, graduate student with Dr. G. Elkan at NCSU, spent two weeks in July 1985 at TAMU studying our methodologies and isolating spores from soils we had previously collected from North Carolina.

Dr. Zhang Meiquing, Peking, China spent 3 days in our laboratory studying mycorrhizae. She has expressed interest in cooperative research and we hope to exchange mycorrhizal pot cultures.

Dr. Omsub Nopamornbodi attended the APRES meeting in San Antonio, Tx in July and spent several days beforehand at TAMU. Dr. Lina Ilag also spent several days at TAMU in July 1985 and visited the research plots at Stephenville and Yoakum, Tx.

The invitation to observe mycorrhizal cowpea field plots in Sri Lanka (under the auspices of the AED, USAID, cowpea project) provided the opportunity to visit laboratories at the University of Peradeniya, Sri Lanka, contact research personnel involved in mycorrhizae research, present several lectures on mycorrhizal fungi at the Post Graduate Institute of Advanced Study and as part of a graduate Horticulture class. A distinct possibility exists for exchange of materials and ideas between scientists in Sri Lanka, Thailand, Philippines, and the U.S. Peanut are grown in the northern part of Sri Lanka.

ABSTRACTS

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5. Nopamornbodi, O., Y. Vasuvat, and R. A. Taber. 1984. Characterization of VAM fungi from peanuts in Thailand. 6th NACOM, Bend, Oregon. June 25-29. In press.

6. Taber, R.A., O. Nopamornbodi, and L. Ilag. 1985. Mycorrhizal fungi associated with peanut. APRES, San Antonio, Tx., July 1985.

EXPECTED IMPACT OF THE PROJECT

In host country - An increased understanding of these beneficial fungi should lead to improved peanut growth and yield in LDC's. Utilization of appropriate, efficient strains of these fungi should allow for peanut plantings in the more arid regions, in areas where soil fertility is low, and increase the value of peanut in intercropping sequences.

In United States - Knowledge of efficient mycorrhizal fungi, access to untested strains, and methodology developed as a result of this project should lead to development of inoculation procedures to assure the presence of appropriate fungi on peanut to obtain maximum yields. In addition, discovery of mycorrhizal strains adapted to soils with high salt contents, low water potentials or flooded conditions could help farmers use land currently unsuitable for peanut growth.

GOAL

To increase peanut yield/unit area in the LDC's and the U.S.A. through manipulation of mycorrhizal fungi in peanut roots and to bring into production acreages presently idle because of lack of sufficient water, high salts in the soils, or flooding conditions.

OBJECTIVES

A. The overall objective is to help maximize peanut production in each country through manipulation of the microbial inhabitants of the root.

B. Conduct a collaborative survey of endomycorrhizal fungi predominant in rhizosphere of peanut growing in the U.S. and LDC's.

C. To establish a collection of mycorrhizal fungi in pot culture, develop inoculation techniques, and field test various mycorrhizal isolates.

D. Establish the effectiveness of selected mycorrhizal fungi for alleviating salinity, drought, and flooding stresses in peanut.

E. Establish the effectiveness of selected mycorrhizal species for increased uptake of phosphorus.

F. Determine whether mycorrhizal fungi can afford the peanut protection against soil-borne diseases.

ORGANIZATION

Texas A&M University

Ruth Ann Taber, Principal Investigator, Dept. of Plant Pathology and Microbiology, College Station
Dr. Robert E. Pettit, Cooperator, Dept. of Plant Pathology and Microbiology, College Station
Dr. Olin D. Smith, Cooperator, Dept. Soil and Crop Sciences.
Mr. Shelby Newman, Station Director, and Kenneth E. Woodward, Cooperators, Stephenville
Ms. Esker Arvanetes, Mr. Timothy Riley, Mr. Stephen Neck, Graduate Students, College Station
Ms. Suzanne Segner, and Dr. Pierce Handley, Technicians, College Station

North Carolina State University

Dr. Gerald H. Elkan, Co-Principal Investigator for Rhizobia, Dept. of Microbiology, Raleigh
Mr. Thomas Schneeweis, Cooperator, Raleigh

Thailand

Department of Agriculture
Dr. Omsub Nopamornbodi, Microbiologist
Dr. Arwooth NaLampang, Microbiologist
Mrs. Yenchai Vasurat, Microbiologist
Dr. Nantakorn Boonkerd, Microbiologist
Khon Kaen University
Dr. Banyong Toomson, Microbiologist
Dr. Aran Patanothai

Philippines

University of the Philippines at Los Banos (UPLB)
Dr. Lina Ilag, Plant Pathologist
Dr. Erlinda Paterno, Microbiologist
Philippine Council for Agriculture & Resources Research & Development (PCARRD)
Dr. D.P. Gapasin, Director, Crops Division
Institute of Plant Breeding
Dr. Ricardo Lantican, Director
Mr. Edilberto Redona, Breeder

Approach

Initial emphasis has been placed on accession and establishment of pot cultures in Thailand, Philippines, and USA. This phase of the research will be continuing process, as will assessment of isolates. We have made much progress in this area. Since our work in all three countries points out the importance of efficiency of species on peanut (VS colonization), we anticipate obtaining chemical analyses of plant tissues in the future as opposed to solely microscopic observations. In

addition, nitrogen fixation rates will have to be considered. We will also devote considerable effort to develop an understanding of environmental parameters which will assure adequate spore production, since spore production can be unpredictable and yet is mandatory for identification and inoculation where it is desirable to accurately regulate inoculum levels. Development of efficient and effective inoculation techniques is an improtant facet of the total research program. The question of a source of virus-free peanut seed from SE Asia for use in experiments in Texas is now being addressed. Arrangements are being made with Dr. Olin Smith, TAMU peanut breeder, to aid in increasing seed obtained from Dr. J. Wayne, NCSU, for the 1986 season. A meeting between the three PI's (Thailand, Philippines, and the U.S.) has been tentatively arranged for February, 1986 at which time research progress will be assessed and further plans made.

"Appropriate Technology for Storage/Utilization of Peanut

University of Georgia - Thailand and Philippines

Tommy Nakayama, Principal Investigator, UGA

INTRODUCTION

The storage and utilization of peanut appear to be constraints which exist in the delivery system in these countries. Technology of the developed countries, i.e. refrigeration, is not deemed appropriate because of the capital and energy costs. Therefore, a major thrust of these projects is to investigate low cost methods of storage and their attendant consequences. Storage in inert gases in laminated plastic bags and treatment of peanut by hot water blanching to enhance non-refrigerated storage stability were evaluated initially.

It has been observed through personal contact and examination of some materials that the area of harvest and postharvest handling has been neglected in developing country peanut research programs and is not particularly covered in ICRISAT's program; that is, interface between production and processing studies. Thus, while adequately developed in the U.S., the conduct of these operations in both Thailand and the Philippines need to be assessed. It would appear that this is a very critical time for aflatoxin to develop and would be the logical place to prevent formation so that subsequent operations would be meaningful. A critical examination of current practices and their resultant effect on aflatoxin formation is needed. We would call particular attention to this for both the researchers in Thailand and the Philippines to work with their counterpart production teams in making this assessment on aflatoxins and subsequent recommendations for research.

Another area of possible thrust in this general area is to conduct a study on the feasibility of shelling semi-dry peanuts. This would obviate necessity of shell drying and lead to less bulk for handling. However, a study on the effect of such practices on quality would need to be carried out. This type of study could ideally be carried out here.

Another major objective of the project is to measure baseline consumption data for the Thai population.

In both countries, peanut is not yet a major item of diet and are used chiefly in confections, sauces, etc. Research to enhance utilization by introduction or development of new food forms of peanut will be conducted.

In both countries, indigenous forms of peanut foods will be investigated with the aim of upgrading quality to enhance utilization and conditions to enable extension of shelf life to aid distribution. This

carries us through year 5. The goals of years 5, 6, 7, and 8 are to capitalize on the start made in the first three years (two years for this project). We anticipate that a consumption study will be done in the Philippines in conjunction with a economic study. Definitive information on storage in laminated packages will be done, however it is our intention to continue with these storage studies in order to elucidate the effect on varieties and local conditions.

MAJOR ACCOMPLISHMENTS

The questionnaires on the consumption data have been coded and subjected to evaluation. The project has revealed the characteristics of the sample households, regional differences in household characteristics, attitudes on use of peanut by sample households, and the use of peanut in various forms, as well as per capita use of peanut products at home and away from home.

Work on the elimination of aflatoxin has commenced with an initial survey of products indicating that mycotoxin is indeed a problem and preliminary results from laboratory manufactured products have shown that careful visual inspection can eliminate aflatoxin-contaminated kernels. Peanut butter samples prepared in the Bangkok laboratories have shown a negative result for aflatoxin. Peanut carefully sorted in Los Banos have likewise shown a negative result.

The evaluation of suitability of laminates for storing seeds continues, although this is not a major objective of this project. The temperature/moisture requirements of seeds have been verified at less than 6% and work in Thailand by Dr. J.J. Duangpatra has defined the conditions for storage as 15 degrees C. The purpose of the packaging is to protect against mold and insects and work by Dr. Elias Escueta in Los Banos has indicated that 60% CO_2 will protect against increase in aflatoxin under storage conditions.

Work continues on the hot water blanching methods. Storage tests utilizing peanut treated at steam temperatures for various lengths of time are underway.

Preliminary work on product development has been made for inclusion of peanut in yogurt-type products, tofu, and in a peanut butter bar containing 20% protein and less than 10% sugar.

Peanut kernels and water extracts of peanut have been evaluated as substitutes for bacterial fermentation. Preliminary data indicate that acceptable natto-lake and yogurt-like products can be produced from peanut.

A technique using immobilized papain to hydrolyze peanut protein was developed. Modification of protein by this treatment results in improvement in some physical and functional characteristics, thus enhancing potential use in food products.

Equipment needs have been fully supplied in the form of a gas chromatograph and peanut butter mill for Thailand, and a gas chromatograph for the Philippines.

In the area of training, one student, Ms. Lucy Branch, has received her Master's degree in August 1984; a technician from Los Banos, Ms. Raquel dela Cueva, has received training in mycotoxin analysis at ICRISAT; and principal investigators, Dr. Elias Escueta and Dr. Chintana Oupadissakoon from Los Banos and Bangkok, respectively, have received short-term training in the United States. The principal investigator from the United States, Dr. Tommy Nakayama, has also visited Los Banos and Bangkok.

EXPECTED IMPACT OF PROJECT

In the host countries, the project, if successful in a most optimistic way, would enable peanut to be stored in edible form to lap over harvests. In this case, the time would be at least six months. Furthermore, the consumption data to be taken would form a reliable base on which to assess any increase in consumption in the future.

In the U.S., this will enable us to assess the acceptability of this type of storage method in the developing countries. It will give us information on storage for transport under inert gas and bag conditions. It will enable us to project possible future markets from the consumption data in these countries.

In the host countries it is not expected that simple recommendations on ideal forms of drying, etc. will be effective in eliminating aflatoxin problems. The socio-economic distribution of producers will inevitably cause mixing of substandard samples to the extent that it will be difficult to eliminate aflatoxin to the high degree required. Therefore, we will start with the premise that the mass of the peanut crop will need to be sorted into edible and processing peanut either by hand sorting or electronic sorters, or a combination.

Another possibility is to subject the materials to extrusion-type operations which are reported to be highly successful in reducing aflatoxin content.

The expected impact of these studies in a most optimistic way would be that aflatoxin production following harvest could be greatly reduced through proper handling procedures. Procedures for shelling semi-dry peanuts will also greatly obviate drying and aflatoxin formation. A successful detoxification procedure would enable utilization of lower grade peanuts not suitable for direct consumption. The ultimate effect of this entire scenario would be a vast upgrading of the practices in the peanut producing sector of these host countries, as well as enhancing the knowledge of peanut chemistry.

GOAL

The ultimate goal of the project is to enhance the capabilities of land-grant-type institutions in the third world countries. This is done through training afforded by collaborative programs in developing the storage and utilization of peanut.

OBJECTIVES

The objective of the training phase of the grant is to foster relations which would enable our counterpart departments in land-grant-type institutions in host countries to train students on their own. Consequently, emphasis is placed on training of graduate students in their country.

The objectives of the research phase of the project are to:

1. Collect and analyze consumption data
2. Devise appropriate technology for long-term storage of peanut to minimize aflatoxin contamination and insect damage.
3. Enhance utilization by improvement of present peanut food forms and introduction/development of new food forms of peanut.

ORGANIZATION

University of Georgia

Dr. Tommy Nakayama, Principal Investigator, Dept. of Food Science, Georgia Experiment Station
Dr. Bob Raunikar, Cooperator, Dept. of Ag. Economics, Georgia Experiment Station
Dr. David Wilson, Cooperator, Dept. of Plant Pathology, Coastal Plain Experiment Station
Dr. Whit O. Slay, National Peanut Laboratory, Dawson, Ga.

Thailand

Kasetsart University

Dr. Chintana Oupadissakoon, Principal Investigator, Department of Product Development, Faculty of Agro-Industry, Food Scientist
Dr. Sopin Tongpan, Cooperator, Dept. of Ag. Economics, Agricultural Economist
Mrs. Dara Buangsuwon, Cooperator, Dept. of Plant Pathology
Mrs. Vimolsri Devapalin, Oilseed Laboratory

Philippines

University of the Philippines at Los Banos

Dr. Elias E. Escueta, Principal Investigator, Food Technologist
Prof. Lilia Madamba, Cooperator, Food Chemist
Dr. Reynaldo Mabesa, Cooperator, Food Microbiologist
Mr. Roberto Reyes, Cooperator, Food Engineer

Approach

The baseline consumption survey in Thailand will be used to direct research on product improvement and development. Survey data showed that primary consumption is in the forms boiled, roasted, and processed into candy.

It is expected that a graduate student from the University of the Philippines at Los Banos will come to Georgia in 1986 to take courses not available in Los Banos, as well as participate in a research project designed to bring training in consumer attitude measurements to Los Banos in order to facilitate the work on product development.

It is planned to coordinate research work between the three sites with personal computers. Pending approval, it is intended that the two host countries will have personnel trained at UGA and thus information can be exchanged via disks. Thus, the linkages formed through collaborative research can be strengthened with a direct physical linkage. Based on previous experience this will take three years to obtain necessary funds, clearance, etc. for effective implementation.

Work on defining the requirements of a bag to control insects at least cost will be a major objective of the U.S. side.

Completion of phases of the storage study using laminates is expected in 1986 with field trials underway.

Work in 1986 includes product development from aflatoxin-free peanut. This would include a prototype of peanut butter and a peanut bar from Bangkok, and dairy-type products from Los Banos. These will be followed by limited acceptability trials. It is expected that they will form the basis of a total system beginning with harvest and culminating in a product free of aflatoxin which will be available for development in the extension phase of the Peanut CRSP project.

CARIBBEAN

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Peanut Improvement for the Caribbean

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Peanut Utilization in Food Systems in the Caribbean

Project Code: GA/BCP/CAR

Country-Site: Caribbean

Linkage Countries: CARDI (Jamaica, Antigua, Belize)

Priority Constraint: Low yield potential and poor adaptation of cultivars with lack of resistance to diseases and insects; Low yield and poor quality due to inadequate cultural practices.

Research Needed: Breeding and cultural practices research to develop cultivars with early maturity, disease resistance and acceptable quality for utilization; and to develop cultural practices which maxmimze the yield potential of the superior cultivars.

Rationale for Site Selection and Research to be conducted:

A. Interest of USAID missions and countries is high.
B. Countries have similar problems contributing to low yields.
C. Peanut can contribute to improving nutrition in the region.
D. Project complements food utilization project in region.

Benefits Expected: Stabilize production, increase food supply, diversify agriculture, and improve nutrition of subsistance farmer and urban population.

Host Country Lead Institutions: CARDI, University of the West Indies Campus, St. Augustine, Trinidad. Collaborators: Dr. Laxman Singh, Antigua; Mr. Horace Payne, Jamaica; Dr. B.K. Rai, Belize.

U. S. Lead Institution: University of Georgia.

U. S. Principal Investigator: Dr. W. D. Branch.

Project Title: Peanut Improvement for the Caribbean

Objectives:

A. Establish regional testing program to identify peanut cultivars suitable for Caribbean.
B. Develop high yielding, early maturing cultivars with acceptable utilization quality, disease resistance and tolerance to mineral deficient soils.
C. Modify cropping systems to increase food supply and utilize quality.
D. Provide training and technical assistance.

Project Site: AAM(FL)/FT/CAR

Country Site: CARDI-Trinidad

Linkage Countries: CARDI participating countries, especially, Trinidad, Jamaica, and Belize.

Priority Constraint: Protein and calorie malnutrition, and the under-utilization of the peanut to overcome the problem, because of lack of simple food product technology.

Research Needed: Development of acceptable food products of high nutritional value containing peanuts or peanut products and determine impact of these products on nutritional intake of population.

Rationale for site selection and research to be conducted:

A. Protein and calorie shortage, especially in children and nursing mothers.
B. Country interest good for increased peanut production, which would provide for expansion of utilization.
C. Low cost due to proximity of host country-site to U. S. institution.

Benefits Expected: Increased food intake of protein and calories due to an increased use of peanut as a basic food component. Generation of income via stimulation of inter-island trade.

Host Country Lead Institution: CARDI, University of the West Indies, Food Technoloty Institute (Jamaica).

U. S. Lead Institution: Alabama A & M University (subgrant to University of Florida).

U. S. Principal Investigators: Dr. B. Singh, Coordinator, Alabama A & M University and Dr. E.M. Ahmed, Principal Investigator, University of Florida.

Project Title: Peanut Utilization in Food Systems in Developing Countries.

Objectives:

A. Assess the sensory, nutritional, microbiological and toxicological quality parameters of the peanut products.
B. Research problems in post-harvest handling and storage.
C. Incorporation of indigenous peanut and peanut products into solid and/or beverage food systems locally consumed.
D. Preparation and presentation of peanut fortified foods in order to determine acceptance and nutritional value of such products.

"Peanut Improvement for the Caribbean"

University of Georgia - Caribbean

W. D. Branch, Principal Investigator, UGA

INTRODUCTION

Because of expanding hunger in the less developed Caribbean Community and because of the subsistence role of the cultivated peanut (*Arachis hypogaea* L.), a peanut improvement project is proposed as one of several priority research areas under the Peanut CRSP. In this region a multidisciplinary research appraoch is needed to stabilize production, increase food supply, and diversify agriculture for the subsistence farmers and the urban population.

Accomplishments

The former project GA/INPEP (Interaction Peanut Evaluation Program) was developed to introduce and evaluate advanced liner/cultivars in countries where a breeding program did not exist, but there was interest and capacity for this level of a program. The Technical Committee, Board of Directors, and ME had perceived that this project covered too broad of a geographical area for the PI to handle and that a more in depth program was needed in the West African and Caribbean countries. The External Evaluation Panel concurred in this decision. The two Africa countries, Burkina Faso, and Niger have been linked to the Texas A&M breeding program in Senegal. The GA/INPEP project was changed to a Caribbean program with increased emphasis on cultivar development, disease resistance and control, and physiological problems.

In the first three years, three sets of germplasm, have been sent to the host countries, and subsequent testing has shown that some of the material may have potential for eventual cultivar development and release.

The U.S. principal investigator visited the host countries in Africa when the projects were established. Each African collaborator had a short term training visit to Georgia. A trip to the Caribbean was made during a recent reorganization of project leadership in CARDI. The three CARDI collaborators had a short term training visit to Georgia.

EXPECTED IMPACT OF PROJECT

Peanut production constraints are numerous and resources limited for the small scale farmers in these countries. The lack of adapted varieties and information on optimal cultural practices are the primary constraints to increasing peanut production in the Caribbean. The introduction and evaluation of improved varieties and cultural practices are expected to result in an increase of food yield. At the same time, it should maintain the viability of this particular crop in regions where its nutritional value is of paramount importance.

Other benefits of this project will include the identification of disease resistant lines. In addition, the information gained from testing in diverse environments should be of scientific interest to all concerned.

GOAL

The overall goal of this project is to identify superior varieties and cultural practices for the Caribbean to improve food yield.

OBJECTIVES

1. Continue a regional testing program to identify superior peanut genotypes (Breeding).
2. Screen early generation populations for adaptability and disease resistance (Genetics).
3. Evaluate various cultural methods to reduce stress (water, heat, and mineral) and enhance yield (Physiology).
4. Identify major disease problems, occurrence of epidemics, and impact of control (Pathology).
5. Provide training and technical assistance.

ORGANIZATION

University of Georgia:
Principle Investigators:
Dr. W.D. Branch, Department of Agronomy, Tifton, Peanut Breeder.
Dr. A.S. Csinos, Department of Plant Pathology, Tifton, Soil-borne Diseases.
DR. C.C. Holbrook, Department of Agronomy, Tifton, USDA Research Geneticist.
Dr. C.S. Kvien, Department of Agronomy, Tifton, Crop Physiologist.
Dr. R.H. Littrell, Department of Plant Pathology, Tifton, Foliar Diseases.
Dr. A.C. Mixon, Department of Agronomy, Tifton, USDA Research Agronomist.

Caribbean:

Caribbean Agricultural Research and Development Institute (CARDI), University of West Indies Campus, St. Augustine, Trinidad.

Dr. Sam Parasram, Executive Director (Trinidad).
Dr. Laxman Singh, Research Collaborator (Antigua).
Dr. B.K. Rai, Research Collaborator (Belize).
Mr. Horace Payne, Research Collaborator (Jamaica).

APPROACH

1. Advanced breeding lines and varieties for testing will continue to be distributed to host countries, and each host collaborator will be responsible for actual replicated field testing. Performance data will be analyzed, compiled, and published in the U.S., and then the results will be disseminated to all cooperators. Any variety and/or experimental line found to be desirable within this program will be subject to an international release between the originating institution and the host country. (W.D. Branch).

2. Rust and leafspot resistant lines will be intermated with cultivars exhibiting adaptability to the Caribbean environments. Early generation progenies will be selected on the basis of adaptability and disease resistance. (C.C. Holbrook and A.C. Mixon).

3. Environmental data (i.e. rainfall, temperature, soil type, etc.) will be collected at all test locations. Soil and plant tissue samples will be analyzed for mineral content to determine toxicity and deficiencies using on site laboratories when possible. Cultural, chemical and genetic avenues will then be explored to determine the best method to correct these deficiencies and toxicities. Maturity evaluations will be made on promising genotypes to determine which will fit into the cropping system of each area, and which are best adapted to the water, heat, and mineral stresses found at that location. (C.S. Kvien).

4. Initial objectives will be to determine the major yield limiting diseases of peanut (foliar, soil-borne, and seed-borne) in the Caribbean. Projects will be initiated at these sites including the training of location personnel and equipping of on site laboratories to isolate and identify pathogens. Programs will then be initiated to evaluate the success of controlling the pathogens determined to be yield limiting. Specific approaches to disease control may include cultural, chemical and genetic avenues. However, specific control programs will be based on the pathogens identified in the initial stages of the program. (A.S. Csinos, R.H. Littrell and A.C. Mixon).

Peanut Utilization in Food Systems in Developing Countries

Alabama A&M University (Subgrantee University of Florida)-
Caribbean Agricultural Research and Development Institute-
and University of West Indies, St. Augustine Campus, Trinidad

Bharat Singh, Principal Investigator, AAMU

INTRODUCTION

Even though peanut was known in the Caribbean region before the discovery of the new world, peanut production in the region is rather limited. Most peanut produced in the region are grown by small farmers and all peanut produced in the region are consumed locally. Local consumption greatly exceeds production and about 13 million lbs of peanut and peanut products are imported from outside the region. Efforts have been made in recent years to increase peanut production in Jamaica, Belize, St. Vincent, St. Lucia, and Antigua for local consumption, as well as trade between countries of the region. This has resulted in increased production. There is an immediate need, however, for research on post-harvest handling, storage, marketing, and processing of peanut. This project is designed to address constraints of utilization of peanut, including food preservation and preparation technology, as well as socioeconomic constraints. The first phase of the study just completed has provided a basis for further research on peanut in this region.

MAJOR ACCOMPLISHMENTS

A. Establishment of the Project

Separate Memoranda of Understanding (MOU) were developed and signed with the University of Florida as a collaborating US institution under a subgrant arrangement, the Caribbean Agricultural Research and Development Institute (CARDI) and the University of the West Indies (UWI) as host country collaborating institutions. The Food Technology Institute (FTI) Jamaica was brought in as a participating institution under the umbrella of the MOU with CARDI.

The linkage has been developed between the Management Entity, Alabama A&M University, University of Florida, CARDI, University of the West Indies, St. Augustine Campus, and Food Technology Institute. Agreements defining roles of each collaborating entity have been formalized through separate MOUs. It has been agreed that Alabama A&M University and the University of Florida will collaborate with CARDI in Belize and Food Technology Institute in Jamaica to conduct research related to post-harvest handling, storage and utilization of peanut in Jamaica and Belize. The research in Trinidad, St. Vincent and Antigua will be corrdinated through the MOU with the University of the West Indies in St. Augustine in collaboration with Alabama A & M University and University of Florida.

B. Research Results

Peanut consumption and post-harvest handling surveys in Trinidad (urban), St, Vincent (urban and rural), and Jamaica (urban and rural) were completed in May 1984. The preliminary analysis of the data has been completed. The results have been used in defining the direction of the food technology research. A plan of work for each collaborating institution has been completed.

Peanut butters produced in Caribbean countries have common problems: (a) oil separation, and (b) texture of the final product. A research plan was developed at Food Technology Institute in Jamaica, CARDI in Belize, and University of Florida to determine the cause of these problems and possible methods of improvement of peanut butter for local consumption.

Research plans have been developed at the University of the West Indies, St. Augustine to determine degree of maturity of peanut at harvest time, evaluation of quality, contamination by mold, and aflatoxin levels and storage practices in Antigua and St. Vincent. A plan of research to determine the post-harvest constraints impacting the quality of peanut for processing in Jamaica and Belize has been developed at Alabama A&M University and Food Technology Institute in Jamaica.

The survey data from Jamaica, Trinidad, and St. Vincent have been analyzed by Alabama A&M scientists. Levels and forms of aflatoxins in samples collected during the survey have been determined using standard procedures.

Protein, oil, carbohydrates, and aflatoxins in other samples and new products will be determined using standard AOAC procedures at the University of the West Indies, Food Technology Institute, and Alabama A&M University.

Microwave energy is begin studied as a means to decontaminate or to decrease the amounts of aflatoxins in peanut during roasting for processing.

REALIZED AND EXPECTED IMPACT OF PROJECT

Host Country

1. The project has established linkages with CARDI, University of the West Indies, and Food Technology Institute. It is expected that these linkages will result in long-term relationship between the collaborating institutions even after the project is ended.

2. Data from the consumption and post-harvest survey have already preovided information that has halped to define appropriate areas for researchin Jamaica, Trinidad, and St. Vincent. It is assumed that needs for peanut research in other Caribbean nations may be similar. Additional contacts with scientists in Belize and Antigua have further confirmed these assumptions.

3. Efforts are being made to address problems of storage, preservation, and preparation for consumption. It is expected that these will lead to improved means of storage and innovative means of processing peanut in various Caribbean countries. The rural, small farm Caribbean populations may have increased and prolonged opportunities to benefit from increased peanut production and consumption.

4. The project specifically will enhance the capabilities of CARDI, the University of the West Indies, and the Food Technology Institute, enabling each to do research on peanut, peanut products, and other food products.

United States

1. The project has provided an opportunity for Alabama A & M University and the University of Florida to acquire the regional experience in conducting research related to solving food problems in the Caribbean region.

2. Since the establishment of the project, the University of Florida has begun research on decontamination of aflatoxin in peanut using microwave energy. Also, University of Florida and Alabama A & M University scientists have considered research on factors controlling textures of peanut butter. The involvement of the scientists from the two universities in these acitivities enhances their professional abilities in teaching and research.

3. It is expected that the States of Alabama and Florida will further derive benefits from the development of new techniques for aflatoxin decontamination or peanut storage.

GOAL

The major goal of this research project is to develop the means for greater utilization of peanut for food by developing new foods or improving existing ones with peanut as an ingredient.

OBJECTIVES

The overall objectives are:

A. Description and understanding of variations in environment, socioeconomics, and food technologies as they constrain the preservation and utilization of peanut supplies.

B. To analyze the current and potential dietary role of existing peanut products.

C. Assessment of the sensory, nutritional, microbiological, and toxicological quality parameters of the peanut product.

D. Research on post-harvest handling and storage problems.

E. Incorporation of indigenous peanut and peanut products into solid and/or beverage food systems locally consumed.

F. To prepare and present peanut fortified foods in order to determine acceptability and nutritional values of such products.

G. To assure safety of the products with particular reference to mycotoxins in raw and finished products.

ORGANIZATION

Alabama A&M University

Dr. B. Singh, Food Scientist, Coordinator, Department of Food Science, Normal, AL
Dr. B. Onuma Okezie, Food Scientist, Cooperator, Department of Food Science, Normal, AL
Dr. John C. Anderson, Food Scientist, Cooperator, Department of Food Science, Normal, AL
Dr. G. C. Wheelock, Rural Sociologist, Cooperator, Department of Agribusiness, Normal, AL

University of Florida

Dr. E. M. Ahmed, Food Scientist, Co-Principal Investigator, Department of Food Science, Gainesville, FL
Dr. H. S. Sistren, Human Nutritionist, Cooperator, Department of Food Science, Gainesville, FL
Dr. R. Schmidt, Food Scientist, Cooperator, Department of Food Science, Gainesville, FL
Dr. Chang I. Wei, Food Toxicologist, Cooperator, Department of Food Science, Gainesville, FL

CARDI

Dr. S. Parasram, Executive Director, St. Augustine, Trinidad
Dr. St. Clair Forde, Director of Research and Development, St. Augustine, Trinidad
Dr. Don Walmsley, Agronomist, St. Augustine, Trinidad
Mr. Horace Payne, Peanut Agronomist, Kingston, Jamaica
Mr. Joseph R. Suah, Head of Unit, Kingston, Jamaica
Dr. L. Singh, Agronomist, Antigua
Dr. B. Rai, Head of Unit, Belmopan, Belize

Food Technology Institute, Kingston, Jamaica

Dr. Althea Townsend, Food Scientist
Ms. Doreen Lewis, Food Scientist
Ms. Frances Brown, Food Scientist

University of the West Indies, St. Augustine Campus, Trinidad

Dr. George Sammy, Food Scientist

Graduate Students and Research for Theses

Mr. Hossana Solomon (started fall, 1984, completed summer, 1985), "Socioeconomic factors related to peanut consumption in Caribbean countries of Trinidad, Jamaica, and St. Vincent".

Mr. E. Miller (started fall, 1985) "Studies on post-harvest handling and storage of peanuts with special reference to Jamaica".

Research Plan and Approach, 1985-89

The first phase of the plan of work (1983-1985) included consumption and post-harvest surveys in the Caribbean region. These surveys have been completed. Based on the survey results and discussion with collaborators, the following research objectives have been planned:

A. Post-harvest Handling and Storage: The research plan has been completed to study post-harvest handling and storage problems in St. Vincent, Antigua, and other eastern Caribbean countries by scientists from the Unversity of the West Indies. Similarly, scientists from the Food Technology Institute in Jamaica, CARDI in Jamaica and Belize will be working on post-harvest handling and storagve problems in Jamaica and Belize. Studies will include research on maturity index, curing, drying, and storage; aflatoxin contamination during post-harvest handling and storage; and pests and their management during storage. This study will be coordinated by Alabama A & M University.

B. Improvements or Modifications in Peanut Processing:

(i) Roasted Peanut: The survey data indicated that the most utilized form of peanut product is roasted peanut. However, there is a need for improvement in roasting methods and packaging of roasted peanut. Studies will be conducted at Food Technology Institute and CARDI in Antigua and Belize on this aspect of the research.

(ii) Peanut Butter: Peanut butter processed in Jamaica and other Caribbean countries has two problems: (a) oil separation, (b) texture of the product. Studies are underway at the Food Technology Institute and at the University of Florida to solve these problems by controlling the processing methods and ingredients.

(iii) Research on Production of New Acceptable Foods: Studies will include production of a peanut based beverage and other foods with acceptable taste and flavor. The method will include improvement of processing techniques to improve flavor (vacuum and steam stripping, ultra high temperature processing) and development of cultured and fermented peanut based products. Studies will be conducted both at the University of Florida and at the University of the West Indies.

(iv) Decontamination of Aflatoxins by Microwave Energy: Studies are in progress at the University of Florida on decontamination of aflatoxin using microwave energy. Further studies will include characterization and toxicity of mycotoxin by-products after treatment with microwave energy.

(v) Quality of Peanut: A closely coordinated program will be started in collaboration with agronomists, peanut producers, and food scientists to study the quality of peanut for humanutilization. It will include determination of proximate compositions, antinutritional factors, mycotoxin contamination, and processing quality. Studies will be conducted at Alabama A & M, University of the West Indies, Food Technology Institute, and the University of Florida.

C. Training Plan: Currently, one student from Jamaica is working on his M.S. thesis on post-harvest aspects of peanut. A plan is underway to bring a member of the Food Technology Institute for a Ph.D. degree in Food Science at the University of Florida. A workshop will be conducted to address the post-harvest problem in peanut in Caribbean countries in 1986. Scientist from the US will be participating in this workshop along with collaborators from the host countries.