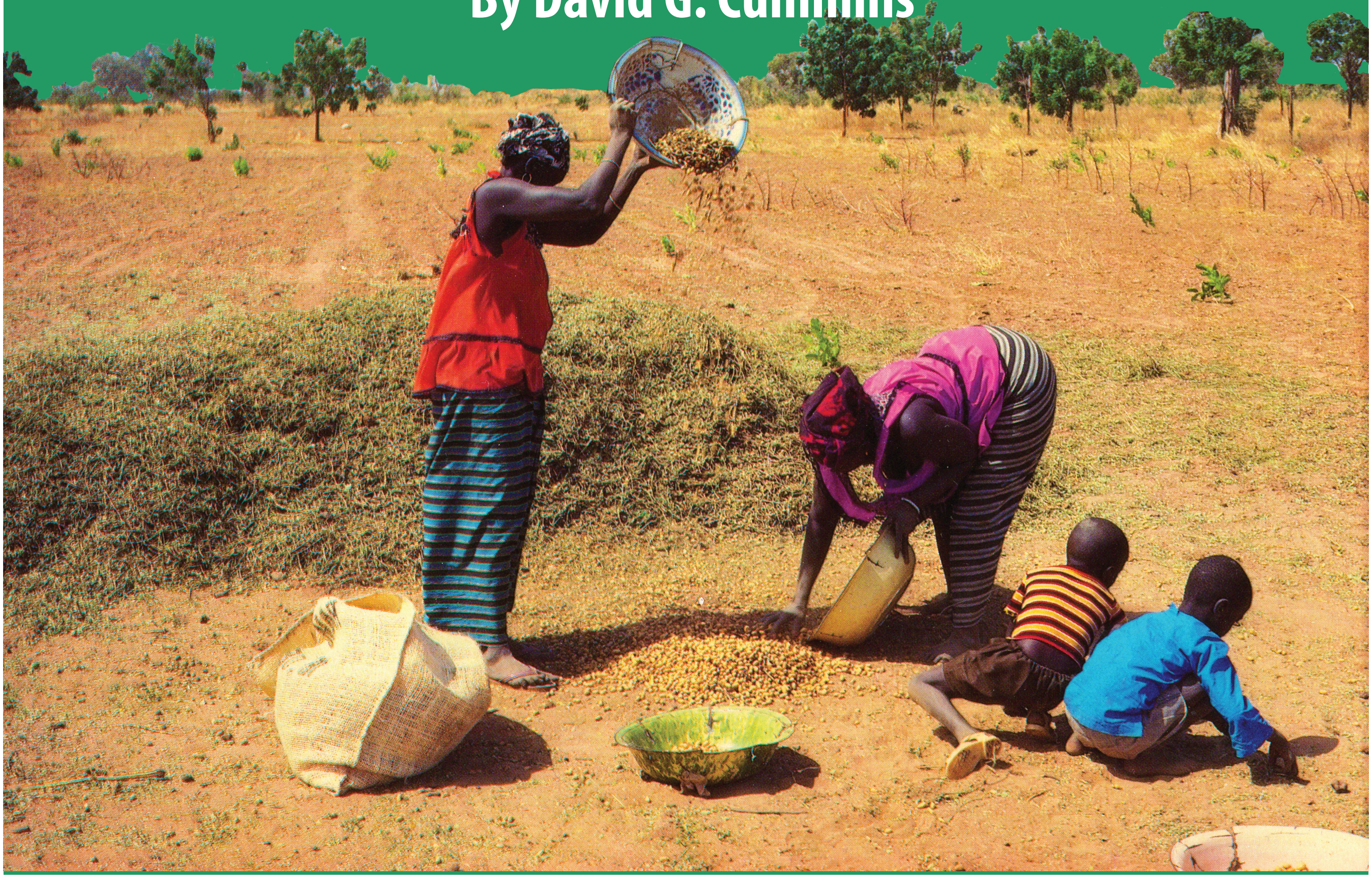
History of the Peanut Collaborative Research Support Program

From the 1980-1982 Planning Effort through the 1982-2012 Research Program

By David G. Cummins



On the Cover: "Winnowing peanut in Senegal." Peanut provides food, feed, oil, and economic returns for people in developed and developing countries worldwide.

The Peanut Collaborative Research Support Program (Peanut CRSP) was funded through Title XII – Famine Prevention and Freedom from Hunger, under the International Development and Food Assisstance Act of 1975. It was implemented by the United States Agency for International Development (USAID), through Planning Grant DAN-4048-GG-2065-00, 1982-1985; Grant No. DAN-4048-G-SS-2065-00 July 1982-1985; Grant No. DAN-4048-G-SS-2065-00, July 1985-June 1990; Grant No.DAN-4048-G-00-6041-00, July 1990-June 1996; Grant No.LAG-4048-G-00-6013-00, July 1996-June 2001; Grant No. LAG-G-00-96-90013-00, July 2001-June 2007; Cooperative Agreement # ECG-A-00-07-00001-00, July 2007- June 2012; and support from the participating United States Universities and Host Country Institutions. The Board for International Food and Agricultural Development (BIFAD) provided an advisory role in the implementation of the Peanut CRSP.

The Peanut CRSP was managed by the University of Georgia throughout its history through the above listed grants and cooperative agreements.

The author was associated with the program throughout its history as the Associate Planning Grant Director and Program Director until his Retirement, and as a Special Consultant for the University of Georgia until the program ended in 2012. The program continued after 2012 as the newly branded Feed the Future Innovation Lab for Collaborative Research on Peanut Productivity and Mycotoxin Control.

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EXECUTIVE SUMMARY

Background of the CRSPs

The Collaborative Research Support Program (CRSP) was created to implement the Title XII program of the United States Foreign Assistance Act of 1975 with a goal to prevent famine and establish freedom from hunger through land-grant university involvement in international development. The goal was later expanded to include contribution to economic development. Title XII guidelines stated that the CRSPs should have impacts in the host or developing countries and also have return benefits to the United States, because of the U.S. university cost-share component of the program.

The concept inherent in the CRSPs was that the success of the U.S. land-grant university system on the development of U.S. agriculture would be transferred to the less developed countries. The Peanut CRSP history reviews the Land-grant Act of 1862 that developed agricultural colleges and universities in each state, the Hatch Act of 1887 to develop associated experiment stations, and the Smith-Lever Act of 1914 to develop associated cooperative extension services. The foreign aid effort developed by the international community at the end of World War II to respond to the European losses in the war formed the International Monetary Fund and the World Bank in 1945. It was followed by the creation of the Marshall Plan in the U.S. in 1948 as an emergency tool of assistance. The Marshall Plan ended in 1951 and its responsibilities merged into the International Cooperation Administration in 1954 under the U.S. Department of State. The Development Loan Fund was established in 1957 to focus on capital development. The Foreign Assistance Act of 1961 provided for the development of the United States Agency for International Development, which helped focus and make more efficient and effective the U.S. foreign aid programs. Various projects utilized U.S. universities and scientists in international development in Asia, Latin America and Africa, and these successes led to the Foreign Assistance Act of 1975 and the Collaborative Research Support Program. The Board for International Food And Agricultural Development (BIFAD) was an advisory group for USAID and the land-grant university system in program development and management.

Plans for the first four CRSPs began in 1978, with grants awarded in 1979. The plans for the next four CRSPs began in 1979-1980 and the grants were awarded by 1982. The Peanut CRSP began in 1982, and in addition to the strengths in peanut research in the universities, several factors have provided a basis for success. These included the research programs in several countries around the world with particular strength in former British and French colonial countries, the development of the American Peanut Research and Education Society and an international journal (Peanut Science) with an origin in 1957, which developed into the first international peanut forum, and the development of the Consultative Group for International Agricultural Research (CGIAR) in 1971 that instituted the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in 1972 with a peanut program beginning in 1976. The Peanut CRSP was fortunate to have this strong base for the beginning of the 1980 planning grant and the 1982 research grant. The 1982-2013 history will attempt to capture and describe major accomplishments and impacts of the effort.

The format of the history will follow the whole value chain of the peanut system (producer values, processor values, consumer values, and information/training/impacts) that developed in the latter phases of the program that will facilitate the following of progress over the total program. Host country and U.S. benefits are both emphasized.

As a point of clarity, developing country and less developed country may refer to any country that may have in-country CRSP research or could access CRSP research information, while host country always refers to a collaborating country for CRSP project(s); and interchanging use of these terms may be noted in the history.

A summary of major impacts is followed by a more fully defined compilation of outstanding accomplishments and impacts in the overall summary. Sixteen U.S. land-grant universities, including three 1890 land-grant universities (historically African American) have served as sub-grantees and one additional 1890 university has been a cooperator.

MAJOR IMPACTS FROM 1982 TO 2012

The major impacts will be listed in a brief format, but will be described with some more detail later. The impacts and accomplishments may have been accomplished in one program phase or through necessary long-term research that extended over multiple phases.

A. Producer values impacts

Host country impacts: Germplasm lines have been distributed to several countries that contributed to development of improved varieties. Rosette Virus Disease Resistant Varieties have been developed in Nigeria, Malawi and Uganda and have spread to other countries, reversing the devastation of the peanut crop in many Sub-Saharan Africa countries stressed with rosette virus disease epidemics. Significant variety development has occurred in Thailand, Philippines, Senegal, Jamaica and Bolivia. Integrated Pest Management (IPM) practices have been developed and implemented in Ghana, Philippines, Thailand and Burkina Faso. Identification of NC Ac 343 peanut line with wide insect resistance has been used in breeding for insect resistance around the world. Productivity increases in Guyana led to the development of the school lunch program using peanut butter and cassava bread to utilize the peanut produce.

U.S. Impacts: High oleic oil varieties have been released in Texas that increase peanut value, delay the development of rancidity, and increase consumer value of peanut products. Higher yielding, insect pest and disease resistant varieties, and higher quality cultivars have been released in North Carolina and Texas. IPM practices developed and implemented in North Carolina have resulted in higher yields with decreased use of insecticides.

B. Processor value impacts

Host country impacts: A hand sorting technique was developed in the Philippines and Thailand that removed essentially 100% of aflatoxin contaminated peanuts prior to processing, resulting in higher value, healthier peanut products. A Peanut Industry Incubator Model (PIIM) developed in the Philippines and Thailand to simultaneously develop and test new or improved product(s) and through participation of an interested processor market the new product; notable impacts were Vitamin A fortified peanut butter (child health value) and "Kare-Kare" sauce produced in the Philippines (domestic and export value) and village level industries in both countries. The development of a village level school lunch program in Guyana utilized increased production that was exceeding market potential.

U.S. Impacts: In the U.S., six new/improved peanut-based products were developed and some are being considered for commercialization by a Georgia-based food company (Bell Plantations, Inc.): 1) resveratrol-enhanced peanuts, 2) peanut butter from resveratrol-enhanced peanuts, 3) cheese-flavored cracker-coated peanuts, 4) caramel-flavored cracker-coated peanuts, 5) chocolate flavored peanut spread and 6) roasted peanuts. The chocolate flavored spread was introduced from the Philippines and tested with a private company. A corresponding product developed and optimized with consideration of the preferences of the American consumer. One U.S. patent for resveratrol-enhanced peanut is provisional.

C. Consumer values impacts

Host country impacts: Research led to the adoption of NovaSil clay to remove aflatoxin from feed and foods (now used in 60 percent of animal feed produced worldwide). NovaSil was shown to be effective for the absorption of fumonisin, another important mycotoxin particularly affecting corn/maize in Africa and linked by the Peanut CRSP to the increased incidence of HIV/AIDS. Control measures were developed and implemented for aflatoxin management by housewives and industry in Uganda. Aflatoxin was shown to depress the immune system with increased potential for the spread of infectious diseases such as HIV/AIDS, tuberculosis and hepatitis.

U.S. impacts: NovaSil clay is important in dairy rations to remove aflatoxin from milk estimated to contribute US $5 million annually to the dairy industry. Nutrition research contributed to an FDA claim for the heart healthy benefits of peanut consumption, which added $500 million dollars annually to the peanut industry.

D. Information/training/impacts

Cooperative publication with ICRISAT of the International Arachis Newsletter from 1983 to 2011 provided a non-journal level outlet for peanut information. There has been extensive degree training of host country and U.S. scientists, many now leaders in their various disciplines and countries. Regional scientific workshops held cooperatively with other international groups have provided training and sharing of information to developing country and U.S. scientists. Key surveys and impact evaluations have helped guide research and measure accomplishments and impacts.

PREFACE

The Collaborative Research Support Programs (CRSPs) were developed based on the Foreign Assistance Act of 1975 that authorized Title XII, which brought the United States Land-grant Institutions into a prominent role of famine prevention and freedom from hunger in the developing world. The Land-grant Institutions (Congressional Acts of 1862 and 1890) provided for agricultural technologies that helped move the United States from primarily an agricultural economy into a highly industrialized economy. Architects of the CRSP concept visualized the transfer of the successes of the U.S. Land-grant program into developing countries for food production and a later added economic development thrust. The success of these goals was dependent on attracting Land-grant scientists and universities with peanut expertise to be committed to the efforts. This commitment was evident in the funding arrangements that required the participating U.S. university to provide matching funds at 25% or more of the USAID funds provided for individual projects, which was always met showing the commitment of the university.

U.S. peanut scientific expertise developed across the peanut production regions, and began to be more interactive through the peanut groups that met annually beginning in the late 1950's, which culminated as the American Peanut Research and Education Society (APRES) and the publication Peanut Science. International scientists were attracted and participated in annual meetings of APRES. Research groups developed in especially the English and French Colonial Regions of Africa, and also in Latin America, Australia, Thailand, Philippines, etc., which provided a research capacity base in a number of developing countries that contributed to the early success of the Peanut CRSP.

The Peanut CRSP planning grant began at the same time in 1980 that the First International Groundnut Workshop was hosted by ICRISAT in India. The Workshop pulled together the international peanut research and development scientists, which was beneficial to the Peanut CRSP in identifying the developing countries that had the most need and interest and a base for research collaboration, and that had a USAID presence. U.S. and host country scientists had the opportunity to meet and interact, many of whom became Peanut CRSP cooperators and collaborators in future projects..

The Peanut CRSP began with breeding, cultural practices, and food technology, with some cooperation across projects. In 1996 Jonathan Williams became involved in planning the 1996-2001 phase, and he introduced the Full Value Chain concept that better linked producer, processor, consumer, and cross-cutting (information, training, and management) research and output. This concept allowed the development within the Peanut CRSP of a 'market pull' influence that enhanced the value of the peanut to the farmer, processor, and consumer.

Information for the History was accumulated from a variety of sources including Annual Reports, various special reports, journal publications, External Evaluation Panel and final reports for each phase, and other available sources.

The History is divided into sections corresponding to the funding phases. U.S. Universities scientists, and students; Host Country Institutions; scientists, and students; U.S. Department of Agriculture participants; public sector contributors; international groups and other country groups working in the international sector that participated in Peanut CRSP activities are cited. Especially important to the success of the Peanut CRSP was the guidance and support from USAID and BIFAD, and the Board of Directors and Technical Committee representing the participating universities. Also important was the Office of International Programs, the Office of the Vice President for Research and Business and Finance, and the College of Agriculture at the University of Georgia, and also support from similar offices in participating universities. Host Country institutions also provided good support. Everyone involved helped assure that the Peanut CRSP had good programmatic and fiscal management.

David Cummins retired as Program Director in 1998, and Jonathan Williams was Director from 1998-2012. David supported Tim in special work, reports, travel, etc from 1998-2012 as a Retired/Rehired University of Georgia employee. In 2010, Dr.Williams suggested that Dr. Cummins should begin spending time on summarizing the overall Peanut CRSP effort from 1980 to 2012 and together they outlined some objectives. The idea of a short summary grew into a more detailed history of the overall effort. The Peanut CRSP ended as a CRSP in 2012 with USAID program changes leading to the Feed the Future Innovation Lab concept, which curtailed the planned publication of the History. Peanut research and development came under the Feed the Future Innovation Lab for Collaborative Research on Peanut Proudctivity and Mycotoxin Control (the Peanut & Mycotoxin Inovation Lab or PMIL for short) also managed by the University of Georgia. Dr. Dave Hoisington, PMIL Director, contacted Dr.

Cummins regarding the status of the history and they agreed to move forward using PMIL support for the publication of the Peanut CRSP History, for which great appreciation is extended. Special thanks are also extended to Christy Fricks, PMIL Communications Specialist, for editing and preparing the document for publication.

Sincere thanks are expressed to everyone that contributed to the successes and impacts of the Peanut CRSP, with anticipation that The History can recognize participants as individuals, institutions, and beneficiaries of the technologies developed. Apologies are extended for any unintentional omission of individuals or institutions that contributed to the success of the Peanut CRSP. Hopefully, the History will also assist in long-term use and impacts of Peanut CRSP advances and contributions.

Written by: Dr. David G. Cummins
Program Director, Peanut CRSP, 1982-1998
Special Assistant to Program Director (Retired/Rehired Professor), 1998-2012
Associate Director, Peanut CRSP Planning Grant, 1980-1982

FOREWORD

Over the thirty years of existence, the Peanut Collaborative Research and Support Program (Peanut CRSP) engaged with many participants and achieved a remarkable return on the investment by USAID, the US universities and their developing country partners. This book, written by David Cummins the Program Director between 1982 and 1998, reflects the history, achievements, challenges, and evolution of the Peanut CRSP from the Planning Grant of 1980-1982 and the Research Program from 1982-2012.

The Peanut CRSP was the fifth CRSP initiated as a result of the Foreign Assistance Act of 1975, which authorized Title XII to prevent famine and establish freedom from hunger through Land-grant University involvement in international development. The guidelines developed by USAID and the Board for International Food and Agricultural Development (BIFAD) responded to the Title XII mandates of mutually beneficial research and capacity development in developing countries and the United States. The funds supplied for the CRSPs were always small relative to the opportunity, but were compensated for by the interest and enthusiasm of the participants. The CRSP model of sustained support for goals and institutions made this low budget effort a highly regarded vehicle for development and international exchange. The Peanut CRSP was there for the long haul, enabling people and institutions to achieve remarkable results.

In 1976, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) as a member of the Consultative Group for International Agricultural Research (CGIAR) established a groundnut improvement program, which organized the first global Groundnut Conference in 1980 in Hyderabad, India. The start of the Peanut CRSP coincided with that event. David Cummins and Curtis Jackson (Associate Director and Director of the Peanut CRSP Planning Grant, respectively) joined the representatives from almost all countries where the peanut crop was grown and with a research interest in peanut, which was where I first met them. I had just joined ICRISAT as the Principal Groundnut Physiologist, and was in the process of establishing a program addressing drought, agronomic management, and environmental stresses. Almost 16 years later, I joined the Peanut CRSP as Associate Director, having become frustrated by the failure of the CGIAR system to address the capacity development needs of national programs, the market development needs, and value chain development. In my experience with the Zimbabwe production system, the Indian groundnut crop, and in West Africa peanut production, peanut can produce much higher yields in almost all places where it is cultivated. Market development is necessary to increase the income from the peanut crop to support the costs of inputs required to sustain the higher production, which requires marketing as higher value human food and not just for lower value oil seed.

While what I did with ICRISAT was exciting scientifically, my tenure with the Peanut CRSP was much more satisfying from the development perspective. I was able to address the critical needs of market development so that production technologies would not be abandoned as increased supply led to the market response of lower prices. This market development, my experience told me, was essential for the sustainable adoption of technology. With the Peanut CRSP, I could also develop a side program that addressed the hidden importance of aflatoxin in the public health context. By the end of the second program phase (first ten years of my experience with Peanut CRSP), we found that despite knowing how to address aflatoxin in the production and value chain we could never get any technology adopted. Literature informed us that aflatoxin was exacerbating health risks that were responsible for 43% of the burden of disease, but the public health fraternity disowned the problem of aflatoxicosis, while the agricultural fraternity was discouraged from admitting to it. The Peanut CRSP took ownership and accorded this problem a high priority, funded with some additional funds from USAID. Brave people inside USAID used scarce Agriculture Funding to support this initiative, but the Health Pillar never did, despite the role of aflatoxin in the HIV epidemic.

There is so much that the Peanut CRSP family can be proud of (and that I am proud of): consider the projects supported by the Peanut CRSP that have been so influential in raising the status of aflatoxin in world consciousness and the development agenda. The fact exists that through Peanut CRSP technology so much of the animal feeds around the world are protected from aflatoxin, which alone justifies the program. Remember also the development of peanut based village industries in Thailand, Philippines, Guyana, and Belize. The research that changed perception in the USA of the nutritional value of peanuts was started by the Peanut CRSP, and quickly expanded on by the US industry. Farmers in Ghana have also adopted production technologies, new cultivars and production practices in several countries… oh there are so many examples of local, regional and globally important discoveries and changes.

But most important is that our partners became independently capable of undertaking research without external support. In most places in which the Peanut CRSP operated, by the time the program moved on the partner institutions had matured. The young scientists who were involved in the beginning had grown in stature and responsibility and were now in leadership roles.

The life of the Peanut CRSP was not without challenges. Funds were always short and needed to be contested for within the Peanut CRSP, and within USAID. The v has been blessed by a great set of people who advised those involved in developing and implementing projects and connecting those projects to make coherent programs, and those who fought what the program needed inside of USAID, in Congress, in US Peanut Commissions and in Universities; in particular the University of Georgia where the program was resident.

The Peanut CRSP fraternity has always been collegial and I am sure that one of the legacies of the program will be the links between institutions and people touched by this effort, impacts on the peanut commodity, and on the development model. I was honored to be involved and responsible for the Peanut CRSP over the second half of its operation. A recording of the history of this program will hopefully provide people into the future with an understanding of the dedication of the Peanut CRSP scientists, their support staff, the USAID program officers, and the good people who advised the program.

David Cummins, who wrote this history, has been involved in the two-year planning process and throughout the 30 year history of the program, except for two years in 1986-1988 when he was with USAID/Philippines as Agricultural Research Advisor under the Joint Career Corps Program (Dr. Tommy Nakayama served as Director during this time). After his retirement and my appointment as Director in 1998, he continued to serve the program as editor and backup in case there were decisions that needed to be made where his intimate knowledge of the program could be exploited.

Written by:
Dr. Jonathan H. Williams
Program Director, Peanut CRSP, 1998-2012; Associate Program Director, 1996-1998

INTRODUCTION

The Collaborative Research Support Program (CRSP) was created to help implement the Title XII program of the United States Foreign Assistance Act of 1975 with “a goal to prevent famine and establish freedom from hunger through land-grant university involvement in international development.” To attain the goals, the research capability of both developing country and U.S. institutions was enhanced through training and support of research. Inherent in the CRSP concept was the need to address constraints that have global implications. The Board for International Food and Agricultural Development (BIFAD) was a Presidential appointed board made up of individuals with university and public experience to advise the United States Agency for International Development (USAID) and the universities in the development, implementation, and management of the CRSPs. These management and support groups were well equipped to advise and support the U.S. and host country administrators and scientists to address research and development activities in the agricultural sector to contribute to the goal of preventing famine and establishing freedom from hunger. The goal was later expanded to include contribution to economic development.

The U.S. Congress, through implementation of the Title XII program, provided financial support for the CRSP programs. USAID, and the Office of Agriculture, in Washington, D.C., were responsible for the programmatic and financial aspects of the programs. The local USAID missions provided overseas support and advice for in-country programs. The funds for a CRSP were provided through a grant to the university based management entity that, in turn, developed sub-grants to other U.S. universities for particular projects in the U.S. and overseas collaborating institutions. The management entity was responsible to USAID for programmatic and fiscal management of the program.

In order to understand the concept that went into the implementation of CRSPs as a means of stimulating agricultural development in less-developed countries, this report will make a review of the U.S. Government in agricultural research, education and extension and the additional role in support of international development. The first four chapters of this report include the history of the United States land-grant university system, the involvement of the United States in international development leading up to the formation of USAID in 1961, the Title XII Amendment in 1975 and the U.S. land-grant system and Title XII Amendment in 1975 and the CRSPs.

The Peanut Collaborative Research Support Program (Peanut CRSP) was one of several CRSPs funded by the U.S. government to support agricultural research and development to enhance food production and economic growth in less developed countries around the world.

Additionally, the paper will describe the Peanut CRSP Planning Process from 1980-1982, define the five grants and one cooperative agreement and their goals that have existed from July 1982 through March 2013, and will highlight accomplishments and impacts during this period. Based on the later format that developed as a full-value chain approach, the program will be classified into four major themes, Producer Values, Processor Values, Consumer Values and Information/Training/Impacts. The Program Descriptions have been modified, expanded or grouped differently over the years, but have in general covered these areas to some degrees. The entry of past information into the present themes simplify the summary model and enable the reader to more easily follow accomplishments of interest over the life of the Peanut CRSP, particularly in seeing the future impacts of long-term research. For example, variety/cultivar development can be followed through the producer values theme, food product development followed through processor values, aflatoxin management followed through consumer values, or support of short- and long-term training through information/training/impacts.

Personal comments on the value of the Peanut CRSP to international development:

“There is no doubt in my mind as to the importance of the Peanut CRSP in encouraging international cooperation in peanut research and development. A particularly important aspect was the forging of links between workers in Anglophone and Francophone African countries. The close linkage with ICRISAT was also important and enhanced the effectiveness of both institutions. Concerning groundnut rosette disease, the May 1983 rosette meeting (Peanut CRSP/Demski virus project), organized in the U.S., was an important stimulus to work on this problem,” wrote Dr. Duncan McDonald, Peebles, Scotland. He served in the British overseas service in Nigeria from 1957 to 1976, and from 1976 until he retired in 1994 was ICRSAT/India plant pathologist, Peanut CRSP external evaluation panel in 2000, and a highly recognized international peanut scientist.

"The most valuable accomplishment of this project is by far the people trained and working for their country; I am a living example. When I first came to the U.S., I hardly understood the language. It was difficult to speak a full sentence. Now you can judge. The friendship with U.S. scientists is also a valuable accomplishment," wrote Dr. Ousmane Ndoye, peanut breeder, ISRA/Senegal, M.S. 1988 and Ph.D. in 1993 in plant breeding at Texas A&M University, Peanut CRSP support. (In: O. Ndoye, O.D. Smith, and A. Ba., 'Fleur 11' Impacts in Senegal. Impacts and Scientific Advances through Collaborative Research on Peanut, Symposium and Workshop, Arlington, VA, 29-31 March 1995.)

"Winnowing peanut in Senegal."Farm families are prime beneficiares of the peanut crop across the developing world.

CHAPTER 1. OVERALL IMPACTS AND ACCOMPLISHMENTS OF THE PEANUT CRSP 1982-2012

A. Producer values

The producer value sector goals focus on challenges from the environment, such as water and nutrient stress, peanut diseases and insect pressures, and market acceptance of current varieties; and the development of varieties and production practices to overcome these constraints.

Host country impacts

Germplasm distribution: The distribution of superior germplasm for variety development was an important impact as the 1982 program began. Some 200 lines and varieties were distributed in Niger, Cameroon, Burkina Faso, Antigua, Belize and Jamaica that contributed to disease resistance, earliness of maturity, soil nutrient response and other factors. Senegalese testing of 115 lines indicated needed disease resistance and other characteristics, and similarly 2,000 lines were distributed in Thailand. The Philippines received 300 lines early in the program. This formed the basis for important advances in variety/cultivar development as the Peanut CRSP progressed in future years. For example, in the 1985-1990 phase, eight cultivars were released in host countries.

Africa cultivar development

Groundnut rosette virus resistance: Groundnut rosette virus has long been a major problem in peanut production across Africa, affecting usually 5-10 percent of plants each year, with periodic epidemics that result in near 100 percent yield losses. Early work in Nigeria on groundnut rosette disease established a procedure to mechanically transmit the virus to peanut plants to enhance the research process. An important finding was that two agents were necessary for rosette virus infection, a luteovirus for transmission and a symptom-inducing agent, which corresponded to the observation that plants may be infected without visible symptoms. These efforts contributed to the future success in the development of resistant varieties.
Rosette/Nigeria – In the 1985-1990 phase, two cultivars were developed, seed increased and released in Nigeria, SAMNUT 17 (short-season, GRD tolerant) and SAMNUT 18 (short-season, GRD-tolerant). These two cultivars began to fill the need for shorter season cultivars for more northern areas of the country, but lacked good resistance to GRD. SAMNUT 10 (long-season, GRD-resistant), SAMNUT 11 (long-season, GRD-resistant), SAMNUT 14 (short-season, GRD-tolerant), and SAMNUT 16 (medium-season, GRD-resistant) were officially released in 1993. SAMNUT 20 (medium-season, GRD-resistant) (medium-season, GRD-resistant), SAMNUT 21 (medium-season, GRD-resistant), and SAMNUT 19 (short-season, GRD-tolerant) were released in 1994. The cultivars filled the need for rosette resistance to GRD, with less GRD-resistant, tolerant cultivars helping to increase productivity. In 2010, ICRISAT estimates were that four of these varieties (SAMNUT 10, SAMNUT 11, SAMNUT 14, and SAMNUT 18) occupied about 70 percent of the Nigeria peanut acreage.

Rosette/Malawi – Work was shifted to Malawi in the 1996-2001 phase. Along with the country program, a good collaboration existed with the ICRISAT/Malawi groundnut program in variety development, seed increase and release for farmer use. Based on Georgia laboratory work on the variability across Africa, the viral coat-protein of the GRV assistor virus should be stable across Africa. A long-season rosette resistant variety was released as Nsinjiro. In 2001, a new, much-needed, short-season, drought-tolerant, Spanish-type rosette resistant variety was released as Baka. Seed distribution is a problem in Malawi, but by 2010 almost 6,000 hectares of resistant material were grown by farmers.

Rosette/Uganda – Cooperative efforts with Uganda from the Malawi program, beginning in 1999, led to the release of the rosette-disease-resistant Serenut 3R (red seeded) Serenut 4T (tan seeded) in 2002, which was important since rosette resistant varieties are desperately needed in many countries in Sub-Saharan Africa. Potential savings were estimated in an economic survey in 2003 to exceed US $47 million annually when adopted by farmers in Uganda, which can be multiplied across the region. Two new lines with high resistance to Groundnut Rosette Disease were released in 2010 as Serenut 5R and Serenut 6T. At least two more lines having GRD resistance and/or leaf spot resistance were field-tested in 2010 and are awaiting approval for release in 2011. The crossing of disease-resistant germplasm with new and desirable traits with local cultivars with the goal of maintaining agronomic traits (such as seed color, size and flavor) preferred by farmers and consumers is of priority in the program, and should result in improved versions of Ugandan landraces/germplasm in due course. Rosette resistant varieties now occupy about 65 percent of the Uganda peanut production. GRD-resistant lines have been transferred to other countries in the region including Ethiopia, Sudan, South Sudan, Western Kenya, Democratic Republic of the Congo and Rwanda. The cultivar Serenut 4T performed well in Ethiopia and in 2012 was near release as a new cultivar. Improved resistance was observed in transgenic material developed with RNAi technology, and with active support of the Uganda Government. Approval for testing of the transgenic material was anticipated in 2011, but due to the request for more information by the Uganda approval committee, approval was anticipated to allow for 2012 greenhouse tests. All transgenic work for rosette resistance will be done in Uganda. The transgenic lines promise to provide GRD resistance that will not break down as readily with continued heavy disease pressure.

Recent work in Uganda has introduced rosette resistance into Valencia germplasm that should return the Valencia "niche market" lost to the rosette virus epidemic. The newly developed breeding lines of Valencia market types are in advanced stages of evaluation prior to their evaluation in "National Performance Trial" for release in Uganda. Seed increase of the promising lines is underway to provide enough seed stocks once either of the lines is notified for release. Efforts are also underway to combine resistance to late leaf spot and rosette virus diseases into the improved genetic background with Valencia characteristics. Development and use of rosette disease-resistant varieties in Uganda and other countries in the region is helping to overcome the devastation in peanut production caused by the rosette virus.

Senegal: In Senegal, the cultivar Fleur 11 was released in 1992 and yielded 25 percent more than the standard cultivar 55-437, larger seeded which was attractive to the edible peanut processors, and had a 90-day maturity cycle adaptable to the shorter rainfall period areas. Based on an economic survey, Fleur 11 could increase the annual value of the crop in Senegal by US $18 million. Six more varieties were released that had CRSP support in development. First, 78-936 is an extra early, 75-day maturing variety, larger seeds and comparable yields with 55-437. Three varieties are 80-day maturity with drought tolerance, 55-33, 73-9-11, and SRV1-19. Two Virginia, 120-day maturity, large seed types were released; PC79-79, resistant to early leaf spot, and H75-0, a large seeded edible type. All these varieties focus on productivity and market acceptability and contribute to economic development and food supply.

Burkina Faso: In 2012, two leaf spot-resistant cultivars were set for release in Burkina Faso; a Spanish cultivar (yields 20 percent higher than the disease susceptible check over eight years of tests) and a runner cultivar (that out yields the same check 50 percent and the Nama cultivar by 100 percent). Progress was being made in germplasm improvement with the potential of development of a leaf spot resistance cultivar in Ghana. A major accomplishment in this project has been the development of high oleic acid cultivars of peanut in Texas and movement into the West Africa program. The high oleic trait delays rancidity of peanut seed and peanut products during storage, which improves the flavor and value of peanut and peanut products. Senegal was in the process of releasing two Spanish cultivars with fresh seed dormancy (will reduce yield losses from germination of mature seed when late rains occur prior to harvest) and drought tolerance along with six other early-maturing varieties released in 2010 under separate funding.

Seed increase, multiplication, commercialization and distribution to farmers are major difficulties for many developing countries, including West Africa. Overcoming these constraints has been the goal of efforts in Senegal, Burkina Faso and Ghana with significant progress being made with the involvement of governmental and NGO entities with the support of the Peanut CRSP.

After six years of tests in Ghana with the IPM program, two cultivars were released that have excellent yield potential, drought tolerance, disease and insect pest resistance. They have shown consistent success at several locations in Central and Southern Ghana.

Southeast Asia cultivar development

Thailand: Three new cultivars were released in Thailand from 1985-1990; Khon Kaen 60-1 (larger seed size for market quality), Khon Kaen 60-2 (higher yielding and better pod characteristics) and Khon Kaen 60-3 as the first large-seeded cultivar in Thailand with high market quality. In the poverty stricken areas of Northeast Thailand, these varieties increased farmer yields 24 percent with available and affordable management practices, returned an additional 42,000 metric tons with a value of US $20,000 annually. Khon Kaen 60-4, a high-yielding boiling-type, was released in Thailand in 1993. In addition, two additional small-seeded varieties were released later that had Peanut CRSP support in development, KK 5 and KKU 40. Growers are currently using all these cultivars.

Philippines: In the Philippines, UPL Pn-6 cultivar was released, and in 1989 estimates from the R&D program showed increased yields of 14 percent with a potential farm value of US $3.5 million annually. UPL Pn-8 with good disease resistance was released in 1988. UPL-Pn10 was released in the Philippines in 1992 with about 33 percent higher yields than the popular BPI P9. UPL PN12 was released in 1994, and was a red-seeded Valencia type that filled a market niche for roasted in-shell peanuts.

Latin America/Caribbean cultivar development

In Jamaica, the evaluation of some 200 CRSP supplied genotypes resulted in the identification and release of CARDI/Payne cultivar in the 1986-1987 project year that was rust-and-leaf spot-resistant. The local extension service evaluations showed increases in yields along with higher farmer profitability. A survey showed a 42 percent yield increase over common varieties with an increase in value of US $600,000 for producers, but the cream-colored seed was not as acceptable in the marketplace as the traditional red-seeded types and resulted in less use of the variety.

In Bolivia, a new variety with improved rust and leaf spot resistance was released in 2004 (Mairana) and another in 2010 and seed was being multiplied. From 2008-2012, significant progress was made in the utilization of wild species in crosses to obtain increased rust and leaf spot resistance. Seven lines were sent to Guyana and 44 lines to Bolivia for the 2011-2012 seasons. Results are not complete, but are anticipated to improve the germplasm base in all three countries and result in the release of new cultivars. This team of scientists has been successful in bringing these genes into cultivated plants, which is a major step forward in breeding programs working with wild species. The result is two lines displaying little or no rust and very little leaf spot diseases. If confirmed in field test studies in Bolivia, where a history of these diseases exist, the results will significantly accelerate development of rust-and-leaf spot-resistant cultivars and a greatly improved peanut production.

Production practices

Peanut production in Bolivia had increased from 2000 to 11,000 hectares from 2001 to 2004 with per ha production increase from 1.0 metric ton/hectare to 2.0-2.5 metric tons/hectare, and further increase was expected from the release of the improved variety, "Mairana," in 2004. In 2010, a new variety has been released and seed is being multiplied, which should further increase peanut production.

In Guyana, peanut production was increased three-fold early in the 2001-2007 phase due to improved varieties, soil amendments and better cultivation practices, but the increased production depressed prices. In collaboration with a local NGO and the Government of Guyana, peanut butter production was improved in seven villages in the Rupununi region, and along with cassava bread, sales were developed for school lunch programs. Laborsaving field equipment contributed to the effort. Profitability and production returned by 2004 in these seven villages.

In Guyana, a peanut field production guide was completed based on the research and on farm demonstrations in the Rupununi region and has been distributed widely to farmers.

Cropping system research in 2012 in Guyana successfully intercropped peanut and cassava, but maize was detrimental to peanut probably because of excessive shading. Peanut cultivars introduced are being grown by local farmers, not due to higher yields, but rather pod architecture and ease of harvest. Smaller plants of the introduced cultivars should contribute to the adoption of mechanical threshers for peanut harvest, which are difficult to use with the large plants in common cultivars. A small gas dryer was well accepted by farmers, and appears to be a valuable asset to farm communities. Even though aflatoxin levels remain low in whole-roasted peanuts and peanut butter, better storage and bagging techniques need to be developed. A streamlined procedure for aflatoxin testing that uses Vicam test kits continues to be developed. Studies to analyze the overall impact of increased peanut production and the associated cottage-processing industries and school-lunch program are under way. Economic analysis should provide growers with a better framework to plan an integrated farming approach, which is lacking in many rural Guyana communities.

In 2012, efforts will culminate to provide: 1) updated production guide, 2) economic assessment, 3) posters and tech-packs in several areas of peanut production and utilization, and 4) final survey of social impacts. In addition, a working summary, which gives an excellent framework for an integrated approach centered on peanut production, will be provided for the implementation of this type of project in other regions in need of this type of development.

In Haiti, a Creole version of the Guyana Peanut Field Production Guide was produced and distributed to farmers. Virtual extension services by University of Georgia scientists have provided farmers in Haiti field days access to the best possible knowledge. This service has been done using wireless internet and video conferencing capabilities. On-farm research continued in 2012 in Haiti with the in-country partner Food and Meds for Kids. The evaluation of peanut germplasm/cultivars for rust resistance continues to be a large and successful effort with rust resistant cultivars from ICRISAT. Aflatoxin continues to be problematic with efforts to address the issues with storage and proper training. Assistance with the processing facility, including fine-tuning and efficiency, has been provided. The ability to obtain adequate peanut produce continues to be an issue, but locally based cooperatives might be a possibility.

In Bulgaria, the sharing of Valencia type germplasm between New Mexico and Bulgaria has stimulated work on new varieties. Production increases have been seen in part due to interest created with the concurrent food technology work.

In Senegal, the work between ENEA and the University of Connecticut has evaluated several years of farm data collected by ENEA and helped the institutional collaboration with ISRA. The work shows that much effort had been made toward work on processes of development, but now recognizes the importance of focusing on the people as the center of the development goal, and has contributed to productivity increases.

Uganda is developing an effective program for seed production, multiplication, and distribution to farmers through seed companies, NGOs, contract farmers and the National Semi-arid Resources Research Institute Serere (NaSARRI Serere) farm offices.
Seed banks in different regions are planned to provide credible sources of new cultivars. Demonstration plots, field days, seed fairs, participation in agricultural shows, exhibitions radio talk shows, workshops and seminars have been used to extend the new cultivars and technologies.

Extensive work was done in Ghana, Burkina Faso, and Benin to use systems modeling to improve resource use efficiency in peanut production. The approach was to use field experiments to determine yield gaps, and to use peanut crop growth simulation to evaluate potential yields and to determine reasons for yield gaps. Data on environmental conditions, including weather, soil, and crop growth data have been collected and have been used, together with data from experiments, to identify production constraints in order to adapt the PNUTGRO crop growth model developed in Florida to conditions in Ghana. Yield gap data has been accumulated to allow evaluation of production constraints. Soil fertility and disease problems are indicated as a major factor in loss of yield potential. The data will contribute to the development of risk management strategies. Application of a combination of phosphorus + fungicide has resulted in doubling of yields, a result closely predicted by the CROPGRO-Peanut Model (developed in Florida). Yield losses due mainly to foliar diseases and lack of fertilizer have been predicted relatively accurate with the PNUTGRO Model. Losses due to pests and diseases can be as high as 50 to 80 percent. Work is continuing to collect data that will allow the development of sub-models for PNUTGRO to predict aflatoxin risk and the development of decision support systems for agricultural applications of climate forecasting and risk/opportunity assessments in Ghana. A number of farmer field days and workshops have been conducted in Ghana and Benin, and farmers appear to very receptive to improved technologies. Extension aids have been developed and distributed, and the field days have had national television coverage. The project is collaborating with a NGO (Plan Ghana) to interact with women's groups.

In Burkina Faso and Ghana weeds are major problems, therefore systems approaches to enhance peanut production included use of new herbicides and fungicides, optimizing use of hand weeding relative to herbicides use, and using enhanced spraying equipment. Multi-location peanut cultivar trials under Peanut CRSP sponsorship show that fungicide use results in 70 percent pod yield increases and improves labor productivity even without herbicide use because production was of higher value. Research in the 2010 and 2011seasons showed yields of improved cultivars about double that of the standard, short-season check cultivars. Also during these years, continued herbicide and fungicide trials showed herbicide and fungicide benefits. Results from two locations each in Ghana and Burkina

Faso continued to show the clear advantage of the improved lines (near double in yields, 15 days longer to maturity, and greater leaf spot resistance). There is a long enough growing season for the longer maturing material, but farmers will have to accept the longer maturity. Two of the lines have been released in Ghana as named cultivars "Nkatesari and Gusie Balan." Four herbicides were tested at two locations in Ghana in 2012, and two of them (pendimethalin and basagran) provided near acceptable weed control without hand weeding. Herbicide and fungicide trials in Burkina Faso are providing promising results. The results of the research will form the basis for cropping system models to apply the information across wide regions in the countries.

Work in Uganda and Kenya sought to institute ways to bring research developments, via training and technology transfer, for better farming practices to conserve soil fertility, promoting advances for increased yields, adding value by improving quality to enhance market expansion, and in doing so, raising peanut output because of increased demand and strengthening participation by women in agricultural programs of the farming communities. Training workshops and application of surveys to gather baseline data on farm practice were valuable to train host country participants in interviews and survey analyses. The U.S. and HC principal investigators have gained greater insight into working with colleagues/teams and communities in both Kenya and Uganda. There have been lessons learned on the implementation of peanut farming systems in both locations, which will benefit expanding efforts in Uganda and Kenya and other geographical locations. Various workshops and training sessions have resulted in showing the importance of human capacity development, which will have long-term impact of institute and ministry personnel to help improve farm enterprise development and profits.

IPM development

Insect surveys and field tests began to identify important problems in the Philippines, Thailand, and Burkina Faso along with IPM efforts in North Carolina, which introduced IPM practices across the areas of work. IPM uses genetic resistance, cultural practices, and biological control to reduce the use of insecticides. Both foliar and root-damaging insects were important. IPM research established thresholds for economic damage from insects to minimize the use of chemical pest control. Termites were a major problem found in Burkina Faso that damage seed pods and promotes *Aspergillus flavus* fungi invasion and aflatoxin development in the seed.

An early impact was the identification of NC Ac 343 in Philippine/North Carolina State work as a broad based/highly insect-resistant line that was valuable in many improved varieties in future breeding efforts, and was confirmed in Burkina Faso as well as in the Philippines and North Carolina.

Termite resistance identified in a peanut line in Burkina Faso that as shown by baseline data could attain benefits of US $50,000 per year when adopted by farmers.

In Ghana, IPM practices developed in the earlier phase are being implemented and scaled-up by the ministry of agriculture. Cropping systems research refined and extended to farmers the production of peanut with irrigation in the dry season, the present market benefits of this system is that farmers market their peanuts at the time of highest prices.

In TAM 137, cultivar development and evaluations were being made in cooperation with the NCS 131 and UF 157 projects with goals to improve effectiveness and profitability of the use of fungicides and herbicides.

Focused research on integrated pest management (IPM) was conducted in Ghana from 1996-2012. Early efforts determined a wide range of disease and insect (leaf and soil) insects. Pests varied considerably in species and abundance, and along with evaluation of high yielding, pest and disease resistant cultivars IPM and cultural practices such as planting date recommendations were goals set out in the project. Farmers were involved early on in the research through farmer field schools to demonstrate the often 50 to 70 percent yield loss that occurred from leaf spot rust, rosette virus, millipedes and termites; and the need to develop good IPM practices. Scarification of pods by the soil insects (millipedes and termites) allowed the penetration of *Aspergillus flavus* into the pods with a subsequent increase in aflatoxin contamination. Chlorpyrifos and Furadan have been used to control soil pests. Both are effective, but costs and toxicity consideration favor use of Chlorpyrifos. Marked increases in yields have been achieved, two-fold in some cases. This has stimulated production, research, and extension. Incomes have been raised; one female farmer had managed to build a new house and another farmer had managed to buy a new vehicle.

IPM practices impact production systems and produce effective, efficient, and minimal pesticide use, including application practices that protect workers, the environment, and food supply. Two new cultivars that would contribute to decreased production costs were released in Ghana in 2012, which have greater drought tolerance, and are more competitive against weeds, produce higher yields and are less susceptible to leaf spot, rust, and insect pests. They also produce a consistent level of yield under varying environmental conditions. The result should be control of Aspergilli fungi (source of aflatoxin) contamination due to soil pest damage of developing pegs, pods, and seeds inside pods.

The introduction of the NGO-full belly project's peanut sheller has relieved the burden of hand shelling, which should result in increased production through increased planting acreage and better timing of marketing. The shellers have been met by much enthusiasm and the farmers are discussing the development of their own industry to build them. From 2010-2012, groundnut shellers were fabricated by CSIR-CRI mechanics for distribution to groundnut IPM farmers who participated in the farmer's field school organized under the Peanut CRSP activities. Shellers were distributed to farmers in six villages in three regions. The quality of peanut in the market was greatly improved with less damage and aflatoxin contamination. The use of planting in rows, germination testing, leaf spot control and timely harvesting are four technologies that added to production, processing and marketing that was vastly improving Ghana's peanut industry, and have been extended to farmers through farmers field schools. Recent socioeconomic studies and a current study document the economic impact of increased cost effective peanut production in Ghana.

Rhizobium and Mycorrhizae research

Early rhizobium efforts showed the value of inoculation to increased nitrogen fixation and identified strains present, and showed mycorrhizae fungi to expand root systems, to increase water and nutrient uptake, and to enhance nitrogen fixation.

U.S. impacts – Producer values

In North Carolina, NC 8C and NC 9 were released from 1982-1985. Black rot was a major disease decreasing productivity in North Carolina and adding cost for fungicides. NC 8C had some resistance, and NC 10C was released in 1987 and NC-V 11 was released in 1990, both with black rot resistance and high impacts for North Carolina peanut growers. In 1992-1993 NC 10C occupied about 20 percent of the North Carolina/Virginia peanut acreage with a net farm-gate value of about $4.5 million annually. VA-C92R was released in 1992 and NC 12C in 1996, both important to production through 2003 and 2007, respectively. Gregory, Perry, Brantley and Phillips were released from 1997-2005. Four varieties are still grown (NC-V 11, Gregory, Perry, and Brantley) in 2011 and occupy 58 percent of the total acreage in North Carolina and 12 percent of the Virginia acreage.

The cultivar Langley, a short-duration Spanish type, and Tamrun-88 were released in Texas with higher yields and shelling grade. The "first sale" increase in gross returns of Tamrun-88 was estimated at $1.0-1.2 million annually. Tamspan 90, a new Spanish type cultivar, was released in Texas in 1990 with 11 percent higher yields in the Texas/Oklahoma growing area and with resistance to *Sclerotinia* blight and *Pythium* pod rot with the initial projected value to exceed $1 million annually. In 1992 and 1993, Tamspan 90 was grown on about 28 percent of the Texas/Oklahoma peanut area with a net value of about $25 million per year. Tamrun 96, a runner-type, was released in Texas in 1996 with partial resistance to tomato spotted wilt virus and *Sclerotium rolfsii* and some other soil-borne diseases, high yielding and good seed size.
Peanuts tend to become rancid during storage due to a lower oleic acid content compared to linoleic acid, termed O:L ratio. High O:L ration cultivars would be of great benefit to processors and consumers, and research began with this objective in Texas in 1994. The first high-oleic varieties released in TX were runner types Tamrun OL01 and Tamrun OL02; and Spanish types Olin and Tamnut OL06. In 2008, the two runner varieties were produced on over 50,000 acres or over 30 percent of the runner acreage, and the two Spanish types were produced on about 19,000 acres or over 50 percent of the Spanish acreage.

Early maturing, high-oleic runner and Spanish peanuts were set to be released for the Texas market. One cultivar under the name Schubert that matures one week earlier and yields 10 percent higher will replace the high oleic cultivar Olin was approved in 2012. Two proposals for runner cultivar release were submitted in Texas in 2011, and releases of an early-maturing, high oleic runner and a high-oleic runner with resistance to root-knot nematodes and *Sclerotinia* blight were approved in 2012.

New Mexico State University will release its first high oleic acid Valencia type peanut cultivar "NuMex-01," which originated from a cross between "Valencia-C" and OLin from Texas A&M University. Yields were about 20 percent higher than the common cultivar. The oleic to linoleic acid ratio ranged from 18 to 25 (compared to only 1 to 2 in the control), which will provide high market value for the "NuMex-01" in the popular roasted, "in-shell" market.

A commercial processor stated that high oleic acid cultivars were one of the major contributions ever made to the peanut industry.

Bolivian germplasm tested in Florida, Georgia and Bolivia resulted in new sources of resistance to the tomato spotted wilt virus, a major problem in U.S. production, and will go into breeding for resistant varieties. The use of wild species to provide new sources of resistance to rust and leaf spot has progressed, and will be valuable to the U.S. as well as Bolivia and the Caribbean. A project visit to Bolivia in 2012 by U.S. scientists shared the project progress with U.S. and Bolivian participants, and the collection and return to the U.S. of seed of several favorite cultivars in Bolivia with necessary quarantine procedures will benefit the U.S. collection of germplasm. Discussions with ANAPO personnel included sending a list of wild peanut germplasm and potentially exchanging material that is not available in the U.S. collection. Technology transfer activities included field and laboratory demonstrations by U.S. scientists, such as aflatoxin testing, controlling plant disease, and weed control.

Intensive laboratory research that began in Georgia in 1982 identified and prevented the spread of peanut stripe virus that was introduced through plant introduction and increased seed sales $100,000 annually through relief of interstate seed distribution restrictions. If peanut stripe virus were to become established in commercial fields in Georgia, a one percent loss could occur and cost growers an estimated $5 million annually.

IPM work was developed in North Carolina, and by 1990, it was shown that the insect tolerant NC-6 cut insecticide use to control southern corn rootworm and savings could reach $1.5 million annually. Coordination with growers to validate lower insecticide use, biological controls and cultural practices, and validation of forecast models for insect populations using pheromone traps have shown that growers can reduce insecticide use by 42 tons per year, and when fully implemented can reduce annual peanut production costs in North Carolina and Virginia by about $840,000. Peanut CRSP contributes to the continued use and improvement of the pest advisory system for farmers in North Carolina. Excellent results have been achieved in North Carolina research on IPM practices, which have been profitable to growers in the North Carolina and Virginia peanut growing region. In North Carolina from 2001-2007, screening trials and evaluations have been completed for thrips, potato leafhopper, Southern corn rootworm, and tomato spotted wilt virus resistance, and a number of germplasm lines showed some levels of resistance. Pest survey and crop loss data has allowed evaluation of production constraints and interventions have been implemented.

In Georgia, insect resistant cultivars (for thrips that carry virus diseases and leafhoppers that defoliate plants) were identified among the popular cultivars that helped farmers select ones that would require less insecticides.

In the New Mexico/Bulgaria Valencia germplasm exchange efforts, lines tested in New Mexico have been adopted by a Nebraska farmer on the edge of the normal peanut growing area, as well as providing new sources of disease and pest resistance for the traditional New Mexico Valencia production area.

B. Processor values

The Peanut CRSP goal in processor values was to harvest, store and process peanut in ways that will supply adequate quantities of safe and acceptable products to consumers.

Host country impacts

Surveys to identify current and potential food products in household, cottage and small-medium scale processors were conducted in Sudan, Philippines, Thailand, and the Caribbean. This provided a basis for program direction. The importance and value of peanut as a food across these categories and regions was confirmed, along with the potential to expand processing use in value-added products. Early in the program, several potentially useful new products were identified. In Sudan, "kisra" (thin bread) was enriched with peanut flour, and one million pounds of peanut flour could be produced annually with a processed value of US $10 million value. Similar estimates were made for "toe" in Burkina Faso. In the Philippines, consumers accepted a peanut-based, cheese-flavored spread rather than cheese-based spread. In Thailand, peanut flour-enriched wheat noodles were highly acceptable to consumers. The direct economic benefits of peanut advance in the food chain in Southeast Asia were estimated at $4 million annually (with a potential return of up to $40 million per year), which showed the value of the research. In Burkina Faso, a private company assisted in the improvement of packaging technology for peanut paste.

In Leyte, the Philippines, in 1994 and subsequent years, efforts were successful to extend processing and marketing technologies to a rural women's cooperative utilizing peanuts, which brought a value-added concept into the production area.

The importance of aflatoxin management in food safety was noted, and a hand-sorting process to remove aflatoxin-contaminated peanuts was developed early in the food-processing project in the Philippines and Thailand cooperative with the University of Georgia that essentially removed 100 percent of the contaminated peanuts. Harvest, handling, and storage were important factors identified for research to improve the quality and supply of food products. (Also applies to the Consumer Values sector).

In the Philippines, 35 percent of the children were deficient in Vitamin A, with consequences of child blindness and a decrease in child survival. In collaboration with a commercial peanut butter processor in Manila, a Vitamin A-fortified peanut butter was developed, which had a 35 percent market share in Manila and was marketed nationwide. Commercial competition was encouraged to spread the Vitamin A to children as well as adults. A 2004 impact study showed a 37 percent increase in peanut butter production in the metro-Manila area. In addition, Newborn Foods, Inc., that produced Lily's brand peanut butter, supplied 68 percent of the Metro-Manila area in 2004, and only produced Vitamin A-fortified product that was not available before 1999. Production was also moving to the largest processor of peanut butter in the Philippines, Best Foods. The impact study showed that older children 7-12 years of age consumed more peanut butter, followed by children age 2-6 that are most vulnerable to Vitamin A deficiency.

In Southeast Asia, liver cancer rates are 36 times those observed in the U.S and aflatoxin consumption can affect these rates. Scientists worked with a Manila company, Marigold, Inc. to hand sort peanut prior to processing to eliminate aflatoxin from the "Kare-Kare" sauce that had lost export opportunities. Production increased 40 percent and thus affected domestic and export use and profitability. Other companies were positioning themselves to adopt the technology. The socioeconomic survey showed that in addition to increased product sales, that employment by the processing industries increased.

The market-pull concept was developed and implemented as the Peanut Industry Incubator Model (PIIM), and the above success stories were products of the PIIM concept development. The essential steps of PIIM were:

- To survey of consumers to identify a desirable product
- To research to develop a new or improve an existing product
- To survey of companies for an interested processor
- To sign an agreement with the company to participate in studies to develop, process, and package the product
- To market the product after the training program

The concept was used in the development of Vitamin A fortified peanut butter and aflatoxin-free "Kare-Kare" sauce.

In early 2013, it was learned that Marigold, Inc. is so successful that the matriarch of the "Mama Sita" trademark was recently awarded a commemorative stamp for her achievements in processing (one product was "Kare-Kare" sauce). It was also learned that a young female who had participated in a Manila training workshop in about 2004 was trained in aflatoxin-free processing had developed a small home-based processing company named EHJE, which has grown from a one kilogram (0.1 ton) per week micro-enterprise to a 30 ton per month operation including exports to Japan and Singapore.

The PIIM concept was extended to Ghana and Uganda in the 2007-2012 phase, but due to funding restraints work did not begin until 2011. Results were accelerated due to the Southeast Asia experience. Surveys involved more than 1000 households in both Ghana and Uganda to identify market opportunities for new and modified peanut products. The importance of these studies was building a baseline of knowledge to support future investments and a market-pull emphasis of consumer desires working with food manufacturers to increase production and utilization of peanuts and peanut products (the basis of the PIIM – Peanut Industry Incubation Model – concept). Vitamin A-fortified, stabilized peanut butter, stabilized peanut butter, and chocolate-peanut spread were selected as products to pursue from these surveys. In 2012, working relationships were developed with four research institutions and six industry collaborators for implementing improved peanut products and processes. The Ghana household survey data summary and analysis strongly supported the development of a peanut soup base with the University of Ghana and Nkulenu, the industrial partner, which met domestic and international safety regulations. The household survey in Uganda confirmed high preference for cookies, making peanut cookies a nutritious food product that is convenient, shelf-stable, and portable. The Vitamin A-fortified chocolate peanut spread manufactured by Food Engravers fits the market niche of the urban consumer in Uganda; the product is nutritious and of high value, and it fills the need for a product that fits an urban lifestyle focused on convenience in food preparation and consumption. Hand sorting of peanuts to eliminate aflatoxin to promote public health was implemented in the commercial processes. Previous accomplishment in product development and link with processors, which had been experienced in the U.S., Southeast Asia and Eastern Europe, were extended to Ghana and Uganda, which contributed to a more rapid technology transfer. Early engagement of industrial partners was utilized in the survey, selection of potential products, and development of products and moving them to consumers. Host country researchers gained much valuable knowledge and experience in research methodologies for surveys, product development, engaging commercial interests in the process, and marketing to consumers. Food Fairs in Ghana and Uganda were valuable in collecting consumer data and insights for product development and distribution. Management of processing costs and product prices was a major factor in the work.

Work in Guyana has linked peanut producers, processors, and consumers to a school-feeding program. Initially, cottage industries were developed in seven villages in the Aranaputa Province and later expanded to 43 villages, which provide consistent market demand and steady income by marketing peanut butter through the school feeding program. The cottage industries also contributed to the development of the private sector with over 50 percent of the income they generated in Aranaputa coming from private sales. There are now individual cottage industries capable of producing 25 kg or more peanut butter per day, and generated $75 million Guyana Dollars in the region per year. A state-of-the-art peanut processing and storage facility was built in Aranaputa in collaboration with the NGO partner, Society for Sustainable Operational Strategies (S-SOS). A satellite program was set up to supply peanut butter. In collaboration with S-SOS, it provided training to processors in 26 new villages.

Consumer market research in Bulgaria has shown a strong market potential for peanut and peanut products, and a food processing pilot plant has been developed to help local industries scale-up their operations.

U.S. impacts

Scientists in the U.S. on Peanut CRSP have transferred the technology of a peanut snack product that is successful in the Philippines to the U.S. market. A North Carolina peanut processing company test marketed the product

C. Consumer values

A major goal of the Peanut CRSP was to seek ways to harvest, store and process peanuts to supply adequate quantities of safe and acceptable products to consumers with a major focus on reducing aflatoxin contamination. There are costs attached to aflatoxin, such as health implications and decreased value of the produce and products. Financially, the problem was quality loss and waste of produce; and health issues include nutritional and immunological effects and the associated modulation of infectious diseases, including HIV-AIDS. Through this effort, Peanut CRSP has elevated aflatoxin to an international development issue. USAID, the African Union, and major development interests now are addressing aflatoxin as a priority.

Host country impacts

Food safety/aflatoxins

Storage stack and field samples in Senegal confirmed the great extent of the aflatoxin problem. An aflatoxin-binding clay was used to develop an improved mini-column method of aflatoxin detection at the village level, which suggested and proved effective that the clay could be used to remove aflatoxin from village-produced peanut oil. A number of clays were tested with the bentonite type being most effective. The clay later defined as best was a processed, industrial clay – NovaSil trademark. In the 1990-1996 phase, it was shown in Senegal that NovaSil could be used in animal feed to detoxify aflatoxin contaminated animal feed and estimates showed that US $5 million could be contributed to the economy each year by the use of this technology.
An improved mini-column was scaled down to a micro-column method employing the bentonite-type clay that will be low-cost and valuable for developing country needs.

NovaSil has been adopted worldwide as a protection against aflatoxin contamination in livestock, and the manufacturer of NovaSil estimated that 60 percent of the world's livestock feed contains the NovaSil clay additive.

An important discovery by the Peanut CRSP has been that NovaSil was also effective and provides protection for animals and humans against a second mycotoxin (fumonisin). Fumonisin is predominately found in maize and has been connected by the Peanut CRSP with the transmission of HIV in Africa.

The insect management work in Burkina Faso showed that late harvest and termite damage to pods increased markedly the invasion of *Aspergillus* fungi and subsequent aflatoxin production.

The hand-sorting technology to remove aflatoxin-contaminated peanuts and keeping them out of the food chain had great impact potential on the consumer of peanut products (described in processor sector above).

Development and use of rapid monitoring techniques for aflatoxin detection in the Philippines has resulted in policy interventions by the Food and Drug Administration by identification and withdrawal of aflatoxin-contaminated peanut butter and other products from the market. Work established aflatoxin management strategies and evaluated them for their effectiveness.

In Ghana, among participants in the peanut marketing chain, there was increased awareness of the effects of aflatoxin contamination on peanut profitability. This led to farmers to increase the adoption and use of improved storage facilities, as well as their disinfection after each use. Both producers and consumers of peanut products in Ghana supported higher control of aflatoxin levels in the products, because producers would not lose since consumers would pay higher prices for cleaner products and both would benefit from the health benefits of lower aflatoxin intake. Women play a major role in food production and safety in Ghana, but have less formal education and less knowledge of aflatoxin contamination in peanuts; therefore, special effort should be made in the training effort of women with regard to the aflatoxin problems.

In Guyana, Grainpro™ storage systems (airtight durable storage bags to prevent moisture accumulation and insect damage) were being supplied to selected villages to ensure reduction in aflatoxin contamination and improved profitability.

In Ghana, the effect of aflatoxin on the immune system was studied. Association was found between aflatoxin exposure and health status. An association was established between aflatoxin B1 exposure levels in pregnant women and birth outcomes, and anemia. It was found that 100 percent of the women had aflatoxin B1 albumin (AF-ALB) in their blood. With regard to birth outcomes, pregnant women with aflatoxin levels in the highest quartile were twice as likely to have low birth weight infants when compared to women in the lowest quartile. There was a trend of increasing risk for low birth weight with increasing aflatoxin levels, and this association remained after adjusting for known confounders, including malaria parasitemia, anemia, and worm infections. Aflatoxin also increased the odds of pregnant women developing anemia in pregnancy, with an 85% increase from the lowest to very high category, which suggested that the prevalence of anemia among these pregnant women is associated with AF-AB levels in their blood. Results suggested that HIV-infected individuals exposed to aflatoxins in the diet may experience faster progression of AIDS. The intensive, multifaceted studies at clinical and immunological levels along with disease progression over time were proving extremely important in understanding these relationships and should allow development of appropriate and targeted strategies to decrease the rate of progression of HIV disease in infected people.

In Uganda, the results of various surveys carried out in 2003 and 2004 show that there is a greater awareness of farm-level populations and government staff in:

- The Ministry of Health (with regard to the health risks of aflatoxin and health benefits of reduction in aflatoxin exposure);
- The Bureau of Standards (regarding the effect of aflatoxin on health safety), and
- The Ministry of Agriculture (in connection with farm aflatoxin contamination).

Maximum limits (MLs) for aflatoxins in peanut and peanut-based products were set. In addition, Hazard Analysis of Critical Points (HACCP) plans for reduction of aflatoxins in peanut-based food, and Information, Education and Communication (IEC) materials on management of aflatoxins in peanuts were developed and communicated to stakeholders. The use of Fourier-Transformed Infrared Reflectance for rapid, non-destructive aflatoxin analyses was introduced in the HACCP effort. Main beneficiaries are farmers and small-scale processors who are mainly women, traders, private medium-scale processors, and eventually consumers because of the availability of aflatoxin-free peanut and peanut products. The impacts have been aided by collaboration with the National Association of Women in Uganda (NAWOU) in developing and disseminating information.

Nutrition

Host countries

Nutrition research confirms that the peanut is an important food source in developing countries and therefore that peanuts are important for USAID's humanitarian response efforts. The information that peanut is a very hunger-satisfying food, with high protein and energy content, shows that this commodity should be exploited in times of civil crisis and famine, since more hunger prevention can be delivered per payload than from the commonly used emergency rations.

Nutritional issues for the developing world are evolving and becoming bi-modal. As important as the problem of under-nutrition is in developing countries, it is also apparent now that peanut has a powerful role/opportunity in the emerging epidemic in these countries associated with poor-quality/over-nutrition (non-communicable diseases and obesity) just recognized by the United Nations. Peanut is an important nutritional and health-giving food grown over much of the developing world, but research to make this evidence-based and exploit this potential has been neglected. Documentation of the positive nutritional aspects of peanuts remains an important priority for Peanut CRSP to promote increased consumption of peanut and peanut products, thereby promoting public health, the market demand for, and profitability of this crop for farmers.

In Brazil, nutrition studies show that inclusion of peanut butter with breakfast helps control appetite and blood sugar in obese women. Data documenting the mechanisms that account for these findings are helping to reinforce the role peanut ingredients play. In addition, evidence shows peanuts consumed in moderation are not fattening. The improvement in the market perception of the healthiness of peanuts is key to expanding their consumption in the U.S. and worldwide.

Preliminary analyses in Brazil and the U.S. show that peanut consumption was associated with marked reduction in blood pressure. Cardiovascular disease is a pressing health problem globally, and confirmation of this work will have strong implications in the health benefits and demand for peanuts worldwide.

Research has developed and tested new types of nutritional and aflatoxin-free ready-to-use therapeutic foods (RUTFs) for vulnerable groups in Haiti and Ghana, which could successfully feed high-risk populations of malnourished adults, young children, and infants. Use of RUTFs is presently limited by the cost and dependence on expensive, imported ingredients. However, Peanut CRSP research is substituting peanut, cowpea, and other locally produced and lower-cost ingredients. Fortification with vitamins A and C, as well as zinc and iron are meeting international food and nutrition standards for special groups (such as HIV infected people and pregnant/lactating women). NovaSil clay additions to the RUTF for removal of aflatoxin from the product are under evaluation.

U.S. impacts

A new peanut line with partial resistance to aflatoxin accumulation in the seed was scheduled for release in Texas, which could lower aflatoxin levels by 15% with possible annual gross returns of $ 1 million in the U.S. with potential sharing with West Africa.

The clay NovaSil added in small quantities to poultry feed in Texas research bound the aflatoxin in the feed and prevented it from accumulating in poultry livers. This research has drawn worldwide attention from scientists and industry, due to the health hazards of aflatoxin. The ability to ensure, economically, that food in developing countries has a minimal aflatoxin exposure risk has enormous potential health benefits.

Nutrition research in Ghana and at Purdue University has shown that the satiety factor in peanut offsets the high energy content of peanut and decreases the obesity and cardiovascular risk from a high caloric intake of peanuts, and has shown that peanut oils are healthy (similar to tree nut oil) and have positive cardiovascular health benefits. This research has received attention in the U.S. through the media, which has helped reverse a decline in peanut use due to health concerns. A major impact of the nutrition work was the contribution to a recent FDA-approved health claim for nuts, including peanuts, which states that "Scientific evidence suggests but does not prove that eating 1.5 ounces of most nuts, such as peanuts, as part of a diet low in saturated fats and cholesterol may reduce the risk of heart disease." This statement is found on some peanut marketing containers. One industry representative stated that U.S. consumption has increased 13 percent since the research began in the 1996-2001 phase. This increase was estimated to have netted the peanut industry $500 million annually during the ensuing 2001-2007 phase.

D. INFORMATION/TRAINING/IMPACTS

Information

The importance of information dissemination, human capacity development through training and the measurement of impacts is an inherent component of the CRSP concept. The International Arachis Newsletter (IAN) was planned and published in cooperation with ICRISAT beginning in 1983, in response to the Peanut CRSP planning grant that the Peanut CRSP would develop a publication for short notes on current world peanut research available to any scientist. IAN did not miss an issue from 1983-2010, and became the leading non-journal international peanut research publication. IAN was distributed by electronic/website in the late 1990s in addition to the paper copies.

The Peanut CRSP plans to work in Thailand led to the development of a coordinated national peanut program after the 1980 planning grant visit and the 1982 program initiation, which has been important to Thai progress. A peanut CRSP workshop was held in Khon Kaen, Thailand, in August 1986. The Philippines initiated the first national peanut consultation and Peanut CRSP Review in 1985. A series of workshops was held in cooperation with ICRISAT. The first, "Agrometeorology of Groundnut Production in the Semi-Arid Tropics," was held in 1985. Networks for information spread were continued with ICRISAT (International Center for Research in the Semi-Arid Tropics), IDRC (International Development Research Centre, Canada), ACIAR (Australian Centre for International Agricultural Research), CIRAD-CA (International Agronomic Research Center for Development-Annual Crops, France), and CARDI (Caribbean Agricultural Research and Development Institute) with synergistic effects for all involved. For example, the Peanut CRSP co-sponsored the 1991 international groundnut workshop in India (first one held in 1980 by ICRISAT) with ICRISAT and CIRAD. The first West Africa groundnut workshop was held with ICRISAT/Niamey in 1988 followed with biannual meetings. Many other workshops and trainings were conducted, which will be listed in more detail in another section.

A website-based collection for the dissemination of worldwide peanut literature was developed. It had a many visitors and was the precursor of the present Peanut Information Network System (PINS), where information is shared on peanut organizations, publications covering the entire peanut value chain, and results of meetings and workshops, as well as related news links. During 2010, the PINS had about 18,000 visits and over 47,000 hits from people across the world.

Training

A more comprehensive coverage of degree, short-term and workshop type training will be listed in another section, but some examples of the Peanut CRSP are listed below.

From 1982-1985, eleven host country students began M.S. and Ph.D. programs in U.S. universities. Host country scientists were trained through visits to the U.S. and in U.S. scientist visits to host countries, which developed a long-term mentoring process. From 1985-1990, U.S. scientists averaged about 300 staff days per year in visits to host countries and about 15 host country scientists visited U.S. collaborators at U.S. institutions. At the mid-term stage of the 2007-2012 phase, about 41 HC staff had been trained with regard to laboratory techniques, research methodology, extension methods, and other areas related to the projects.

From 1990-1996, 85 students with full-or part-time support have completed M.S. or Ph.D. degrees, and most are active in research in host countries, non-host countries or the U.S., depending on their origin. At least six lead collaborators have received degrees under the guidance of their U.S. collaborators during this period. Short-term training continues to be valuable. Gender numbers in the 1996-2001 phase showed 26 female and 44 male degree and short-term trainees. At the midterm period of the 2007-2012 phase, 18 or 75 percent of the advanced degree students were from partner-host country institutions, and at this midterm time 24 or 80 percent of the planned total scholars (17 M.S. and 7 Ph.D.) are pursuing their degree programs in HC and U.S. universities. The majority of the students are pursuing specialized topics related to consumer and social values (food safety/health, nutrition, social and gender). Because of the difficulty of foreign students to obtain student visas to the U.S., many scholarship slots for degree training have been converted to HC universities.

A comprehensive package for virus control was developed in Thailand during 1994-1995 and a publication was in press. The basic tenants of this package incorporate plant resistance, use of virus free seed and cultural practices such as adjustment of sowing date, use of high plant density and intercropping with fast growing non-host plants. In addition to use in Thailand, this package can be used in regional training proposed for Thailand in the 1996-2001 Peanut CRSP phase. A training course on quality evaluation and the utilization of food legumes was held at Kasetsart University in cooperation with FAO and the department of product development. The month-long course employed Thai, Philippine, and U.S. scientists as trainers for participants from several Southeast Asian countries. It served as the basis for the regional training effort that continued in the 1996-2001 phase after Thailand, due to economic development, became a USAID "graduate country" in 1993. Peanut CRSP continued to support in a small way this regional effort. There has been an increased capacity for researchers in Thailand and the Asian region resulting from the training courses held in Thailand. Villagers have participated in the training workshops on post-harvest processing and packaging technologies, which have extended to scientists and extension workers.

At the mid-term period of the 2007-2012 phase, 422 men and 201 women farmers were trained on various topics related to the technologies developed. Processors, traders, marketers, consumers and other people in the peanut value chain have also been trained. There was also a focus on publication of media materials such as brochures for farmers, technical guides, training materials for researchers, as well as radio and TV programs.

Impacts

The early phase/s of the Peanut CRSP did not have a strong focus on impact assessment, since the intent of the program was to emphasize research, and analyses were primarily on surveys that guided production, processing, and consumer research.

As emphasized in the 1994 EEP Report, in a Mayan Village in Belize on the fringe of the rain-forest increased profitability from peanut stimulated by the Peanut CRSP supported production and post-harvest practices have caused improvement of farming from slash and burn agriculture to sustainable, rotation-based farming. Peanut has provided the economic base to enhance the local economy and greatly improved the farmers' lifestyle.

Through the development of women's cooperatives in the province of Chiangmai in Thailand, on the island of Leyte in the Philippines, and in the city of Accra in Ghana, the potential for production areas benefiting from added crop value by processing have been successfully demonstrated. Both processing and marketing skills were being learned.

A socioeconomic evaluation of the Thailand site revealed an almost two-fold increase in profitability for women farmers who marketed processed peanut.

In the 1990-1996 phase, USAID required a focus on natural resource management and sustainable agriculture, and some accomplishments follow.

Natural Resource Management – Low soil pH and high aluminum content of soils in Burkina Faso benefited and showed yield response of 221 percent from ash treatment, 46 percent increase from calcium sulfate, and 37 percent increase from phosphorus. Shade and acid tolerant peanut lines in the Philippines could allow cropping under coconut trees and in marginal soil areas. Tamspan 90 variety was more responsive to soil moisture that a standard variety in Texas.

Sustainable Agriculture – Over 10 percent of farmers in Jamaica adopted the new variety, CARDI/Payne with a 42 percent yield increase as shown in a socioeconomic study. A pilot program in the Philippines in cooperation with PCARRD extended CRSP technology (Varieties and IPM) to farmers in the Cagayan Valley (the major peanut growing region in the Philippines), which produced higher yields with less pesticide inputs and promised to enhance sustainability. The food technology effort in Thailand, which extended into the "USAID graduate country" period, extended post-harvest technology transfer to villages and provided value-added products and higher incomes. In Jamaica, Thailand and Ghana digging, pulling pods from plants, hand shelling, lack of improved drying and storage were all shown to be detrimental to profitable peanut production, and research advances provided ways to overcome these handicaps and peanut cooperatives could be a way to disseminate information.

Socioeconomic research in Senegal has suggested there was a need for more focus by the government on farm level peanut problems, and that pricing policies, fiscal practices, and market structure measures are not fully serving the peanut sector of the country.

Socioeconomic research in Jamaica shows that even though the use of the CARDI/Payne cultivar was less due to less desirable seed type, the adoption of improved production, harvesting, storage and marketing technologies introduced with the new variety were still in use some 15 years later.

Socioeconomic impact studies have assisted projects in the Philippines and Thailand in evaluating results, i.e. Vitamin A-fortified peanut butter in the Philippines, aflatoxin-free "Kare-Kare" sauce, and newly released varieties in both countries. In Uganda, the rosette resistant varieties when fully adopted could contribute about USD 47 million annually to the economy and reduce poverty by 1.3 percent.

The achievements of the Peanut CRSP continually generate social benefits and impacts positively on vulnerable groups including poor households and female family members. A new effort was initiated in 2010 to document the impact of ongoing research in Bolivia, Ghana, and Uganda. Some studies initiated were household surveys in Ghana and Uganda to determine the benefits received by the low, medium, and higher-income farmers and female-headed households.

The management entity also has an information and analytical role. Analysis by the ME focused on the socioeconomic impacts of the Guyana peanut value chain project and on the role of mycotoxins on public health. In a widely reported (BBC, Reuters) publication the connection between maize consumption and HIV transmission in Africa was discovered that linked fumonisin in maize to the mycotoxin/health problem providing a new potential intervention in the HIV epidemic. This was an unplanned result emerging from analysis seeking to document the connection between infectious diseases and aflatoxin-prone communities.

Project years were normally July to June, and programmatic reports followed those dates. For convenience in summarizing the 30 years phase-by-phase summary, budget years are also listed in the below summary as July to June. Earlier program years fit more the July-to-June years, but as years progressed, financial allotments fit more the federal government fiscal year of Oct. 1 to Sept. 30. Allotment dates sometimes changed to time of appropriation by Congress.

Financial Support provided to Peanut CRSP by USAID

July 1982-June 1985	$5,059,276	Grant # DAN-4048-G-SS-2065-00
July 1985-June 1990	$8,199,098	Grant # DAN-4048-G-SS-2065-00
July 1990-June 1996	$9,335,768	Grant # DAN-4048-G-00-6041-00
July 1996-June 2001	$7,573,300	Grant # LAG-4048-G-00-6013-00
July 2001-June 2007	$11,904,401	Grant # LAG-G-OO-96-90013-00
July 2007-June 2012	$13,473,096	Cooperative Agreement # ECG-A-00-07-00001-00
Total (30 years)	**$55,544,939**	

In addition to the USAID financial support, projects were required to cost-share at least 25% of the U.S. component of the project budgets (those USAID funds spent in the U.S. in support of project activities).

CHAPTER 2. HISTORY OF THE U.S. LAND-GRANT SYSTEM

Basic to the development of the Collaborative Research Support Program (CRSP) concept was the United States land-grant university system.

The U.S. had about 80 percent of the population on farms prior to 1860. Agricultural exports to Europe comprised mostly crops such as cotton and tobacco, with Great Britain and other countries importing from the U.S. Science for agricultural growth was primarily based on European advances, and the growth of agriculture in Europe was ahead of U.S. growth.

Prior to 1860 and the Civil War, most every city and large town had manufacturing plants making farm equipment, tools, harness, wagons and buggies – things needed around the farm home. Still, the principal interest and source of wealth was agriculture. Information shows that a very large percentage of business and professional men were owners of farms that were operated by an overseer or by some form of rental. Thus, most of the population was directly concerned in the improvement of the farm economy. The agricultural press of the time was filled with answers to requests for better methods of performing farm operations, varieties of farm crops, handling of livestock, among other things. There was considerable discussion of agricultural education and of agricultural and mechanical schools already in operation in Europe, but generally untried in the U.S. Four such schools had been established prior to 1860 – Sheffield Scientific School at Yale College in 1847, Michigan Agricultural College in 1857, Agricultural College of Pennsylvania in 1859, and Maryland Agricultural College in 1859 – but none of these had, as yet, produced outstanding results. (Higgins 1975)

A bill was passed by U.S. House of Representatives on April 22, 1858, and then moved to the Senate. In order to establish agricultural colleges, the bill proposed the allocation of 20,000 acres of public lands to each state per senator and representative to which the state was entitled. There was a proviso that 10 percent of the amount could be used to purchase land for an experiment station. For some reason the bill failed to pass the Senate, but on July 2, 1862, it passed as the Morrill Act. Most northern states soon accepted the grants, but in the southern states only Maryland (with an earlier college), Kentucky, Missouri, and Virginia had accepted prior to the close of the Civil War, but schools were not opened until after the war. In August 1859, an editorial in the Southern Cultivator pointed out three ways the Georgia Legislature could help the state's agriculture: 1) by means of railroads, 2) by a geological survey of her territory, and 3) by establishing an agricultural school and experimental farm. It was further stated that, "We need an Experimental Farm. It is perhaps at this time the greatest need of Southern Agriculture." (Higgins 1975). This provides some background to the mood that might have encouraged Congress to approve the Land-grant Act of 1862 and that provided the motive force behind its success and the passage of subsequent acts.

U.S. expansion was focused on the West. The U.S. Department of Agriculture was established in 1860 and devoted to the improvement of agriculture based on scientific inquiry. Education was somewhat elitist and strongest in the Ivy League schools in the East, with few opportunities for the general population to have affordable college education. The Morrill Act of 1862 was designed to establish affordable college education in each state, and was to be funded by federal land-grants to the states to fund the development of the colleges. Agricultural education was a primary focus of the program, along with engineering. Many were named agricultural and mechanical colleges. Records show that there was more engineering training than agricultural in early years. This was significance to the growth of agriculture, since mechanization grew from the engineering development, which lessened labor necessary for agricultural production. This was evidenced by the labor force: 58 percent in agriculture in 1860 and 38 percent in 1900.

Concurrent with the Morrill Act was the Homestead Act of the same year. The latter encouraged migration to the west to homestead lands obtained from the federal government. Population growth came from the eastern U.S., and from an influx of European immigrants, many of who settled on the western frontier.

The capability of the land-grant institutions to produce information was growing later in the 1880s, but they were still primarily focused on education. Another landmark piece of legislation in the U.S. Congress was the Hatch Act of 1887, which provided for federal support to develop agricultural experiment stations in each state associated with land-grant institutions. Then the second legislative act extended the land-grant concept to colleges, primarily in southern states, providing education to the African-American population (16 institutions in 16 states, plus a second in Alabama, Tuskegee Institute, a total of 17).

The Adams Act (1906) doubled the funding for state experiment stations and provided a basis for the inclusion of agricultural economics within the research agenda of land-grant universities.

Soon it was recognized that there were limitations to moving technologies and making them available to farmers. The next piece of landmark legislation in Congress was the Smith-Lever Act of 1914, which created the Cooperative Extension Service, designed to extend information to farmers. It was managed through the U.S. Department of Agriculture and developed within the land-grant universities.

The uniqueness of teaching, research, and extension areas within the same institutions provided for a more rapid and more effective flow of information that would hasten the growth of U.S. agriculture. Faculty may be involved in one, two, or all three of the areas, which increases commitment to a particular segment (i.e. teaching plant breeding, breeding new peanut cultivars, and extending the cultivars to farmers).

The "Second Industrial Revolution" was developing in the U.S. prior to 1900 and was concurrent with this growth in agriculture. Returns to labor in agriculture were increasing, which released agriculture workers to supply labor for the growing industrial sector. A cheaper and more diverse and abundant food supply contributed to U.S. economic growth, and an increase in agricultural exports. As a side note, this combined growth of agriculture and industry contributed to the U.S. successfully facing the two world wars of the 1900s.

Land-grant colleges contributed to an economic takeoff that made the U.S. a major industrial power by the end of the 1800s. From 1900-1920, the System hastened the development of new crop varieties with higher yields and resistance to diseases and insects, improved animal production, equipment development, among many other examples.

In 1860, 80% of the U.S. population lived and made its livelihood on farms. By 2010 this figure had dropped to just two percent. This is a tribute to the land-grant system, which is still having a tremendous impact on U.S. agriculture.

Reference:
Higgins, B. B. A History of the Georgia Experiment Station. Georgia Experiment Station, Experiment, Georgia, Jan. 1975.

CHAPTER 3. THE GROWTH OF U.S. FOREIGN AID

A major factor in the development of the CRSPs was a growth in U.S. foreign aid. There is much history beginning in earnest in 1944 about what would happen at the end of the war in Europe. Europe was becoming devastated, and there was concern about its reconstruction.

By the end of World War II, Europe had suffered substantial loses, physically and economically. In response to Europe's call for help, the international community established the International Monetary Fund (IMF) and the International Bank for Reconstruction and Development (the World Bank) in December 1945. In April 1948, through the enactment of the Economic Cooperation Act, the United States responded by creating the Marshall Plan. The IMF and the World Bank were created as permanent institutions, whereas the Marshall Plan was established as an emergency tool of assistance.

The Marshall Plan ended in June 1951, with Congress in the process of piecing together a new foreign aid proposal designed to unite military and economic programs with technical assistance. In October 1951, this plan became a reality when Congress passed the first Mutual Security Act and created the Mutual Security Agency.

In 1953, the Foreign Operations Administration was established as an independent government agency outside the Department of State, to consolidate economic and technical assistance on a worldwide basis. Its responsibilities were merged into the International Cooperation Administration (ICA) in 1955 under the Department of State, whose role was to administer aid for economic, political, and social development purposes.

The Mutual Security Act of 1954 introduced the concepts of development assistance, security assistance, a discretionary contingency fund, and guarantees for private investments. The Food for Peace program was implemented in 1954, introducing food aid. Congressional approval of a revised Mutual Security Act in 1957 led to the creation of the Development Loan Fund (DLF), which acted as lending arm of the ICA. The DLF financed everything other than technical assistance, but was most noteworthy for financing capital projects.

Neither the ICA nor the DLF addressed the need for a long-range foreign development program. By 1960, support from the American public and Congress for the existing foreign assistance programs had dwindled and became an issue during the 1960 presidential campaign. The new Kennedy Administration made the reorganization of and the recommitment to foreign assistance a top priority. It was thought that to renew support for foreign assistance at existing or higher levels, to address the widely known shortcomings of the previous assistance structures, and to achieve a new mandate for assistance in developing countries, the entire program had to be "new." That led to the creation of the U.S. Agency for International Development (USAID) in 1961.

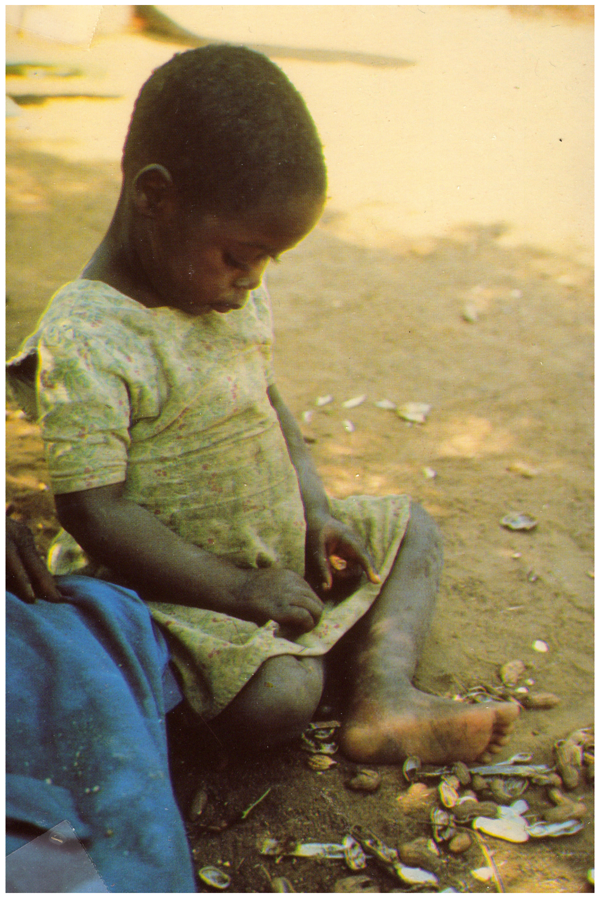
A consequence of legislative process begun by President Kennedy, the Foreign Assistance Act of 1961 was a relatively concise document that recognized the economic and political principles expressed in the President's transmittal message. Namely, development assistance consisted primarily of two programs:

- A development loan fund whose primary purpose was to foster plans and programs to "develop economic resources and increase productive capacities" (i.e. a significant amount of capital infrastructure)
- A development grant fund, to focus on "assisting the development of human resources through such means as programs of technical cooperation and development" in less developed nations

Many attempts have been made in Congress to redesign the Foreign Assistance Act of 1961, but have all essentially failed. Subsequently, all foreign aid programs have been funded under the auspices of the 1961 Act. Legislation that established the United States Agency for International Development (USAID) helped focus and make more efficient and effective the foreign aid programs.

Early work had considerable agricultural focus, among those such as the development of system of agricultural colleges/universities in India in the 1950' and early 1960s, the results of which are remarkable. Grants to develop this system were given to U.S. universities that in turn stationed U.S. professors from land-grant institutions in India to develop the Indian system. Other projects assisted agricultural growth in Asia, Latin America, and Africa. An example would be the program that led to the growth of the soybean industry in Brazil.

It was out of these experiences in development that led to the Title XII Amendment to the Foreign Assistance Act of 1975. A new era in international agricultural development began that merged the domestic successes of the U.S. land-grant university programs with the visions of transferring this success to resolve constraints to agricultural development in less-developed countries.



Peanut is an important food for children

CHAPTER 4. TITLE XII AND THE U.S. LAND-GRANT SYSTEM

One could go to a number of sources to describe and document the many discussions that led to a broad acceptance of the Title XII program by the U.S. land-grant system, and subsequently the development of the concept of the CRSPs that were a major outcome of Title XII. The contributions that the U.S. land-grant system can make to international agricultural development were well expressed by Dr. Orville G. Bentley.

The following are fourteen excerpts from Orville G. Bentley (Dean of Agriculture, University of Illinois). "Extending our Commitments: A Challenge to U.S. Agricultural Universities." Address delivered July 25, 1977 at the 69th Annual Meeting of the American Society of Animal Science, conducted at the University of Wisconsin, Madison, Wisconsin.

1. In the technical and economic assistance area, Congress may have written a new chapter for international education when it added the Title XII Amendment to the Foreign Assistance Act of 1975. In the general provisions of the title, Congress declares, "In order to prevent famine and establish freedom from hunger, the United States should strengthen the capability of the United States land-grant and other eligible universities in program-related agricultural institutional development and research [for the purpose of] solving food and nutritional problems of developing countries."

2. Food, malnutrition, and agricultural development are among the issues that will challenge human ingenuity in coping with increasing population. By the year 2000, a world population of more than 6 billion is expected to place an unprecedented demand on the world's renewable and non-renewable resources.

3. In the preface to the report of the National Research Council (N.R.C.), Committee on World Food and Nutrition, Harrison Brown recently observed, "Few of the challenges facing humanity are larger or more important than the problem of world hunger and malnutrition." Of the major recommendations made in the N.R.C. study report, most fall within the traditional domain of the colleges of agriculture. These are expanded research, increased training, and assistance to developing nations on the mobilization and organization of research and development resources as a means of increasing food production. Storage, processing, and utilization of such foodstuffs must also be considered.

4. Fortunately, America's agricultural research and education had been development oriented beginning with the Land-grant Act of 1862.

5. Given the success of educational institutions in agricultural development in the U.S., it was not surprising that the American people and the federal government turned to universities for assistance in carrying forth the U.S. worldwide research and development programs in food, nutrition, and agriculture.

6. The magnitude of the educational impact on the U.S. was suggested by a National Academy of Sciences study, which stated that research and extension can be credited with 60-70% of American agriculture's increased efficiency from 1929 to 1972, and with 80% of its growth.

7. Major involvement of U.S. universities in fulfilling the American development efforts began during the early 1950s under the Truman administration's "Point Four" program. In writing about this involvement in the July (1977) issue of "Illinois Agricultural Economics," Professor Harold Guither stated that, "The international efforts of land-grant universities to develop institutions for agricultural teaching, research, and extension actually date back many years. From 1951 to 1975, 37 U.S. universities worked in 43 countries under 88 rural development contracts with the U.S. Agency for International Development or its predecessor agencies. These contracts usually involved efforts to improve educational programs, research, and extension with degree-granting institutions and ministries of agriculture in less-developed countries. Others involved projects with technical training schools."

8. The Consultative Group for International Agricultural Research (CGIAR) was established under the leadership and support of the Ford and Rockefeller Foundations. The CGIAR is an array of international

agricultural research centers, which receives assistance from many governments, particularly the United States. These began in 1971 with the International Rice Research Institute (IRRI) in the Philippines, International Maize and Wheat Improvement Center (CIMMYT) in Mexico, International Center for Tropical Agriculture (CIAT) in Columbia, and the International Institute of Tropical Agriculture (IITA) in Nigeria. In 1972 the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) was developed in India with research on peanuts added in 1976. Although these Centers were not directly related to the U.S. University involvement in the CRSPs, important research and training cooperation developed between U.S. and Host Country participating Institutions in the CRSPs and these Centers (and other Centers that followed).

These highly successful centers are based on the concept that research and education are the best strategies for accomplishing agricultural development, for solving the problem of malnutrition, and for staving off world hunger.

9. The passage in 1975 of the Title XII Amendment to the Foreign Assistance Act of 1961 "Famine Prevention and Freedom From Hunger, under the International Development and Food Assistance Act of 1975" opens a new horizon for institutions having the capability for research and education in food, agriculture, and nutrition. The Title XII legislation addresses the following program areas:

    - Strengthening of American universities in research, teaching, and extension work so that they can execute both current and future agricultural programs

    - Development of institutions to generate agricultural skills in developing countries, so that these countries can contribute more solutions to international agricultural problems and can adapt new solutions to their local circumstances

    - Assurance of federal support for universities to do long-range, collaborative research on food production, distribution, storage, marketing, and consumption

    - Support for an increased involvement by American universities in the international network of agricultural sciences. This network includes the international agricultural research centers (CGIAR), the research institutions of agricultural organizations as the United Nations (UN) Development Program (UNDP), and the Food and Agricultural Organization (FAO).

    - And finally, Title XII authorizes government support of international research centers; support of projects directed toward solving specific agricultural problems in developing nations; and fortification of national agricultural research systems in the developing countries themselves.

10. The Act stipulates some unique provisions for its implementation. As a means of involving the universities in initiating Title XII activities, the Act calls for the establishment of BIFAD. Of the seven members appointed by the President, four of them are to be selected from universities. The board was established in the fall of 1976 with Dr. Clifton Wharton, Jr., President of Michigan State University, as Chairman.

    BIFAD began meeting in about November 1976 with the Administrator and other top officials in USAID to discuss policy and procedural issues. These activities include developing: (1) programs and policies for involving U.S. universities more effectively in internationally oriented programs, and (2) policy positions and procedures for incorporating Title XII activities into the sometimes-tedious budget-making process of the Agency. While BIFAD participated in discussions concerning the fiscal 1978 budget, the first significant impact of its participation in the budget process should be felt in the 1979 Fiscal Year.

11. An important aspect of the board's activity was the establishment of communication and planning linkages with eligible universities, federal agencies, and other public or private institutions eligible to participate in Title XII activities. Two major committees were developed that aided in these early planning activities. The Joint Research Committee (JRC) was charged with developing research program recommendations consistent with the objectives set forth in Title XII and consistent with the interests of the universities and other eligible agencies. The Joint Committee on Agricultural Development (JCAD) will develop

procedures for matching the expertise of eligible universities and federal agencies with the needs and interests of developing countries and emerging institutions overseas. An important role of BIFAD, JRC, and JCAD will be to interact with USAID administrative and programming structures, e.g., the centrally funded programs of the Technical Assistance Bureau, and the country-oriented programming organized under the USAID's four regional bureaus – Latin America, Africa, the Near East, and Asia.

12. Colleges of agriculture have a new opportunity to develop programs that will serve them well institutionally and that will add to an already impressive list of accomplishments. The job will require strong leadership. At times, it will test the strength of the institutions as they come to grips with some of the baffling problems that arise in the international development process. From the universities' standpoint, the past successes in cooperative programs in the public and private sectors must underpin all possible approaches to creating a USAID/university/Title XII program. Creative thinking, not rigid patterns must prevail, on the part of both USAID and the universities bridged by BIFAD, JRC, and JCAD.

13. One of the strengths of higher education in the United States is its diversity and flexibility. Institutions will be encouraged to respond to Title XII in a variety of modes. Some recommendations are as follows:

    - Research and extension programs should be an integral part of ongoing activities program content should be related to the expertise of the faculty and staff of each university involved.

    - The instructional programs of the universities will further emphasize graduate education as a means of meeting future manpower needs both for Title XII programs and for the expected expansion in domestic agricultural research. Overseas students in the program should be instilled with the philosophical rationale for the land-grant approach to agricultural teaching, research, and extension.

    - The successes of international programs often depend upon the level of commitment of university administrators, which affect the subsequent effectiveness and dedication of the faculty in the programs.

    - Planning and implementing international programs should be an integral part of ongoing state, regional, and national planning efforts.

    - Support for international activities should be sought from traditional clientele groups by showing, where possible, the interrelationship of international and other ongoing domestic programs. Institutions should decide if their interests and the programs they seek to develop could best be implemented by a single university or by a "cluster" of institutions having common program interests
    - The thrust of Title XII programs should emphasize problem solving at the institutional level, hopefully in a format adapted from the land-grant concept of educational institutions.

14. Obviously, the United States has empathy for current and future food needs of developing countries. The nation is richly endowed with the expertise and other resources needed to conduct programs that could help developing countries achieve their agricultural and food production potential and to address equity issues of the world's rural poor. This is the experience and success of land-grant institutions in the U.S. Congressman Paul Findley (U.S. Representative from Illinois from 1961-1983) once said, "The greatest contribution the American people could make to preventing world famine would be to help developing countries establish their own land-grant system through which each can build its own reliable and progressive food system."

CHAPTER 5. TITLE XII AND THE COLLABORATIVE RESEARCH SUPPORT PROGRAM (CRSP)

The CRSP concept was developed from Title XII legislation in the U.S. Congress with the purpose of extending the land-grant system successes into developing countries, which were that agriculture and food commercialization enabled non-agricultural economic growth. As agricultural economist Joe Purcell (University of Georgia, Georgia Experiment Station, Experiment, GA) once commented, "A country must first be able to feed itself before it can grow economically" (as heard by David Cummins about 1980).

BIFAD, JRC, and JCAD in concert with the appropriate offices within USAID conceptualized the Collaborative Research Support Program (CRSP) to implement a portion of the Title XII program of the United States Foreign Assistance Act of 1975 with a goal to prevent famine and establish freedom from hunger through land-grant university involvement in international development. To attain these goals, the research capability of both developing country and U.S. institutions is enhanced through training and support of research. Inherent in the CRSP concept is the need to address constraints that have global implications.

The CRSP planning effort led to the identification of eight disciplinary/technical areas that would become the first CRSPs. USAID held planning meetings with interested universities in 1978 that identified disciplinary oriented universities to lead a planning grant in each area. These areas had strong core capacity in individual and "cluster" universities, and determined to be of primary importance to a wide range of developing countries across the globe. The first four CRSPs developed and implemented were bean/cowpea, sorghum/millet, tropical soils, and small ruminant; followed by nutrition, peanut, pond dynamics/aquaculture, and fisheries stock assessment. Plans were developed in the first four CRSPs beginning in 1978, with the research grants awarded to begin work in 1979. The last four CRSPs were identified later and planning grants were awarded in 1979 and 1980, and the last four research grants awarded and work begun by 1982.

The Peanut CRSP was approved in July 1979, by JRC and the planning grant awarded to the University of Georgia for fall 1979 funding. The funds to support planning grant activities were not approved until Aug. 1, 1980. From Chapter 5 forward, focus will be on the Planning process from 1980-1982 and the implementation of the first planning grant in Aug. 1, 1982, and the history of the CRSP from that time until the present.

Peanut germplasm shared and tested with host country collaborators,
also provided opportunities for US Principal Investigators to mentor and train collaborators

CHAPTER 6. FACTORS CONTRIBUTING TO PLANNING AND ESTABLISHMENT OF THE PEANUT CRSP

United States peanut sector

Peanut has been grown for many years in the United States. It was likely introduced into Africa from South America in the early 1500s by Portuguese traders, then to the U.S. in the early 1600s probably by the African slave traders, but the time and place of the African and U.S. introductions has not been fully documented. Peanut was mainly a garden crop in the early part of the 1800s, but after 1865, the crop area grew fast and was consumed mostly as in-shell, roasted peanut. Peanut butter was first pushed in the market place in 1894 and following. In 1901, a "penny-in-the-slot" peanut machine and the production of peanut candy provided an impetus for growth. The development of processing equipment had a strong influence on the expansion of peanut use. Peanut developed into a strong food and economic crop after the boll weevil devastated the cotton crop in the South in the decade beginning in 1909. Research by George Washington Carver at Tuskegee Institute in Alabama developed many products from peanut mainly from 1915 to 1923 and showed the great potential for food and other uses. He developed about 330 uses of peanut. Although, peanut farming was already catching on and becoming popular, Carver's inventive spirit, his promotion of the peanut and its many uses, and his glowing reputation for scientific achievement helped boost the use of peanuts and peanut farming to new heights in the early part of the 1900s. The U.S. Department of Agriculture and the State Agricultural Experiment Stations in the peanut growing areas of the Southern States region began to develop research, extension, and education programs that enhanced peanut production and use that expanded greatly beginning in the 1920s. A number of these institutions and scientists became leaders in peanut programs across the region over the next two or three decades. The scientists in these programs covered several disciplines and might be termed "first generation" peanut scientists. The contribution of the Georgia Experiment Station, Griffin, Georgia to the field of knowledge on the peanut from the late 1920s to the early 1940s was more extensive than that of any other research institution in the world (breeding, cultural practices, diseases, chemistry, post-harvest handling, food processing, animal feeds, engineering, economics).

The list is not exhaustive, but the following scientists contributed much to the growth of the industry and shows how training and mentoring expanded and enhanced peanut science in the U.S.

- Walt Gregory, genetics and breeding, North Carolina State University
- Ken Garren, peanut pathology, USDA/ARS, Suffolk, Virginia
- L.W. Boyle, peanut pathology, Georgia Ag. Exp. Sta., Griffin, 1950s-early '60s
- J.G. Woodruff, food technology, Georgia Ag. Exp. Sta., Griffin Horticulture Dept. 1922, frozen food research 1925-40, and then the Food Processing Dept.
- C.R. Jackson, aflatoxins, Georgia Coastal Plains Exp. Sta., Tifton
- Ray O. Hammons, genetics/germplasm enhancement, USDA, Coastal Plains Experiment Station, Tifton, Ga.
- Allan J. Norden, breeding, University of Florida, Gainesville
- B.B. Higgins, pathologist and botanist at the Georgia Experiment Station; started peanut breeding in Georgia in 1931 and released seven varieties from 1938-1952, including GA119-20, which is still popular in West Africa
- B.C. Langley, agronomist/breeder, Texas A&M University
- Art Harrison, plant pathologist, Texas A&M University
- Romney Sorrenson, agricultural engineer, Texas A&M University
- Walter Thames, nematologist, Texas A&M University
- Ralph Matlock, agronomist/breeder, Oklahoma State University
- David Hsi, pathologist/breeder, New Mexico State University

These men a few of whom were active until in the early 1980s were good scientists that contributed much knowledge to peanut science, but were also great teachers and inspirers of students and developed the "second generation" of peanut scientists in the U.S. These second and sometimes "third generation" scientists were capable and interested individuals dedicated to contributing to the continued growth of the peanut industry. In addition, there was an intense interest in these younger scientists to make contributions to the food supply and the wellbeing of people worldwide. They became the U.S. scientists in the Peanut CRSP.

African peanut sector

Peanut was introduced into Africa in the 1500s from South America: largely by Portuguese traders. Most of the production was in Sub-Saharan Africa. Peanut was primarily a subsistence crop in the countries until the early 1900s, similar to the U.S. situation. The Colonial System had developed across these regions, with much of these peanut production areas colonized by the French and English. Peanut was contributing to the cooking oil demand in France and England with countries such as Senegal and Nigeria producing oil for exporting into France and England. Food use and export of peanut also increased. Production increases were needed to meet the needs pointing to the need for crop improvement. The French system under IRHO (Institut de Recherches pour les Huiles et Oleagineaux, or Research Institute for Oil and Oilseeds) conducted peanut research in francophone African countries such as Senegal, Upper Volta (later named Burkina Faso), Ivory Coast, and Cameroon. The British Colonial System under the Overseas Development Agency formed research and development institutes in countries such as Nigeria, Nyasaland (later named Malawi), and Southern Rhodesia (later named Zimbabwe). The institutions began to develop and contribute to the growth of the peanut industry in the 1920s similar to that in the United States. These programs also developed the "first, second, and sometimes third generation scientists.

Prominent among these scientists, but again not exhaustive, showed how training and mentoring enhanced peanut science and development in the major producing areas of the Colonial World. They were active in these counties from the 1950s into the 1970s.

- R.W. Gibbons, breeding/genetics, British Overseas Service, Malawi
- D. McDonald, pathology, British Overseas Service, Nigeria.
- Colin Harkness, breeding/genetics, British Overseas Service, Nigeria.
- John A. Brook, entomologist, British Overseas Service, Nigeria.
- Joseph Smartt, breeding/genetics, British Overseas Service, Zambia
- Pierre Gillier, breeding/genetics, French Overseas Service, Senegal
- Pickford Sibale, groundnut breeder, Malawi

Latin American/Caribbean sector

South America contributed much to the world peanut industry. Foremost is that peanut is native to South America (center of origin based on greatest genetic diversity) and spread worldwide by the traders as mentioned earlier. In addition, peanut grew from a subsistence crop to an important domestic and export crop. As an example Argentina exported oil and oil meal to Europe for cooking oil and livestock feed. Similar to other areas of the world, research and development institutions developed beginning in the 1920s, which contributed to the growth of the peanut industry. Notable among these were in Argentina, Brazil, Paraguay, Peru, Bolivia, with expansion into the Caribbean region. Country programs were somewhat focused with a large country like Brazil having most peanut research concentrated at one site. South American programs were important to the world in the efforts they made in collecting and preserving germplasm and cooperating with other countries in sharing this germplasm. The Caribbean nations had developed a coordinated research program, CARDI (Caribbean Agricultural Research and Development Institute) that provided a good basis for Peanut CRSP activities. These programs produced the "first, second, and sometimes third generation scientists over the next two or three decades. Ironically, in 1960 peanut meal from Brazil and exported to England caused deaths in turkey poults, with the deaths determined to be caused from aflatoxin produced by the fungus *Aspergillus flavus*. This led to the surge in concern for control of aflatoxin/mycotoxin contamination in peanuts.

Prominent among these scientists, but again not an exhaustive list include:

- A. Krapovickas, germplasm, Ministry of Agriculture, Argentina
- A.S. Pompeu, plant breeding, Brazil
- Horace Payne, plant breeding, CARDI, Jamaica
- Bruno Mazanni, peanut breeder and agronomist, Venezuela

Asian sector

Significant research and development programs existed and were being strengthened in countries such as India, Australia, Philippines, Thailand, and Indonesia as the Peanut CRSP was being planned. In 1978, India was the world's largest peanut producer. The Indian Research program had been developed under the British Overseas Program and strengthened by the U.S. program in the 1950s and 1960s that developed the agricultural university system across the country. Also, India would greatly benefit by the presence of ICRISAT. Australia had a local research program, but impacted the regional peanut program with grants in countries like Thailand. The Philippines had a significant research program in the universities and the Department of Agriculture, with coordination beginning with the USAID support to develop the Philippine Council for Agricultural and Resources Research Development (PCARRD) in 1972. The Thailand research program was separated and not well coordinated, but following the Peanut CRSP planning visit a coordinated effort was planned and established for the "National Coordinated Peanut Research Program" prior to the implementation of the Peanut CRSP there in 1982. The International Development Research Centre (IDRC) – Canada and the Australian Centre for International Agricultural Research (ACIAR) were supporting research including peanut in countries such as Thailand.

Scientists active in the 1950s to the 1980s include:

- Dr. Arwooth Na Lampang, Breeding, Thailand
- Dr. K.J. Middleton, pathologist, Austraila
- Dr. Ricardo Lantican, breeder, University of the Philippines, Los Banos

ICRISAT

The Consultative Group for International Agricultural Research (CGIAR) was developed with international support in 1971 and headquartered in the World Bank, Washington, D.C. It developed from concerns about food supplies in developing countries. The roots of CGIAR go back to the Rockefeller Foundation support of wheat research in Mexico in the 1950s and rice research in the Philippines beginning in1960. A series of Agricultural Research Institutes were developed in strategic areas of the world to devote efforts on particular crops important to developing countries. Focus was on the improvement of both crops and livestock. In 1972 the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) was formed by CGIAR and located in Hyderbad, India. The intent was for ICRISAT to provide a worldwide focus for germplasm collection and improvement along with other areas such as plant pathology, entomology, and plant physiology that would train and supply information to developing countries. The groundnut/peanut program was developed in at ICRISAT in 1976. The Colonial Systems were disbanding with the independence of the various countries. The importance of the research and development programs in peanut in these Systems can be seen in the staffing of the ICRISAT peanut research team, as most came from the British Overseas Program Stations, the "first and second generation" scientists. A West-Africa (later classified as West and Central Africa) ICRISAT Center was developed in Niger in 1985, and an Eastern and Southern Africa Center in Kenya in 2003. ICRISAT country programs in Malawi, Mali, and Nigeria have been important contributors to peanut research. In addition to providing research leadership, germplasm and other scientific information, ICRISAT has provided the forum for a periodic International Groundnut Workshop in 1980 and 1991 and regional Workshops in Africa and Asia co-sponsored by the Peanut CRSP, CORAF, ACIAR, and other groups, which has contributed much scientific exchange. Additionally, ICRISAT produced in cooperation with the Peanut CRSP the International Arachis Newsletter for short and timely publication of research advances from 1983 to 2010.

Communications and interactions of world peanut scientists

Communication among peanut scientists during the earlier stages was generally within countries, regions, and particular Colonial Systems. Some information flowed through international publications, but there were no publications strongly devoted to peanut. The Peanut Improvement Working Group (PIWG) was formed in the U.S. in 1957, changed to the American Peanut Research and Education Association (APREA) in 1968, and became the American Peanut Research and Education Society in 1979. The Annual Programs held in different States of the peanut producing Southern region included scientists from public and private institutions and the commercial sector. The programs soon began to attract international scientists, thus becoming an important forum for scientists to become acquainted and share information and expertise. Also, the Society promoted the exchange of scientists and training of students. Peanut Science, a scientific proceedings or journal was developed by the Association/Society in 1974, and is the major journal worldwide devoted to peanut science. Peanuts-Culture and Uses, published by PIWG, and Peanut Science and Technology, published APREA, preceded Peanut Science. ICRISAT contributed extensively to communications through workshops, training, publications, and cooperative research.

Conclusions

What did the status of the international peanut science community mean to the development and success of the Peanut CRSP? This brief and admittedly non-exhaustive history ends with the development of ICRISAT. The end of the Colonial Systems had left significant research institutes in many countries. The U.S. had a strong, successful, peanut research, extension, and teaching community that had interest in international development. The Peanut CRSP planning grant from 1980-1982 had much from which to draw. International peanut scientists (some "first generation" scientists) with long-term and wide experience served in roles to advise the director and associate director in CRSP planning, along with other scientists who provided assistance more informally. The First International Groundnut Workshop held by ICRISAT in Hyderabad, India in October 1980 provided a forum to meet and interview many peanut scientists from around the world and, along with mailed questionnaires to others, provided the basis for the publication, "State of the Art of World Peanut Research". The annual APRES meeting in the U.S provided a forum to meet and discuss items of interest with members of the U.S. peanut scientific community as well as international attendees

A primary goal of the Peanut CRSP was to enhance existing institutions and scientists to improve peanut production and use and the well-being of people in less-developed countries. Research groups developed by the former Colonial Systems were maintained in the less-developed countries and other institutions emerged as these countries became independent, which provided a base for making a contribution to agricultural development in the short- to medium-term range in countries selected to participate in the Peanut CRSP. A strong cadre of mostly "second" and sometimes "third" generation peanut scientists in U.S. universities existed that along with their universities were interested in international agricultural development as well as to remain strong contributors to the U.S. community. The Peanut CRSP provided the opportunity for these U.S. Universities and Host Country Institutions and scientists to team together to contribute to international food and agricultural development and the well-being of people

.In a sense, the time was right for the Peanut CRSP to come on the scene. The U.S. universities that housed the U.S. scientists were committed to the CRSP concept and the role that their institutions and scientists could have in the Peanut CRSP as a basis of providing food supply and economic growth in developing countries.

CHAPTER 7. PEANUT CRSP PLANNING GRANT ACTIVITIES FROM 1980-1982

The CRSP planning and implementation effort by BIFAD and USAID led to the identification of eight disciplinary/technical areas that would become the first CRSPs by 1982. The first four CRSPs (bean/cowpea, sorghum/millet, tropical soils, small ruminant) were implemented by 1979, and the second four (nutrition, peanut, pond dynamics/aquaculture, and fisheries stock assessment) were implemented by 1982. These areas, which had strong core capacity in individual and "cluster" universities, were judged to be of primary importance to developing countries worldwide.

(The following two paragraphs were developed from the remembrances of Dr. Darl Snyder and Dr. Curtis Jackson, University of Georgia.)

Dr. Darl Snyder, director of international agricultural programs for the University of Georgia College of Agriculture, learned that peanuts, a major food and economic crop worldwide between the 40 degree north and 40 degree south latitudes, was not included in the initial CRSP effort. Peanut was an important crop in Georgia and the southern U.S. The region also had well-developed and effective teaching, research, and extension programs on peanut in the land-grant universities and the USDA/Agricultural Research Service. In his International Program role, he made several trips to Washington to encourage BIFAD to recommend the inclusion of a Peanut CRSP. With encouragement from Dr. Elmer Kiehl at BIFAD, Dr. Snyder involved Dr. Curtis Jackson and and Dr. Darrell McCloud in discussions about a Peanut CRSP. Jackson was director of the University of Georgia College of Agriculture, Georgia Experiment Station, Griffin, and formerly a peanut pathologist with a focus on aflatoxins at the Coastal Plain Experiment Station, Tifton. McCloud was a peanut physiologist serving in international programs at the University of Florida. Together, the three put together a proposal and discussed it with Dr. Kiehl. Many discussions among these four individuals followed, which resulted in a BIFAD recommendation and USAID approval of a Peanut CRSP.

The potential for and interest in a Peanut CRSP had been discussed with other people in the universities of the southern region. As the time approached to accept proposals for the planning grant, it appeared that North Carolina State University and Texas A&M University were interested in applying for the Planning Grant, and the University of Georgia Coastal Plain Experiment Station where much of the Georgia Research was located was not interested. After discussions with the Dean of Agriculture at the University of Georgia, Drs. Jackson and Snyder decided to develop a proposal for the planning grant at the Georgia Experiment Station, Griffin.

At a June 28, 1979 organizational meeting in Atlanta, the University of Georgia was nominated to be a potential recipient of a planning grant for the Peanut CRSP, and chosen for this grant by the Joint Research Committee on July 10, 1979. The planning grant was awarded for an 18-month period on Aug. 1, 1980 (grant no. AID/DSAN-G-0247). Subsequently, Alabama A&M University was selected for a sub-grant following solicitations to all the 1890 land-grant universities and Tuskegee University, with leadership to be provided in the socioeconomic and food science phases of the planning effort.

The University of Georgia, as planned, housed the planning grant activities at the Georgia Experiment Station, Griffin. Dr. Curtis R. Jackson was selected as planning grant director with one-half time to be applied to the grant. He selected Dr. David G. Cummins to serve full-time as associate planning director. Dr. B. Onuma Okezie, food scientist and director of international programs, and Dr. Gerald Wheelock, socioeconomist, were named as assistant planning directors at Alabama A&M University. All were approved by their respective universities and by BIFAD and USAID. Due to the lack of funds, among other reasons, the planning grant was not funded from USAID to the University of Georgia until Aug. 1, 1980 rather than in 1979 as anticipated. Jackson and Cummins spent considerable time in assembling information in preparation for the grant during this 1979-1980 period.

In anticipation of Peanut CRSP concept approval and a planning grant by BIFAD and USAID, a cable was sent by USAID in April 1979 to all the USAID missions in peanut producing countries to determine interest from these missions and host country programs for participation in the Peanut CRSP. Responses outlined in general for each host country: the importance of peanuts, present research on peanuts, identified constraints to production and use, and interest in and level of participation in a Peanut CRSP. Participation was perceived at the following three levels:

1) Primary collaboration site – collaboration would be achieved by integrating on-site research and training programs on peanuts with the CRSP, and local scientists would work directly with U.S. scientists in the program; 2) Secondary collaboration site – locations where peanuts are somewhat a less important crop, institutional capability is less adequate, and/or the less developed country designates peanuts at a lower priority, and for such cases, field trials, research programs, and training activities could be initiated to the greatest extent possible; and 3) Tertiary collaboration site – countries with considerably lower levels of peanut importance, institutional capability, and/or interest and participation could utilize primary research results and germplasm as requested and the provision of technical guidance in response to mission or host country queries, and training in this case might also be provided by the collaborating institutions if funded from other sources.

Analysis of 54 cable responses showed 12 countries with interest as primary sites, 7 with secondary interest, 8 with tertiary interest, 10 with possible interest, and 17 with no interest. Nine African, 6 Asian, and 4 Latin American countries expressed primary and secondary interest. The results were later provided to the planning grant team.

A steering committee was organized to advise the directors:

- Dr. Ray Hammons, USDA peanut geneticist, Tifton, Ga.
- Dr. Frank McGill, extension agronomist for peanuts, University of Georgia, Tifton
- Dr. Darl Snyder, director of International Programs, University of Georgia
- Dr. Fred Hutchinson, Joint Research Committee/BIFAD, Washington
- Dr. Robert Jackson, USAID, program manager for the Peanut CRSP planning grant.

The steering committee met twice (September 1980, prior to the country assessment trips, and Feb. 25-26, 1981), corresponded in various ways, and proved invaluable in providing direction to the planning efforts.

Questionnaires were prepared and discussed with the steering committee prior to country visits. They were mailed extensively around the world, and distributed during the country site visits. Production levels and prices for peanuts, and a rating of importance of various potential constraints and sub-constraints to production and utilization were the major questions covered. The responses were well distributed across regions. The steering committee also had the USAID/mission cable surveys for input in the planning process.

Four country assessment trips were made in the fall and winter of 1980-1981. Country visits were determined from interest revealed in the USAID cable responses, advice from the steering committee, and opinions of senior officers of USAID regional bureaus during a visit to Washington on Sept. 25, 1980. 1) Oct. 5-30, 1980 trip by Drs. Jackson and Cummins. West African peanut research was discussed with Dr. Pierre Gillier, IRHO, Paris, a former peanut breeder in Senegal. A proposed world research program on peanuts by UNCTAD was discussed with UNCTAD officials in Geneva, Switzerland. The UNCTAD program and other world interests were covered in a visit to FAO, Rome, Italy. They attended the First International Groundnut Workshop at ICRISAT, Hyderabad, India, Oct. 13-17, 1980. Included in this workshop were scientists from 20 countries and scientists from 16 developing countries gave reports on production and research in their countries. The proceedings from the workshop was published and proved a valuable source of international peanut and peanut research information for the planning process. Discussions were held with scientists from ICRISAT/ India, and several countries relative to their programs and research needs. Visits were then made to research locations in Thailand, Indonesia, and the Philippines. 2) Dr. Cummins and Dr. Charles Swann (peanut scientist from Tifton, Ga.) visited research locations in Paraguay, Brazil, and Trinidad from Nov. 30-Dec.10, 1980. 3) Dr. Cummins and Dr. Wheelock (Alabama A&M University) visited research locations in Senegal, Malawi, and Cameroon from Jan. 25-Feb. 8, 1981. Dr. Jackson and Dr. Okezie (Alabama A&M University) visited research locations in Niger, Nigeria, and Sudan during the same period. 4) Dr. Okezie and Dr. Wheelock visited ICRISAT in India and Thailand following the Africa visits in February, 1981.

The proceedings from the International Groundnut Workshop at ICRISAT were published and proved a valuable source of international peanut and peanut research information for the planning process. In addition, discussions or interviews were also held with scientists from ICRISAT, India, and several countries during the workshop relative to their programs and research needs.

A progress report was presented to the JRC on Feb. 10-11, 1981. The information presented was obtained from the assessment trips, the questionnaires that were distributed on the assessment trips and mailed to a number other countries around the world, and other sources such as FAO data sources. In total, there was a good distribution of responses and a wealth of information was obtained. In addition, the planning team had the results of the USAID survey to 54 countries that was circulated in April 1979. This provided information on the institutional capabilities and the range of constraints within the peanut sector that could be addressed in a research program. Advice from JRC was organized and then reviewed in the second steering committee meeting on Feb. 25-26, 1981.

A technical panel that had been selected and approved met with the steering committee and planning staff on March 31-April 2, 1981 to recommend priority research themes and locations based on the above actions. The members of the technical panel were:

- Dr. Pierre Gillier, director of Groundnut Department, Institute for Oilseeds Research, Paris, France
- Dr. Ron W. Gibbons, groundnut breeder and groundnut program leader, ICRISAT/India
- Dr. Bruno Mazzani, peanut breeder and agronomist, Maracay, Venezuela
- Dr. Donald C. Pickering, tropical agriculturalist, assistant director of general agriculture, World Bank, Washington, and formerly with the British Overseas Service in Nigeria
- Dr. John Fulkerson, plant pathologist and principal scientist, USDA/CSRS, Washington
- Dr. Mervin Yetley, economist, USDA/IED, Agricultural Development Branch, Washington
- Dr. J. G. Woodroof, food scientist, distinguished professor emeritus, University of Georgia, Griffin
- Dr. Cornelia B. Flora, rural sociologist, Kansas State University, Manhattan, Kansas;
- and Pickford Sibale, groundnut breeder, Chitedze Agricultural Research Station, Lilongwe, Malawi (received notification on March 30, that he could not attend March 31 meeting).

A number of items were provided to the technical panel by the planning grant team. A summary of prioritized constraints and identified research was developed from the actions listed above. Program strategies were developed to also include economic studies, coordination with ICRISAT, regional research plans, country sites, and linkage countries. The effort resulted in the development of a Peanut CRSP research plan, a financial and institution/scientist involvement plan, an implementation plan, description of management entity duties, and an environmental impact statement.

A summary of prioritized constraints (selected from 13 potential constraints presented by the planning team) and identified research to relieve the constraints was developed from the actions listed. The priority constraints identified were:

- low yields because of unadapted varieties and lack of varietal resistance to diseases, insects, and drought;
- health hazards and economic losses due to mycotoxin contamination;
- yield losses due to infestations of weeds, insects, diseases, and nematodes;
- food supplies inadequate and peanuts are not generally considered a primary food source;
- economic and sociological problems preventing efficient production and utilization;
- physiological and soil microbiological barriers resulting in low yields.

Research needed to relieve the constraints was defined as:

a) Advanced line, variety testing and cultural practices – Introduction of high yielding, disease and drought tolerant advanced breeding lines and varieties. Variety maturity and adaptation will fit short rainy seasons and multi-cropping systems. Cultural practices will be evaluated, adjusted, and research recommended, if necessary to take advantage of yield potentials in new cultivars. (This addresses constraint a.). Justification – In LDC's where priority on peanut research is not adequate to support a breeding program, support is needed to insure introduction of genotypes adequate to overcome yield constraints.
b) Breeding, cultural practices – Breed high yielding, disease, insect, and drought tolerant cultivars, with maturity to fit needs of short rainy seasons and multi-cropping systems. Adjust cultural practices to take advantage of yield potentials in new cultivars. (This addresses constraint a.). Justification – High yielding, disease, insect, and drought tolerant cultivars are not available in many LDC's. Program support is necessary to address the needs.
c) Mycotoxin Management – Development of simple detection, monitoring, and detoxification procedures and techniques for prevention of contamination. Determine time, infection sites, and location (e.g. field, storage) of contamination and develop practices to minimize infection. (This addresses constraint b.).

Justification – Mycotoxin contamination is a worldwide problem. Aflatoxin in peanuts is produced by *Aspergillus flavus*, a ubiquitous fungus that invades peanuts pre- and post-harvest and produces aflatoxin as a metabolic product. Aflatoxin has been linked to animal deaths due to liver cancer, and is a carcinogen in humans. The problem is often underestimated in developing countries.

d) Weeds, insects, diseases, nematodes – Develop low cost and efficient control measures for these pests. (This addresses constraint c.). Justification – Diseases and pests are a major constraint to peanut production worldwide. In addition to resistant varieties (the most desired means of control, but sometimes unattainable at economic threshold levels), cultural and/or biological control measures are needed to minimize yield reductions from diseases and pests.
e) Food Technology – Determination of the role of peanuts in the food supply and development of improved and new products. (This addresses constraint d.). Justification – The reasons for under-utilization of peanuts as a food in many LDC's lie with the lack of identifiable local food forms made of peanuts, lack of knowledge on the part of LDC people of the food value of peanuts, lack of appropriate processing technology to transform the peanut and its by-products into food forms acceptable to the people, and the aflatoxin contamination problem. An increased peanut production that cannot be translated into direct human consumption is inadequate for contributing to the food needs of the people.
f) Socioeconomics – Research to develop an understanding of land, labor, management, capital, and role of sexes as related to peanut production and utilization and relationships of peanuts to other crops in the cropping systems. (This addresses constraint e.). Justification – Economic and sociological implications of peanut production and utilization are often not understood sufficiently to fully exploit the potential peanuts have as a food and cash crop in developing countries.
g) Physiology, soil microbiology – Determine physiological barriers to production such as drought tolerance, flowering, photosynthesis and partitioning (top/fruit ratios) and aid breeders in identifying superior germplasm for incorporation into varieties. Improve nitrogen fixation efficiency in peanut/rhizobia associations, and determine role of mycorrhizae in peanut growth. (This addresses constraint f.). Justification – The physiological characteristics of peanuts are little understood, especially when grown under high-stress conditions prevalent in developing countries. Varietal improvement should be enhanced through physiological research. Inadequate levels of biological nitrogen appear to be a major limiting factor to peanut production, especially in drier climates, a problem needing research answers. Mycorrhizae are present as intra-and intercellular fungi on many plant roots including peanuts, and could possibly be exploited to increase production if their role was better understood.

Based on the judgment of the steering committee, JRC, and the technical panel, a global program was formulated that would provide research to address the constraints identified, and was proposed for:

- Semi-Arid Tropical Africa (Senegal, Nigeria, Niger, Sudan, Mali, Upper Volta, and Cameroon) for all seven research areas
- Southeast Africa (Malawi) for research areas b, d, f, g
- Southeast Asia (Thailand, Philippines) for all seven research areas
- Caribbean (CARICOM countries through CARDI, Dominican Republic) for research areas a, c, d, e, f

A request for proposals was then developed.

An expression of interest was mailed to all qualified U.S. universities, USDA research locations, and placed in the Commerce Business Daily on April 10, 1981. Those that responded by May 11, 1981 were sent a request for proposals with a July 3, 1981 response deadline. Forty proposals were received and reviewed by the technical panel on July 28-31, 1981.

In order to insure an objective, extensive, and intensive review of the Proposals submitted the technical panel was expanded to 22 members, which included members of the planning grant team and the steering committee. Members participating were:

- Dr. James Acton, food scientist, Clemson University, South Carolina
- Dr. Virginia Caples, associate dean, School of Agriculture, Environmental Science, and Home Economics, Alabama A&M University

- Dr. David Cummins, associate planning director
- Dr. St. Clair Forde, chief of research, CARDI, Trinidad
- Dr. Cornelia Flora, rural sociologist, Kansas State University
- Dr. Andrew Fowler, plant pathologist and Kano Experiment Station superintendent, Kano, Nigeria
- Dr. John Fulkerson, plant pathologist and principal scientist, USDA/CSRS, Washington
- Dr. Kenneth Garren, peanut pathologist and principal scientist, USDA/ARS, Suffolk, Virginia
- Dr. Ron Gibbons, groundnut breeder and program leader, ICRISAT/India
- Dr. Ray Hammons, geneticist and peanut research leader, USDA/ARS, Tifton, Georgia
- Dr. Sid Hays, head, Department of Entomology, Clemson University, South Carolina
- Dr. James Howell, head, Department of Entomology, Georgia Experiment Station, Griffin, Georgia
- Dr. C. R. Jackson, planning grant director
- Dr. James Marion, food scientist and director of research, Goldkist, Inc., Atlanta
- Dr. Bruno Mazzani, peanut breeder and agronomist, Maracay, Venezuela
- Dr. B. Onuma Okezie, food scientist and assistant planning director, Alabama A&M University
- Dr. Donald Pickering, tropical agriculturalist, The World Bank, Washington
- Dr. Darl Snyder, director of International Programs, University of Georgia
- Dr. Gerald Wheelock, socioeconomist and assistant planning director, Alabama A&M University
- Dr. David Wilson, soil microbiologist, University of Georgia, Coastal Plain Experiment Station, Tifton
- Dr. J.G. Woodroof, food scientist emeritus, University of Georgia, Georgia Experiment Station, Griffin
- Dr. Mervin Yetley, economist, USDA/IED, Agricultural Development Branch, Washington

Each member had expertise in and reviewed projects in from one, to as many as three, of the constraint areas listed above.

The technical committee recommended the following general program scope and organization. The Peanut CRSP as proposed for a minimum funding level, will link researchers in six U.S. universities with institutions in 12 host countries in Africa, Southeast Asia, and the Caribbean. One additional U.S. university will be involved as a sub-grantee for socioeconomic research. In the second year of the CRSP, minor linkages may be developed in additional LDC countries in an advanced line/variety test project. Training activity needs will be determined as linkages are established. The major support will be requested from USAID, but U.S. universities will provide matching funds and LDC institutions will contribute a substantial amount of resources to the program.

The administration of the Peanut CRSP will be a management entity guided by a board of directors and assisted by a technical committee and an external evaluation panel, along with assistance from a USAID program officer and a BIFAD representative.

The six U.S. universities recommended for inclusion in the CRSP were: Alabama A&M University, University of Florida, University of Georgia, North Carolina State University, Oklahoma State University (to include a subgrant to the University of Wisconsin), and Texas A&M University.

Participating host countries and institutions in priority according to regions were:

Semi-Arid Tropical Africa – Senegalese Institute for Agricultural Research, Bambey and Kaolak, Senegal; Institute for Agronomic Research, Tarna Research Station, Maradi, Niger; Institute for Agricultural Research, Ahmadu Bello University, Zaria (and Kano), and University of Ife or Ibadan, Nigeria; Agricultural Research Corporation Khartoum, Sudan; Ministry of Agriculture, Bamako, Mali; Ministry of Agriculture, Ouagadougou, Upper Volta; Institute for Agricultural Research, Yaoundé, Cameroon.

Southeast Asia – Ministry of Agriculture, Bangkok and Northeast Field Station Kalasen; Kasetsart University, Bangkok and/or Khon Kaen University, Khon Kaen, Thailand; Philippines Council for Agricultural Research Resources, Los Banos (for research with Ministry of Agriculture and University of Philippines at Los Banos), Philippines.

Caribbean – Caribbean Agricultural Research and Development Institute, Trinidad; Ministry of Agriculture, Santo Domingo, Dominican Republic.

Southeast Africa – Citedze Research Station, Lilongwe, Malawi.

The regions/countries, U.S. universities, and constraints with minimum funding levels were summarized as follows:

SAT Africa		
Senegal, Nigeria, Niger	Oklahoma State U	Socioeconomics
Senegal, Nigeria, Sudan	Texas A&M U	Mycotoxin management
Nigeria, Sudan	Alabama A&M U	Food science
Senegal, Nigeria	Texas A&M U	Breeding, cultural practices
Niger, Mali, Upper Volta Cameroon	U of Georgia	Advanced line, variety testing and cultural practices
Senegal, Nigeria, Niger	U of Georgia	Insect management, peanut viruses
Southeast Asia		
Thailand, Philippines	Oklahoma State U with subgrant to U of Wisconsin	Socioeconomics
Thailand, Philippines	U of Georgia	Food science
Thailand, Philippines	North Carolina State U	Breeding, advanced line, variety testing, cultural practices, insect management
Thailand, Philippines	North Carolina State U, Texas A&M U	Nitrogen Fixation, mycorrhizal fungi
Caribbean		
CARDI	Oklahoma State U, U of Wisconsin	Socioeconomics, food consumption surveys
CARDI	U of Florida	Food science
Dominican Republic	U of Georgia	Advanced line and variety testing, cultural practices
Southeast Africa		
Malawi	U of Georgia	Peanut viruses

Additional projects with Intermediate Funding levels:

Southeast Asia	
Thailand, Philippines	Mycotoxin management
Thailand, Philippines	Diseases
Southeast Africa	
Malawi	Socioeconomics
Malawi	Breeding, Cultural Practices

Additional projects with maximum funding levels:

SAT Africa	
Senegal, Nigeria, Sudan	Physiology
Caribbean	
CARDI	Mycotoxin Management
CARDI	Diseases
Southeast Africa	
Malawi	Soil Microbiology

A preliminary report with budgets was submitted to USAID/BIFAD for grant approval Sept. 14, 1981, and following review and revisions a final report was submitted on Nov. 17, 1981. After approval a revised report without budget was submitted on March 16, 1982.

Visits to host countries and institutions with U.S. principal investigators and planning grant staff were made from January-June 1982 (the planning grant was given an unfunded extension from March to June). Some modifications in projects and country focus were made in further discussions on these trips. In Jan. 1982, Malawi declined to participate, so the virus project was moved to Nigeria. Work planned in Dominican Republic was not accomplished, so the program focused on CARDI and University of the West Indies. The final program planned and negotiated with the host countries will be detailed in the 1982-l985 grant summary in Chapter 8.

A world-wide state-of-the-art document mandated in the planning grant was developed that included peanut production estimates, summary country reports, researchers and locations, research in progress, and research and production constraints. The document included a tabulation of production by countries throughout the world where peanuts comprise a reasonably important component of agricultural production, an inventory of U.S. and developing country institutions with a manifest interest and capability in peanut research, and an inventory of research being conducted in the U.S. and to the fullest extent possible the rest of the world. It was published as "World Peanut Production, Utilization and Research," University of Georgia College of Agriculture Experiment Stations, special publication no. 16, April 1982. David G. Cummins and Curtis R. Jackson, editors (associate director and director of planning grant, respectively). Alabama A&M University had a sub-grant to compile the socioeconomic, post-harvest and food technology component of the document, and was contributed by Dr. Gerald Wheelock, socioeconomist, and Dr. Onuma Okezie, food scientist.

Planning grant summary

The planning grant activities were well supported from a broad view by the vision of Congress to develop and enact Title XII based on the U.S. land-grant experience. The experience, foresight, and interest of USAID that this model would benefit development were important to the process. Then BIFAD bridged between USAID and interested University participants to implement the CRSP model that was necessary to implement the CRSP model for international agricultural development.

Leadership within USAID Office of Agriculture, JRC, JCAD, BIFAD, and the University of Georgia planning grant team in implementing the planning grant all performed in a committed, collaborative, and cooperative manner to accomplish the process. These groups all recognized the role that research could play in effecting a growth in food production and economic growth in developing countries.

The Peanut CRSP planning grant set forth guidelines for development of an organizational foundation for a collaborative research program between U.S. scientists and scientists in developing countries. The research was to be directed toward solving socioeconomic and biological constraints to increased production and utilization of peanuts in developing countries where peanuts are an important economic food crop of rural and urban poor.

The global research and development factors contributing to planning and establishment of the Peanut CRSP were discussed in Chapter 5. From among these, the following factors were especially salient to the planning process.

1. The development of the American Peanut Research and Education Association in 1961, later named American Peanut Research and Education Society (APRES). This organization pulled together the peanut research, teaching, and extension faculties in the land-grant institutions as well as the U.S. Department of Agriculture. These faculties and USDA scientists were extremely competent and dedicated to their work with peanuts, and formed the basis of scientists that comprised the first CRSP projects. APRES met annually and as the program developed it attracted international and country scientists again valuable to the CRSP process.

2. The establishment in 1976 of the Groundnut (Peanut) Improvement Program at ICRISAT that helped to focus on the global research needs of the crop. This led to the First International Groundnut Workshop in October attended by Drs. Jackson and Cummins. There were 71 individuals from 20 countries in attendance. Participation in the sessions and interviewing of the top peanut scientists in country and

international programs was of immeasurable value in obtaining information for production of the SOTA required in planning, and in the development of the first Peanut CRSP research plan, the goal of the planning grant.

3. The commitment of U.S. land-grant universities and the U.S. Department of Agriculture, as mentioned above, to the CRSP concept was of primary importance. Within these institutions, the research, teaching, and extension scientists were highly committed and competent and formed the principal investigators (PIs) for the administrative and scientific leadership for planning and leading the future-first research grant.

4. The assembly of the information in the planning grant to design the first research grant was greatly aided by 1) a five member steering committee that represented International Programs, Peanut Research, and Extension in Georgia, and BIFAD and USAID in Washington, and 2) a technical panel comprised of nine (expanded to 22 members for the review of research proposals) U.S. and internationally recognized peanut scientists and administrators. The technical panel members were products of the international peanut research and development community, and their knowledge of international peanut research needs was invaluable.

5. The culmination of the planning grant included visits to host country sites by the U.S. principal investigators that successfully competed and were selected for the first Peanut CRSP grant. They met their counterparts in the host countries and were able to fine-tune plans for their future projects.

Steps followed in the planning process were as follows:

1. Appointment of a steering committee to advise the process.

2. Request and evaluate cable response from USAID missions for country needs and interest in participation (54 cable responses showed 12 countries with primary interest, and seven countries with secondary interest – nine African, six Asian, and four Latin American).

3. Consultations with USAID regional bureaus on their visions that might impact the CRSP.

4. Extensive mailing and distribution on site visits around the world of questionnaires to determine institutional capabilities and constraints within the peanut sector (a good distribution of responses was received); attending the first International Groundnut Workshop at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in India in October 1980 (scientists were present from over 20 countries, and scientists from 16 developing countries gave reports on production and research in their countries, and the planning team interviewed a number of scientists from both developed and developing countries and international institutions); special consideration was given to the countries in item 2 above that responded to the April 1979 cable through the USAID missions.

5. Making four assessment trips which included site visits in 13 countries; (country visits were determined from interest revealed in the cable responses, advise from the steering committee, and opinions of appropriate advisors in USAID to help in the identification of participating countries); and the knowledge gained from scientists and administrators visited that included both developed and developing country individuals.

6. Development of a world-wide State-of-the-Art document mandated in the planning grant on peanut production estimates, summary country reports, researchers and locations, research in progress, and research and production constraints. The document included a tabulation of production by countries throughout the world where peanuts comprise a reasonably important component of agricultural production, an inventory of U.S. and developing country institutions with a manifest interest and capability in peanut research, and an inventory of research being conducted in the U.S. and to the fullest extent possible the rest of the world.

7. Assembly of a technical panel to assist in prioritization of research needs and program development. The panel met with the steering committee and planning staff on 31 March-2 April 1981 and recommended priority research areas and locations. The technical panel met for the second and final time 28-31 July,1981 to evaluate the proposals and select those considered appropriate for inclusion in the Peanut CRSP.

The Peanut CRSP was funded and implemented in August 1982 with the intent of a five-year outlook, but required the review by an external evaluation panel at the end of two years. The review resulted in programmatic changes beginning in the 1985-1986 year, and USAID/BIFAD adjusted the program to a five-year plan 1985-1990. That resulted in the Peanut CRSP to be reported as a three-year plan rather that a five-year plan in the outset, and followed by five-year sequences or phases.

In subsequent years as anticipated in the CRSP concept, new and concurrent grants for following periods were developed after an EEP evaluation, and presented to USAID for approval and/or modifications. New grants have been awarded for 1985-1990, 1990-1996 (one-year extension), 1996-2001, 2001-2007 (one year extension), and 2007-2012 (a cooperative agreement). The University of Georgia led the planning grant and has been the management entity for all the phases. The other U.S. universities and developing countries that have been involved will be evident later in this manuscript describing the program over the full time period.

Small farm equipment such as threshers have helped reduced labor needs and contribute to expansion os productions.

CHAPTER 8. DESCRIPTION OF 1982-1985 GRANT

The University of Georgia was selected by participating U.S. universities as the management entity to implement and lead the 1982-1985 program that included Alabama A&M University, the University of Georgia, North Carolina State University and Texas A&M University in the United States; Africa – Senegal, Niger, Mali, Upper Volta (Burkina Faso), Nigeria, Sudan; Southeast Asia – Thailand, Philippines; and the Caribbean coordinated through the Caribbean Agricultural Research and Development Institute. Variety introduction research planned for Cameroon could not be implemented so it was moved to Upper Volta, virus research planned for Malawi could not be implemented and was moved to Nigeria, and variety introduction work in Dominican Republic could not be implemented. The University of Florida food science project in the Caribbean was implemented as a sub-grant under Alabama A&M University. Agreements were not concluded with Oklahoma State University and University of Wisconsin. Program coordination with ICRISAT was strengthened with a requirement that an ICRISAT scientist be included on the Peanut CRSP board of directors, and for the cooperative publication of an international peanut newsletter.

Global plan

The Peanut CRSP was designed to address a set of global constraints to sustainable production and use:

- Low yields because of unadapted varieties and lack of varietal resistance to diseases, insects, and drought;
- Health hazards and economic losses due to mycotoxin contamination;
- Yield losses due to infestations of weeds, insects, diseases, and nematodes;
- Food supplies inadequate and peanuts are not generally considered a primary food source;
- Economic and sociological problems preventing efficient production and utilization;
- Physiological and soil microbiological barriers to higher yields;
- Projects also addressed training, information, and outreach needs. It was recognized that there were insufficient numbers of trained researchers and support personnel; and there was inadequate availability and use of technology by producers and processors.

The program began with 11 (the soil microbiology project had two parts which in effect gave 12 projects) projects that encompassed breeding, cultivar evaluation, mycotoxin (aflatoxin) management, virus management, insect management, food technology, and soil microbiology. Long- and short-term training of students and scientists was a part of all projects, and with goals to transfer technologies to end-users.

United States and Host Country University and Institutional Participants 1982-1985

The University of Georgia management entity (ME) Office was located in the College of Agriculture at the Georgia Station (later termed Griffin Campus), Experiment Georgia. The major role was responsibility to USAID for technical and administrative matters for the Peanut CRSP. Duties included negotiating agreements, fiscal management, report of technical progress, and project modification.

In 1982, the ME's staff were Dr. David G. Cummins, program director, and Barbara Donehoo, administrative secretary. Support staff included Ted Proffer, business manager, University of Georgia College of Agriculture, and Dr. Darl Snyder, director of international development and Title XII representative, University of Georgia, served in an advisory role. Overall responsibility for programmatic and fiscal accountability for the grant was in the offices of the vice-presidents for research and for business affairs, with day to day management assigned to the ME Office with support from the College of Agriculture. USAID funds supported the ME office and sub-grants to U.S. universities for U.S. and host country support of individual projects. BIFAD served in an advisory role bridging USAID to the University involvement.

Eleven projects in the technical areas listed above were the subjects of sub-grants to four U.S. universities with host country collaborating institutions with corresponding investigators, co-investigators, and administrative support.

Board of directors

The board of directors served in an advisory role to the ME and provided liaison to their respective institutions. The duties of the board of directors are to establish policy for the CRSPs, approve annual budgets, approve recommendations on programs, and review accomplishments for the CRSP. The board consists of one administrative representative from each of the participating U.S. institutions and one from ICRISAT. The ICRISAT representative was recommended in the planning grant. Term lengths are at the discretion of the individual institutions. The board met twice during this initial year of the CRSP.

The first members of the board of directors were:

- Dr. Dudley T. Smith, associate director, Texas Agricultural Experiment Station, Texas A&M University
- Dr. E. Broadus Browne, director, Georgia Agricultural Experiment Station, University of Georgia 1982-1983
- Dr. Charles W. Laughlin, associate director, Georgia Agricultural Experiment Station, University of Georgia 1984
- Dr. B. Onuma Okezie, director of International Programs, Alabama A&M University
- Dr. Billy E. Caldwell, head, Department of Crop Science, North Carolina State University
- Dr. Ron Gibbons, groundnut program leader, ICRISAT/India

Technical committee

The technical committee acted in an advisory role to the board of directors and management entity. Primary duties were 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. The committee consisted of one principal investigator from each participating U.S. institution.

The first technical committee included:

- Dr. Johnny C. Wynne, Department of Crop Science, North Carolina State University
- Dr. James W. Demski, Department of Plant Pathology, Georgia Experiment Stat., UGA
- Dr. Bharat Singh, Department of Food Science, Alabama A&M University
- Dr. Olin D. Smith, Department of Soil and Crop Science, Texas A&M University

The Committee met one time in the first year and individually advised the board and ME on several occasions.

Coordination with USAID and BIFAD

Liaison was maintained with USAID 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 programmatic and fiscal reports. Dr. John Yohe was the first USAID Peanut CRSP project manager in 1982, but soon departed for the University of Nebraska and was replaced by Dr. Loren Schulze during 1982.

Advice from BIFAD was provided in various areas of concern in program development and management. William Fred Johnson was the BIFAD liaison to the Peanut CRSP.

Program support

The Peanut CRSP grant from USAID provided $877,229 for the period 1 July 1982 to 30 June 1983. In addition to this, $116,723 was pledged by the U.S. institutions as their non-federal cost sharing contribution to the program. U.S. participating institutions were required to contribute not less than 25% of the total support to CRSP projects, except for management entity and host country activity costs. The USAID funds for the first year were less than expected, therefore only six of the eleven projects planned were implemented in the first year of the three year grant.

In 1983-84, USAID provided $1,772,773 and the universities cost shared 482,979 which allowed all eleven projects to be funded. In 1984-85, USAID provided $2,409,274 and with $527,401 University cost share, which maintained and expanded funding for the eleven projects. For the first three years, July 1982-June 1985, the total budget was; USAID $5,059,276 (4,117,117 for program and 942,159 for ME); University cost share 1,127,103 for a total funding level of $6,186,379.

CHAPTER 9. PROJECT, U.S. AND HOST COUNTRY SCIENTIST AND INSTITUTIONAL MAKEUP, 1982-1985 GRANT

The 1980-1982 planning grant process for the Peanut CRSP selected and developed eleven projects in the Africa, Southeast Asia, and Latin America/Caribbean regions for collaboration with the four U.S. universities. The projects, U.S. universities, host countries and institutions, and U.S. and host country principal investigators and cooperators follow. Based on the precepts advanced in Title XII, major benefits were anticipated in the host countries and at the same time return benefits to the U.S.

As indicated earlier due to the limitation of funds the first year, six projects were funded beginning in July 1982 and with increased funding the other six began in July 1983. As noted earlier, the projects were grouped into the themes of Producer Values, Processor Values, Consumer Values, and Information/Training/Impact, which were adopted in later grant descriptions. This will facilitate the following of progress and activities in the individual themes over the life of the Peanut CRSP.

Prior to the planning grant visit to Thailand in late 1980 and interest in collaboration established, a coordinated program between independent programs of The Department of Agriculture, Khon Kaen University, and Kasetsart University was established in 1981 prior to CRSP implementation. This greatly increased research efficiency and impact potentials as the CRSP cooperation developed in future years. This effort was led and coordinated by Dr. Arwooth Nalampang, Department of Agriculture, Bangkok. Through the leadership of Dr. Dely Gapasin, PCARRD crops research department head/director of research, an integrated Philippines/Peanut CRSP effort was developed for research planning, conduct, and extension of information to end-users.

A. Producer values

GA/INPEP/N,M,BF,CAR (funded July 1982) – International Peanut Evaluation Program

Principal and Co-Principal Investigators:
- Dr. W.D. Branch, University of Georgia, Tifton Station, breeder and principal investigator
- Dr. R.O. Hammons, USDA/ARS, Tifton, Ga., breeder and geneticist, U.S. co-principal investigator.

Niger Collaborator:
- Amadou Mounkaila,L'Institut National de Recherché Agronomiques du Niger (INRAN)

Mali Collaborator:
- **Mali:** Amadou Mounkaila, L'Institut d'Economie Rurale (IER)Deilmousssa Soumano

Upper Volta (name later changed to Burkina Faso) Collaborator:
- Amadou Mounkaila, l'Institut Superieur Polytechnique (ISP) Dr. Philippe Sankara

Caribbean Collaborators:

Caribbean Agricultural Research and Development Institute (CARDI) based at University of West Indies Campus, St. Augustine, Trinidad
- Dr. Sam Parasram, executive director
- Dr. Syed Q. Haque, coordinator for research cooperator
- Dr. B. K. Rai, Belize
- Dr. Laxman Singh, Antigua
- Horace Payne, Jamaica.

Initial plans for collaboration with Cameroon were not concluded.

The overall goal of GA/INPEP was to improve peanut production in the host countries through the introduction of superior germplasm by means of an advanced line/variety testing program. Under this program, collaborative research was conducted by U.S. and host country scientists, to identify superior performing genotypes adapted to each particular country. U.S. cooperators provided general leadership in obtaining advanced-generation breeding lines and varieties from around the world, increase of the selected test material at the Coastal Plain Experiment Station, Tifton, Ga., and subsequent distribution to host countries. Each investigator was responsible for actual replicated field testing using cultural practices acceptable to farmers in the area. Performance data was analyzed, compiled, and published in the U.S., and then the results disseminated to all cooperators. Any variety and/or experimental line found to be desirable within this program was subject to an international release between the originating institution and the host country.

TX/BCP/S (funded July 1982) – Disease resistant peanut varieties for semi-arid environments

Principal Investigator:
Dr. Olin D. Smith, Texas A&M University, breeder

Cooperators:
- Dr. C.E. Simpson, breeder; Texas A&M University
- Dr. D.H. Smith, pathologist, Texas A&M University
- Dr. A.M. Schubert, pathologis, Texas A&M University
- Dr. T.E. Boswell, pathologist, Texas A&M University
- Dr. R.E. Pettit, pathologists, Texas A&M University
- R. A. Taber, physiologist, Texas A&M University

Senegal Collaborators:
- J.C. Mortreuil (breeder), Institut Senegalais de Recherches Agricoles (ISRA)/Centre Nord de Recherches Agricoles (CNRA), Bambey,
- Dr. Aly N'Diaye (physiologist), Institut Senegalais de Recherches Agricoles (ISRA)/Centre Nord de Recherches Agricoles (CNRA), Bambey,
- Jean L. Khalfoui, Institut Senegalais de Recherches Agricoles (ISRA)/Centre Nord de Recherches Agricoles (CNRA), Bambey.

The overall goal of TX/BCP was to identify or develop peanut lines and varieties adapted to non-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 the environments of Senegal/West Africa and Texas.

NCS/BCP/TP (funded July 1982) – Peanut varietal improvement for Thailand and the Philippines

Principal Investigator:
- Dr. J.C. Wynne, North Carolina State University, breeder

Cooperators:
- Dr. H.T. Stalker, breeder-cytogeneticist, North Carolina State University,
- Dr. M.K. Beute, plant pathologist, North Carolina State University,
- Dr. W.V. Campbell, entomologist, North Carolina State University,
- Dr. G.H. Elkan, microbiologist, North Carolina State University.

Philippine project coordinator: Dr. Ricardo Lantican, director of the Institute of Plant Breeding (IPB), Los Banos, Philippines

Philippine collaborators:
- Edilberto Redona, breeder,IPB
- Rodante Tabien, breeder, IPB
- Leonila A. Lantican, breeder, IPB
- Dr. Lina Ilag, pathologist, IPB
- Pau, pathologist; Paningbatan, pathologist, IPB

- Dr. Candida Adalla, entomologist, IPB.

Philippine cooperators:

- Dr. Rustico Santos, agronomist, Isabella State University
- Silvino Tejada, agronomist, Cagayan State University
- Delia Concepcion, Bureau of Plant Industry, Tupi Experiment Station

Philippine Country coordinator:

- Dr. Dely P. Gapasin, director of research, PCARRD

Thailand Project Coordinator:

- Dr. Arwooth Nalampang, Thailand Department of Agriculture, agronomist

Thailand collaborators:

- Dr. Vichitr Benjasil, breeder, Department of Agriculture, Bangkok
- Preecha Surin, pathologist, Kasetsart University,
- Dr. Aree Waranyuwat, breeder, Kasetsart University,
- Dr. Tharmmasak Sommartaya, pathologist, Kasetsart University,
- Dr. Orapin Bhumibhamon, microbiologist; Khon Kaen University
- Dr. Aran Patanothai, breeder, Khon Kaen University
- Dr. Orapin Bhumibhamon, microbiologist, Khon Kaen University
- Dr. Sopone Wongkaew, pathologist, Department of Agriculture,Khon Kaen
- Dr. Montien Sompee, agronomist, Somjintana Toomsaen, breeder, Department of Agriculure, Khon Kaen,
- Chalaem Rompruekse, agronomist, Department of Agriculture, Khon Kaen,
- Sopone Kittisin, pathologist, Department of Agriculture, Khon Kaen,
- Vuthisak Boothanu, pathologist, Department of Agriculture, Khon Kaen.

Dr. Ron Gibbons, head of the groundnut improvement program at ICRISAT and member of the Peanut CRSP board of directors served as cooperator for NCS/BCP in both countries. ICRISAT provided technical advice, made germplasm available and assisted in the training of both Thai and Filipino scientists.

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

GA/PV/N (funded July 1982) – Peanut viruses: etiology, epidemiology, and nature of resistance

Principal Investigator:

- Dr. James W. Demski, University of Georgia

Cooperator:

- Dr. Cedric Kuhn, University of Georgia

Nigeria Collaborators:

- Dr. Steve Misari, entomologist, Department of Crop Protection, Ahmadu Bello University, Samaru-Zaria,
- Okon Ansa, virologist, Institute for Agricultural Research, Samaru-Zaria,
- Phindile Olorunju, plant breeder, Department of Crop Protection, Ahmadu Bello University, Samaru-Zaria.

Other cooperators include: Dr. D.V.R. Reddy ICRISAT/India, Dr. Rudolph Casper, Virus Institute, Braunschweig, West Germany, and Dr. Tony Murant, Scottish Crops Research Institute, Dundee, Scotland.

Goal – Virus diseases, in epidemic proportion, are limiting factors in peanut production. The three most destructive viruses infecting peanut worldwide basis are peanut mottle virus (most research in U.S.), groundnut rosette (incidence and research confined to Africa), and bud necrosis (most prevalent in India with ICRISAT research focus). In-depth research focused on groundnut rosette virus, some epidemiological and resistance studies on peanut mottle virus, and the identification of other viruses of peanut that occurred in Africa and the U.S. Therefore, the major goal of this project was to attain a better understanding of the casual agent of rosette and the disease, so that some methods of control can be developed, along with efforts to control the other present and later identified major viruses.

NCS/IM/TP (funded July 1983) – Management of arthropods on peanut in Southeast Asia

Principal Investigator:
- Dr. W.V. Campbell, entomologist, North Carolina State University.

Cooperator:
- Dr. J.C. Wynne, plant breeder, North Carolina State University.

Thailand Collaborators:
- Dr. Manochai Keerati-Kasikorn, entomologist, Khon Kaen University
- Dr. Aran Patanothai plant breeder and cooperator, Khon Kaen University
- Dr. Sathorn Sirisingh, entomologist and collaborator, Department of Agriculture
- Dr. Pisit Sepsawardi, entomologist and cooperator, Department of Agriculture.

Thailand Project Coordinator:
- Dr. Arwooth Nalampang, Department of Agriculture

Philippines Collaborators:
- Dr. Eliseo Cadapan, entomologist and collaborator, University of the Philippines at Los Banos;
- Dr. Fernando Sanchez, entomologist and cooperator, National Crop Protection Center;
- Dr. Candida Adalla, entomologist and cooperator, Institute of Plant Breeding.

Philippine Country Coordinator:
- Dr. Dely Gapasin, director of research, PCARRD, Los Banos

The goal of NCS/IM was 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.

GA/IM/BF (funded July 1983) – IPM strategies for peanut insects in SAT Africa

Principal Investigator:
- Dr. Robert E. Lynch,, entomologist, University of Georgia/USDA, Tifton;

Collaborator:
- Dr. Albert Patouin Ouedrago, entomologist, University of Ouagadougou, Burkina Faso.

The GA/IM/BF goal was the identification of the major economic pests of peanut and their relationship with aflatoxin contamination, develop economic thresholds for these pests, and develop integrated pest management (IPM) strategies and control measures to reduce losses to these pests. The development of IPM strategies to control these insects within the socioeconomic framework of the host country will reduce this direct threat to peanut production stability.

NCS-TX/SM/TP (funded July 1983) – Influence of Rhizobia and Mycorrhizae on nitrogen fixation and growth of peanuts in Thailand and the Philippines. A. *Rhizobium* Considerations

Principal Investigator:
- Dr. G.H. Elkan, microbiologist, North Carolina State University.

Co-principal investigators:

- Dr. T.J. Schneeweis, microbiologist, North Carolina State University
- Dr. Ruth Ann Taber, Mycorrhizae specialist, Texas A&M University

Cooperator: J.C. Wynne, breeder and, North Carolina State University.

Philippine Collaborator:
- Dr. Erlinda Paterno, Institute of Biotechnology (*Rhizobium*); University of the Philippines at Los Banos

Philippine Cooperators:
- Dr. Lina Ilag, Institute of Plant Breeding (Mycorrhizae), University of the Philippines at Los Banos
- Edilberto Redona, University of the Philippines at Los Banos
- Dr. Remedios Abilay (breeding for high biological nitrogen fixation), University of the Philippines at Los Banos

Philippine Country Coordinator:
- Dr. Dely Gapasin, director of research, PCARRD.

Thailand Collaborator:
- Yenchai Vasuvat, (*Rhizobium*), Department of Agriculture, Bangkok

Thailand Cooperators:
- Dr. Nantakorn Boonkerd, (*Rhizobium*), Department of Agriculture, Bangkok.
- Preecha Vadeesirisak (*Rhizobium*), Department of Agriculture, Bangkok.
- Dr. Omsub Nopamornbodi (Mycorrhizae), Department of Agriculture, Bangkok.
- Dr. Orapin Bhumibhamon, microbiologist, Kasetsart University.
- Dr. Banyong Toomsan (*Rhizobium*), Khon Kaen University.
- Dr. Aran Patanothai (plant breeding), Khon Kaen University.

Cameroon Cooperator:
- Timothy Schilling, Institute of Agronomic Research.

The major goal was to improve the efficiency of symbiotic nitrogen fixation by rhizobium bacteria associated with peanuts, therefore an improvement of peanut yields. Secondarily, the improvement of nitrogen fixation by peanuts grown in rotation with non-legume crops can provide a source of nitrogen in the rotation. Optimization of biological nitrogen fixation is of considerable importance to the entire food and feed production program of these countries.

NCS-TX/SM/TP (funded July 1983) – Influence of Rhizobia and Mycorrhizae on nitrogen fixation and growth of peanuts in Thailand and the Philippines. B. Mycorrhizae considerations

Principal Investigator:
- Dr. Ruth Ann Taber, Mycorrhizae specialist, Texas A&M University.

Cooperators:
- Dr. Robert E. Pettit, plant pathologist, Texas A&M University
- Billy L. Jones, Shelby Newman, Texas A&M University
- Kenneth E. Woodward, Texas A&M University
- Dr. Gerald H. Elkan, microbiologist, North Carolina State University
- Dr. Thomas Schneeweis, North Carolina State University

Thailand Collaborator:
- Dr. Omsub Nopamornbodi, microbiologist, Department of Agriculture, Bangkok;

Thailand Cooperators:
- Dr. Arwooth Nalampang, agronomist, Department of Agriculture, Bangkok
- Yenchai Vasuvat, microbiologist, Department of Agriculture, Bangkok

- Dr. Nantakorn Boonkerd, microbiologist, Department of Agriculture, Bangkok:
- Dr. Banyong Toomson, microbiologist, Khon Kaen University
- Dr. Aran Patanothai, agronomistKhon Kaen University.

PhilippineCollaborators:
- Dr. Lina Ilag, University of the Philippines, Los Banos
- Dr. Erlinda Paterno, microbiologists, University of the Philippines, Los Banos

Philippine Cooperators:
- Dr. Ricardo Lantican, breeder, Institute of Plant Breeding
- Dr. Edilberto Redona, breeders, Institute of Plant Breeding.

Philippine Country Coordinator:
- Dr. Dely Gapasin, Director of Research, PCARRD.

The goal of the project was to increase yield/unit area through manipulation of mycorrhizal fungi in peanut roots (which serve to increase the size and efficiency of the root system) and to bring into production acreages presently idle because of lack of sufficient water, high salts in the soils, or flooding conditions.

Processor values

AAM/FT/S (funded July 1982) – An Interdisciplinary Approach to Optimum Food Utility of Peanut in SAT Africa.

Principal Investigator:
- Dr. Bharat Singh, and food scientist, Alabama A&M University

Cooperators:
- Dr. John C. Anderson, food scientist, Alabama A&M University,
- Dr. Virginia Caples, home economist, Alabama A&M University,
- Dr. H. Jones, economist, Alabama A&M University,
- Dr. R. Rao, nutritionist, Alabama A&M University,
- Dr. G.C. Wheelock, rural sociologist, Alabama A&M University.

Sudan Country Coordinator:
- Dr. H.M. Ishag, national coordinator, groundnut research.

Sudan Collaboration Team in Food Research Centre, Khartoum, include:
- Dr. B. Basir, deputy principal investigator,
- Dr. A.B. Amadi, plant breeder,
- Dr. S.M. Badi, cereal chemis,
- Dr. A.S. Khalid, microbiologist,
- Dr. B. I. Magboul, nutritionist,
- Dr. A.G. Tayeb, chemist,
- A.B. Zakari, rural economist,
- Dr. Asha El Karib, economist.

The general goal of the project was to foster interdisciplinary (nutrition, food science, social and economic) institutional-based linkages between U.S. and LDC scientists serving major peanut producing and consuming populations of the Sahel region of Africa for the purpose of optimizing the food utility of peanut. The specific goals of the project were consistent with the general goal of the Peanut CRSP to develop collaborative research and development programs on peanut between social scientists and food scientists at Alabama A&M University and the Agricultural Research Corporation in the Sudan.

GA/FT/TP (funded July 1983) – Appropriate Technology for Storage/Utilization of Peanut.

Principal Investigator:
- Dr. Tommy Nakayama, food scientist, University of Georgia.

Cooperators:
- Dr. L.R. Beuchat, food scientist, University of Georgia
- Josephine Miller, food scientist, University of Georgia
- Dr. Robert Rauniker, economist, University of Georgia
- Dr. R.E. Worthington, food scientist, University of Georgia
- Dr. Anna Resurreccion, food scientist, University of Georgia
- Dr. Robert Brackett, food microbiologist, University of Georgia
- Dr. D.M. Wilson, plant pathologist/aflatoxins, University of Georgia
- W.O. Slay, pathologist, USDA (located at University of Georgia, Tifton)

Thailand Collaborator:
- Dr. Chintana Oupadissakoon, food scientist, principal investigator, Kasetsart University, Bangkok

Thailand Cooperators:
- D. Buangsuwon, pathologist, Kasetsart University, Bangkok
- V. Devapalin, chemist, Kasetsart University, Bangkok
- Vichai Haruthaithanasan, food scientist, Kasetsart University, Bangkok
- Dr. S. Tongpan, economist, Kasetsart University, Bangkok.

Philippine Collaborator:
- Dr. Elias E. Escueta, principal investigator and food technologist, University of the Philippines at Los Banos

Philippine Cooperators:
- Prof. Lilia Madamba, food chemist, University of the Philippines at Los Banos
- C. Intong, food scientist, University of the Philippines at Los Banos
- Robert Mabesa, food microbiologist, University of the Philippines at Los Banos
- L. Madamba, food chemist, University of the Philippines at Los Banos
- Roberto Reyes, food engineer, University of the Philippines at Los Banos.

Philippine Country Coordinator:
- Dr. Dely P. Gapasin, director of research, PCARRD, Los Banos.

The ultimate goal of the project was to enhance the capabilities of research institutions in the developing countries patterned by the successes of the land-grant institutions in the U.S. In the case of this project, it was done through training afforded by collaborative programs in developing the storage and utilization of peanut.

AAM/FL/FT/CARDI (funded July 1983) – Peanut utilization in food systems in developing countries.

Principal Investigator (1983-1984), then cooperator:
- Dr. Onuma Okezie, food scientist and, Alabama A&M University.

Co-Principal Investigator:
- Dr. E.M. Ahmed, University of Florida

Cooperators at Alabama A&M University
- Dr. Bharat Singh, food scientist and cooperator then principal investigator (1984-1985)
- Dr. John C. Anderson, cooperator and food scientist
- Dr. G.C. Wheelock, cooperator and economist
- Dr. H.S. Jones, rural economist
- Dr. Virginia Caples, home economist

Cooperators at the University of Florida

- Dr. H.S. Sistren, nutritionist
- Dr. R. Schmidt, food scientist
- Dr. J.F. Gregory, food scientist
- Dr. Chang I. Wei, food toxicologist

CARDI Co-Collaborators:

- Dr. Sam Parasram, executive director
- Dr. St. Clair Forde, director of research and development, Trinidad, coordinator
- Dr. Don Walmsley, agronomist, Trinidad
- Horace Payne, agronomist, Jamaica
- Dr. Laxman Singh, agronomist, Antigua
- Dr. B. Rai, agronomist, Belize
- Dr. Althea Townsend, food scientist, food technology Institute, Jamaica
- Doreen Lewis, food scientist, food technology Institute, Jamaica
- Frances Brown, food scientist, food technology Institute, Jamaica

University of the West Indies Co-Collaborator:

- Dr. George Sammy, food scientist, St. Augustine Campus, Trinidad.

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

C. Consumer values

TX/MM/S (funded July 1982) – Mycotoxin Management in Peanut by Prevention of Contamination and Monitoring.

Principal Investigator:

- Dr. Robert Pettit, Texas A&M University,

Cooperators:

- Ruth Ann Taber, mycologist, Texas A&M University
- James P. Stack, pathologist, Texas A&M University
- Dr. Timothy Phillips, Department of Veterinary Public Health, mycotoxicologist, Texas A&M University
- Eric Shepherd, Department of Veterinary Public Health, mycotoxicologist, Texas A&M University
- Randall Geiger, electrical engineer, Texas A&M University.

Senegal Collaborators:

- Amadou Kane, mycotoxins, Institut de Technologie Alimentaire (ITA)/Dakar
- Bashir Sarr, mycotoxins, ITA/Dakar, Senegal

Senegal Cooperators:

- Dr. Amadou Ba, physiologist, ISRA/Kaolak
- Dr. Aly N'Diaye, physiologist, CNRA/Bambey
- Jean Claude Mortreuil, breeder, CNRA/Bambey

The goals of the Peanut CRSP mycotoxin research project were to enhance mycotoxin management within the LDC's and the U.S. 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.

Information/Training/Impacts

The Information/Training/Impacts sector will report activities such as Newsletters, Workshops, Short-term training visits, and impact surveys.

CHAPTER 10. ACCOMPLISHMENTS AND IMPACTS 1982-1985 GRANT

The U.S. scientists were able to visit host country collaborators on planning grant funds in early 1982, and plan for first year (1982-1983) activities. The grant was funded in August 1982, and advances made to U.S. universities. Some of the agreements were completed at the onset of the research, but part of the work began by host country collaborators on good faith, with fund reimbursements after MOU's were completed in 1983. Although the areas of work were not divided into the producer values, processor values, consumer values, and information/training/impacts sectors until later years, the accomplishments and impacts will be divided among these areas from the beginning years to enable or ease the following of progress in particular areas through the CRSP history.

Accomplishments 1982-1985

A. Producer values

GA/INPEP/BF/N/CAR.
From 1982-1985, GA/INPEP distributed and began the testing of some 200 lines and varieties in Niger, Cameroon, Burkina Faso, Antigua, Belize, and Jamaica. This effort greatly increased the germplasm base for variety improvement in these countries. Early observations in Burkina Faso indicated differences in Cecospora leaf spot and earliness of maturity in the introduced germplasm. Also, early observations in the Caribbean showed different disease and soil nutrient responses.

TX/BCP/S.
The breeding project (TX/BCP) in Senegal received 115 lines in 1982 and began initial seed increase, screening, and testing of the germplasm. Also, eight Texas breeding lines that had been selected for leaf spot disease (a major peanut disease worldwide) resistance yielded above the mean of six local checks, but equal to the local checks in disease resistance. Eight Senegalese varieties were tested in Texas for yield and disease resistance. Replicated tests in Senegal to evaluate leaf spot and pod rot (resistance decreases aflatoxin contamination of seed) resistance of Texas germplasm found lines with reasonable adaptation. Development of breeding populations in Senegal continued. A survey of the important peanut production constraints was made in all major peanut production areas of Senegal during September, 1984. Drought was the predominant constraint, but early leaf spot, pod rot, aphids, and millipedes were serious problems in some areas. Rust, and clump, spotted-wilt, and peanut mottle viruses were observed.

NCS/BCP/TP
The breeding project for Thailand and the Philippines (NCS/BCP) introduced more than 2000 peanut lines into Thailand in 1982 with seed increase beginning that year, although funding from the CRSP was not received in Thailand until 1983. After the Peanut CRSP planning grant visit to Thailand in late 1980, a coordinated Thai peanut research program was developed in anticipation of the CRSP, which provided coordination between the Department of Agriculture, Khon Kaen University, and Kasetsart University and promised a more rapid advance in peanut research. Disease resistance trials beginning in 1982 were positive in identifying superior lines, with Tainan 9 a notable line for leaf spot and rust resistance.

In the Philippines, a new peanut breeder, Edilberto Redona, (with a 1983 training visit to NCSU planned) was employed by the Institute of Plant Breeding to work with the CRSP. Fifty new disease and insect resistant lines were introduced. Philippine variety improvement activities increased with the 1982 season, and UPL Pn-4 was a promising new peanut line. Overall, Thailand and Philippines received some 250 lines each.

In North Carolina two cultivars were released. The first cultivar was NC 8C, which was a cross between NC Ac 03139 and Florigiant made in 1966 and released in 1982. It was grown from 1982-1988 with a production maximum of 6,100 acres and average of 3,000. The second cultivar was NC 9, which was a cross between NC 2 and Florigiant made in 1966 and released in 1985. It was grown from 1987-2001 with a production maximum of 24,900 acres and average of 15,400.

GA/PV/N

Early work in Nigeria by GA/PV established a procedure to mechanically transmit the rosette virus to peanut plants to enhance the research process. Field contamination of the rosette into peanut plants by aphids was observed, and the virus disease infection in peanut was transmitted by two causal agents. It was confirmed that two agents are necessary for rosette virus infection; a luteovirus for aphid transmission of rosette, and a symptom inducing agent associated with the infectious nucleic acid. Infection is probably controlled by the presence or absence of a cell coat-protein allowing penetration of the infection into the cell.

In the U.S. under GA/PV/N, a new virus, which naturally infects peanut, was isolated, a potyvirus, but not related to peanut mottle virus endemic in peanut in many parts of the world. It is seed transmitted and early research in the green house showed a 20% yield loss. The virus was associated with foundation seed that had been received from China and was detected in plantings in two states. Twelve commonly grown U.S. cultivars were fully susceptible. An ELISA (later replaced with a dot-blot test that was more sensitive and reliable) based seed test was developed, and used to test over 20,000 seed planted in spring of 1985. The results indicate that most infected seed were eliminated by the seed test, but a few contaminated seed were not detected that resulted in a primary source of virus that can be disseminated to other healthy plants. Thus, efforts have been successful in eliminating the virus that was named Peanut Stripe Virus (PStV).

NCS/IM/TP

In Thailand field trials were established under NCS/IM/TP. One soil insect and ten above ground insects were identified as pests of peanut. Leaf miner was the most prevalent above ground insect and was suppressed by insecticides. A coconut bait and insect trap proved best for subterranean ant control monitoring and control.

In the Philippines, ten major insects and two fungal pathogens of insects were identified. *Spodoptera litura,* a major defoliator of peanut should be controlled early to prevent major defoliation. Suppression of the insect complex was demonstrated with microbial and standard insecticides. The germplasm line, NCAc 343 was identified in the resistant group early in the program, and was valuable in many improved varieties in future breeding efforts.

In North Carolina an integrated pest management (IPM) research program was initiated that would integrate crop management practices (seeding date and rate, etc.), and cultivar improvement (identify and use insect resistant cultivars) with a goal of minimizing the use of chemical pesticides. Insect thresholds were being established to guide IPM research. A large collection of international germplasm and breeding lines with pest resistance potential were evaluated for resistance to the insect complex. A number of entries with multiple pest resistance were identified, which will be valuable to U.S. and host country research and development.

GA/IM/BF

In Burkina Faso, field research was initiated in the summer season of 1984. Three major objectives were addressed and implemented: 1) Survey the arthropods associated with peanut production throughout the major peanut growing areas of Burkina Faso and determine their relative abundance in relation to plant phenology; 2) determine the influence of different seed-bed preparations on arthropod damage to peanut; and 3) evaluate U.S. and local germplasm for susceptibility to insects. During three survey trips, ten orders of arthropods were collected on peanut for identification. Four groups of insects were classified as of potential 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 as soils began to dry after the end of the rainy season.

NCS-TX/SM/TP

The project was not officially implemented until the second year, 1983-1984. Preliminary work began with some field, laboratory and training activities in 1982-1983. A two-week long nitrogen fixation course was held for 20 Thai technicians to provide more support for the CRSP program and to 30 extension agents to demonstrate the value of BNF to farmers, and then presented to 24 researchers and extension agents in the Philippines (for research support and to demonstrate the value of BNF to farmers). A cooperative effort was begun in the Cameroon, with limited CRSP funds. Twelve promising strains of *Rhizobium* from tropically grown peanuts were selected from the North Carolina State University collection and sent to Thailand and the Philippines for field testing and further development. Environmental stress factors considered in the field testing included soil acidity, flooding (paddy rice rotation), shading, soil type, etc. Also, some peanut cultivars that showed higher BNF capacity were sent to both countries. Cooperative efforts with Dr. Ruth Ann Taber at TAMU were conducted to determine the interaction of mycorrhizae and rhizobium on BNF in peanut.

NCS-TX/SM/TP.
Research in the Philippines and Thailand showed that there was a difference in peanut varietal response to mycorrhizae inoculation, and some mycorrhizal fungi produced higher plant and seed yields. Preliminary results in Thailand showed that inoculation with a mycorrhizal fungus may enhance rhizobial nodulation. Early results suggested that mycorrhizal inoculation may improve production on high saline conditions and also improve water uptake by plants.

B. Processor values

AAM/FT/S
The project in collaboration with Sudan was initiated in July 1982. During the first year, two survey instruments were developed for Sudan, one for consumption and food utility aspects of peanut and the other dealing with post-harvest technology of peanut. Urban and rural populations were surveyed in January 1984. Arrangements were made for an aflatoxin laboratory to be developed in the Food Research Centre in the fall of 1983.

The surveys revealed that peanut were widely used in Sudan, and more in the rural areas. Common products were roasted peanut in-shell, shelled peanut roasted by covering with ash, and peanut paste in various food preparations. The survey showed that much improvement was needed in post-harvest and storage methods. Peanut samples from rural areas showed aflatoxin levels were usually less than 20 ppb. Cost of peanut reduced amounts consumed in urban areas, with a more consistent level used by farmers and rural villagers. Research was initiated to improve the quality and consistency of peanut paste and to improve marketing of that product (grinding, packaging, marketing improvements) and the processing and marketing of the commonly used roasted peanut. Small roasters, variety in taste through spices, and packaging technologies were needed by the small entrepreneurs selling roasted peanuts. Other priorities identified were new food products, incorporation of peanut flour into existing foods, socioeconomic impacts, and assessing and improving the role of women in post harvest activities, and areas of prime involvement by women.

GA/FT/T
In the Philippines and Thailand work on the elimination of aflatoxin began with an initial survey of products indicating that mycotoxin was indeed a problem and preliminary results from laboratory manufactured products have shown that careful visual inspection can eliminate aflatoxin-contaminated seed. These observations led to the development of a method to hand sort visually damaged and aflatoxin contaminated peanuts from a lot of peanuts that improved their processing value and provided more health benefits for consumers. The seed were heated to remove the skins, and then steam heated for two minutes to enhance the brown color that indicated aflatoxin contamination. Peanuts carefully sorted in Los Banos and peanut butter samples prepared in Thailand from hand-sorted peanuts have shown greatly reduced aflatoxin levels.

Household surveys in Thailand showed 15% of the households consume peanut regularly and mostly as raw, boiled, or roasted peanut and in candies. Peanut was considered to be healthy, nutritious, inexpensive, and clean, which indicated opportunities for research and development in peanut utilization. Product development began in Thailand with tofu and yogurt like products. Storage tests in the Philippines showed peanuts stored in plastic bags with CO2 and under refrigeration gave the longest shelf-life.

AAM/FL/FT/CAR
Peanut consumption and post-harvest handling surveys were conducted in Trinidad (urban), St. Vincent (urban and rural) and Jamaica (urban and rural) and completed in May 1984. Eighty percent of the households reported use of roasted peanuts, and about half the households used peanut butter or candy products. Cost was the major reason for not using more peanut. The production surveys showed labor intensity the major reason for high costs. The post-harvest surveys showed small storage losses on farm since the peanuts were marketed soon after harvest. Some 15% was lost in home storage for seed or food uses, indicating research in this area might be helpful. Field samples of peanut had generally low levels of aflatoxin.

C. Consumer values

TX/MM/S

The mycotoxin project, Mycotoxin Management in Peanut by Prevention of Contamination and Monitoring (TX/MM), was initiated in 1982 with Senegalese plans completed in early 84 (MOU signed in March 1984.

The Peanut CRSP had a goal of seeking ways to harvest, store, and process peanut in ways to supply adequate quantities of safe and acceptable products to consumers. A major objective in this goal was to minimize and detoxify aflatoxin, a highly carcinogenic metabolic product of *Aspergillus flavus,* in food products. *A. flavus* is a ubiquitous fungus that produces aflatoxin and infests peanut and other feed and food products such as rice, maize, and coconut products from the field to storage. There are costs attached to aflatoxin, such as health implications, and decreased value of the produce and products. Aflatoxin has been a major concern for the Peanut CRSP since its inception.

Aflatoxin was determined in kernels and shells from a large pile of commercial peanut stored in the open near Bambey and in shells of seed stored in the laboratory as a beginning of understanding the aflatoxin problem. These were collected in a January 1982 planning trip. Analysis showed a range of toxin producing fungi present, with particularly significant presence of *Aspergillus flavus* and *Aspergillus parasiticus* that are of concern on peanuts.

Field samples from Senegal revealed significant *A. flavus* contamination in immature pods, mature pods and seed in storage. Insect damage to pods may have been major cause of field and storage infestation of *A. flavus*. Samples from 22 areas of Senegal showed *A. flavus* infested from 39-63% of pods and 7-25% of seed. Windrow drying of harvested plants in Senegal lowered aflatoxin levels in seed.

In surveying various inert agents during 1982-83, it was found that a specific type of processed earth (PE) bound aflatoxins tightly. This characteristic was utilized in the development of an improved mini-column method of aflatoxin detection. The column sensitivity was found to be 5 ppb in aflatoxin spiked oil samples. The tight binding of aflatoxin to PE suggested that this sorbent could be used to remove aflatoxin from contaminated raw peanut oil in a village setting. In the PE work, the bentonite clays were determined to be highly effective in removing aflatoxins B1, B2, G1, and G2 from raw peanut oil. From 90 to 94 % of the aflatoxin were bound to the clay in 60 minutes. Bentonite clays continued to be superior in aflatoxin binding compared to other clays in 1984 studies, attapulgite 75 % and kaolinite 32 %. Attapulgite, a clay common in Senegal, bound up to 75% of the aflatoxin present in oil samples, while kaolins and zeolites were less effective in binding aflatoxins. Based on these results a simple and inexpensive method for detoxification of raw peanut oil was developed for use in Senegalese villages. The training visit of Bashir Sarr to TAMU in October 1984 with Dr. Tim Phillips helped focus this work on developing country needs,

During the early project period (1982-83), preliminary work was completed on a new HPLC procedure for the rapid analysis of aflatoxins in peanut products. This method involves the use of new state of the art HPLC columns coupled with a novel method of extraction. A new procedure for the fast sample preparation of contaminated peanut products has been developed. An improved mini-column method for rapid detection of aflatoxin was scaled down to a micro-column method. The new column employed a bentonite-type processed clay and promised a low-cost procedure adaptable to developing country needs.

In 1984, 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.

Two samples out of 40 food samples taken had excessively high levels of aflatoxin.

Extensive studies have been done in Senegal determine what aflatoxin/mycotoxin fungi are present both in the field and in storage. This will guide future research as control measures are sought.

D. Information/Training/Impacts

Information

The International Arachis Newsletter (IAN) was planned and published in cooperation with ICRISAT beginning in 1983. In the completed planning grant plan, there was a provision that the Peanut CRSP would develop a publication for short notes on current world peanut research available to any scientist. Interaction and discussion with ICRISAT staff led to a jointly developed and funded newsletter to be published by the ICRISAT/India institution. IAN did not miss an issue from 1983-2010, and became the leading non-journal international peanut research publication.

The national peanut program was developed in Thailand in response to the planning grant visit in 1980. It was organized under the leadership of Arwooth Nalampang, Department of Agriculture, Bangkok in time for the U.S. principal investigator visit in early 1982 to meet collaborators and finalize project plans the 1982 research grant. The program provided a forum for communication and cooperation on peanut research and development themes among the Department of Agriculture and the universities. Exchanges are made in such venues as planning meetings, workshops, and written correspondence.

The First National Peanut Consultation and Peanut CRSP Review held at PCARRD on Feb. 7-8, 1985. This was the result of a PCARRD led effort to better integrate the Philippine peanut research and development program influenced by the Peanut CRSP beginning in 1982. The scientists took initiative to review the overall peanut research and how it was complemented by the CRSP. Program modifications and additions were suggested. Periodically over the years a similar meeting was held.

A Workshop on the "Agrometeorology of Groundnut Production in the Semi-Arid Tropics" was held ICRISAT/Niamey in August 1985. ICRISAT, Peanut CRSP, and the World Meteorological Organization cosponsored the Workshop.

Training

A number of host country, non-host country, and U.S. students were trained for M.S. and Ph.D. degrees. These will be listed in a summary of all students from 1982-2012, since the beginning and ending dates of many of these students cross over program phases. The numbers and country and regional representation of non-U.S. students and the number of U.S. students show the high focus on human capacity development in the Peanut CRSP. A number of students were supported in programs in their own countries. Both the foreign and U.S. students did research for theses and dissertations that benefited both the U.S. and the home countries of the students.

A Thai graduate student is studying at NCSU along with two U.S. students funded by the NCS/IM/TP project. Under GA/IM/BF, J. Arsene Solibo Some will complete his M.S. in Entomology at UGA and return to Burkina Faso as a project cooperator in April 1985, and Idrissa Ousmane Dicko visited the U.S. for training in summer of 1984. Two students from Sudan enrolled for M.S. degrees at AAMU under AAM/FT/S will complete degrees in June 1987 and return to FRC. Under AAM/FL/FT/CAR, Hossana Solomon completed an M.S. in socioeconomics in summer of 1985, and E. Miller began an M.S. in the fall of 1985 (post-harvest handling and storage).

Short-term Training. Key to research was short-term training of host country collaborators. Some did not have interest/confidence in language skills and academic background to opt for degree training, but were important to program and long-term contributions in their country, while some had advanced degree training. Participating host country scientists benefited from short-term training visits to the U.S. as well as in long-term contacts with U.S. scientists. Some of these will be listed. Under TX/MM/S Dr. Amadou Ba spent time at TAMU with Drs. Taber and Stack in May 1985.

Impacts

Significant impacts or accomplishments in the 1982-1985 phase were summarized in the value chain sectors, which were developed later, for ease of following them across all future years of the CRSP.

A. Producer values

Genetic Resources Improved – During this phase, the Peanut CRSP assessed the world collection of peanut germplasm and used it to develop, through conventional and advanced biotechnological techniques, genetic lines with superior attributes. These superior lines were used in efforts to develop and release new varieties/cultivars. This germplasm infusion in the host countries became the basis for the development of higher yielding, disease and pest resistant and higher quality varieties in future years.

Cultivar Development – In North Carolina two cultivars were released. The first one, NC 8C, was a cross between NC Ac 03139 and Florigiant made in 1966 and released in 1982. It was grown from 1982-1988 with a production maximum of 6,100 acres and an average of 3,000. The second, NC 9, was a cross between NC 2 and Florigiant made in 1966 and released in 1985. It was grown from 1987-2001 with a production maximum of 24,900 acres and average of 15,400.

Integrated Pest Management Introduced – Peanut CRSP researchers began studying insect life cycles, alternate plant hosts, time of appearance of insects on the crop, insect population levels, and subsequent damage to the plant. Research included genetic control through resistant cultivars, cultural control, biological control (fungal, bacterial, and parasitic insects), and naturally occurring chemicals. Such knowledge provided the basis for IPM recommendations and programs that contribute to lower use of chemicals. IPM research has established thresholds for economic damage from insects to minimize the use of chemical pest control. These contributions were noted in the Philippines, Thailand, Burkina Faso and the United States.

Peanut Stripe Virus – Intensive laboratory research that began in Georgia in 1982 identified and thwarted the spread of a potential virus that was named peanut stripe virus, and resulted in elimination of extensive yield losses (initially estimated at 20%). Restrictions on the interstate sale of peanut seed were relieved and annual seed sales were estimated to be increased by $100,000.

Peanut rosette virus – Rosette virus has long been a major problem in peanut production across Africa, with periodic epidemic that result in near 100% field losses. Generally, the resistance to rosette virus does not appear due to vector/aphid resistance. After rosette transmission by aphids, the luteo component of the virus may show up without virus symptoms, without the luteo component virus symptoms may appear, and peanut plants may have both virus symptoms and luteo virus. Determination of the infection mode was a major effort in research between the University of Georgia and Nigeria, which could lead to the development of resistance in peanuts. There was a tentative identification of two viral agents that may be responsible for transmitting and inducing symptoms of the rosette virus.

Rhizobia bacteria and Mycorrhiza fungi – *Rhizobium* bacteria are responsible for nitrogen fixation in legumes, and mycorrhiza fungi may extend root systems for uptake functions. Base line testing was being done in Thailand and the Philippines on the type of bacteria and fungi present and the effect on plant growth.

B. Processor values

The Peanut CRSP goal in processor values was to harvest, store, and process peanut in ways that will supply adequate quantities of safe and acceptable products to consumers. Primary objectives are to increase awareness of the high energy and protein value of peanut; and to increase the use of peanut in traditional foods; and to develop new products that are culturally acceptable.

Food consumption surveys in Africa, Southeast Asia and the Caribbean helped determine the dietary habits and food needs of people in the individual countries and the acceptability of peanut as a food product. This information was used to guide food processing research and the design of new products.

Early in the program, several potentially useful new products were identified. In Sudan, "kisra" (thin bread) was enriched with peanut flour. In the Philippines, a peanut-based, cheese-flavored spread was accepted by consumers. In Thailand, peanut flour-enriched wheat noodles were highly acceptable to consumers.

Surveys in the Caribbean showed that roasted peanuts, peanut butter and raw peanuts were the most common use. Improvements were needed in uniform roasting and packaging of roasted peanuts, more uniform grinding, emulsifying the oil, and better packaging in peanut butter.

C. Consumer values

Extensive studies have been done in Senegal with cooperative with Texas A&M University to determine what aflatoxin/mycotoxin fungi are present both in the field and in storage. This will guide future research as control measures are sought.

Bentonite type clays have been shown to be very effective in removing aflatoxins B1, B2, G1 and G2 from raw peanut oil. From 90-94% of the aflatoxins present are bound to the clay in less than 60 minutes. Based on these earlier results and work in the laboratory of Dr. Tim Phillips (Texas) a simple and inexpensive method for detoxification of raw peanut oil was developed for use in Senegalese villages. Further laboratory research in Texas showed enhanced sorption of aflatoxin using a refined Na/Ca alumino-silicate. Also, a clay common to Senegal, attapulgite, was shown to bind up to 75% of the aflatoxin present in oil samples. Kaolins and zeolites were less effective. The training visit of Bashir Sarr to TAMU in October 1984 with Dr. Tim Phillips helped focus this work on developing country needs,

An improved mini-column method for rapid detection of aflatoxin was scaled down to a micro-column method. The new column employed a bentonite-type processed clay and promises a low-cost procedure adaptable to developing country needs.

In Burkina Faso, it was found that termite damage to pods prior to harvest increased *Aspergillus flavus* entry and aflatoxin accumulation in the seed. Timely harvest would be important, but there was a labor tradeoff in timely peanut harvest for the harvest of food grain crops such as sorghum and millet. (Work done in Insect Management project).

A new peanut line with partial resistance to aflatoxin accumulation in the seed was scheduled for release in Texas. This can result in 15% lower aflatoxin levels and possible annual gross returns in the United States of $ 1 million, with potential sharing of the germplasm with collaborators in West Africa. (Work done in Peanut Breeding project).

Cooperative research with the University of Georgia, the Philippines, and Thailand developed a method to hand sort visually damaged and aflatoxin contaminated peanuts from a lot of peanuts that improved their processing value and provided more health benefits for consumers. The seed were heated to remove the skins, and then steam heated for two minutes to enhance the brown color that indicated aflatoxin contamination. (Work done in Food Processing project).

D. Information/Training/Impacts

Information – The *Arachis International Newsletter* was first published in 1983 in cooperation with ICRISAT, as proposed in the planning grant.

The National Peanut Program was developed in Thailand in response to the planning grant visit in 1980, which has improved the coordination of Thai peanut research and Peanut CRSP cooperation.

The First National Peanut Consultation and Peanut CRSP Review held at PCARRD on Feb. 7-8, 1985. This was the result of a PCARRD led effort to better integrate the Philippine peanut research and development program influenced by the Peanut CRSP beginning in 1982.

A Workshop on the “Agrometeorology of Groundnut Production in the Semi-Arid Tropics” was held ICRISAT/Niamey in August 1985. ICRISAT, Peanut CRSP, and the World Meteorological Organization cosponsored the Workshop.

Training

Eleven host country students began M.S. and Ph.D. programs in U.S. universities. Host country scientists were trained through visits to the U.S. and through U.S. scientists visits to the host countries. Details of the trainees in relation to name, country, degree, dates of beginning and ending will be given in a later chapter; all trainees across years/phases.

Baseline Assessments (for determining later impacts)

Although, the 1982-1985 phase of the Peanut CRSP did not have high focus on impact assessment, it was recognized early that research should focus on the needs of the end-users. Some baseline studies in cropping practices and food consumption patterns were conducted that helped guide the research..

Integrated pest management programs – Research began in Southeast Asia and Africa to determine the presence and importance of various insects and diseases that formed the basis of future efforts.

Production survey – In the Philippines and Thailand, a production survey helped determine the direction of research to relieve present constraints.

Soil resource analyses – In Burkina Faso and Thailand, soil resource analyses of research sites assisted in transfer of information to production areas.

Food consumption surveys – In the Caribbean, the Philippines, Sudan and Thailand, food consumption surveys assisted in development and improvement of food products directed to fit local tastes, consumption patterns, and expressed needs for new processes or products.

Socioeconomic study – In West Africa, a socioeconomic study identified constraints to production and use of peanut.

A peanut line selected in tests in the Phillipines resistant to insects has made great impact in several world regions, including the U.S., in the development of resistant varieties and improved IPM systems.

Chapter 11. External Evaluation Panel report for 1982-1985 grant

An External Evaluation Panel (EEP) is an integral part of all CRSPs as defined in the guidelines developed by BIFAD/USAID. The external evaluation by the EEP is most important to the CRSP operations to assure objectivity in decision making on important and sometimes difficult institutional issues. It was explicit in the 1982 grant document that an external evaluation panel review be done at the end of two years, which had positive and long-term effects on the program, and provided guidance to define any needed program adjustments early in the time-frame. Because of the importance of this early review in long-term effects on the Peanut CRSP, it will be discussed in considerable detail.

Consistent with the criteria, the Peanut CRSP document for the 1982-1985 grant established an EEP consisting of three to five eminent scientists recommended by the CRSP management entity to USAID/ BIFAD for specific terms of appointment. Periodically as appropriate and mandated the EEP was to 1) review projects and programs of the CRSP and provide written evaluation, and 2) make recommendations for the addition, elimination, or modification of component projects and overall objectives; to include retention, elimination or addition of new overseas sites.

The new set of guidelines for the CRSPs was circulated by BIFAD/USAID on June 21, 1985 that further defined the EEP roles. These guidelines had been under development for some time, and some of the bases were incorporated into the Peanut CRSP review, when the EEP had their first activity in July 1984. The 1985 guidelines gave the following principles for an evaluation.

- Maintain programmatic focus and effective scientific balance of research toward achievement of objectives.
- Identify inadequate performances, and identify activities irrelevant or marginal to CRSP objectives.
- Consider effective balance between research and training for development of institutional research capacity.
- Assess the balance of domestic versus overseas research in terms of effectiveness to resolve constraints in developing countries.
- Evaluate the cost-effectiveness of the entire CRSP operation in terms of actual cost of doing business versus costs of alternatives that may require less funding, or may otherwise be more efficient or more effective.
- Examine ways of dissemination of research results, and the effectiveness of utilization, a measure of the appropriateness of the research.
- Report its findings and recommendations annually to the ME, the board, USAID and JCARD/BIFAD.

Some evaluation needs to be made at least annually, although components of an evaluation may be on-going throughout the year. In-depth evaluations with overseas and U.S. site visits should be made within the triennial period in preparation for the Triennial Review.

EEP Members (1982-1985)

A slate of nominees for the Peanut CRSP was proposed by the principal investigators, technical committee, board of directors, and program director during mid-1983. The board later approved a list of five nominees that were presented to USAID/BIFAD. Approval was received in May 1984.

Basic criteria used in choosing the EEP were: a) a background in and a basic understanding of science, b) experience in international agricultural research and/or development and knowledge of LDC problems, c) specific in-depth experience in peanut research, and d) an understanding of the U.S. land-grant research system.

The EEP members selected were:

- Donald C. Pickering, associate director, agriculture and rural development, The World Bank, Washington. He served from 1954-1967 in the northern Nigeria peanut production region in agricultural development with the British Colonial Agricultural Service, and since 1967 in several roles of project development and management with The World Bank. His strengths were criteria a and b above.

- Professor A.H. Bunting, professor emeritus of agricultural development overseas, the University of Reading, England. He has had extensive experience in agricultural development, including responsibility in the British schemes for peanut production in East Africa during the colonial period. He served on a consultative team to develop the groundnut program for ICRISAT. His strengths were criteria a, b, and c above.
- Dr. Pierre Gillier, retired, head of the Annual Oil Crops Department of IRHO, Paris. He was head of the peanut research department and peanut breeder at Bambey, Senegal under the French colonial system for a number of years prior to nearly 20 years in IRHO, Paris. He had expertise in peanut research peanut research and development in the West Africa Francophone countries. His strengths were a, b, and c above.
- Dr. Kenneth Garren, former peanut research leader, USDA, Suffolk, Virginia. He had extensive experience in peanut pest management and production, and was a recognized authority on mycotoxins. His strengths were a, b, c, and d above.
- Dr. Max Milner, former Executive Officer for the American Institute of Nutrition. He had a university background at the University of Minnesota (biochemistry), Kansas State University (grain science and industry), Columbia University (human nutrition), and the Massachusetts Institute of Technology (international nutrition), and extensive experience in food related activities with several international groups. His strengths were a, b, c, and d above.

The board of directors and technical committee felt that this five member EEP was manageable in size and collectively strong in the basic criteria used in the selection process. However, it was recognized that an EEP of this size could need additional input in some specific areas during an in-depth evaluation, such as the Triennial Review. If deemed necessary at the time of developing a scope of work, the EEP would be complemented with short term advisors to provide additional expertise in specific areas.

The 1982-1985 EEP evaluation included activities performed, impacts observed, general comments, and recommendations.

A. Producer values

GA/INPEP
General problem – The U.S. principal investigator did not have the time, or taken time to visit project sites, was overloaded, and had no co-principal investigator. Probably more progress would have been made if the U.S. principal investigator had visited collaborators in Burkina Faso and Niger, provided more advice, given clearer, more understandable instructions, and more on site training. Results suffered from low rainfall in the 1983-1984 seasons.

Burkina Faso – It may be too early to forecast impact of the research to date, but it was interesting to note good behavior patterns for certain strains with regard to *Cercospora* leaf spot tolerance and earliness of maturity. Sankara is a capable scientist, and a laboratory was available for disease study (rust and leaf spot). There was low government support, and little coordination or help from the U.S. principal investigator. In 1985 seed from TAM/BCP was introduced.

In Mali and Niger peanut research was stopped at the end of the bilateral French agreement, only some minor variety testing remained, which limited rate of implementation and progress on the project. The Mali agreement was signed in early 1985, which delayed the onset of research.

Niger had a good collaborator, Amadou Mounkaila, but had a low level of infrastructure, far from Niamey at Maradi. There is moderate support for peanut research, because of low production due to drought, reduced farmer interest, and reduced exports in the oil market. There was a need for U.S. principal investigator contact and guidance, and an increased level of research to include varieties as well as constraints of insects, diseases and nematodes. Peanut research is being maintained only because of Peanut CRSP support, and although funds for research are limited, the government wants to restore peanut production. There are few trained researchers, and Mounkaila needs graduate training. There is a concern about a regional project with TX/BCP in that the stronger program (Senegal) would dominate.

Caribbean – Antigua and other island testing of 55 INPEP cultivars showed disease and nutritional differences that need to be looked at further. Belize shows nutritional differences. Jamaica has the potential to produce, market and consume more peanuts. The EEP recommends more economics of production and marketing, and aflatoxin contamination research and reduction to compete with imports. Need more input from the U.S. collaborator. It was too early to see much impact of the new varieties, yield, etc.

TX/BCP/S
The project was well conceived, meshed well with a broader program of peanut breeding and varietal selection of TAMU, and the program was strengthened by the CRSP. There was not any special impact yet on established priorities in TAMU program. With more opportunity for training of Senegalese scientists to take over the projects in Senegal, its potential for outreach to sahelian Africa may well be speeded up. There is good staff at TAMU. Texas and Senegal is a good climatic fit. There is need for more training of Senegalese breeders and technicians.

The major difficulty was fiscal management. Funds were not moving down from ISRA administration to the research program. The World Bank was working on this problem. The car provided by the CRSP was in hands of the CNRA-Bambey director, and not available to researchers. The collaborators, N'Diaye, Mortreuil and Kalfaoui were good scientists. There was a need to build the strength of local scientists, since the core researchers were still from the French system.

Peanut clump disease was a problem; DD-Shell was a control chemical. There was a good set of Senegalese control varieties to compare with TAMU introductions. There was now a good germplasm base for breeding.

NCS/BCP/TP
Progress in institutional development was good, strong NCSU capabilities in breeding, and there were effective arrangements and good work begun in Thailand and the Philippines. There was strong commitment of NCSU staff to the collaborative efforts. Progress was good in training via principal investigator visits, provision of relevant literature, facilitation of workshops and attendance at courses held by cooperating country personnel. The 1985 results from field research should be more definitive on effectiveness of research on objectives in both U.S. and host country. Breeding is a long-term effort to produce new varieties, and seems well on track. There was coordination with the IDRC/Canada support program (which discontinued in 1988).

In the Philippines, the objectives of this project were such that its potential for alleviating peanut constraints was great. Although it was too soon to evaluate accomplishments or impacts of a breeding program, PCARRD will assure that deserving new peanut lines are publicized and distributed. The addition to the germplasm base was strengthening the institutional base for breeding. Philippine graduate training in the U.S. was planned (i.e., Redona, the collaborator at IPB). Overall, the Philippines had a good research team, but there was a relatively large turnover in management, which hopefully will be positive. The role of PCARRD in coordinating research is evolving.

In Thailand, the formation of a Coordinated Peanut Program between DOA, Kasetsart University, and Khon Kaen University in response to the Peanut CRSP planning grant had resulted in CRSP as an integral part of a national peanut improvement effort as viewed by administrators and scientists. Field research was developing well, although it was too early to evaluate a long-term breeding effort. Graduate training efforts should be expanded. Thai staff confirmed the strength of the NCSU team. Overall, Thailand had a good research team, which will contribute to program success

GA/PV/N
Work was initiated to find nature of resistance to groundnut rosette and its transmission agent, and the identification of other viruses. Groundnut rosette virus disease was recognized as a severe problem in Sub-Saharan Africa. The project should contribute to the Nigerian program of rehabilitation of the peanut crop in due course, and relevant to other African nations. The non-robust Anglophone-Francophone country links could reduce early transfer of technology in Africa.

Major impact in U.S. was the identification of Peanut stripe virus (PStV that was introduced from seed from China into the foundation seed program). A simple and non-seed destructive identification method was developed to determine the presence in seed before spreading though seed exchange for breeding and seed multiplication commercially. This effort was credited with curbing PStV as a major/destructive virus in the U.S. peanut industry. Internationally, it may have prevented further spread of the disease through seed exchange programs.

Phindile Olorunju was scheduled to come to UGA for graduate degree training. Mary Abraham was a student from India at Amadou Bello University.

The equipment in IAR was marginally adequate and maintenance a problem. Considering the very bad time IAR was experiencing – all Nigerian funds devoted to salaries and none for operations and maintenance – the moral support of the management and the devotion of the investigators was most credible. These people deserve all the support the CRSP can give.

The cooperation developed with Scotland and Germany to do work with live viruses was notable. They are non-peanut producing countries and would accept the live viruses, which was not true for U.S. laboratories and probably for ICRISAT/India as a cooperator.

There was a noted difference in green and chlorotic rosetted plants. Transmission and infection of rosette was caused by two viruses, one symptom causing virus and one an assistor virus. It is transmitted by an aphid (*Aphis craccivora*). Research completed as noted in the 1983 CRSP Annual Report: 1) improved method to mechanically inoculate peanut with groundnut rosette virus-chlorotic strain; 2) association of an infectious nucleic acid with the symptom inducing agent which causes the chlorotic rosette; and 3) confirmation of the requirement of the presence of the assistor or luteovirus for aphid transmission of rosette, which may be a single strand RNA encapsulated in a protein coat of the "assistor" virus, and that this agent moves only in the phloem of the host plant.

Dr. DVR Reddy, virologist at ICRISAT/India, did sabbatical leave for research at the University of Georgia virus lab, followed by a survey of peanut diseases in SE Asia that was enabled by financial support of Peanut CRSP. The survey publication contained this quote: "The ICRISAT Asian Legume Program will start in 1985 and the information we have obtained on groundnut problems in East Asian countries through cooperation with your organization will (Peanut CRSP) be of great value to us."

NCS/IM/TP
The project was implemented well by the principal investigator, with support by NCSU. An important aspect of the project has been the establishment of similarities in pest characteristics between U.S. and host countries, and hence the progress made in developing economic thresholds for the most important pests in host countries, (i.e., CRSP concept of impacts to host countries while at same time feedback to U.S.). The project was based on sound scientific principles. Dr. Campbell, the U.S. principal investigator will spend a six month sabbatical leave in Thailand, which will enhance both the Thai and U.S. program.

The focus was on field insects, and the comment was made that overall the CRSP was neglecting post harvest insects.

There was a strong collaborator in Philippines, Dr. Cadapan. He perceives that most peanut produced was consumed rather locally, which needs to be met by increased production with a focus on expanding the broader processing industry. Storage improvement needed for this second advance. There was a good mix of Peanut CRSP research into Philippine research, so that they were not seen as separate programs, which was a strength.

There were no plans in institutional development to train a Ph.D. to later succeed Dr. Cadapan.

As the reviewers saw it for early progress; there is much insect damage to peanuts in the Philippines; influenced by time of planting and plant density; frequency of application and amount of insecticide applied can be reduced without affecting efficacy. Need to better coordinate insect management with breeding efforts of Dr. Adalla in IPB that is cooperating with Peanut CRSP breeders.

Relations with and the support of USAID/Manila were good, perhaps due partially to the groundwork laid by Dr. Beebe's predecessor (Ed Rice) in the mission, Dr. Cummins, program director of Peanut CRSP, and Dr. Dely Gapasin of PCARRD.

This project and the other projects were enhanced by a Feb 7, 1985 Philippine "National Peanut Consultation and Peanut CRSP Review" held concurrent with EEP visit.

In Thailand, there were good collaborating scientists and technicians for conducting research, and good cooperation with breeding program to produce resistant varieties.

Work seems to be progressing well on resistance work, the effectiveness of insecticides, and other factors. The most important and practical result was obtained in a study of minimizing insecticide use by good knowledge of leaf miner cycle and of economic level of insecticide to be applied. The research was setting the stage for the development of an effective Integrated Pest Management Program (IPM).

GA/IM/BF
The project was initiated in 1983 and the first research was in the 1984 growing season. Surveys showed the most important pests to be thrips on flowers and pegs, termites with pod infestation during pre-harvest at the end of the rainy season when soils began drying, and millipedes with pod perforation during growing phase. In particular, termites and millipedes were related to *Aspergillus flavus* infestation, and later aflatoxin contamination. Basic surveys and planning and preparation makes the project well poised for progress in 1985 and later seasons.

The EEP commended the principal investigator for involving Dr. J. Suh of IITA/SAFGRAD with his experience in establishing the Burkina Faso project. The University of Ouagadougou was a good collaborator for the basic research, but will need to enlist others in technology transfer. It was a good priority project for Burkina Faso, since most entomology research had been focused on cotton and cereals. Government support was provided to the extent possible, and the importance of the research was recognized. Good cooperation between U.S. principal investigator, Bob Lynch and BF collaborator, Ouedrago who is serving while others are in degree training in the U.S. Dr. Lynch brought a high level of expectation to the project.

The EEP commended the short term training of Idrissa Dicko, and for the graduate training of Solibo Some.

NCS/TX/SM/TP
NCS/*Rhizobium* – The project was well supported by U.S. and host country administrators and scientists, and has only been operational for two years. Good progress has been made in the first phase of identifying rhizobia effective with local peanut cultivars, evaluating inoculation needs for locally adapted peanut cultivars, determining the efficacy of inoculants from strains effective with local peanut cultivars, testing (biological nitrogen fixation) BNF ability of new peanut crosses, and effect of acid soils on BNF capacity.

In the Philippines, the EEP felt that due to high fertilizer prices and low soil acidity, the BNF/cultivar and low soil acidity effects on peanut yields has promise, and also can have impact on improved performance of cropping systems. Similar observations were made in Thailand.

TX/Mycorrhizae – Good project support as with the rhizobium component above was noted. The research is long range for applicability, and behind the rhizobium aspect in providing applied technologies for improving production and response to root mycorrhizae enhancement, the goal of which was to increase nutrient and water uptake by plants. Research objectives may be too broad. The training plan for Philippines was weak. In both Philippines and Thailand some progress has been made in selecting mycorrhizae strains positive for growth, and in Thailand observations were made on positive mycorrhizae and rhizobium interactions. Soils vary in natural inoculant levels. No major recommendations for changes in the project were made by EEP.

B. Processor values

AAM/FT/S
The Sudan site visit of the EEP was not made, because the USAID mission would not give clearance for travel due to mitigating circumstances. Two efforts for travel were made. The EEP visited AAMU April 4-5, 1985.

The project seemed well focused, and had good AAMU leadership. It brought more University wide commitment to international activities.

The first phase, which involved a consumer peanut food utilization survey, was almost complete and helpful to guide future efforts in relevant peanut product development and distribution to processors and end users. It was not entirely clear whether objectives were the most appropriate, and based on the survey a reassessment in concert with the host country collaborators of the priorities and objectives was recommended. Information from past assistance efforts by British and UN activities may be useful.

GA/FT/TP
The strength of the UGA scientists to lead the project was recognized as strong, and there were good collaborators in both Thailand and the Philippines.

The survey of 700 families in Thailand to evaluate peanut food consumption was almost complete, and the EEP recognized its importance in defining future research and development activities. Some interesting results were obtained in the consumption survey. Studies in alternate storage methods with shelled and unshelled peanuts, elimination by hand sorting of aflatoxin contaminated peanut seed, peanut butter and peanut butter bar fabrication and evaluation of their acceptability drew attention of authorities to the aflatoxin problem, which became the first constraint to peanut product development. The Annual Groundnut Research Workshop (developed concurrent with the coordinated peanut program in Thailand after the planning grant visit in October 1980) promotes at the national level a good flow of information on the results obtained by this program. If the elimination of aflatoxin contaminated peanut could be developed on a large scale, the major constraint will be eliminated and the impact on the production and consumption will be very important (processors were ready to pay 30% more for peanut seeds of good quality).

Research in the Philippines has been on inert atmosphere (CO2) storage of peanuts. The work has been satisfactory, but the EEP agrees with the principal investigator that the use of the technologies would be best for seed storage rather than peanuts for food use. Work has been initiated in the Philippines on aflatoxin management, based in part on hand sorting of contaminated peanuts.

Current research at UGA has focused on steam and dry heat blanching of seed for processing, but cost in the host countries may be a problem. Development of peanut as a larger food crop in both countries depends on supply of peanuts from farm production.

The EEP believes that the UGA workers should undertake a very thorough review with their counterparts in both countries, in order to better identify food science research that relates to the most urgent problems in peanut utilization in these countries. Aflatoxin control had a high priority in the Philippine and Thai program. The Thai survey will help in this endeavor.

AAM/FL/FT/CARDI
The EEP cited management problems, and slow development of MOU's with host countries, which may be due to several sub-grantees and time constraint of the principal investigator. Sub-grantees to Alabama A&M University were the University of Florida, University of the West Indies-Trinidad (UWI), Caribbean Agricultural Research and Development Institute (CARDI), and Jamaica Food Technology Institute. The EEP agreed to recommend continuation with assurance from AAMU that more effective management, coordination, and monitoring procedures be instituted. Dr. Bharat Singh assumed the principal investigator role in mid-1985.

A study entitled "Caribbean Peanut Production and Post Harvest Survey" was completed by CARDI and AAMU/UFL in August 1985. Dr. Walmsley, CARDI/Trinidad, should help plan future post harvest and food product development and testing studies. Two additional studies were planned with UWI, Dr. Sammy and JFTI primarily on food product development.

Ad hoc committee review for food technology

An ad hoc committee was recommended by the EEP to further evaluate and recommend directions or focus for the Food Technology research area/projects. A committee was named:

- Dr. J.G. Woodroof, University of Georgia, retired food scientist
- Dr. L. W. Rooney, Texas A&M University, food scientist
- Dr. John P. Cherry, USDA/Southern Research Laboratory, food scientist

They met on Dec. 19-20, 1985 in Griffin, Ga. The principal investigators and cooperators from the three Peanut CRSP Food Science projects were present, along with Dr. Max Milner, EEP member and food scientist, and Dr. David Cummins, program director. The ad hoc committee purpose was to advise the board of directors about the relevance of the three Peanut CRSP Food Science projects at the request of the EEP following their earlier review. The following comments and recommendations were submitted by the group.

The Committee evaluated the EEPs concern that the food technology projects involved only technology transfer activities without basic research. It was recognized that much basic research has been done in the U.S. institutions, but not included in the Annual Reports, because it was done with funds other than the CRSP. Since the CRSP should be enhanced by the U.S. institution strengths, and the U.S. benefits from feedback from the host country research, the overall accomplishments should be reported.

Major surveys on post harvest utilization of peanuts have been conducted to determine how peanuts are used in foods, and have served a useful purpose to identify problems and project directions. A joint report of these surveys would be in order to show differences and individuality in peanut use in the Southeast Asia, Africa, and Caribbean regions where the projects were located. It was recommended that research on the problems uncovered by the surveys should be a major focus, compared to more surveys in the future.

Aflatoxin management in the food processing area, along with other quality factors should have priority in the research. Research to improve harvesting, handling, storage, packaging, and processing of peanut for food should include evaluation of the effects on aflatoxin levels. Collaboration with other CRSP project microbiologists working on mycotoxin management was desirable.

The food technology program should cooperate closely with the breeding programs to insure that new varieties have improved food quality, and fit the needs of the processors and consumers.

Modification of existing peanut products to enhance their acceptability was warranted. Socioeconomic constraints in developing countries should be understood to insure the marketability of new products in the various socioeconomic environments.

Worthy of recognition is that some of the research in food technology covered by the ad hoc committee was included in the top three priorities of the First National Peanut Consultation and Peanut CRSP Review held at PCARRD on Feb. 7-8, 1985. The scientists in the CRSP have already taken the initiative to expand the projects to cover more fully the important areas of postharvest handling and subsequent utilization, which the ad hoc committee recommended to be supported by the EEP. (This report was summarized in the EEP report as shown below.)

- Establishment of benchmark information and agro-economic assessment of production, post-production, utilization and marketing.
- Improvement of postharvest handling techniques such as stripping, drying and storage to manage aflatoxin problems; standardization and improvement of packaging to prolong shelf life and improve acceptability of food products.
- Development of a seed production, processing, storage and distribution scheme.
- Development of low cost technology to reduce high input costs such as use of rhizobium and mycorrhizae, organic fertilizer, green manuring, botanical pesticides, biological control and minimum tillage.
- Development and improvement of village level processing and utilization.
- Establishment of water and fertilizer requirements under various cropping systems.
- Disease management with emphasis on epidemiology of virus diseases and development of integrated approaches to control major diseases.
- Testing, evaluation and improvement of farm tools and equipment suitable for small farm conditions.
- Testing and evaluation of production technologies under various agro-economic conditions.
- Development of technology transfer techniques.
- Development of integrated insect pest management and establishment of economic threshold levels for major insect pests.
- Development of high yielding, pest resistant varieties tolerant to stress conditions, and suited to various cropping systems, e.g., rice-based, coconut-based, corn-based, and sugarcane-based.

In summary, the ad hoc committee believed that the Peanut CRSP Food Science/Technology projects were in the process of responding positively to the EEP criticisms by initiation of changes in research activities. There was no unnecessary duplication of research noted, but Annual Reports on the research could be improved to include companion research in U.S. programs, even if not supported by CRSP funds. There should be better interaction of the food science technology projects with other appropriate Peanut CRSP institutions that support Peanut CRSP host country activities. The Caribbean project seemed to be underway, and should be productive. Publications are needed to summarize the survey results and the current information on peanut processing qualities, especially in respect to plant improvement programs.

The EEP Chairman, Dr. Don Pickering, reviewed the ad hoc committee report and was in full agreement with the deliberations and recommendations. Dr. Max Milner, EEP member for Food Technology, was involved in the meeting and his views were incorporated into the report. The principal investigators have recognized needs for improvement since obtaining preliminary reports from the EEP review (site visits made between February and September, 1985), and have begun to modify research to reflect the EEP review, and were committed to improve the projects based on both the EEP and ad hoc committee reviews.

C. Consumer values

TX/MM/S

There was higher than expected devotion of time by TAMU participants, and the CRSP work meshed well into an ongoing program at Texas A&M on peanut aflatoxin management, mycotoxicology, and veterinary public health. Participation in the CRSP has strengthened the TAMU program, and also its international aspect and contribution. The project will strengthen the Senegal laboratory and scientists to do basic research to address food aflatoxin problems on a consumer basis. The EEP commended the socioeconomic study underway on the extent to which aflatoxin-contaminated foods and feeds seem to be getting into the Senegalese food and feed chains, and the apparent effects of such contaminated foods and feed on public health. Mycological surveys have established the prevalence of *Aspergillus flavus* and other toxigenic fungi in Texas and Senegal, information needed to design research projects.

Colloidal clay as a means of removing aflatoxin from peanut oil in Senegal seems promising, and further research is advised, as well as to continue mycotoxin analysis of peanut oil and products in Senegal

A di-electrical procedure to determine aflatoxin in peanut samples appears to be potentially applicable.

There was a need for simple guidelines in Senegal and all of Africa for aflatoxin management.

Short term training of Dr. Amadou Ba in Texas was noted as good. There was also a request to provide graduate training at TAMU for Bashir Sarr a technician at ITA (Food Technology Institute).

Fiscal management was a problem in ITA as noted in ISRA.

D. Information Training/Impact

The First National Peanut Consultation and Peanut CRSP Review held at PCARRD on Feb. 7-8, 1985 was commended.

The EEP commended the graduate and short-term training in a number of projects.

The number of surveys to determine research needs and formulation of plans was positive.

E. Management Entity

Overall, the EEP gives the program director very high marks for the efficient and economically operated management program for the Peanut CRSP. There was good program and fiscal responsibility backed by the College of Agriculture, Office of International Development, the Research Foundation and Vice President for Research Office, and the Office of Business and Finance. Clear lines of communication and understanding between USAID, the participating U.S. universities, and host country participants have led to the minimization of bureaucratic delays in program implementation, and for good programmatic progress.

F. Recommendations

The EEP made the following recommendations for the 1985-1990, 5-year Plan. As noted elsewhere, the initial concept of a 1982-1987 plan was changed in the USAID plan to end in 1985 as a three-year plan, followed by future 5-year plans from 1985-1990 forward.

- GA/INPEP/N/M/BF/CAR. Recommendation of EEP and TC in Oct 1984 to merge Africa component with T/BCP and let GA/INPEP focus on Caribbean.
- TX/BCP/S. The work should expand to the Casamance region (South Senegal) to get higher rainfall for higher yields and disease development, which was later revised to expand project into Burkina Faso and Mali to get the higher rainfall conditions for research. Graduate training of staff to assume core role in research, and better fiscal management was needed, which was a result of the transition from French to domestic leadership.
- NCS/BCP/TP. Progress overall was good, and was introducing a wider range of germplasm to the Philippines and Thailand. Training during U.S. principal investigator visits was good, and graduate training plans were underway. Two U.S. graduate students were spending one-year in each of the countries to conduct their thesis research, which was good, and strengthens the tie to the U.S. for host country institutional development.
- GA/PV/N. The EEP supported the project in the present form, and commended the direction to help resolve a major African problem/constraint, groundnut rosette virus. Also, the project was helping to resolve the Peanut Stripe virus problem in the U.S. that came from Chinese plant introductions, and has worldwide implications. The training underway was good.
- NCS/IM/TP. Progress overall was good, survey methodology to determinate the nature of problem insect pests was developed and utilized, and research initiated to resolve the constraints. There was good U.S./host country scientist interaction. The U.S. principal investigator, Dr. William Campbell had plans to spend a 6-month sabbatical in Thailand, which will complement this and other CRSP projects in country with a spill-over to the Philippines.
- GA/IM/BF. Good progress was made in surveying insect problems, and then in initiation of necessary research to solve the problems. An important factor to study was relating aflatoxin contamination in peanuts to post harvest insects. Training plans were initiated well.
- NCS/TX/TP-Rhizobia. Favorable with program direction in the Philippines and Thailand. There was a potential for technologies to increase yields, but there was a question on economic affordability in developing countries in the area of seed inoculation.
- NCS/TX/TP-Mycorrhizae. Research was sound and innovative, but the EEP was concerned whether application to the field could be made. In effect, mycorrhizae extends the root system, increases water and nutrient uptake, and enhances nitrogen fixation. There was a question as to whether inoculation procedures can be economical.
- AAM/FT/S. The EEP commended the implementation of the project, and food surveys to establish research. The EEP did not travel to Sudan because of internal country unrest, which later resulted in moving the project to Burkina Faso.
- GA/FT/TP. There is a need to focus on aflatoxin reduction/management in pre-and post-harvest handling, and in food products. Surveys should guide the appropriate areas of product development – consumer needs and acceptability. Assure that there was not unnecessary duplication of research in the two countries.
- AAM/FT/CARDI. The U.S. principal investigator had a heavy workload, including administrative duties, which required consideration of a new principal investigator. Generally, work should follow findings of the food survey, and has promise to provide good information for the region.
- TX/MM/S. Generally supported project direction; survey work underway to understand problems, the recognition of public health needs and focus, and progress in use of adsorptive clays to remove aflatoxin from peanut oil in Senegal.

CHAPTER 12. DESCRIPTION OF 1985-1990 GRANT

Global plan and constraints

USAID policy reduced the first five-year 1982-1987 to three years ending in 1985, thereby initiating a five-year phase from 1985-1990. An extensive and intensive external evaluation panel review was conducted in 1984-1985 as required in the grant agreement, which considered research direction and progress, and project and program management. Although the review recommendations resulted in a number of changes in priorities, directions, and focus in the projects, the eleven (divided the North Carolina/Texas A&M microbiology project to make twelve) initial projects continued in the second phase. As recommended, the international peanut evaluation project was re-focused as a breeding effort for the Caribbean, and the Niger, Mali, and Burkina Faso components were incorporated into the Texas A&M-Senegal breeding project. The Gramm-Rudman-Hollings initiative resulted in an 18% budget reduction in the 1985-1986 project years, which was adsorbed across projects.

The EEP Review assured that the research objectives remained focused on the established constraints. Only minimal modifications were recommended, and the 1985-1990 phase followed the same general set of constraints to sustainable production and use as described earlier in the 1982-1985 phase:

- Low yields because of unadapted varieties and lack of varietal resistance to diseases, insects, and drought
- Health hazards and economic losses due to mycotoxin contamination
- Yield losses due to infestations of weeds, insects, diseases, and nematodes
- Food supplies inadequate and peanuts are not generally considered a primary food source;
- Economic and sociological problems preventing efficient production and utilization
- Physiological and soil microbiological barriers to higher yields
- Projects also addressed training, information, and outreach needs. It was recognized that there were insufficient numbers of trained researchers and support personnel
- There was inadequate availability and use of technology by producers and processors.

The four U.S. universities continued to provide the critical mass for a highly manageable and productive program. Resources have been directed for minimum management costs and maximum program expenditure and impact. U.S. universities (Alabama A&M, Georgia, North Carolina State, and Texas A&M) remained the same.

Collaboration with nine prime host countries provided a global plan and impact into three major regions. The same regions and countries (Africa-Senegal, Mali, Niger, Burkina Faso, Nigeria, Sudan; Southeast Asia-The Philippines and Thailand; Caribbean through CARDI and the University of the West Indies-Trinidad, Jamaica, Belize, and Antigua are represented in the host country participants as in the first three-years. The limited effort to establish rhizobium work (NCS/TP-Rhizobia) was not continued in Cameroon.

The projects were arranged in the four themes adopted later in the program to facilitate
the following accomplishments and impacts across phases or years. Projects, participants and goals of 1985-1990 program follow.

A. Producer Values

GA/BCP/CAR. Breeding and Cultural Practices for the Caribbean

Co-Principal Investigators:
- Dr. W.D. Branch, plant breeder, University of Georgia
- Dr. C.V. Kvien, agronomist, University of Georgia.

Cooperators:
- Dr. A. S. Csinos, plant pathologist, University of Georgia
- Dr. C.C. Holbrook (USDA peanut breeder), University of Georgia.

CARDI Collaborators:

- Dr. Sam Parasram, executive director/Trinidad,
- Dr. Brian Cooper, Antigua,
- Dr. S. Haque, Trinidad,
- Horace Payne, Jamaica,
- Dr. B.K. Rai, Belize.

The project (GA/BCP/CAR) changed from cultivar development to post-harvest handling systems for the small producer (GA/PH/CAR) in 1987-88. Associated with this project were:

Prinicpal Investigator:
- Dr. Manjeet S. Chinnan, principal investigator, food engineer, University of Georgia

Cooperators:
- Dr. Brahm Verma, agricultural engineer, University of Georgia,
- Dr. Craig Kvien, breeder, University of Georgia,

CARDI Collaborator:
- Dr. Brian Cooper, Antigua.

CARDI Cooperators:
- Dr. B.K. Rai, Belize,
- Joscelyn Grant, Jamaica,
- Dr. Gordon Muller, Trinidad,
- Dr. Murali Rao, St. Vincent.

The project was planned and the Memorandum of Understanding was signed.

Goal: The overall goal of GA/BCP/CAR was to identify superior varieties and cultural practices for the Caribbean to improve food yield. Objectives were to continue a regional testing program to identify superior genotypes; screen early generation populations for adaptability and disease resistance; evaluate various cultural methods to reduce stress (water, heat, and mineral) and enhance yield; identify major disease problems, occurrence of epidemics, and impact of control; and provide training and technical assistance.

The goal of the GA/PH/CAR was to investigate and identify suitable methods for maintaining postharvest quality and reducing post production cost through improved postharvest handling operations that include harvesting, drying, threshing, shelling, storing, cleaning, and packaging.

TX/BCP/S. Disease-resistant peanut varieties for semi-arid environments

Principal Investigator:
- Dr. O.D. Smith, peanut breeder, Texas A&M University.

Cooperators:
- Dr. C.E. Simpson, peanut breeder, Texas A&M University,
- Dr. D.H. Smith, plant pathologist, Texas A&M University,
- Dr. A.M. Schubert, plant physiologist, Texas A&M University,
- Dr. R.E. Petti, plant pathologist, Texas A&M University,
- R.A. Taber, mycologist, Texas A&M University.

Senegal Collaborators:
- Dr. Mbaye N'Doye, director, CNRA/ISRA, Bambey,
- Dr. Aly N'Diaye, peanut physiologist, CNRA/ISRA, Bambey,
- J.C. Mortreuil, peanut breeder, CNRA/ISRA, Bambey,
- Daniel Annerose, CNRA/ISRA, Bambey,
- Jean L. Khalfoui, CNRA/ISRA, Bambey.

Burkina Faso Collaborators:

- Dr. Philippe Sankara, pathologist, University of Ouagadougou,
- Dr. Alfred Traore, director, ISP, University of Ouagadougou.

Niger Collaborator:

- Amadou Mounkaila, INRAN, Maradi.

Mali Collaborators:

- Dielissouma Soumano, Bamako,
- Sadio Traore, IER, Bamako.

Goal: To develop and identify peanut lines adapted to important ecological areas of West Africa and Texas resistant to pathogens causing important economic loss, and identify cultural practices that will maximize the yield potential of cultivars in those environments.

NCS/BCP/TP. Peanut varietal improvement for Thailand and the Philippines

Principal Investigator:

- Dr. Johnny C. Wynne, breeder, North Carolina State University
- (Dr. Thomas Isleib, became principal investigator in 1990).

Cooperators:

- Dr. H.T. Stalker, breeder-cytogeneticist, North Carolina State University,
- Dr. M.K. Beute, plant pathologist, North Carolina State University,
- Dr. W.V. Campbell, entomologist, North Carolina State University,
- Dr. G.H. Elkan, microbiologist,North Carolina State University,
- Dr. A. Weissinger, pathologist, North Carolina State University,
- Dr. W.F. Anderson, pathologist, North Carolina State University,
- Dr. Barbara Shew, pathologist, North Carolina State University,
- Dr. Randy Wells, crop science, North Carolina State University.

Thailand collaborators:

- Dr. Vichitr Benjasil, director, Field Crops Research Institute, Department of Agriculture (DOA), Bangkok, coordinator and peanut breeder
- Preecha Surin, plant pathologist, DOA
- Dr. Duangchai Choopunya, plant virologist, DOA
- Dr. Montien Sompee, director, DOA, Khon Kaen Field Crops Research Center, assistant coordinator and agronomist
- Somjintana Toomsaen, peanut breeder, DOA Khon Kaen
- Anon Wayawanont, agronomist, DOA Khon Kaen
- Sopone Kittisin, plant pathologist, DOA, Khon Kaen
- Dr. Aran Patanothai, peanut breeder, Khon Kaen University, (KKU)
  Dr. Sopone Wongkaew, plant pathologist, KKU

Philippine Collaborators:

- Dr. Ricardo Lantican, coordinator of project, Institute of Plant Breeding (IPB), University of the Philippines, Los Banos
- Dr. Remedios Abilay, project leader and breeder**,** IPB
- Dr. Randy Hautea, breeder, IPB
- Ms. A. Pau, pathologist, IPB
- Dr. Candida Adalla, entomologist, IPB
- Dr. D.A. del Rosario, plant pathologist, IPB
- Dr. H.P. Samonte, soil scientist, IPB
- Dr. Erlinda Paterno, microbiologist, IPB

- Andy Pascua, agronomist, IPB
- Dr. Rustico Santos, Isabella State University
- Jimmy Domingo, agronomist
- Francis Francisco, Cagayan State University
- Dr. Pablito Pamplona, agronomist, University of Southern Mindano.

Goal:
Thailand. (1) To develop cultivars with desirable agronomic traits of high yields, early maturity and drought tolerance with resistance to rust, *Cercospora* leaf spots and *Aspergillus flavus*. (2) To provide plant pathology information required for development and utilization of disease-resistant peanut cultivars. (3) To develop an agronomic system of production suitable for exploitation of new cultivars in cropping systems of northeast Thailand.

Philippines. To develop cultivars with (1) desirable agronomic traits of high yields, early maturity, drought tolerance, and tolerance to highly acidic soils and shade; and (2) resistance to rust, *Cercospora* leaf spots, *Aspergillus flavus* and *Sclerotium* wilt. The development of cultivars high in nitrogen fixation capacity and resistant to insect was being pursued collaboratively with activities under projects NCS/IM/TP and NCS/SM/TP.

GA/PV/N. Peanut viruses: etiology, epidemiology, and nature of resistance

Principal Investigator:
- Dr. James W. Demski, virologist, University of Georgia, Georgia Experiment Station, Griffin.

Cooperator:
- Dr. Cedric Kuhn, virologist, University of Georgia, Athens.

Nigeria Collaborators (Ahmadu Bello University, Samaru-Zaria):
- Dr. Steve Misari, vector entomologist, Dept. of Crop Protection,
- Dr. Okon Ansa, virologist, Dept. of Agricultural Research
- Phindile Oloranju, peanut breeder, Dept. of Crop Protection

Other cooperators:
- Dr. D.V.R. Reddy ICRISAT/India
- Dr. Rudolph Casper, Virus Institute, Braunschweig, West Germany
- Dr. Tony Murant, Scottish Crops Research Institute, Dundee, Scotland

Goal: Virus diseases, in epidemic proportion, were limiting factors in peanut production. The three most destructive viruses infecting peanut, on a worldwide basis, were peanut mottle virus (PMV), groundnut rosette virus (GRV), and bud necrosis virus. BNV was especially damaging in India, where major research efforts at ICRISAT were directed towards the problem. PMV was worldwide in distribution, but except for identification and yield loss documentation, little research had been done outside the USA and ICRISAT in India. GRV, although restricted to Africa, was extremely important because of the serious losses it induced and the large number of peanut produced in the African countries. In-depth research was proposed on GRV, 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 was through research efforts to attain a better understanding of the causal agent of GRV and the disease, so that some methods of control can be developed for GRV, with more limited research on other viruses.

NCS/IM/TP. Management of arthropods on peanuts in Southeast Asia.

Principal Investigator:
- Dr. W.V. Campbell, entomologist, North Carolina State University

Cooperator:
- Dr. Johnny C. Wynne, peanut breeder, North Carolina State University

Thailand collaborators:

- Manochai Keerati-Kasikorn, entomology, Khon Kaen University
- Aran Patanothai, plant breeder, Khon Kaen University
- Vichitr Benjasil, coordinator and breeder, Department of Agriculture, Thailand
- Sathorn Sirisingh, entomologist, Department of Agriculture, Thailand
- Pisit Sepsawardi, entomologist, Department of Agriculture, Thailand
- Chuwit Sukprakarn, post-harvest insects, Department of Agriculture, Thailand

Philippine collaborators:

- Eliseo Cadapan, entomologist, University of the Philippines, Los Banos (UPLB)
- B. Morallo Rejesus, post-harvest insects, UPLB
- Fernando Sanchez, entomologist; National Crop Protection Center
- Candida Adalla, Institute of Plant Breeding, ULB.

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

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

Principal Investigator:

- Dr. Robert E. Lynch, entomologist (USDA/Tifton), University of Georgia.

Burkina Faso Collaborator:

- Dr. Albert Patoin Ouedrago, University of Ouagadougou.

Goal: Identify the major arthropod pests of peanut in Burkina Faso, develop economic thresholds for these pests, develop IPM strategies and control measures to reduce losses to these pests, and determine the relationships between arthropod damage to peanut pods and the incidence of aflatoxin contamination.

NCS/SM/TP. Influence of soil microbiology on nitrogen fixation and growth of peanuts in Thailand and the Philippines. A. Rhizobial considerations

Principal Investigator:

- Dr. G.H. Elkans, microbiologist, North Carolina State University.

Cooperator:

- Dr. Johnny C. Wynne, peanut breeder; North Carolina State University.

Thailand collaborators:

- Dr. Vichitr Benjasil, coordinator, Department of Agriculture, Bangkok (DOA,B)
- Dr. Nantakorn Boonkerd, principal investigator and microbiologist, (DOA,B)
- Yenchai Vasuvat, microbiologist (DOA,B)
- Dr. Montgien Somabhi, microbiologist, Khon Kaen University (KKU)
- Dr. Banyong Toomsan, microbiologist, KKU
- Dr. Aran Patanothai, agronomist: KKU

Philippine collaborators:

- Dr. Erlinda Paterno, principal investigator and microbiologist, University of the Phillipines at Los Banos (UPLB)
- Fe G. Torres, microbiologist, UPLB
- Dr. Randy A. Hautea, microbiologist, UPLB
- Bill Temauel, Isabella State University, Philippines

Goal: The overall goal of the project was to optimize (or eliminate constraints) biological nitrogen fixation to allow improved peanut production and, then develop the BNF-peanut symbiosis as part of a "farming system" approach as a source of transferring nitrogen to subsequent crops using crop rotation and/or intercropping approaches. Peanut cultivars would be selected that fix higher levels of nitrogen and then incorporate them into the local cropping systems, which would both increase the yields in the rotation and reduce the amount of commercial nitrogen required for optimum production.

TX/SM/TP. Influence of soil microbiology on nitrogen fixation and growth of peanuts in Thailand and the Philippines. B. Mycorrhizal considerations

Principal Investigator:

- Dr. Ruth Ann Tabor, Texas A&M University.

Cooperators:

- Dr. Charles Simpson, breeder, Texas A&M University,
- Dr. Donald Smith, plant pathologist, Texas A&M University,
- Dr. Wyatte Harman, economist, Texas A&M University,
- Dr. Robert Pettit, plant pathologist, Texas A&M University,
- Dr. Olin Smith, breeder, Texas A&M University.

.

Thailand collaborators (Department of Agriculture/Bangkok):

- Dr. Omsub Nopamornbodi, principal investigator and microbiologist
- Yenchai Vasvat, microbiologist
- Dr. Nantakorn Boonkerd, microbiologist

Philippine Collaborators:

- Dr. Lina Ilag, plant pathologist, University of the Philippines at Los Banos (UPLB)
- Dr. Erlinda Paterno, microbiologist, Institute of Biotechnology, UPLB
- Dr. Ricardo Lantican, coordinator, Institute of Plant Breeding, UPLB

Philippine Coordinator:

- Dr. Dely P. Gapasin, Crops Research Department, PCARRD, Los Banos.

Goal

To increase peanut yield/unit area in the host countries 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.

B. Processor values

AAM/FT/S. An interdisciplinary approach to optimum food utility of the peanut in SAT Africa.

Principal Investigator:

- Dr. Bharat Singh, food scientist, Alabama A&M University.

Cooperators:

- Dr. John C. Anderson, food scientist, Alabama A&M University,
- Dr. Virginia Caples, home economist, Alabama A&M University
- Dr. Hezekiah Jones, agricultural economist, Alabama A&M University
- Dr. D.R. Rao, nutritionist, Alabama A&M University
- Dr. G.C. Wheelock, rural sociologist, Alabama A&M University.

Sudan Collaborators:

- Dr. H.M. Ishag, Principal Investigator, National Coordinator, Groundnut Research, Agricultural Research Corporation, Khartoum, (ARC/FRC)
- Dr. B. Bashir, Co-Principal Investigator, ARC/FRC.

Sudan Cooperators:

- Dr. A.B. Ahmadi, plant breeder, ARC/FRC
- S.M. Badi, cereal chemist, ARC/FRC
- Dr. A.S. Khalid, microbiologist, ARC/FRC
- Dr. B.I. Magboul, nutritionist, ARC/FRC
- Dr. A.G. Tayeb, chemist, ARC/FRC,
- and Dr. Asha El Karib, economist, ARC/FRC

Due to problems of unrest in the Sudan, the project was moved to Burkina Faso. In 1988, an MOU was completed with the University of Ouagadougou, Burkina Faso, and research was initiated.

Burkina Faso collaborator (University of Ouagadougou):

- Dr. Alfred S. Traore, principal investigator and food scientist

Burkina Faso Cooperators:

- Solibo Some, entomologist, University of Ouagadougou,
- Albert Ouedraogo, entomologist, University of Ouagadougou,
- Lactitia Ouedraogo, food technologist, University of Ouagadougou,
- Dr. Alain N. Sawadogo, director, I.S.N., University of Ouagadougou,
- Herve Campaore, food technologist, University of Ouagadougou,
- Francois T. Ouedraogo, food technologist, University of Ouagadougou,
- Dr. Philippe Sandara, phytopathologist, University of Ouagadougou.

Goal

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

GA/FT/TP. Appropriate technology for storage/utilization of peanut

Co-principal investigators:

- Dr. Tommy Nakayama, food scientist, University of Georgia/Griffin
- Dr. Larry R. Beuchat, food scientist, University of Georgia, Griffin
- Dr. Beuchat assumed the role of principal investigator in the 1987-1988 year.

Co-Investigators:

- Dr. Robert E. Brackett food scientist, University of Georgia/Griffin
- Dr. Anna V.A. Resurreccion, food scientist, University of Georgia, Griffin
- Dr. Robert Rauniker, agricultural economist, University of Georgia, Griffin

Cooperators:

- Dr. Philipp E. Koehler, plant pathologist, University of Georgia
- Dr. David Wilson, plant pathologist/UGA-Tifton
- Dr. Whit O. Slay, USDA, Dawson, Ga.

Thailand collaborators (Kasetsart University, Bangkok):

- Dr. Chintana Oupadissakoon, principal investigator and food scientist, Department of Product Development (DPD)
- Dr. Vichai Haruthaithanasan, food scientist (DPD)
- Dr. Penkwan Chompreeda, food scientist; DPD

Thailand Cooperator:
- Chuleeporn Piemsomboon, Department of Marketing, Kasetsart University, Bangkok

Philippine collaborators:
- Dr. Eli E. Escueta, principal investigator to March 1986, University of the Philippines, Los Banos,
- Dr. Virgilio V. Garcia, principal investigator after March 1986, food scientist, University of the Philippines, Los Banos.

Philippine cooperators:
- Dr. Ricardo R. del Rosario, food scientist, Institute of Food Science and Technology, Los Banos
- Dr. Renaldo C. Mabesa, food scientist, Institute of Food Science and Technology, Los Banos,
- C. Intong, food scientist, Institute of Food Science and Technology, Los Banos,
- Dr. Paciencia-Castillo Manuel, agricultural economist; University of the Philippines, Los Banos.

Goal

The ultimate goal of this project remains to enhance the capabilities of Kasetsart University and the University of the Philippines at Los Banos in food technology. The training of cooperators from Thailand, the Philippines, and the USA in developing and transferring appropriate peanut storage and utilization technologies was the mechanism for all institutions to enhance their capabilities to improve and assist in economic and human development.

AAM/FL/FT/CARDI. Peanut utilization in food systems in developing countries

Principal Investigator:
- Dr. Bharat Singh, food scientist, Alabama A&M University.

Co-principal investigator:
- Dr. E.M. Ahmed, food scientist, University of Florida.

Cooperators:
- Dr. B. Onuma Okezie, food scientist, Alabama A&M University
- Dr. John C. Anderson, food scientist, Alabama A&M University
- Dr. Gerald C. Wheelock, rural sociologist, Alabama A&M University
- Dr. H.S. Sistren, human nutritionist, University of Florida
- Dr. R.H. Schmidt, food scientist, University of Florida
- Dr. Chang I. Wei, food toxicologist, University of Florida

The University of Florida did not continue in the project in 1988.

Collaborators (CARDI):
- Dr. S. Parasram, entomologist and executive director, St. Augustine, Trinidad
- Dr. St. Clair Forde, director of research and development, St. Augustine, Trinidad
- Dr. Don Walmsley, agronomist, St. Augustine, Trinidad
- Horace Payne, peanut agronomist, Jamaica
- Joseph R. Suah, head of unit, Jamaica
- Dr. Brian Cooper, agronomist, Antigua
- Heyden Thomas, food scientist, Antigua
- Dr. B. Rai, head of unit, Belize

Cooperators (Food Technology Institute, Kingston, Jamaica):
- L. Hope Kerr, food scientist
- Marcia Brown, food scientist
- Dr. M.H. Ahmed, microbiologist

Cooperators (University of the West Indies, St. Augustine, Trinidad):
- Dr. George Sammy, food scientist (deceased in 1988);
- Margaret Hinds, graduate research assistant (began in 1985)

Goal

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

C. Consumer values

TX/MM/S. . Mycotoxin Management in Peanut by Prevention of Contamination and Monitoring.

Principal Investigators:
- Dr. Robert E. Pettit, plant pathologist, Department of Plant Pathology and Microbiology, Texas A&M University. Dr. Pettit retired Oct. 1, 1991.
- Dr. Marian N. Beremand, and Dr. Nancy Keller, Dept. of Plant Pathology and Microbiology were appointed principal investigator and co-principal investigator, respectively.

Cooperators (Texas A&M University):
- Ruth Ann Taber, mycologist, Department of Plant Pathology and Microbiology
- Dr. James P. Stack, plant pathologist, Department of Plant Pathology and Microbiology
- Dr. Randall L. Geiger, electrical engineer, Department of Electrical Engineering
- Dr. Timothy D. Phillips, mycologist, Department of Veterinary Public Health
- Dr. Eric. C. Shepherd, mycologist, Dept. of Veterinary Public Health

Senegalese collaborators:
- Dr. Mbaye N'Doye, Institut Senegalese Research Agicole, (ISRA), Bambey
- Dr. Aly ND'Diaye, physiologist (ISRA), Bambey
- Dr. Amadou Ba, technologist (ISRA), Bambey
- Dr. Andre Rouziere, coordinator, Programme Arachide, ISRA, Kaolak
- Dr. J.C. Mortreuil, Selectionneur Arachide, ISRA/CNRA/Bambey
- Dr. Ndiaga M'Baye, Chef de Service de Physiologie and Nutrition, Dakar
- Par A. Ndoye, directeur, Service Alimentation, Nutrition Laboratoire National D'Elevage, Dakar
- Dr. Ousmane Kane, Directeur, Institut, de Technologie Alimentaire, (ITA) Dakar
- Mouhamadou Diop, directeur technique, ITA/Dakar
- Amadou Kane, directeur, Laboratorie Mycotoxines, ITA/Dakar
- Bashir Sarr, mycotoxologist, Institut de Technologie Alimentaire. Dakar

Goal

The goals of the Peanut CRSP mycotoxin research project were 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. These technologies will render contaminated products safe for consumption.

D. Information/Training/Impacts

Workshops, publications, degree and short-term training, and contracted economic surveys were planned.

Three projects AAM-FL/FT/CAR, NCS/SM/TP, and TX/SM/TP were discontinued in 1989-1990 due to reduction in funds.

Administration and management

E. Management entity – Dr. David G. Cummins was the program director, and served as a Joint Career Corp member in the USAID /Manila, Philippines from April 1986 to April 1988, and was on sabbatical leave from the University of Georgia. Dr. Tommy Nakayama, food scientist, University of Georgia/Griffin and Peanut CRSP principal investigator on the Philippines and Thailand food technology projects, served as program director during this period. Barbara Donehoo was administrative secretary, and Michelle S. Dillard, UGA College of Agriculture Business Office, Athens, accounting assistant. Support staff: Ted Proffer, business manager, UGA College of Agriculture/Athens; Dr. Darl Snyder, director of international development and Title XII representative, UGA/Athens.

Board of directors

- Dr. Dudley T. Smith, associate director, Agricultural Experiment Stations, Texas A&M University
- Dr. B. Onuma Okezie, director of international programs, Alabama A&M University
- Dr. Charles W. Laughlin, associate director, Georgia Agricultural Experiment Stations, University of Georgia
- Dr. Billy Caldwell, head, Department of Crop Science, North Carolina State University
- Dr. Ron W. Gibbons, director of ICRISAT Sahelian Center and West Africa Programs, Niamey, Niger.

USAID – Dr. Loren Schulze, USAID/Office of Agriculture was the Peanut CRSP project manager.

BIDAD – William Fred Johnson was the BIFAD liaison to the Peanut CRSP.

Yield losses of from 25% to 100% are caused by rosette virus across sub-sahhelian Africa. Resistant vaireities have been developed and make large impacts on controlling rosette virus and increasing peanut yileds in West, East, and Southern Africa.

CHAPTER 13. ACCOMPLISHMENTS 1985-1990 GRANT

Research accomplishments in the 1982-1985 phase provided a good basis for the 1985-1990 phase, which will be evident in the summary of accomplishments.

A. Producer Values

GA/BCP/CAR
Cultivar and line testing continued in the Caribbean in 1986. Thirty cultivars tested for in Belize for high soil pH, and 13 were advanced to further evaluation. In Jamaica, 61 cultivars were tested and five were advanced to farm level tests. Two of 28 cultivars did well in Antigua; one was Tennessee Red.

Two Georgia Tifrust peanut lines were evaluated in Jamaica work. One (Tifrust 2) was released as a new variety in the 1986-87 project year. This Virginia type peanut has shown dramatic yield increases when compared to the currently grown varieties. It was named CARDI/Payne in honor of the late Horace Payne, who had been Peanut CRSP collaborator in Jamaica since the start of the program. It was an important accomplishment/impact since rust was a yield restricting disease in peanut across the Caribbean.

The project (GA/BCP/CAR) changed from cultivar development to post-harvest handling systems for the small producer (GA/PH/CAR) in 1987-88. The project was planned, and the Memorandum of Understanding was signed. Participants were listed earlier.

An old thresher from the University of Georgia/Tifton was refurbished and shipped to Jamaica in 1988 for research and development work, which was tractor mounted on a three-point hitch. A hand operated sheller with replaceable screens was fabricated at Georgia, which was further modified to adapt to pedal power operation. Extensive testing on different seed-sized peanuts was done in Belize.

The cultivar work continued in 1988 with the leadership of Craig Kvien, with particular emphasis on promoting CARDI/Payne in farmer tests. Kidang cultivar was also liked by the farmers. Selection efforts continued to evaluate rust resistance.

There were several areas of research across the islands in 1988-89. Open air drying on concrete floors common in Antigua was modified with a moveable shelter protection during rain times. In Belize, a kerosene dryer was added to a storage facility in a farmer cooperative to be more cost effective. The motorized thresher proved successful in Belize. A tractor mounted thresher was acceptable to farmers in Jamaica. Poor storage ventilation was found to lead to aflatoxin contamination in Belize. Planting and harvesting takes 22 % of labor in St. Vincent, which shows the need for mechanical interventions. A survey was completed to determine the focus of Trinidad research.

Research in 1989-90 continued to seek ways to maintain postharvest quality, and to reduce costs of harvesting, threshing and shelling. These high costs limit the expansion of the peanut crop. In the promotion of work that was done in Trinidad in the M.S. thesis of Urvan Wilson to test a harvester, different size threshers were also tested in Antigua, Belize, Jamaica, and St. Vincent. Shellers were also tested in these countries. Dryers and good storage conditions kept moisture below 10% for extended times and maintained less that 20 ppb aflatoxin. In general, it was demonstrated that better post harvest methodologies could be introduced.

TX/BCP/S
Collaboration began with the University of Ouagadougou, Burkina Faso in 1986. Five germplasm lines from a recent South American collection trip showed low rust scores in Burkina Faso. Leaf spot resistance is showing up in some Texas lines in West Africa.
Several germplasm lines recently collected from South America and pre-tested for leaf spot reaction in Texas showed good resistance to leaf spot and rust in Burkina Faso in 1987, and might be useful in breeding in both domestic and LDC programs.

A drought tolerant line yielding 20% over present cultivars was selected in 1988 in Texas and Senegal and should be released to growers in the near future. A leaf spot resistant line was also nearing release. The line developed in

Texas and Senegal yields 17% higher with 25% lower leaf spot incidence than present cultivars. A disease survey in Burkina Faso and Niger in the 1987 season showed leaf spot as the major disease. Rust was found in more humid regions of Burkina Faso. Pod rot was economically important in the drought affect areas of Niger. These findings show importance of focused disease resistance breeding.

Tests showed rosette virus disease to be a problem in non-resistant varieties grown in Niger. Thirty to 60 new lines were tested in N/BF/Mali. Leaf spot was a major concern in the U.S. and West Africa. Fleur 11 was the best variety tested in two Senegal locations.

The Spanish breeding line Tx798736-1 was released in Texas as 'Tamspan 90' in 1990, and yielded 11% higher than 'Starr' and had resistance to some important soil borne diseases (*Sclerotinia* blight and *Pythium* pod rot).

Fleur 11 performed well in 1990 at eight sites in Senegal with a 42.5% increase in yields over the widely grown Sn 55-437 variety. Progress was made in selecting lines for leaf spot and aflatoxin resistance. In Texas, 104 lines from ICRISAT/India and 250 germplasm lines from South American introductions were evaluated for several characteristics, particularly disease resistance, which would benefit both the U.S. and host countries.

NCS/BCP/TP

Thailand variety improvement research in 1986 found lines better than the check Tainan 9. One of them, Moket, has larger seed size and will be considered for release in Thailand.

In the Philippines, IPB Pn 2-25 was approved for release as UPL Pn 6. Multiple pest resistance in new varieties continued to be a priority, and NCAc 343 continued to be superior in these characteristics in the Philippines.

In North Carolina, two CBR resistant lines were increased in 1986. CBR is a serious disease of peanut in North Carolina. In 1987, one of these lines, NC AC 18417 a *Cylindrocladium* black-root rot (CBR) resistant selection from the cross of NC-8C and Florigiant, was approved for release to growers as NC-10C. It will replace NC-8C for use to manage the CBR disease, and was released to growers in 1988.

NC 10C – This was a cross between NC 8C and Florigiant made in 1979 and released in 1988. It was grown from 1988-2001 with a production maximum of 17,400 acres and average of 9,000.

NC-V11 – This was a cross between NC Ac 17257 and NC Ac 17922 made in 1975 and released in 1989. It was grown from 1990-present with a production maximum of 32,800 acres and average of 21,600.

Two peanut cultivars were officially released in Thailand in 1988. Khon Kaen 60-1 yields more and has larger seed than the commonly grown cultivar, and Khon Kaen 60-2 has improved boiling characteristics. UPL Pn-6, locally known as Biyaya 6, was increased and released for farmer use in the Philippines. The new cultivar out yields the local cultivars and has moderate resistance to leaf spot and rust.

In Thailand in 1989, a selection from the cultivar NC 7 was officially released by the Department of Agriculture (DOA) as a large-seeded type cultivar and named 'Khon Kaen 60-3'. It is the first large-seeded type cultivar ever released in Thai. This work also received the first prize award from the DOA as the best accomplishment of the DOA in 1988.

In the Philippines, a good yielding line with moderate resistance to rust, late leaf-spot, and *Sclerotium* wilt has been approved for release as UPL Pn 8.

Regional trials continue for identification of superior peanut lines in specific cropping systems in both Thailand and Philippines in 1989. Thirty shade tolerant entries have been identified and are being evaluated in yield trails as an intercrop under coconut in the Philippines, and the work continued into the 1990 season.

In North Carolina, the breeding line NC AC 18411 was approved for release in 1989 as NC-V11, and the release was official in 1990. It has resistance to *Cylindrocladium* black rot disease, termed as a root pruning disease due to death of roots when infected. It has good maturity and superior yielding ability. Early maturity and large-seeded types are of interest in selection.

Thailand research in 1990 continued to have priority on disease and insect resistance, and large seed and boiling qualities are also a priority. Peanut stripe virus is a focus at Khon Kaen University.

GA/PV/N

Peanut Stripe virus was found in the U.S. in 1982, and measures developed through this project to restrict seed distribution of infected seed were in place in 1985, which has limited spread and damage from the virus.

The nature of rosette virus work continued in 1985. Three types of disease reactions can be identified in plants that have been inoculated with aphids that had previously fed on plants infected with groundnut rosette. Some plants have no symptoms, but react positively in serological tests for a luteo virus. Other plants exhibit rosette symptoms, but do not give a positive serological reaction to luteo virus. Some plants exhibit symptoms and give positive serological reactions for luteo virus. Virus spreads when aphids feed on plants containing both components, the luteo virus, and the symptom inducing agent. Cooperators in the German and Nigerian laboratories have shown three types of infection: the luteo agent alone, the rosette symptom inducing agent alone, and both together. The luteo agent was in both resistant and susceptible lines, which suggests that resistance is not against the luteo agent. The typical GRV can be spread only when aphids feed on plants containing both components, the luteo virus, and the symptom inducing agent.

In 1986 one ton of seed of a rosette resistant variety were produced, RMP-12 (a 120 day maturity line) and best adapted to the southern area with a longer rainy season. In addition, three resistant lines are being increased. One line not resistant to rosette (RRB, a 110 day maturity variety) is being increased for the area north of Zaria. A production guide was produced for each growing area.

The use of insecticides that controlled the aphid vectors of rosette was effective in preventing rosette virus epidemics. An IPM recommendation made in 1987 of using systemic insecticide along with early planting and close spacing of peanut plants was effective against rosette epidemics, even when rosette susceptible cultivars were planted.

Many growers by 1988 had reduced or eliminated peanut production in Northern Nigeria because of the rosette epidemics of 1975 and 1985. CRSP research has helped define the etiology, epidemiology, and nature of host-plant resistance to rosette. Resistant cultivars are available for the longer growing seasons of Southern Nigeria but not for the shorter seasons further north. Three lines with shorter maturity and rosette resistance have been identified and recommended for release that will contribute to the solution of the problem. A breeder is being trained under the CRSP and will continue efforts to introduce resistance into short season cultivars adaptable to Northern Nigeria.

The GA/PV/N project was expanded to Thailand in 1988, and Dr. Sopone Wongkaew, Khon Kaen University was the primary cooperator. Later in 1988, it was expanded to the Philippines, with Dr. Marina Natural, University of the Philippines at Los Banos as the primary cooperator. Peanut stripe virus surveys and plans for research were begun in both countries. Preliminary studies on Peanut Stripe Virus (PStV) in Thailand in 1988 indicate that yield reductions to PStV may be higher than those observed in the United States. Symptom expression in Southeast Asia is also more severe than in the U.S. Control measures are under development to reduce yield losses from PStV.

In 1988, twenty-eight crosses for potential rosette resistance were made in the U.S. by the Nigerian graduate student, Phindile Olorunju. The F3 generation was being tested in Nigeria. Resistant (RMP 12) and susceptible lines for rosette are being increased and given to farmers in Nigeria to show them the value of resistant varieties.

In Nigeria, a mechanical inoculation procedure was developed in 1990 to screen groundnut plants for resistance to the green strain of rosette virus. Mechanical inoculation produced 100% infection in susceptible plants and 2% infection in resistant plants.

In Thailand in 1990, twenty-four isolates of peanut stripe virus from the Asia region showed 8 strains of the virus, and it was concluded that the virus had been present since 1972. In the Philippines, PStV and PMV (Peanut Mottle Virus) are the major viruses. TSWV (Tomato Spotted Wilt Virus) increased in Georgia in 1990, and 300 lines of peanut were tested for resistance, and work continued on PstV, and PMV.

NCS/IM/TP

An IPM plan was established and research initiated in 1986. Insect population thresholds for damage, planting date, seed rate, minimum tillage, double cropping, and cultivar were components for the IPM program. *Spodoptera litura* a major defoliator in the Philippines was studied. Chemical treatments for insects in Thailand were more effective if applied in the first 48 days after seeding. An international experiment established in Thailand, Philippines, and North Carolina in 1987 demonstrated that peanut germplasm selected for insect resistance in North Carolina exhibited similar resistance to the same genera of insects in Thailand and the Philippines. Furthermore, many genotypes were resistant to multiple pests in multiple locations or countries.

Multiple resistance studies continued in 1988, based on the 1987 results. Thrips cause earlier season damage in North Carolina, and later season damage in the Philippines and Thailand, but often at sub-economic levels. Tolerant varieties in the IPM program reduced the levels of thrip damage. The work continued in 1989 in North Carolina on IPM development; germplasm evaluation, use of pheromone traps to measure insect populations, and damage threshold levels to develop minimum pesticide levels, and this work carried on into 1990. The results point to an IPM program that is lower cost, effective, and lower in chemical use in the control of insect pests in peanuts.

The egg parasite *Trichogramma* sp. and a microbial pesticide *Bacillus thuringiensis* were incorporated into the pest management program in the Philippines in 1989 to enhance control of defoliating lepidopterous insects. Pilot IPM programs were conducted in multiple locations in the Philippines using the CRSP IPM package, and it was compared with farmer practices for pest management. The IPM package resulted in less damage and higher yields than the farmer programs. The IPM tests continued in 1990 in the Philippines and Thailand that considered economic pests present, use of chemical control measures, thresholds of insects that were economically important, cultural practices and biological controls. The IPM practices increased yields at lower input costs. In summary, the IPM research and outreach efforts showed that the reduced use of chemicals, insect resistant/tolerant cultivars, and timely applications of chemicals were more effective at less cost than the farmer practices.

A selection of NC 7 identified as KK60-3 exhibited multiple pest resistance and a higher yield compared with three local cultivars in three locations in Thailand in 1989. Other lines are being tested for pest resistance.

GA/IM/BF

Research in Burkina Faso in both 1985 and 1986 evaluated germplasm and varieties for resistance to insects, and some of the lines showed good resistance and will be incorporated into cultivars to contribute to the development of sustainable, low-input production systems. Thrips, jassids (leafhoppers), millipedes, and termites were found to cause most damage to peanut in Burkina Faso in 1986 work. The damage was most severe from termites late in the growing season, which also increased *Aspergillus flavus* growth and aflatoxin contamination.

Research in 1987 and 1988 confirmed the last season results that delayed harvest of groundnuts in Burkina Faso intended for better maturity increased termite damage to groundnut pods. In turn, the delayed harvest greatly increased the incidence of *Aspergillus flavus*, the organism that produce aflatoxin on groundnut seeds. Tests conducted in 1988 found termite resistant varieties and germplasm, and these lines will be incorporated into cultivars to contribute to the development of sustainable, low-input production systems

Chemical applications increased yields up to 30% in 1989 in Burkina Faso if harvested timely, but delayed harvest increased pod damage and decreased yields 30% and increased aflatoxin in seed, which ranged from 6 to 1600 ppb. Research including harvest dates from 90 to 125 days after seeding was conducted in 1990, which showed that delaying harvest from 110-125 days after planting was most notable and increased termite damage to pods by 27%.

Research in 1989 in Georgia to collect information on insect populations and control found that Lesser Cornstalk Borer did similar damage to pods as termite in SAT Africa, and served as a pathway for *Aspergillus flavus* invasion into unharvested pods and later aflatoxin accumulation.

NCS/SM/TP

Research in 1986 studied biological nitrogen fixation (BNF) in different strains of peanut in North Carolina. Microbial inoculants of seed to improve BNF in the Philippines and Thailand did not affect yields materially.

Seed levels of sugars, amino acids and other chemicals varied with strain of *Bradyrhizobium* used to inoculate seed, which could have an affect on their ability to fix soil nitrogen (North Carolina, 1987).

Earlier studies in Cameroon supported by the CRSP, showed a 28% yield increase of a local cultivar 28206 when inoculated with a particular rhizobium species, NC92. In 1988, a Cameroonian company was preparing to produce the rhizobium for local use.
More consistent yield responses to rhizobium inoculation of peanut were obtained in Thailand when molybdenum was applied with the inoculum.

Technology transfer in U.S. was observed in 1989. *Rhizobium* strains from the tropics, which are screened for domestic use, have been incorporated into commercial inoculum for peanuts by the major inoculum producer in the U.S. A contract was signed with two biotech firms in 1989 for further testing and possible use of an improved inoculum for commercial use. A major peanut product producer has recently contacted the principal investigator, Dr. Elkan, for the purpose of pursuing research in the modification of peanut seed composition through the use of our *Rhizobium* strains, with anticipated change in amino acids, free sugars, and fatty acids.

The project was not active in 1990 due to a reduction in CRSP funds.

TX/SM/TP
Mycorrhizal fungi inoculation in 1986 showed positive growth effects in peanuts in Texas, Thailand, and the Philippines. In effect, the fungi serves to expand the root systems and enables the plants to tolerate less desirable conditions, such as low soil water and fertility. Peanuts inoculated with specific mycorrhizal fungi in non-fumigated field soils in 1987 responded with an increase in root and shoot weights (i.e. mycorrhizal plants were larger that controls).

Evidence was accumulated by 1988 that documents the beneficial effects of mycorrhizal fungi on peanut growth. Differences in efficiencies of various species have been demonstrated. Mycorrhizal colonization in the roots increases yields, phosphorus and manganese uptake, rhizobium infection/nitrogen fixation, and water uptake, and also decreases nematode damage.

As reported in 1989, it was concluded that mycorrhizal fungi inhabit the roots of most plants, including important crop plants such as peanut, and promotes mineral uptake, protects roots from disease, and increases salt/drought/flood tolerance. Mycorrhizae may act synergistically with *Rhizobium*. Inoculation with *Glomus intraradices* spp. decreased nematodes on roots, and increased leaf area and dry weights after 54 days growth. *Rhizobium* and mycorrhizae inoculation enhanced total biomass production.

The project was not active in 1990 due to a reduction in CRSP funds.

B. Processor values

AAM/FT/S
Research in Sudan in 1986 showed that the nutritive value of bread and cookies increased with addition of peanut flour. Similarly, Gari and Kishara were improved. Further study in 1987 on fortification of sorghum-based Kishara, a commonly used Sudanese product, showed that a very acceptable Kishara can be prepared using peanut flour up to a 30% level. This study provided an opportunity to work cooperatively between Peanut CRSP and Sorghum-Millet CRSP (INTSORMIL) in SAT African countries.

The work on Kisra was completed in Sudan in 1988, and the product was acceptable and has increased protein and other nutritive value. Kisra is a thin, pancake like leavened bread made from sorghum floor. It is a staple in the sorghum growing areas of Sudan, and is presently consumed with peanut products. Combination assures better nutrition in daily diet. Water and steam blanching and storing in glass jars extended shelf life of peanut up to three months. Peanut milk can replace regular milk in mish, a yogurt like product.

Due to problems of unrest in the Sudan the project was moved to Burkina Faso. In 1988, an MOU was completed with the University of Ouagadougou, Burkina Faso and research was initiated. The participants were listed earlier.

In Burkina Faso in 1988, a survey was made of peanut for protein, fat vitamins and aflatoxin. Peanut paste samples were also collected.

The successful Kisra research in Sudan was applied to Toe in Burkina Faso in 1989, and used 80% sorghum and 20% defatted peanut flour. The peanut and peanut paste samples from the 1988 quality surveys continued to be evaluated. It was concluded from the earlier surveys that the major constraint in increasing peanut utilization in SAT Africa was the unavailability of peanut in processed forms at affordable costs; packaged roasted, butter, defatted flour, milk, candies and other confectionaries. Secondly, contamination of peanut with molds, insects, and mycotoxin further limits the utility for human consumption.

Toe (boiled flour) is a major sorghum food in West Africa. An 85% sorghum and 15% defatted peanut flour increased the protein content of Toe by 66% and was acceptable by sensory evaluations in 1990. Boiled peanuts and peanut paste obtained from markets in Burkina Faso show that protein and fats are variable, and both defatted and full-fat pastes are available. Significant aflatoxin levels were present. These results show the need for quality control research.

GA/FT/TP
Surveys in Thailand markets in 1986 showed that consumers are highly acceptable of roasted peanuts in general and also incorporated into various products. A Thai peanut /sausage product was good. Shelf life work in Philippines used heating of peanut to delay rancidity. Exceptional progress has been made in 1987 toward utilizing peanut in the form of spreads for bread and crackers, and in beverages, sausage and noodles. These products show potential for acceptability among Thai, Filipino and U.S. consumers.

In Thailand in 1988, work was conducted on unroasted peanut paste for use in meat, fruit, and chocolate pastes. The products were acceptable, and the peanut was hot water treated rather than roasted. Also work with peanut butter bar, spread, beverage, and meat mixture work continued with acceptable products produced.

In a survey in the Philippines in 1988, eighteen food products were collected to study quality, acceptability, texture, and other quality factors for the potential product improvement. In the same collection, analyses showed 55% of peanuts, and 27 % of products tested positive for aflatoxin. A milk type product made from peanut was of interest.
Fried peanut patties from Bangkok markets in 1989 showed that 88% had 20% or more aflatoxin, and were often rancid. This showed the need for product improvement. Product testing showed that 7.8% peanut protein in ice cream was acceptable.

Food products (such as meat products) packaged with full fat films in the Philippines become rancid. A substitute film made with peanut was under test in 1989.

Further work was being done in Georgia on peanut beverages.

Three foods that contained peanut were produced at pilot scale in Bangkok in 1990: peanut supplemented Chinese-type noodles, supplementary food for pre-school children, and defatted peanut flour. Protein content was higher and the products were acceptable in sensory tests.

The potential for expanded success of peanut based products in Philippines, Thailand, and the U.S. is shown in the 1986-90 research.

AAM/FL/FT/CARDI
Surveys completed in 1986 have identified problems in post-harvest handling and storage in the Caribbean. Problems include: length of harvest period results in non-uniform maturity; poor storage conditions; aflatoxin contamination, low quality standards during processing; and low oil content causes texture problems in products.

Cooperative efforts with industry included the study of peanut butter quality from Jamaica Frozen Food Plant that showed problems of low quality peanuts, oil separation, and undesirable color and texture.

The cause of an unacceptable textural quality of peanut butter made from Jamaican peanuts (Valencia) was determined in 1987 to be low oil content. The texture can be improved by including additional amounts of oil in the formula. This confirmed the findings of the 1986 survey.

A survey was conducted in May 1984 to provide the basis for research in Trinidad, St. Vincent and Jamaica. Fresh seed quality, poor curing and storage, mold, texture, color, maturity were identified problems. Maturity indices were done by Margaret Hinds for an M.S. thesis (begun in 1985 and completed in 1990), which influenced later work by Dr. Chinnan in the GA/PH/CAR project that began in 1988 to replace the present project.

Proximate compositions, fatty acids, and amino acids were determined in 1989 on cultivars grown in Jamaica in 1986. Physical characteristics and sensory evaluation data on pods have been determined to provide a basis for establishing maturity indices for the cultivar NC 2 grown in the Eastern Caribbean region; also fatty acid composition of Eastern region peanuts was determined. The goal was to improve post harvest quality with adapted procedures.

The project was not active in 1990 due to a reduction in CRSP funds.

C. Consumer values

TX/MM/S
Peanut cultivars were screened for resistance to *Aspergillus flavus* and *A. parasiticus* in Texas in 1987, which revealed that the cultivars Florunner, SN 55-437, J-11, and several selections from the breeding program were less severely infested with these fungi compared to the check cultivars. Low seed coat permeability of *A. flavus* slowed aflatoxin production in seed. Shells, which formed sclerenchyma bands early in their development, were less susceptible to hyphal penetration from the fungus. Kernel invasion was influenced by hilum and testae structure. Tannin-like compounds from testae of some cultivars inhibited *A. flavus* growth and aflatoxin production. These results can apply to use in both the U.S. and host countries.

Peanut cultivars tested for resistance to soil-borne plant pathogens under field conditions in 1988 revealed that some select breeding lines have moderate levels of resistance to invasion by the aflatoxin producing fungus, *Aspergillus flavus*. Little is known of the mode of resistance, but recent research points to the presence of a protein synthesized shortly after fungal inoculation, termed “pathogenesis related protein,” that contributes to the defense. Enzyme levels and free phenolic acid levels were higher in lines that resisted *Aspergillus flavus* infection in 1989 studies.

The aflatoxin content of contaminated peanut paste was reduced by approximately 80% of the original concentration after boiling in water for about two hours.

Research continued to transfer methodology to the village level in Senegal, specifically the use of highly adsorptive clays for removal of aflatoxin from crude peanut oil and adaptive studies showed over 90% removal. Further experiments to remove aflatoxin from peanut oil (22-34 ppb aflatoxin in oil) were conducted in Senegal/ITA Dakar, and aflatoxin was lowered to less than 1 ppb by bentonite clay. Adsorbent clay did not affect any oil quality characteristics. Tests in Senegal in 1990 evaluated aluminosilicates (NovaSil) to adsorb aflatoxin in peanut oil, and showed that over 98% of aflatoxin was removed from samples containing 160 ppb aflatoxin B1. Clays used to eliminate aflatoxin from peanut oil were hard to remove from the oil and required centrifugation to remove the clay, and settling and filtration was slow and impractical for use at the field level.

Subsequent poultry studies in Texas have shown that a small percentage of the NovaSil clay, when added to diets that were highly contaminated with aflatoxins significantly prevented growth faltering and other adverse effects in young chicks.

Other work in Texas showed the field-practicality of rapid analytical tests for mycotoxins (SAM) that used mycotoxin-selective sorbent materials packed in novel mini- and micro-columns to separate and identify prevalent toxins from maize and peanut.

CHAPTER 14. SUMMARY OF MAJOR ACCOMPLISHMENTS AND IMPACTS FOR 1985-1990 GRANT

A. Producer Values

Genetic Resources Improved – During this phase, the Peanut CRSP continued to assess the world collection of peanut germplasm and used it to develop, through conventional and advanced biotechnological techniques, genetic lines with superior attributes. Based largely on the material introduced in host countries in the 1982-1985 efforts, and the extensive base in the U.S., thirteen cultivars (8 in host countries and 5 in the United States) were released for grower and consumer use. These new cultivars have higher yield potential, increased tolerance to diseases and insects, and better quality and consumer acceptability. Development of other cultivars with additional tolerance to drought and aflatoxin was still ongoing.

Termite resistance – A genetic line resistant to termite was identified in Burkina Faso; its use in breeding programs will reduce insect-related pod damage and resulting aflatoxin contamination. In addition the insect population and severity continued to be defined. Reduction in termite damage with resistant genotypes suited to the maturity and drought-stress constraints in Burkina Faso gave higher percentages of undamaged pods, which by using conventional baseline data could attain benefits estimated at $50,000 annually by adoption of the cultivar by the nation's growers. Since aflatoxin contamination is directly related to pod damage and to delayed harvest, changing cultivars and digging the crop at normal maturity should reduce aflatoxin levels by a significant degree and contribute to food safety and environmental quality.

Rosette virus resistance – In much of West Africa, rosette disease is a critical constraint. Rosette normally infects 5-10 percent of plants on an annual basis and can cause total crop loss in epidemic years. Two cultivars resistant to rosette virus were re-selected, increased, and distributed to Nigerian farmers; and their use will help increase yields now lost to this virus, a potential of up to an average of 25% increase in yields. The most promising, RMP-12 (SAMNUT 10), requires too long a growing season for much of the Northern SAT Africa area, but is a useful source of resistant germplasm for breeding already in progress to stem the downward slide in peanut production in West Africa, which has adversely affected food supply, nutrition, and farm income. The second variety was RRB (SAMNUT 18) that matures in 110 days is more suitable to the northern areas of the country.

Black rot resistance – Growers in North Carolina can use a cultivar determined to be resistant to a major disease, *Cylindrocladium* black rot. The cultivar, NC 10C, was released in 1987 and saves growers the cost and environmental impacts of chemical control of the disease. A second resistant cultivar, NC-V 11 was released in 1990 for the North Carolina-Virginia growing area. NC 8C was released earlier. The cultivar, NC 10C, was expected to become a key component in the program to control *Cylindrocladium* black rot disease by genetic resistance and reduce chemical outlay and minimize environmental effect, with the other cultivars contributing in areas of specific adaptation.

In Thailand, three new cultivars were released. Khon Kaen 60-1 was higher yielding with larger seed size. Khon Kaen 60-2 is 12% higher yielding with improved pod characteristics. Khon Kaen 60-3 was released as the first "large seeded" peanut cultivar in Thailand. In the poverty-stricken area of northeastern Thailand, the new cultivars grown with the available low input management practices gave an average 24 % advantage in farmer's fields for a potential to return an additional 42,000 metric tons with a current market value of $20,000. The three new cultivars increased supplies of food for each of the normal ways peanut was consumed in Thailand: boiled, roasted, snacks, as food ingredients, and as peanut butter. The Thai Department of Agriculture recognized the Khon Kaen 60-3 cultivar as the Outstanding Research Accomplishment of 1988. These new cultivars should increase farmer interest in an increased level of production and market value.

In the Philippines, a new cultivar was named UPL Pn-6, was resistant to insects, rust and leaf spots, and yielded 14% more than the standard cultivar. It was entered into an R&D program led by PCARRD in Northern Luzon that was expected to increase farmer peanut yields by 50%. In 1989 estimates from the R&D program showed that UPL Pn6, with a average 14% increase over the standard cultivar, had the potential of increasing the value to Filipino farm families by more than $3.5 million. UPL Pn-8 was released in 1988, with good yields, and moderate resistance to rust, late leaf spot and *Sclerotium* wilt. Shade tolerant genotypes, identified in the Peanut CRSP program at Los

Banos, have potential for even greater impact for food security by expanding production to new areas through intercropping the extensive coconut groves of Southeast Asia.

In Jamaica, rust and leaf spot pathogenic fungi limit peanut productivity in Jamaica (and several other Caribbean nations). After evaluation of some 200-CRSP-supplied genotypes under farmer's management regimes and with end product commercial processing, one line with resistance to the rust and leaf spot diseases and produced high yields was released as the cultivar CARDI/Payne in Jamaica where rapid small farmer acceptance was observed. Notably, the cultivar was named for the late Horace Payne, peanut breeder and original Peanut CRSP collaborator at CARDI/Jamaica. The local extension service established a demonstration program that also provided seed for farmers that later showed increases in yields of 25% along with higher farmer profitability.

The development and release of the Langley and Tamrun-88 cultivars in Texas should have impact in the Southwestern U.S. production area and in West Africa. Langley, a short duration bunch cultivar of the Spanish market type and Tamrun-88, a runner market type, both have higher shelling grade and yield. Tamrun 88 was not as high yielding, but contributed to the areas growing runner types. The "first sale" increase in gross return with normal penetration of Tamrun-88 in Texas agriculture was estimated at 1.0 to 1.2 million dollars annually. Tamspan 90 a new Spanish type cultivar was released in 1990. Tamspan 90 had 11% higher yields than the variety Starr in the Texas-Oklahoma growing region and has resistance to *Sclerotinia* blight and *Pythium* pod rot. This genotype should reduce the risk of loss from *Pythium* pod rot and *Sclerotinia* blight. Moreover, under heavy *Aspergillus flavus* pressure, the aflatoxin content of seed produced by this genotype averaged 15 per cent lower. The projected annual gross increase in Texas was expected to initially exceed $1 million/year. Where *Sclerotinia* blight limits the Florunner cultivar, substituting the new genotype should contribute another million dollars annually.

The U.S. stands to benefit from 305 rust resistant lines contributed by collaborators in West Africa.

Three years of cooperative research on peanut stripe virus (PStV) introduced into U.S. germplasm pools from Chinese introduction led by two Peanut CRSP principal investigators in Georgia, resulted in the elimination of State Department of Agriculture restrictions upon the interstate movement of peanut seed which increased estimated sales by $100,000 annually. PStV was found to be in the same plant virus group as peanut mottle virus (PMV), was vectored by the same aphids, and was seed transmitted. If PStV becomes established in commercial fields in Georgia, and spreads like PMV, a one percent loss could occur, costing Georgia's growers an estimated $5 million.

Early research searched for more effective strains of rhizobium for increased nitrogen fixation, and to determine to contribution of mycorrhizal fungi on peanut plant growth. Mycorrhizal fungi on peanut roots may in effect increase the root capacity and functions in plant growth.

Insect tolerance – Insect-tolerant peanut lines have been identified in Burkina Faso, the Philippines Thailand, and the United States that can be used in development of insect-tolerant cultivars. A line identified in North Carolina State University – Philippine collaborative research (NCAc343) had broad-based resistance to insects, and has been used extensively in U.S. and worldwide insect resistance breeding programs.

Biological control agents – Growers in West Africa and Southeast Asia now use more biological agents for insect control.

Integrated Pest Management Introduced – Peanut CRSP researchers have determined insect life cycles, alternate plant hosts, time of appearance of insects on the crop, insect population levels, and subsequent damage to the plant. Such knowledge provides the basis for integrated pest management (IPM) recommendations and programs that contribute to lower use of chemicals. Research is ongoing in genetic control through resistant cultivars, cultural control, biological control (fungal, bacterial, and parasitic insects), and naturally occurring chemicals. Improved IPM programs promise to provide economic and safety benefits to farmers and to lessen the potential harmful effects of chemicals on the environment. Breeding programs can use peanut lines selected for their increased tolerance to insects to develop insect-resistant cultivars. Development of pest-resistant cultivars, and cultural and biological controls have already helped guide IPM strategies in North Carolina, Thailand, and the Philippines, and in Georgia and Burkina Faso.

Threshold establishments – IPM research has established thresholds for economic damage from insects to minimize the use of chemical pest control. These contributions were noted in the Philippines, Thailand, Burkina Faso and the United States.

As an example of the value of the early implementation of IPM, the development of IPM for peanut in the North Carolina-Virginia area centered on southern corn rootworm. Use of the tolerant NC 6 cultivar cut in half the cost of systemic insecticides, provided even greater savings in costs of applying the chemicals, and reduced the environmental impact. Under current production costs, monetary savings in the area could reach $1.5 million annually.

B. Processor Values

The Peanut CRSP sought to harvest, store, and process peanut in ways to supply adequate quantities of safe and acceptable products to consumers. Primary objectives were to increase awareness of the high energy and protein value of peanut; and to increase the use of peanut in traditional foods; and to develop new products culturally acceptable.

Research achievements on drying and storage technologies and application of aflatoxin detection methods to peanut pastes showed how peanut quality can be improved and maintained after harvest to processed foods. This information was presented to food industry personnel through universities in the Philippines, Thailand and Burkina Faso. These efforts provided knowledge on the proper storage/handling of peanut products and the control of Aspergilli/aflatoxin contamination.

Food consumption surveys in Africa, Southeast Asia and the Caribbean helped determine the dietary habits and food needs of people in the individual countries and the acceptability of peanut as a food product. This information was used to guide food processing research and the design of new products. Some examples of potentially useful new products identified and part of early research were: in Sudan, "kisra" (thin bread) was enriched with peanut flour; in the Philippines; a peanut-based cheese-based cheese-flavored spread was accepted by consumers; in Thailand, peanut flour-enriched wheat noodles were highly acceptable to consumers. Major problems in peanut utilization identified in Jamaica, St. Vincent and Belize were non-uniform maturity, poor storage, aflatoxin contamination, small processors that were unable to control quality, and high product cost to consumers.

A wide range of peanut containing products were developed or improved and consumer tested in the Philippines and Thailand to help determine food preferences and program direction. Similar work was conducted in Sudan. The formulation of dairy-like products from peanut such as milk, yogurt, coffee whitener, and simulated cheese pastes were technological developments achieved by the Peanut CRSP and tailored for acceptability in Southeast Asian countries, in particular the Philippines. Similar achievements were noted in Thailand where Chinese noodles were fortified with peanut proteins to a level equivalent to that of meat. The direct economic benefits of peanut advances as food in Southeast Asia were estimated at about $4 million with a potential return of up to $40 million per year.

Utilization research supported by the Peanut CRSP produced nutritionally superior quality food product(s). The work in Sudan with 'Kisra' (thin pancake-like leavened bread made from sorghum flour) blended sorghum and peanut flours and showed the potential impact on food supplies and incomes. The use of peanut flour in the blend improved protein levels in a protein-deficient diet. Presently, peanut cake is used as feed or fertilizer. As an edible flour, its value increases substantially. It was estimated that in Sudan "one million lb/yr" of peanut flour could be processed for kisra, a net processed value of U.S. $10 million. Similar estimates were made for "toe" in Burkina Faso. Another major benefit was the reduced suffering and medical costs due to the sorghum-induced pellagragenic effect.

Cooperative research in the 1982-1985 phase with the University of Georgia, the Philippines, and Thailand developed a method to hand sort visually damaged and aflatoxin contaminated peanuts from a lot of peanuts that improved their processing value and provided more health benefits for consumers. The seed were heated to remove the skins, and then steam heated for two minutes to enhance the brown color that indicated aflatoxin contamination. The method was further perfected and used during this phase with great impact on food quality.

C. Consumer values

The Peanut CRSP has a goal of seeking ways to harvest, store, and process peanut in ways that will supply adequate quantities of safe and acceptable products to consumers. A major objective in this goal was to minimize and detoxify aflatoxin, a highly carcinogenic metabolic product of *Aspergillus flavus*, in food products. *A. flavus* is a ubiquitous fungus that produces aflatoxin and infests peanut and other feed and food products, such as rice, maize, and coconut products from the field to storage. There are costs attached to aflatoxin, such as health implications, and decreased value of the produce and products. Aflatoxin has been a major concern for the Peanut CRSP since its inception.

Clay – Research at Texas A&M University with a linkage to Senegal research has shown that local bentonite clays removed aflatoxin from crude peanut oil (first reported in the 1982 Annual Report). The clay later defined as best was an industrial clay (NovaSil). Small quantities of NovaSil added to poultry feed bound the aflatoxin and prevented it from accumulating in poultry livers. The use of the clay as a feed additive, promises to be an efficient and widely adaptable means of controlling aflatoxin contamination in both peanut and other food products. This research has drawn worldwide attention from scientists and industry. Estimation of the value of improving human/animal health by reducing the aflatoxin hazard in food and feed are almost incalculable. Aflatoxin ranks among the most serious carcinogens known.

Varietal resistance – A new peanut line with partial resistance to aflatoxin accumulation in the seed and was scheduled for release in Texas. This can result in 15% lower aflatoxin levels and possible annual gross returns in the United States of $ 1 million, with potential sharing with collaborators in West Africa.

Methodology – Mini- and micro-column chemical methods for aflatoxin detection developed in the first phase have been improved and simplified, so that they were useful and affordable and available in developing countries. The hand-sorting technology to remove aflatoxin contaminated peanuts and keeping them out of the food-chain has great impact on the consumer of peanut products (also reported in processor value sector).

D. Information/training/impacts

Information.

The Peanut CRSP co-sponsored with ICRISAT, World Meteorological Organization (WMO), and the Food and Agriculture Organization of the United Nations (FAO) the International Symposium on Agrometeorology of Groundnut in the Semi-arid-tropics in Niamey, Niger in 1985.

A peanut CRSP workshop was sponsored in Khon Kaen, Thailand August 19-21, 1986.

The West Africa Groundnut Workshop was initiated in cooperation with ICRISAT/Niamey in 1988 and will generally meet biannually. Scientists from across the region meet for formal paper presentations, informal discussions, and other communication and planning activities to enhance peanut research and development in the region.

The Peanut CRSP-ICRISAT cooperative publication, the International Arachis Newsletter (IAN) continued.

Training

A number of host country, non-host country, and U.S. students were trained for M.S. and Ph.D. degrees. These will be listed in a summary of all students from 1982-2012, since the beginning and ending dates of many of these crossover program phases. The numbers and country and regional representation of non-U.S. students and the number of U.S. students show the high focus on human capacity development in the Peanut CRSP. A number of students were supported in programs in their own countries. Both the foreign and U.S. students did research for theses and dissertations that benefited both the U.S. and the home countries of the students.

Short-term Training. Key to research was short-term training of host country collaborators. Some did not have interest/confidence in language skills and academic background to opt for degree training, but were important to program and long-term contributions to their country, while some had advanced degree training. Participating host country scientists benefited from short-term training visits to the U.S. as well as in long-term contacts with U.S. scientists. Some of these will be listed.

Scientist participation was active in 1986-1987. U.S.-based scientists participated in 330 total days of overseas collaborative and support work; this reflects approximately 1.27 man years of senior scientists interacting with counterparts in LDC research sites and program coordination. LDC based scientists reviewed programs and discussed mutual interests; 14 scientists and LDC representatives visited collaborators at several U.S. research locations – primarily on a scientist-to-scientist basis. Common methodologies and research plans resulted to advance on-going research initiatives.

During 1987-1988, 13 host country (HC) scientists visited U.S., 10 HC scientists visited "third country" scientists. There were 25 HC students supported by HC budgets enrolled in graduate programs. Also, there were 24 students (22 U.S. and 2 HC) supported by U.S. budget components. In addition, 14 U.S. scientists made site visits in HCs, 225 days or 0.96 many years.

During 1989-1990, 10 HC scientists visited U.S. counterparts, and 16 HC scientists visited third country scientists. There were19 HC graduate students in U.S. universities, and five completed M.S. degrees at Kasetsart University in Thailand. Also, 20 U.S. scientists visited HCs for a total of 270 many days.

Impacts

Although, the 1985-1990 phase did not have high focus on impact assessment, it was recognized early that research should focus on the needs of the end-users. Effective use of natural resources (agronomic, economic, engineering, and sociological) enables efficient production and consumption of peanut. Agronomically, cropping practices must ensure that production is sustainable and is not detrimental to the environment. Labor-saving mechanical devices need to be introduced where feasible. New technology must fit into the sociological framework of the society. Food supply and income levels should increase. Above all, the total system must be economical.

Production survey – In the Philippines, a production survey helped determine the direction of research to relieve present constraints.

Soil resource analyses – In Burkina Faso and Thailand, soil resource analyses of research sites assisted in transfer of information to production areas.

Food consumption surveys – In the Caribbean, the Philippines, Sudan and Thailand, food consumption surveys assisted in development and improvement of food products directed to fit local tastes, consumption patterns, and expressed needs for new processes or products.

Socioeconomic study – In West Africa, a socioeconomic study identified constraints to production and use of peanut.

CHAPTER 15. EXTERNAL EVALUATION REPORT FOR 1985-1990 GRANT

An External Evaluation Panel (EEP) is an integral part of all CRSPs as defined in the guidelines developed by BIFAD/USAID. The external evaluation by the EEP is most important to the CRSP operations to assure objectivity in decision making on important and sometimes difficult institutional issues. Some evaluation may be done annually with a major review toward the end of a grant to aid in the development of a proposal for the next phase. The EEP was to 1) review projects and programs of the CRSP and provide written evaluation, and 2) make recommendations for the addition, elimination, or modification of component projects and overall objectives; to include retention, elimination or addition of new overseas sites.

The new set of guidelines for the CRSPs was circulated by BIFAD/USAID on June 21, 1985 that further defined the EEP roles. These guidelines had been under development for some time, and some of the bases were incorporated into the Peanut CRSP review, when the EEP had their first activity in July 1984. The 1985 guidelines gave the following principles for an evaluation. 1) Maintain programmatic focus and effective scientific balance of research toward achievement of objectives; 2) Identify inadequate performances, and identify activities irrelevant or marginal to CRSP objectives; 3) Consider effective balance between research and training for development of institutional research capacity; 4) Assess the balance of domestic versus overseas research in terms of effectiveness to resolve constraints in developing countries; 5) Evaluate the cost-effectiveness of the entire CRSP operation in terms of actual cost of doing business versus costs of alternatives that may require less funding, or may otherwise be more efficient or more effective; 6) Examine ways of dissemination of research results, and the effectiveness of utilization, a measure of the appropriateness of the research; 7) Report its findings and recommendations annually to the ME, the board, USAID and JCARD/BIFAD.

A slate of EEP nominees was proposed by the principal investigators, technical committee, board of directors, and program director during mid-1987. The board later approved a list of four nominees that were presented to USAID/BIFAD, which approved them in June 1988. Their selection was based on: 1) a background in and a basic understanding of science, 2) experience in international agricultural research and/or development and knowledge of developing country problems, 3) specific in-depth experience in peanut research, and 4) an understanding of the U.S. land-grant research system. Members selected were:

- Dr. John P. Cherry, director, USDA/ARS Eastern Regional Research Center, Philadelphia, food scientist/biochemist (strengths 1, 3, 4)
- Dr. Ray O. Hammons, special consultant to the EEP, and retired as supervisory research geneticist, USDA/ARS, Tifton, Georgia, with long-time peanut genetics/breeding experience and international knowledge (strengths 1, 2, 3, 4)
- Dr. Allan J. Norden, emeritus professor of agronomy, University of Florida, and formerly peanut program leader for Florida, successful peanut breeder with strong international knowledge (strengths 1, 2, 3, 4)
- Dr. Johnny W. Pendleton, emeritus professor of agronomy, University of Wisconsin and department head, formerly professor of crop production, University of Illinois, formerly head of the Multiple Cropping Department and leader of farming systems research, International Rice Research Institute (IRRI), Philippines, and deputy director of the General International Institute for Tropical Agriculture (IITA), Nigeria (strengths 1, 2, 3, 4).

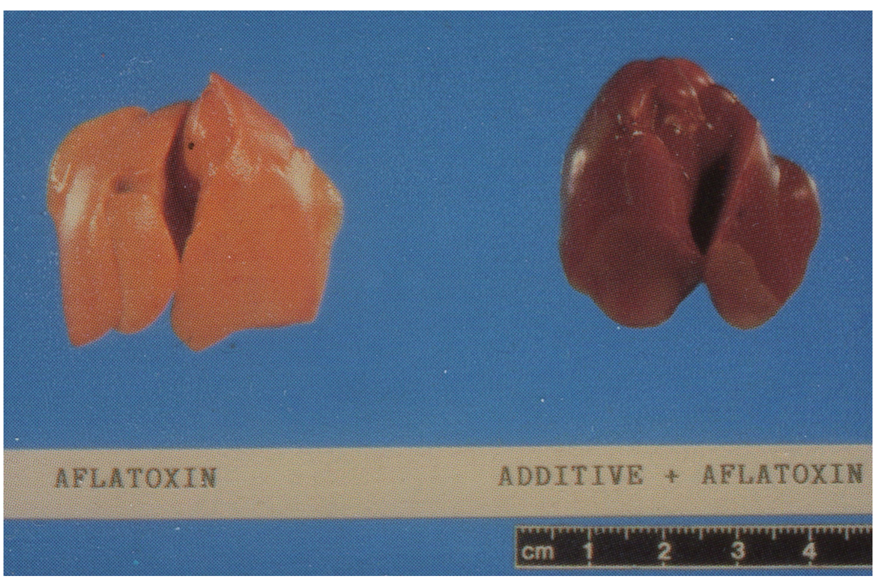
A scope of work was developed that reduced duplication in the review process that included: achievements of objectives; implementation and management of projects by researchers and administratively; institutional development; adequacy of science, applicability of research to host country and U.S.; observations of strengths and/or weaknesses; and recommendations.

The External Evaluation Panel (EEP) evaluation, which included host country and U.S. site visits, was conducted from January to November, 1989 for the 1985-1990 Program and Recommendations for 1990-1995 Program (Extended one year until 1996). Many of the conclusions in the 1989 review considered the results of the 1982-1985 phase, due to the short-time of the 1982-1985 phase to study long-term research such as variety development and most projects had completed eight years of research.

Based on the accomplishments with special view of the 1985-1990 phase, the EEP recommended extension of the Peanut CRSP for continued development of sustainable agricultural systems that are environmentally sound. Included are crop production systems, postharvest and utilization technology that will produce sustained levels of quality food, improved technologies adapted to resource management systems, and a bridge of the communication gap between the researcher and the end-user. Also, graduate and short-term training is an important component of the research program along with the provision of key items of equipment. The diets, economy, and production systems in the focal regions of the Peanut CRSP were improving, but hardly keep pace with the growing populations. Peanut is a legume adapted to areas of the world where food problems are greatest, provides nitrogen for itself and for a positive soil nitrogen balance for other crops, fits into many mono- and multi-cropping systems, and provides a source of high protein and energy food and cash income for rural and urban people. Therefore, the Peanut CRSP should be extended so that it can continue its role in enhancing the well-being of people in developing countries as well as the United States.

The recommended plan will address low yielding cultivars, yield losses due to pests, health hazards due to mycotoxins, food supplies inadequate, resource management (agronomic and socioeconomic evaluations), inadequate numbers of trained researchers, and information not available to disseminate new and improved technologies. Specific recommendations led to the development of a five-year plan, approval by the Peanut CRSP Management, presentation to and approval by USAID and BIFAD.

The plan for 1990-1995 (later extended one year to 1996), the value of peanut in developing countries and the goals of the CRSP to attain development, constraints to be addressed, the global plan for the program, and the projects that will make up the research program to resolve the constraints and provide technologies to improve food supplies and contribute to economic development will be presented in Chapter 16, Description of 1990-1996 grant.



NovaSil Clay added to poultry rations high in aflatoxin prevent aflatoxin from accumulatiin in and damaging poultry livers.

Chapter 16. Description of 1990-1996 Grant

Introduction

Peanut is a crop grown in most countries, both developing and developed, between 40 degrees North and 40 degrees South latitudes. The constraints to peanut production and use are similar worldwide, and there is the potential for collaborative research to relieve these constraints. Peanut can contribute to an increased food supply in areas where total food and protein supply is marginal.

It is becoming more and more evident that agriculture must be sustainable and was a goal for USAID during this phase. Peanut contributes to sustainability because it can be productive while maintaining or enhancing the environment in at least these ways: 1) Fixation of atmospheric nitrogen through bacterial symbiosis, thus returning nitrogen to the soil for its own use and for use by future crops; 2) Provides a nearly closed canopy that minimizes soil erosion; 3) A relatively short growing season that makes it fit within a range of cropping systems, both monoculture and multi-cropping, as well as intercropping with grain crops and under-story planting in tree crops, and it can be planted late in the season in case previous crops have been lost or were poor producers; 4) An important source of high protein and energy for humans, as well as a high-quality animal feed; 5) Provides a source of cash income for rural and urban people; 6) Helps meet need for vegetable oil; 7) Tolerates drought conditions, including the extreme drought of Sub-Sahelian Africa, and peanut is also able to mature in the short rainy season of that area; and 8) Suppresses weeds when intercropped with grain crops, which reduces labor-intensive weeding activities.

The Peanut CRSP was implemented for 1982-1985, followed by a 1985-90 phase (initiated for 1982-1987 but adjusted to 1982-85 and 1985-1990), and subsequently this 1990-1996 phase. The CRSPs were created to implement the Title XII program of the United States Foreign Assistance Act of 1975 with a goal to prevent famine and establish freedom from hunger through land-grant university involvement in international development. To attain the goals, the research capability of both developing country and United States institutions is enhanced through training and support of research. Inherent in the CRSP concept is the need to address constraints that have global implications.

Constraint Driven

The Peanut CRSP was designed around a set of constraints to sustainable production and utilization identified during the 1980-1982 Planning process. Based on the numerous advances achieved by the Peanut CRSP during the 1982-1989 phase, the external evaluation panel in 1989 evaluated the continuing validity of the following constraints and found them to be valid as a basic framework for the Peanut CRSP in the near future. With some adjustment in the project designs to address the constraints, the Constraints have remained similar over this period.

1) Low yields because of unadapted cultivars and lack of cultivar resistance to diseases, insects, and drought;
2) Yield losses due to infestations of weeds, insects, diseases, and nematodes;
3) Health hazards and economic losses due to mycotoxin contamination;
4) Food supplies inadequate and lack of appropriate food technologies to exploit a relatively well adapted peanut crop that is not generally considered a primary food source;
5) Physiological and soil microbiological barriers to higher yields;
6) Resource management (agronomic, engineering, economic and sociological) situations preventing efficient production and utilization;
7) Inadequate numbers of trained researchers and support personnel; Lack of adequate equipment to conduct research; Information is not available to beneficiaries for support of production and utilization efforts.

Global Plan for July 1, 1990 – June 30, 1995.

In 1995 due to strategic planning and funding situations in USAID, the program was extended one year to June 30, 1996.

Peanut has a global nature as a result of the worldwide nature of the crop, the importance of the crop in both developing and developed countries, the marked similarity of production and utilization constraints worldwide, the potential for research to relieve production and utilization constraints and better realize this potential to contribute to an increased food supply in countries where total food and protein supply is marginal, and the synergistic effect of international cooperation among international agricultural research centers and other donor groups.

Global Thrusts – Sustainability of production and delivery of food to the population was a primary problem in the developing world. USAID strategy during this phase focused the thrust in this direction. Based on the importance of peanut in contributing to sustainable production of food, and the problems facing optimization of the crop, the Peanut CRSP had three global thrusts related to sustainability; research addressed the above seven constraints as well as the following efforts that addressed sustainability.

1. Sustainable agriculture production and food delivery systems that were environmentally sound were the major global research thrusts of the Peanut CRSP to relieve the identified constraints to peanut production and utilization.
2. Resource management research to relieve situations that restrict efficient management of production and utilization systems.
3. Communication of research outputs to clientele.

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

Since its inception, the Peanut CRSP has enhanced research and technology activities through synergistic relationships with other international organizations. Cooperative planning, support for research, and conduct of workshops and other outreach activities characterize these global relationships. Organizations include the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT, based in Patancheru, India), ICRISAT Sahelian Center (Niamey, Niger), the French Institute for Oilseeds Research (IRHO based in Paris), the International Development Research Centre, Canada (IDRC), and the Australian Center for International Agricultural Research (ACIAR). The external evaluation panel and the USAID administrative review team both recognized the benefits of cooperation with these organizations.

Paramount to the goals of the Peanut CRSP was to provide information of value to its beneficiaries. The collaborative nature of the CRSP results in two-way benefits with: 1) focus on solving constraints and improving the well-being of people in host countries, and 2) results of value to the constituents of the participating U.S. institutions. Host country beneficiaries were small-scale farmers, which include rural women, as well as food processors and both rural and urban consumers. Benefits come in the form of adequate quantities of more nutritious and safe food, and increased incomes. United States beneficiaries are farmers, processors, and both rural and urban consumers.

The Peanut CRSP participants have recognized from the beginning in 1982 that research is a dynamic process, not an event. Consequently, Peanut CRSP Management revisited the Global Plan on a continuing basis to keep the CRSP abreast of changes in the international peanut research environment, while keeping in mind the contribution of advancements in research and maturation of technologies for transfer to beneficiaries on the continued development of the program.

Projects 1990-1996

The following projects were recommended by the EEP, approved by USAID, and implemented that presented the best opportunity to meet the Global Plan and to provide resolution to the more broad constraints and to the sustainability constraints that limit production and use.

A. Producer values

TX/BCP/S, BF, N – Disease-Resistant Peanut Varieties for Semi-Arid Environments.

Principal Investigator:
- Dr. O.D. Smith, Texas A&M University

Cooperators:
- A.M. Schubert, Texas A&M University
- C.E. Simpson, Texas A&M University
- D.H. Smith, Texas A&M University
- W.J. Grichar, Texas A&M University
- Robert Pettit, Texas A&M University
- Ruth Ann Taber, Texas A&M University.

Senegal Collaborators:
- J.C. Mortreuil,
- Ousmane Ndoye,
- Daniel Annerose,
- Jean Khalfoui.

Burkina Faso Collaborator:
- Philippe Sankara.

Mali Collaborator:
- Dielimoussa Soumano.

Niger Collaborator:
- Amadou Mounkaila.

The goals of this project were: 1) develop peanut lines adapted to important ecological areas of Sahelian West Africa and Texas that have resistance to pathogens causing economic loss, effectively utilize available moisture, and acceptable to growers and users of peanut products; 2) identify cultural practices that will maximize the yield potential of cultivars under these environments; 3) strengthen peanut improvement programs in the collaborating countries through encouragement, training, and improved expertise in peanut research.

NCS/BCP/TP – Peanut Varietal Improvement for Thailand and the Philippines.

Principal Investigator:
- Dr. Thomas J. Isleib, North Carolina State University

Cooperators:
- Dr. Marvin Beute, North Carolina State University
- Dr. Thomas Stalker, North Carolina State University
- Dr. William Campbell, North Carolina State University
- Dr. Gerald Elkan, North Carolina State University
- Dr. Arthur Weissinger, North Carolina State University
- Dr. Barbara Shew, North Carolina State University

Thailand Collaborators:
- Dr. Aran Patanothai, Khon Kaen University,
- Dr. Sanun Jogloy, Khon Kaen University.

Philippine Collaborators:
- Dr. Remedios M. Abilay, University of the Philippines at Los Banos
- Dr. M.P. Natural, University of the Philippines at Los Banos

The goals of this project were to increase yields and quality of peanut in cooperating Asian countries and the U.S., while decreasing the dependency on chemical inputs. This should improve not only the economic situation for farmers, but also have a positive impact on the ecology and sustainability of agriculture. Breeding efforts need to be directed toward development of cultivars that fit current and future cropping systems and marketing potential.

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

Principal Investigator:
- Dr. Robert E. Lynch, entomologist, University of Georgia/USDA Coastal Plain Experiment Station, Tifton.

Cooperators:
- Dr. Olin Smith, breeder, Texas A&M University
- Dr. Bharat Singh, food scientist, Alabama A&M University

Burkina Faso Collaborators (University of Ouagadougou, IDR):
- Dr. A.P. Ouedraogo, entomologist
- Dr. Idrissa Dicko, entomologist

Burkina Faso Cooperators:
- Dr. Philippe Sankara, plant pathologist, University of Ouagadougou
- Dr. Alfred S. Traore, food scientist, University of Ouagadougou

In the 1993-94 project year, Dr. Lynch stepped down as principal investigator, because of other duties, and Dr. Keith Ingram, associate director of Peanut CRSP became interim principal investigator. The project was scheduled to close Sept 30, 1994 due to budget reductions by USAID. All work for the 1994 season was in Burkina Faso with no Georgia component.

The major goals for the research were**:** 1) identify the major arthropod pests of peanut in Burkina, Faso; 2) determine the economic significance of these arthropods on peanut yield; 3) develop IPM strategies and control measures to reduce losses to these pests; and 4) determine the relationship between injury to peanut pods by arthropods and the incidence of aflatoxin contamination.

NCS/IM/TP – Management of Arthropods on Peanut in Southeast Asia

Co-Principal Investigators:
- Dr. R.L. Brandenburg,(following retirement of Dr. W.V. Campbell)
- Dr. Mary Barbercheck, entomologists, North Carolina State University;
  (following retirement of Dr. W.V. Campbell)

Cooperator:
- Dr. Thomas Isleib, breeder, Department of Crop Science, North Carolina State University.

Thailand collaborators
- Dr. Manochai Keerati-Kasikorn, entomologist, Khon Kaen University
- Dr. Turnjit Satayavirut, entomologist, Department of Agriculture, Thailand

Philippine collaborators
- Dr. Virginia Ocampo, University of the Philippines, Los Banos
- Dr. Eliseo Cadapan, entomologist, University of the Philippines, Los Banos

The major goal of this project was the effective management of those arthropod pests that limit peanut production through an effective pest management program based on sound principles of IPM and sustainable agriculture.

GA/PV/N/TP – Peanut viruses: etiology and epidemiology and nature of resistance

Principal Investigator:
- Dr. James W. Demski, plant pathologist/virologist, University of Georgia, Georgia Station.

Nigeria Collaborator:
- Dr. Phindile Olorunju, breeder, Ahmadu Bello University, Samaru.

Thailand Collaborator:
- Dr. Sopone Wongkaew, virologist, Khon Kaen University.

Philippine Collaborator:
- Dr. Marina Natural, virologist, University of the Philippines, Los Banos

The overall goal of this coordinated research program was to develop strategies and control measures to minimize incidence of the major peanut virus diseases, to foster interdisciplinary studies between countries, and to develop linkages between supporting food production agencies. This will primarily be accomplished by strengthening peanut production programs in the host countries and the U.S. through training and active research projects.

B. Processor values

AAM/FT/BF – An interdisciplinary approach to optimum food utility of the peanut in SAT Africa.

Principal Investigator:
- Dr. Bharat Singh, food scientist, Alabama A&M University.

Cooperators:
- Dr. John C. Anderson, food scientist, Alabama A&M University,
- Dr. Casimir Akoh, food scientist, Alabama A&M University,
- Dr. M. Elena Castell-Perez, food scientist, Alabama A&M University.

Burkina Faso Collaborator:
- Dr. Alfred Traore, University of Ouagadougou, Burkina Faso.

Burkina Faso Collaborators:
- Solibo Some, entomologist, University of Ouagadougou,
- Albert Ouedraogo, entomologi, University of Ouagadougou,
- Lactitia Ouedraogo, food technologist, University of Ouagadougou,
- Herve Campaore, food technologist, University of Ouagadougou,
- Francois T. Ouedraogo, food technologist, University of Ouagadougou,
- Dr. Philippe Sankara, phytopathologist, University of Ouagadougou.

Ghana was added as a collaborating country in 1993-1994.

Ghana Collaborators:
- Kafui Kopodo, food scientist, Food Research Institute, Accra, Ghana
- Dr. Wisdom A. Plahar, food scientist, Food Research Institute, Accra, Ghana

Ghana Cooperators:
- Hodare-Okae, food microbiologist, Food Research Institute, Accra, Ghana
- N.T. Annan, nutritionist/biochemist, Food Research Institute, Accra, Ghana

The general goal was to foster interdisciplinary (nutrition, food science, social and economic) institution-based linkages between U.S. and LDC scientists serving major peanut producing and consuming populations of the Semi-Arid Tropic regions of Africa for the purpose of optimizing the food utility of the peanut. The specific goal was consistent with the general goal of the Peanut CRSP to develop a collaborative research and development program on the peanut between scientists at Alabama A&M University, the University of Ouagadougou in Burkina Faso, and other SAT countries (later Ghana was added).

GA/FT/TP – Appropriate Technology for Storage/Utilization of Peanut

Principal Investigator:
- Dr. Larry R. Beuchat, food scientist, University of Georgia.

Thailand Collaborators:
- Dr. Penkwan Chompreeda, food scientist, Kasetsart University.

Thailand cooperators:
- Dr. Chintana Oupadissakoon, food scientist, Kasetsart University
- Vichai Haruthaithanasan, food scientist, Kasetsart University
- Paiboon Thamratwasik, food scientist, Kasetsart University

Philippine Collaborators:
- Dr. Virgilio V. Garcia, food scientist, University of the Philippines, Los Banos,
- Dr. Lutgarda Palomar, ViSCA, Baybay, Leyte (collaborator 1993-1994).

Philippine cooperators:
- Dr. Ricardo R. del Rosario, food scientist, University of the Philippines, Los Banos
- Dr. Reynaldo C. Mabesa, food scientist, University of the Philippines, Los Banos

The goal of the project was to enhance the capabilities of scientists, technicians and students at KU, UPLB and UGA. The training of cooperators from Thailand, the Philippines, and the U.S. in developing appropriate peanut storage and utilization technologies was the mechanism by which all institutions will enhance their capabilities to improve and assist in economic and human development.

GA/PH/CAR – Postharvest handling systems for the small peanut producer

Principal Investigator:
- Dr. Manjeet Chinnan, food scientist, University of Georgia.

CARDI Collaborators:
- Dr. Brian Cooper, Antigua
- A.K. Sinha, Belize
- Dr. Joe Lindsay, Jamaica
- Dr. Gordon Miller, Trinidad

CARDI Cooperators:
- B.O. Enriquez, BFAC, Belize
- Urvan Wilson, Engineer, Jamaica
- Dr. Charles Douglas, economist, Jamaica
- Dr. Clement Sankat, Engineer, University of the West Indies, Trinidad

The goal of the project was to develop a global model for evaluating the acceptability and profitability of peanut postharvest system(s) for Caribbean countries, in particular, and developing countries in general, by developing and/or adapting technologies for the available economic and natural resources and by incorporating climate, socioeconomics and existing infrastructure for marketing and consumer acceptance factors.

C. Consumer values

TX/MM/S – Mycotoxin management in peanut by prevention of contamination and monitoring

Principal Investigator:
- Dr. Robert E. Pettit, plant pathologist, Texas A&M University.

Cooperators:
- Dr. Timothy D. Phillips, Department of Veterinary Public Health, Texas A&M University
- Dr. Olin Smith, Department of Soil and Crop Sciences, Texas A&M University,
- Dr. Ralph D. Waniska, Department of Soil and Crop Sciences, Texas A&M University,
- Dr. Raul G. Cuero, Prairie View A&M University, Texas.

Senegal Collaborators:
- Amadou Ba, ISRA (Senegalese Institute of Agricultural Research), Kaolack, and ITA (Institute of Food Technology) Dakar.
- Amadou Kane, ISRA (Senegalese Institute of Agricultural Research), Kaolack, and ITA (Institute of Food Technology) Dakar.

Ghana Collaborators (1992-1993):
- Dr. Richard T. Awuah, plant pathologist, UST, Kumasi,
- Kafui Kpodo, food biochemist, FRI, Accra.

The goals of the mycotoxin project were to develop and apply techniques, which reduce the severity of the mycotoxin contamination problems within the Less Developed Countries and the United States. Prevention of mycotoxin contamination through the development of aflatoxin resistant cultivars, and improved production, harvest, storage, and processing procedures should help reduce the costs of excessive processing to remove mycotoxins. For those peanuts which still contain mycotoxins, the goal was to develop improved inspection and diversion procedures, and cleanup and detoxification procedures which will reduce the levels of mycotoxins present within peanut and peanut products in order to meet health and governmental safety standards.

D. Information/training/technology transfer

Information – The Peanut CRSP has matured to the point of having many new and improved technologies for dissemination, and the goal was to assure better communication of results. The International Arachis Newsletter was continued and published in cooperation with ICRISAT. An increased effort was made to produce brochures, publications, and leaflets for dissemination of information. An increased number of Workshops were to be supported. International cooperator networks were identified as means for information dissemination.

Training – The training effort was restricted in the first eight years due to budget limitations. Leverage funds primarily within the scope to the U.S. universities have supplemented the amount of training possible. About twice the budget for degree and short-term training was planned in the 1990-1996 phase.

Technology Transfer (Impacts) – Technology transfer through expanded on-farm and cottage-industry pilot projects was planned.

E. Administration and Management 1990-1996

Management entity staff – Dr. David G. Cummins continued as program director. Dr. Keith Ingram, agronomist and deputy head of the Agronomy, Plant Physiology and Agroecology Division, International Rice Research Institute, Philippines, was selected for the position of assistant program director, effective Oct. 15, 1993. Dr. Ingram assumed a tenured faculty position in the Department of Crop and Soil Science/University of Georgia/Griffin Campus in October 1995. Dr. Jonathan H. Williams, peanut physiologist, ICRISAT-Sahelian Center, Niamey Niger served as interim associate program director while on leave from ICRISAT from October 1995 to July 1996 at which time he was employed by the Peanut CRSP as associate program director. Grace Hutto was administrative secretary, and Amy King was senior secretary (half time with Peanut CRSP and half time with SANREM CRSP).

Gina Thomas, accountant, UGA/Athens, College of Agriculture Business Office, was part-time accountant for the Peanut CRSP.

Board of directors

- Dr. Onuma Okezie, Alabama A&M University
- Dr. Louis Boyd followed by Dr. Ed Kanemasu, University of Georgia
- Dr. Johnny Wynne, North Carolina State University
- Dr. Dudley Smith, Texas A&M University.

Technical committee:
- Dr. Thomas Isleib, Chair, North Carolina State University
- Dr. Manjeet Chinnan, University of Georgia, Vice-Chair
- Dr. Elena Perez, Alabama A&M University
- Dr. Robert Lynch, University of Georgia
- Dr. Olin Smith, Texas A&M University
- Dr. Mike Schubert, Texas A&M University.

USAID project managers:
- Dr. Robert Schaffert 1990-1993
- Dr. Phillip Warren 1993-1994
- Dr. Dianne Janczewski 1994-1996
- Dr. Terri Hardt beginning in 1996, USAID/R&D/AGR.

BIFADEC liaison: William Fred Johnson, BIFADEC/Washington/DC was the liaison to the Peanut CRSP.

Inter-CRSP activities: The program director participated in monthly discussions with the CRSP Council (directors from all CRSPs) to foster Inter-CRSP research activities.

One result was the development of collaborative research in Egypt supported by the USAID/Egypt mission. Three Peanut CRSP projects were planned and approved during 1990-1991 for funding that began on July 1, 1991; a total of $450,000 over three years. Research was supported in:

- Peanut breeding (Dr. James L. Starr, principal investigator, Texas A&M University, Egyptian principal investigators, A.R.A. El Deeb and M.A.M. Khalil, Plant Pathology Research Institute, Agricultural Research Corporation)
- Soil microbiology (Dr. Gerald Elkan, principal investigator, North Carolina State University; Egyptian principal investigators, Dr. Mohamed E. Hassanb and Dr. Samir M. Abd El-Wahab, Soils and Water Research Institute, Agricultural Research Corporation)
- Food technology (Dr. Tommy Nakayama, initiated the project in 1991 and was followed by Dr. Anna V.A. Resurreccion and Kay H. McWaters as co-principal investigators, University of Georgia; Egyptian principal investigators, Dr. A.M. Korshed, N.A. Ibrahim, and S. M. Mansour, Food Technology Research Institute, Agricultural Research Corporation).

The long-term goals of the nitrogen fixation and plant pathology/nematology projects were to increase peanut yields potential and quality, and thus provide a superior product to the consumers. The food technology project had as long-term goals to enhance utilization of the superior primary and secondary products derived as benefits of the nitrogen-fixation and plant pathology/nematology projects.

A second activity was an InterCRSP program in West Africa funded for $150,000 in the project year 1995-1996. Dr. Chandra Reddy, Alabama A&M University agronomist with some eight years of experience of project management experience in Niger provided overall leadership for the project and the field activities. Dr. David Cummins, program director, Peanut CRSP, coordinated the areas of Infrastructure Support and Training of INRAN/Niger scientists; Drs. Elena Perez and Victor Nwosu, food scientists, Alabama A&M University, resource personnel for post-harvest activities; Dr. Issaka Mahamane, INRAN, country coordinator and coordinator for soil amendment activities;

Amadou Mounkaila, INRAN, coordinator for variety trials; and Moussa Oumarou, INRAN, coordinator for Post-harvest activities.

The specific goal of the project was, to provide assistance to the USAID/Niger mission in assuring that technologies developed by the Peanut CRSP and also from other sources (i.e. the Niger National Program, ICRISAT Sahelian Center) are transferred to farmers and processors.

Resistant varieties and IPM practices to reduce termite damage to pods contribute to lower aspergillus flavus fungi invasion and aflatoxin accumulation in peanut seeds.

CHAPTER 17. ACCOMPLISHMENTS OF 1990-1996 GRANT

Research Accomplishments in Natural Resource and Sustainable Agriculture are highlighted in response to USAID focus during this phase, which cut across the “value” sections that follow. In the “value” sections, accomplishments are also defined for impact on Economic Growht and Environmental issues.

Natural resource management

In Burkina Faso led by TX/BCP in a five-location yield trial, peanut yields were relatively low at the Bobo Dioulasso and Niangoloko locations despite high rainfall at these locations. Recent collaboration between the Peanut and Soil Management CRSPs has shown a low soil pH and high aluminum content at Bobo. The first-year of a multiple-year experiment to study the effect of soil amendments on soil pH and peanut yields was completed. Treatments included lime, phosphorus, lime + phosphorus, ash, and a control with three locally grown peanut cultivars. First year results showed a cultivar x soil amendment reaction. In the second year, there was a 221% yield increase from ash treatment, a 46% increase from calcium sulfate, and a 37% from phosphorus. Research was conducted on the same plots both years, and there was a cumulative effect from amendments.

Under TX/BCP, Tamspan 90 yielded better than Starr in East Texas, but not in Central Texas, which answered concerns by farmers as to the relative merits of the two varieties. Tamspan 90 had earlier shown better yields under irrigation, especially in soils infested with *Sclerotinia minor, Pythium myriotylum,* and *Rhizoctonia solani*. Thus Tamspan 90 was more responsive to increased soil moisture.

In the area of sustainability and environmental concerns, on-farm trials of promising shade-tolerant lines were grown under coconut at four locations in the Philippines, and IPB Pn82 82-25 consistently had the highest pod and seed yields. Some six lines continue to show tolerance to highly acidic soil conditions. These findings could contribute to cropping under coconut that could stabilize soils and for peanut to provide nitrogen for the trees, and allow cropping in marginal soil areas.

Sustainable agriculture accomplishments

An extensive program in Jamaica was led by CARDI and the Jamaican Extension Service for farmer adoption of the new CRSP developed CARDI/Payne variety. A socioeconomic study showed that yields of the new variety were 42% higher than traditional varieties and had been adopted by over 10% of farmers in two years. (Survey by Purcell/UGA, Moxley/NCSU, Wheelock/AAMU through special USID funds via Michigan State University, Bean/Cowpea CRSP).

A study in Senegal by the TX/MM project used row spraying of conidial suspensions of *Aspergillus flavus* at different times in the growing season to increase aflatoxin contamination in peanut. Soil inoculation at pegging time resulted in higher aflatoxin levels in seed at harvest. Thus, the pegging-period is a decisive stage for peanut pre-harvest infection by *A. flavus* and subsequent aflatoxin contamination of the seed.

A Pilot Program in cooperation with PCARRD continued in the Philippines that extended CRSP technology (varieties and IPM) to farmers in the Cagayan Valley of Luzon, which is the major peanut growing region. Higher yields with less pesticide inputs promised to enhance sustainability.

New peanut varieties were being multiplied in a program with farmers in Thailand, which will accelerate the adoption of the new varieties on a wide-scale. These varieties promise to maintain higher yields under reduced production costs. From the cropping system/sustainability viewpoint in Thailand, breeding for earliness to develop high yielding peanut lines which mature in 80-85 days for use in short-season cropping systems have resulted in three lines in 1992 which are superior to the local check. These lines will continue to be tested in expanded yield trials.

Under the project UGA/FT, technology transfer to village scale peanut processors at Huay-Bon-Nua, Phroa District, Chiangmai Province, Thailand was fully established in 1992-93. Linkage with Chiangmai University through project investigators at KU facilitated this effort. (Future evaluations of this work showed that the processors and local consumers benefited greatly from this work. This effort contributed to the establishment of Thailand/Peanut CRSP Southeast Asia Outreach and Training Program after Thailand became a USAID "graduate country" and the research program was no longer supported).

Another major emphasis of the project UGA/FT was the training component. Thailand, Philippine and American students are pursuing advanced degrees at University of Georgia with support from the project. The M.S. and Ph.D. programs in the Department of Product Development at Kasetsart University have come into existence in part due to the strengthening of the faculty through Peanut CRSP collaboration and to the judicious use of support provided by this project. Undergraduate thesis projects at Institute of Food Science and Technology at the University of the Philippines at Los Banos continued to be supported by the Peanut CRSP. A Postdoctoral Associate from Trinidad (Margaret Hinds), who received her Ph.D. while supported by the AAMU food science project, joined the UGA research team in 1992-93. Workshops on peanut utilization were expected to have even a bigger impact on processing and the nutritional well-being of consumers throughout Southeast Asia in future years as the project achieves fulfillment of its goal to have an impact on the entire region.

Linkage was established with Khon Kaen University via Kasetsart University to conduct research for improving postharvest handling systems in Southeast Asia, particularly peanut growing areas of Thailand. The work is facilitated through linkage with the GA/PH/C project. A field survey to determine peanut postharvest handling operations in NE Thailand was conducted. It was concluded that in irrigated areas of Northeast Thailand, peanut was grown by small farmers with average planted area of 0.6 hectares per family and average production of 0.84 metric tons per family. Harvest and postharvest operations were done by hand labor, which led to drying problems when drying is done in the rainy season that could lower peanut quality. Thus, it is recommended that the quality of peanut be determined at all stages of harvest and postharvest operations; quality of seed stored on-farm should also be determined.

A similar study by the GA/PH/C project in Jamaica showed that 94% of farmers harvested peanuts by hand pulling, 52 % dried the peanuts in the field, 88% pulled the pods from the plants by hand, and 51% shelled by hand and mechanical shellers usually shared across farms. Farm storage was usually a problem with loss to insects and animal pests, molds, and theft. It was concluded that these post harvest problems are detrimental to the growth of the peanut industry in Jamaica and need to be addressed, which also included better access to markets.

A survey on production and postharvest technologies was conducted in Ghana by the AAM/FT project. Little mechanization was used, which may contribute to low production levels due to the high cost of manual labor required for production. There appears to be a need for introduction of more improved varieties, with attention given to farmers regarding their preferences for particular types. Farmers had little knowledge about the aflatoxin problem in peanuts. Therefore there was an urgent need to create more awareness about the problem, the health effects, and ways of preventing or reducing contamination. Formation of peanut cooperatives could be an avenue for dissemination of information. Simple and appropriate technologies for peanut production need to be developed for use by Ghanaian farmers or transferred from other programs and adopted in Ghana. Resolution of production problems would result in subsequent increase in production and utilization.

A. Producer values

TAM/BCP/S, BF, N

Dr. Mike Schubert transferred to Texas A&M University Research and Extension Station, Lubbock, July 1, 1993, which initiated high plains peanut breeding and other research. This gave an opportunity to compare with West Africa and broaden the potential of exchanging adapted germplasm.

Shelling equipment was purchased and delivered to each of the four collaborating host country scientists.

West Africa breeding/economic growth

The testing and evaluation of Fleur 11 against present varieties toward its possible release for farmer use in Senegal continued in the 1990-1996 phase of the Peanut CRSP. The collaboration for this work was with the TAM/BCP project and ISRA/CNRA/Bambey station in Senegal. Based on two years of multiple location testing (1990 and

1991 seasons), the results confirmed on-station test results that indicated this variety should improve the nutritional needs and income of farmer's in Senegal. Pod yields of Fleur 11 exceeded 55-437 by 20% at Bambey and 33% at other locations in Senegal, and release was anticipated. The seed weight of Fleur 11 was higher than 55-437, which contributes to a better market quality.

In 1992, approval for release of Fleur 11 in Senegal was given based upon documentation of pod yield increase in excess of 30% compared to 55-437, a common cultivar, during 5-years on-and off-station research. Seed increases began in 1994. In 1995, Fleur 11 seed was increased in the Senegal River Basin under irrigation and at the ISRA station near Bambey. Seed supply should be sufficient for significant grower production in the 1995 season. The variety consistently yields 25% more that presently grown varieties.

Examination of lines valuable to the Senegalese production program continued. In 1992-93 it was noted that the lines, PC 79-79, and H75-0 were performing well. The need for *Aspergillus flavus* resistant varieties for West Africa has been known for a number of years. In 1990-1991, breeding lines with seed coat resistance to *Aspergillus flavus* in three popular Senegalese varieties yielded similarly to the parental varieties.

The breeding for rosette virus disease resistance began in Burkina Faso in 1992-93. By the 1994-95 season, significant variability in rosette virus reaction was found among F3 and F4 families from rosette resistant x West African adapted varieties in rosette screening trials at Niangoloka, Burkina Faso. Confirmation and repeatability of reactions to rosette virus infection are being tested. Rosette virus epidemics can cause up to 100% yield losses.

In Burkina Faso, several years of research by the GA/IM/BF project determined that termite damage to unharvested pods decreased yields and increased aflatoxin contamination in the seed. Therefore, breeding research to identify termite resistant germplasm began in Burkina Faso in 1992-93. It was of interest to note that one of the resistant lines used in this effort was identified as having broad based insect resistance by the NCS/IM/TP project in the Philippines in the early 1980s, which emphasizes the value of the regionally coordinated Peanut CRSP program.

Many of the commonly grown peanut varieties grown in West Africa do not have seed dormancy. Therefore, considerable seed germination occurs before harvest. Based on heritability studies in Senegal in 1990-1991, transfer of dormancy to early, non-dormant varieties to avoid late season loss from germination should be feasible.

Four short season (early maturing lines) and cultivars adaptable to the short rainy season area were compared again in 1991-1992 with check cultivars in Mali. This was the third consecutive year in which four lines performed satisfactorily. The decision was made to increase seed of the four breeding lines 73-28, M 13, HYQ (CG) S-49, and EH 310-9 in 1992 for on-farm tests in prospect of cultivar release to farmers based on performance in three years of on-station tests.

Texas breeding/economic growth

"Tamspan" 90 was released as a new cultivar in Texas in 1990 and was resistant to two important soil-borne diseases, *Sclerotina* blight and *Pythium* pod rot, and yields 11% more than "Starr" the previous most popular cultivar. It was grown on about 28% of the total peanut area in Texas and Oklahoma in 1992 and 1993 with a net value of about $25 million per year.

In 1990-91, backcrossing to introduce early and late leaf spot and root knot nematode resistance has proceeded from 6000 initial seeds to 5 plants in the fourth generation that show resistance characteristics. Populations were being screened for root knot nematode, *Sclerotinia* blight, spotted wilt virus, leaf spot, rust, and *Aspergillus flavus* resistance in Texas in 1991-1992. Two breeding lines with resistance to root knot nematode were released in Texas in 1993. Work continued to improve the cultivars resistant to *Sclerotinia* blight and transfer it to different market types. Populations were being screened for *Sclerotinia* blight in Texas in 1992. This progressed until five runner-type breeding lines with good yields in multiple location trials in Texas and Oklahoma and low relative damage from *Sclerotinia* blight (caused by *Sclerotinia minor*) in a 1995 disease nursery were selected for pure seed increases of 0.1 to 1.0 acres each. The shelling percentage, seed size, and quality were evaluated along with 1996 multiple location, two-state test data for decisions regarding preparation of proposals for release.

In 1991-92, the breeding and food technology projects cooperated to evaluate aflatoxin resistant lines, and although no line was aflatoxin free, some lines had less contamination and could be an important aspect in cultivar development to reduce aflatoxin in peanut and peanut products. The cooperation across disciplines was important to realize future impacts in product quality.

Additionally, six percent of 2010 lines (from South America and lines already in Texas) tested in Texas in 1990-91 for leaf spot resistance have shown sufficient resistance to retest. In 1991-92, an additional 250 peanut accessions were added for a total of 2260, were field screened for leaf spot reaction at Yoakum. About one percent of the 2260 accessions were considered worthy of further testing. This emphasizes the long-term requirement for a breeding program to have impacts, since this initial identification of superior germplasm was often followed by 10-12 years of crossing and selection before a new cultivar can be developed and released for farmer use.

The breeding for resistance to virus diseases was noted in 1991-92. The Texas runner-type breeding line Tx896100 competed favorably for yield with commercial cultivars in the U.S. regional peanut test, scored favorably in tests for reaction to southern blight, and ranked low in disease incidence in tests with challenge by spotted wilt virus. Seed increase was under consideration. In 1994, increase of the runner-type breeding line Ts896100 was initiated in Texas. The new line exceeded the common Florunner variety by over 50% at sites with severe tomato spotted wilt virus disease pressure. Agronomic traits are acceptable for commercial production. Resistance to this virus is much needed, since the virus can cause significant yield losses and was becoming more widespread.

Peanut tends to become rancid during storage, due to a lower oleic acid content compared to linoleic acid, termed O:L ratio. High O:L ratio cultivars would be of great benefit to processors and consumers. Eighteen Spanish families of crosses were compared in 1994 in Texas for O:L oil ratios. Lines with higher O:L ratios tended to yield lower. The material was planted again in 1995, particularly looking for stability in lines. In 1995, BC2 high oleic Spanish populations were produced and selections made for the third backcross. Some 84 single and first backcross selections were tested for yield and *Sclerotinia* reaction in Texas and Oklahoma. Also in Texas, runner-type segregates with improved oil chemistry and *Sclerotinia* blight and/or spotted wilt virus resistance have been identified and employed in a back crossing program.

In 1995, eighteen F2:5 Spanish peanut families with varied O:L rations were again compared in Texas. The purpose of the tests was to confirm 1994 data on the stability of the O:L ratios in the varied climates; in that lines with elevated O:L ratios at low (250 foot) elevations would also show improved oil chemistry at elevations of 2500 feet. The populations were derived from crosses of Spanish varieties with unadapted, unusually high oleic acid, Spanish-type parents. The results confirmed the 1994 results, which indicated marked improvement at all locations among lines with the genetically superior oil chemistry. As in 1994, the O:L ratios were higher among the high O:L lines at the lower elevations than in west Texas. No differences in the rate of emergence between the high and low oleic entries were apparent, as has been reported in cotton. As in 1994, the yields of the single cross, high oleic lines was inferior to the best commercial Spanish check varieties at all locations.

“Tamrun 96” formerly identified as Tx896100, a new runner-type peanut adapted for production in the Southwest U.S. peanut production region was released in the late spring of 1996. Seed increases made in 1995 and 1996 brought the total seed supply to approximately 59 tons which was used and sold by the Texas A&M University Foundation Seed Services for multiplication and Registered Seed production. The principal advantages of the new variety included partial resistance to tomato spotted wilt virus, partial resistance to *Sclerotium rolfsii* and some other soil-borne diseases, high yield, and good seed size.

NCS/BCP/TP

Southeast Asia breeding/economic growth

Research to improve germplasm and cultivar development continued in the Philippines and Thailand in the 1990-1996 phase of the Peanut CRSP. Cooperation continued between North Carolina State University and the Institute of Plant Breeding, Los Banos Philippines, and the Department of Agriculture and Khon Kaen University in Thailand.

Philippines

In the Philippines in 1991, three entries (IPB Pn 82 70-64, IPB Pn 82 71-19, and JL-24) were under consideration for recommendation as Philippine Seed Board varieties in 1992. These were under test in on-farm trials across locations. Four selections from the IPB breeding project's general yield trials across three locations were entered as new entries in the national cooperative yield trial planted in June 1991. Seed of three promising entries for the three specific growing environments (full sunlight optimum conditions, partial shade and highly acidic soil conditions) was increased. The three lines were subsequently tested on-farm.

In the Philippines, JL-24 was approved as a Philippine Seed Board cultivar in May 1992 and released as UPL Pn10. It yielded 11% more that the national check cultivar, BPI Pn2. UPL Pn 10 is high yielding, large seeded, resistant to leafhopper, highly resistant to defoliators and moderately resistant to *Aspergillus flavus* infection (aflatoxin producing fungus). This emphasizes the progress in disease and insect resistance/tolerance breeding and the impact of the Peanut CRSP on their program, and the cross-discipline (breeding, pathology, and entomology) efforts that were strengthened. Seed production of UPL Pn 10 by 1994 was sufficient to seed 15 hectares, and tests that year showed that the cultivar yielded 1.9 t/ha compared to 1.4 t/ha for BPI P9 a popular farmer variety.

Furthermore in the area of sustainability and environmental concerns, on-farm trials of promising shade-tolerant lines were grown under coconut at four locations in the Philippines, and IPB Pn82 82-25 consistently had the highest pod and seed yields. Some six lines continue to show tolerance to highly acidic soil conditions.

Cultivar development progress continued in the 1993 season. Two breeding lines were ready for release by the Philippine Seed Board. IPB Pn 85 2-40 was leafhopper and rust resistant. IPB Pn 85 10-68 was leaf spot and late leaf spot resistant and had moderate rust resistance. The continued progress will expand the adaptability of cultivars into more production regions of the country.

One Philippine Seed Board variety, PSB Pn2, was released in 1994. It was further known as UPL Pn 12 or Biyaya 12, and was a Valencia peanut variety derived from a three-way cross among Philippine and North Carolina lines. PSB PN 2 yielded 13-18% more than two check varieties and had better resistance to rust and late leaf spot damage. It had high seed viability even after six months pod storage at ambient storage conditions. The Valencia (long-pod, red seeded market type) will fill a particular market niche, often as roasted/in-pod sales.

The Philippine Seed Board variety/cultivar PSB Pn1, tested as UPL Pn10, released in 1992 and marketed as 'Biyaya10', was multiplied and distributed to growers in the Province of Isabella in 1996, where it was well accepted by local growers. Biyaya 10 yielded significantly more peanuts than the commercial variety BPI Pn9 (2.44 t/ha vs. 1.95 t/ha) pilot tests. UPL Pn10 continued to be a stable and useful cultivar.

The breeding program continued to be active into 1996. Three new entries were included in the National Cooperative Test conducted at nine locations across the Philippines in May 1996. In trials performed at the Institute of Plant Breeding, all three have produced greater yields, larger seeds, and improved insect resistance compare with Biyaya 10.

Thailand

Three new peanut lines were identified in Thailand in 1991 that have increased levels of leaf spot resistance when grown in both the wet and dry seasons. The lines were different combinations or crosses of NC Ac 17090, GP-NC 343, and PI 109839. Taiwan 2 x UF71513-1 was identified as a high yielding-boiling type peanut in Farm Trials by the Department of Agriculture in 1992 and was considered for recommendation as a new cultivar. It yielded more that Khon Kaen 60-2 (released in 1988), the check cultivar and a boiling type peanut. Disease resistance in cultivars remains a concern in Thailand, and peanut lines have been identified in 1991 that have increased levels of leaf spot and rust resistance and will be further tested in the 1992 rainy season. In 1993, Taiwan 2 x UF 71513-1 performed better than the check cultivar Khon Kaen 2, yielded 10% higher pod yield that the check, with larger seed size. Taiwan 2 x UF 71513-1 was released as 'Khon Kaen 60-4', a high yielding boiling type cultivar. (Khon Kaen 60-1 introduced as Moket was a small seeded type, and Khon Kaen 60-2 introduced as TMV 3 was a larger seed type than Khon Kaen 60-1 and a boiling type were both released earlier in 1988, and Khon Kaen 60-3 was released in 1989).

From the cropping system/sustainability viewpoint in Thailand, breeding for earliness to develop high yielding peanut lines which mature in 80-85 days for use in short-season cropping systems have resulted in three lines in 1992 which are superior to the local check. These lines will continue to be tested in expanded yield trials.

After 1993, support for the Thai project ended because USAID considered Thailand a 'graduate country' and further research could not be funded. However, support to Kasetsart University continued until 1996, which supported training and technology transfer.

In Thailand, a design for modification of an existing sheller was developed for the Khon Kaen 60-1 variety, which was developed and released with Peanut CRSP support in 1995. Improved shelling resulted from the modification, which will assist in increased farmer acceptance of the variety. This was financially supported by the Training and Technology Transfer funds provided to Kasetsart University.

North Carolina

In North Carolina, peanut breeding efforts have focused on higher yields, disease and insect resistance, better quality and market acceptability. Cooperation has and continues to exist between breeders and entomologists seeking effective IPM programs. This focus reaches back to the beginning of the NCSU/Peanut CRSP effort that began in 1982.

Late funding delayed and limited the 1991 season research. Dr. Arthur Weissinger was brought into the program as a cooperator at NCSU. His work in genetic transformation has the potential to provide a means of introducing into peanut genes from other organisms that could not possibly be introduced by sexual means. Of particular interest are protein coat genes from peanut stripe and tomato spotted wilt viruses that may provide cross-protection to transformed plants, chitinase genes to retard fungal growth in peanut tissue that could provide resistance to aflatoxin contamination, and the Bt toxin gene from *Bacillus thuringiensis* that provides resistance to lepidopteran larvae.

In 1991, a number of interspecific hybrids between cultivated and wild species were evaluated in North Carolina for resistance to early leaf spot in the field and the green house and for resistance to late leaf spot in the greenhouse. High levels of resistance were observed to both leaf spots, and field tests on resistance in these lines will continue. Studies in North Carolina indicate that deployment of genotypes with resistance to both early and late leaf spot was probably necessary to ensure stability of resistance to peanut leaf spot, because with single resistance the particular disease will become predominate where the most susceptible varieties were grown.

In North Carolina, 27 interspecific hybrids between cultivated and wild species were evaluated in 1992 for resistance to early and late leaf spot. Four of these lines were released as breeding lines.

In North Carolina, extensive work was done in 1993 to develop CBR resistance; a root disease that causes high losses in yields, and the use of expensive and environmentally degrading insecticides. Resistant cultivars will contribute significantly to the IPM work in the NCS/IM Peanut CRSP project. In 1994, N90013E a cross between NC 7 and NC 9 was moderately resistant to CBR, yields about same as the only resistant variety available, NC 10C, but has much superior seed-grade characteristics.

By 1995, peanut transformation technology was improved in North Carolina research, decreasing the time required to produce transgenic cell lines and improving the fertility of transgenic plants. Peanut plants transformed with the peanut stripe virus coat protein gene were tested for resistance under controlled conditions. Two lines showed reduced or delayed symptoms, while others appeared to develop then lose symptoms after an initial infection period.

In North Carolina two genes for resistance to root-knot nematodes were transferred from a wild species of peanut into a cultivated type in 1995. The two genes reside near each other on the same chromosome. Located between them is a molecular marker gene that allows the presence or absence of the two resistance genes to be detected without the cumbersome test of nematode resistance.

In North Carolina, NC12 C peanut cultivar was released in 1996. It is resistant to *Cylindrocladium* black rot and was tested as breeding line N90013E. Registered seed was produced in the 1996 growing season; certified seed will be produced in 1997 and the cultivar will be in the hands of peanut growers in 1998.

In North Carolina, germplasm release was planned for several genotypes derived from interspecific crosses (between cultivated and wild species) and possessing resistance to early leaf spot (*Cercospora arachidicola*), root-knot nematodes (*Meloidogyne incognita*), or insects (*Helicoverpa armigera, Empoasca fabae* and *Diabrotica undeecimpunctata*).

GA/IM/BF environmental

Impact listed for 1992-93. The peanut aphid, *Aphis craccivora*, jassids, *Empoasca dolichi* and *E. facialis,* a termite, *Microtermes thoracialis*, lepidopterous larvae, *Helicoverpa armigera* and *Spodoptera littoralis,* the peanut bruchid, *Caryedon serratus,* and millipedes, *Peridontopyge* spp., have been identified as potential economic threats to peanut production in the Sahel of West Africa (Lynch et al. 1986). Germplasm with resistance to a number of these insects, closely related species, or the diseases that insects transmit has been identified (see Lynch 1990 for a list of resistant *Arachis* germplasm). Research in Burkina Faso has shown that pre-harvest damage to peanut pods by termites exacerbates aflatoxin contamination of peanut seed. Germplasm with resistance to termites has been identified in Burkina Faso, and cooperative research with the Texas A&M Breeding project in The Peanut CRSP has been initiated to evaluate crosses with the resistant germplasm for termite and aflatoxin resistance. Development of aflatoxin resistant peanut germplasm would be of tremendous benefit to the people and livestock of this region.

Work continued in Burkina Faso and Georgia to improve pest management practices, based on the previous research and development activities in the last two phases.

In 1991 in Burkina Faso, studies focused on insecticide application at different growth stages, harvest date on yield and termite injury to pods and plants, evaluation of ICRISAT lines for termite resistance, and neem (biological insecticide made from neem trees) for control of insects. The insecticide, Temik, was effective for insect control in Burkina Faso. There was minimal effect from neem, a commercial product, in insect control, and was still not promising as insect control agent in 1992 tests.

Work in 1991 continued to show that a delay of harvest from 100 to 115 days and then 125 days after seeding increased termite damage and decreased yields. There was a decrease in soil moisture from an average of 16% at 90 days to 4.5% at 120 days. Some insect resistant lines were not showing resistance to termites, maybe because pods are scarified and not penetrated by termites. In Georgia lesser cornstalk borer acted similar to termite in BF, particularly the pod damage and delayed harvest relationships

Several lines, NCAc 343, NCAc 2240, NCAC 2242, NCAc 2243, M 13, RMP 40 and RMP 12 had relatively high resistance to termite damage in 1992 tests when harvest was delayed in Burkina Faso. NCAc 343 was identified as one of the most resistant to termite damage (line selected by NC/IM/TP, which showed to have high and broad-based insect resistance in early 1980s Peanut CRSP testing in the Philippines). Crosses were made by the TX/BCP breeding project, NCAc 343 x West African germplasm, and a limited number of advanced lines were sent to Burkina Faso for field testing.

As reported in 1993, peanut yield was substantially greater for NCAc 343 than for any of the other cultivars/lines evaluated in Burkina Faso. NCAc 343 yielded more than twice that of its nearest competitor even with the lowest plant population of all those tested. Yields were lowest for NCAc 2240, NCAc 2242, and NCAc 2243.

In the 1992 and 1993 growing seasons in Burkina Faso, field research confirmed findings that pod damage from termites and millipedes increases the longer harvest is delayed and soils dry, and that the level of termite damage is directly to the level of aflatoxin contamination. Peanut lines shown to be termite resistant in field research in India also had good levels of termite resistance in Burkina Faso, but they yielded much less than varieties selected for termite resistance in Burkina Faso or Texas. Thus, termite resistance appears to have broader geographic adaptation that does yield ability.

Georgia

Research in Georgia in 1991 on the interaction of lesser cornstalk borer (LCB) injury to peanut pods and incidence of aflatoxin showed that drought significantly increased aflatoxin in seed from drought stressed plants compared with aflatoxin in seed from irrigated plants. Application of Lorsban reduced pod injury during drought and significantly reduced the aflatoxin concentration in seed from both uninjured and LCB-injured pods compared with seed from drought stressed plants.

In 1992, twelve of the original 54 peanut genotypes selected in Georgia in 1991 in cooperation with NCS/IM were tested for resistance to thrips, corn earworm and velvet bean caterpillar. Some resistance was noted compared to Florunner cultivar. Crosses with the line NCAc 343 continue to show resistance to a number of insects, including three in this experiment.

In Georgia in 1993, Lorsban insecticide applied for lesser cornstalk borer control at planting, at pegging, or at planting and at pegging did not affect the pod weight, pod moisture or aflatoxin in undamaged, scarified, or penetrated pods under drought conditions. Dry pod weight for scarified and penetrated pods increased with an increase in the period of drought, while soil moisture of the pods declined with an increase in the duration of the drought. Overall, aflatoxin was significantly greater in externally damaged pods than in undamaged pods, and significantly greater in penetrated pods than in externally damaged pods. A significant days x damage category interaction was noted as a result of a more rapid accumulation of aflatoxin in the seed of damaged pods, both externally damaged and penetrated, than in the seed from undamaged pods. These results were supportive of 1991 studies and correspond with delayed harvest, termite damage, and aflatoxin accumulation in Burkina Faso.

Thrips damage among recommended peanut cultivars in Georgia in 1993 was significantly lower on Georgia Runner, GK-7, Southern Runner, and Sunrunner than on Florigiant (commonly grown cultivars). Leafhopper damage was significantly greater for Georgia Runner and NC 9 than of Southern Runner. Yield and value were greater on Georgia Runner, GK-7, and Sunrunner than for NC-7. These results show the value of cultivar selection for insect resistance, which ultimately will decrease the need, use, cost, and environmental effects of insecticides.

NCS/IM/TP environmental

A major focus in the Philippines, Thailand and North Carolina was the development of a suitable and effective integrated pest management (IPM) program. Among the factors considered are cost of insect control, host plant resistance, cultural practices such as seeding, harvest dates and crop rotations, and biological control measures.

In the Philippines and Thailand work continued on IPM studies or alternate insect control strategies in a farm setting in 1991. Germplasm resistant to leafhopper was being looked for in both countries. In 1992, an excellent database on genetic resistance of a number of peanut lines had been developed in the Philippines. The genetic resistance can be used in developing host plant resistance for use in IPM programs. This has economic implications also for farmers that usually cannot afford to buy insecticides.

Philippines

The improved use of insecticides was studied at several locations in the Philippines. Studies to evaluate insecticide timing, off-target effects, and incorporation into an IPM system, as well as the economic benefits, have improved the understanding of the use of pesticides. Promising lines of insect resistance materials were identified in both Philippines and Thailand in 1994.

IPM researchers in the Philippines had made outstanding progress by 1995 in evaluating host-plant resistance, biological control, alternative management strategies, developing economic thresholds, and pest biology. The progress seen in the host plant resistance work has developed an excellent data base evaluation under Philippine production systems. The principal investigators have taken the next important step and were testing the integration of this information into IPM programs in the production regions of the Cagayan Valley and Central Luzon. The data from these trials showed that overall insect damage in IPM plots was less that in standard ‘farmer managed’ plots and conventional insecticide use was often avoided. Some additional studies have looked at current Seed Board recommended varieties and promising cultivars used in conjunction with classical biological control programs.

Also in the Philippines, the continuation of studies into 1995 validating the use of biological control programs using *Trichogramma* sp. and a microbial insecticide *Bacillus thuringiensis* showed promise for future wide-scale implementation. Biological control studies have shown practicality and profitability using an integrated program in IPM evaluation trials.

The development of IPM control strategies continue in Thailand in 1995. This included basic insecticide evaluations to improve the timing of application to increase yield, and a total integrated program using host plant resistance as well as cultural and biological control methodologies. Since insecticides were relied upon quite heavily in certain areas these studies were essential. Five-years of IPM work were being developed into an integrated program for Thailand and for use in Regional Training as projected in the 5-year extension of the Peanut CRSP.

In the Philippines, reduced funding in 1995-96, the final year of the integrated pest management project (IPM), limited the overall program and objectives to host-plant resistance and the IPM systems evaluations. The overall research program in the Philippines has made outstanding progress in evaluation of host-plant resistance, biological control, alternative management strategies, developing economic thresholds, and pest biology. The progress seen in the host pant resistance work has developed an excellent data base evaluation under Philippine production systems. The principal investigators have taken a critical step forward in the final deployment of IPM practices and are testing the integration of this information into IPM programs in the various production regions. Study sites have included the Cagayan Valley, Pampanga, and Mandaue City. These trials have shown that IPM is a viable alternative to standard "farmer managed" plots and conventional insecticide use is often avoided. These studies have looked at current Seed Board recommended varieties and promising cultivars used in conjunction with classical biological control programs.

In the Philippines, biological control materials such as *Bacillus thuringiensis* have proven very effective against a complex of defoliators. These studies and those on the effects of intercropping and fertilizer use have contributed greatly to the development of effective IPM programs. Studies to validate the use of biological control programs using *Trichogramma* sp. and a microbial insecticide *Bacillus thuringiensis* show promise for future wide-scale implementation. Biological control studies have shown practicality and profitability using an integrated program in IPM evaluation trials.

Thailand

In Thailand, research in 1995-96 continued to place primary emphasis on the evaluation of germplasm for insect resistance at both the Department of Agriculture and Khon Kaen University. Studies have focused on the development of a variety of control strategies, including host plant resistance, for IPM programs. Since some farmers use insecticides, one objective included basic insecticide evaluations to improve the timing of application to increase yield and look at the total integrated program using host plant resistance as well as cultural and biological control methodologies. Research on the relationship of virus incidence and transmission by insect vectors has been slow, but there was steady progress. These studies enhance the understanding of the dispersal of several insect pests and the risk of disease transmission.

More recent studies (1995-96) in Thailand have included research investigating relationship of pod-feeding insects and the incidence of aflatoxin. Recent surveys have documented the widespread nature and seriousness of soil insect pests of peanuts in Southeast Asia, therefore this work was critical and long overdue in developing a complete understanding of crop loss assessment. However research on soil insects was tedious, labor intensive, and slow to provide usable results. It was also important for future aflatoxin elimination management strategies. Results of the tests indicated that the percentage of aflatoxin infested pods and seeds increased in relation to the increase in damage from insects to the pod or seed. Cultivars also affected incidence of aflatoxin with Tainan 9 having a higher incidence and peanuts grown during the dry season also had a higher level of contamination. This was similar to termite research in Burkina Faso, and lesser cornstalk borer research in Georgia.

North Carolina

In 1991, IPM development in North Carolina reported the use of pheromone trap technology to reduce or eliminate chemical treatments. When less than 45 adult beetles were caught in the traps per week, chemical treatments were reduced by about 16%.

In North Carolina, the development of a sustainable agricultural system for peanut continues to be a major objective into 1995. Efforts to minimize preventive pesticide use and to integrate into the control system biological control products were showing increasing promise for insect management in peanuts. These studies closely correlated to similar studies in the Philippines. The validation of forecast models for the lesser cornstalk borer and spider mites has proven to be an invaluable tool for pest management. Evaluations of pesticide interactions are increasing our understanding and provide us with an approach to reduce overall pesticide dependence.

Thrips were the insect vector of tomato spotted wilt virus in peanut. In North Carolina, studies have been completed in 1995 on thrips dispersal, migration, and over wintering habits, which have enhanced the biological and ecological information on this pest. Newly developed procedures in 1993-1994 allowed, for the first time, documentation of thrips overwintering in the soil of fields previously in peanut, and second year results confirmed the first year results. These studies will dramatically improve the understanding of the vector and help to manage tomato spotted wilt virus disease. The work supports similar efforts in Thailand.

In North Carolina, emphasis continued in 1996 on the development of a sustainable agricultural system for peanuts in the U.S. An increased effort to minimize use of preventive pesticides and to integrate biological and cultural control practices into the system have made significant progress. Coordination with growers organizations have established a working relationship for enhanced on-farm validation of this research. The validation of forecast models for the lesser cornstalk borer and spider mites proved to be an invaluable tool for pest management. Evaluations of pesticide interactions were increasing the understanding to reduce overall pesticide dependence, minimize the threat from tomato spotted wilt virus, and minimize secondary pest outbreaks.

GA/PV/N-TP Economic

Nigeria

The development of an efficient mechanical inoculation technique for groundnut rosette disease (GRD) that permits the rapid and reliable testing of peanut plants for resistance was reported in 1991. This technique gives peanut breeders the latitude of an extra generation (probably in greenhouse) each year. A disease rating was developed for accessing the effects of groundnut rosette on different peanut lines, useful for the GRD resistance breeding program.

In Nigeria, 57 lines (selected from 260) having less than 10% GRD infection in 1991 were planted in 1992. Thirty-three of these were free of GRD infection and show promise of some being acceptable to growers. Promising lines that yield from 2.5 to 3.0 metric tons per hectare are being multiplied for state trials.

Four peanut GRD resistant varieties were grown in the 1992 cropping season as breeder seed and foundation seed. A total of 100 kg of breeder seed and 0.89 m/tons of foundation seed was produced. Seed are in great demand to supplement the production by the National Seed Service. The varieties grown were SAMNUT 10 (RMP 12), SAMNUT 11 (RMP 91), SAMNUT 14 (55-437) from Senegal, and SAMNUT 16 (M554.76). These four varieties were released in 1993.

Twenty eight state yield trials in 14 states of the federation were reported in 1992. It is from these trials that high yielding GRD resistant varieties were identified for release for the different ecological zones.

Two medium maturing, rosette resistant varieties, and one short season, rosette susceptible variety have been identified for release in 1993. The susceptible variety was high yielding under Sudan Savannah ecological region.

A total of 30 rosette resistant advanced lines were sent to ICRISAT/Niamey in May 1993 for yield and selection trials.

In Nigeria, three new varieties, SAMNUT 20 (M412.801), SAMNUT 21 (MDR 8-19), and SAMNUT 19 (K720.78) were released in 1994. The first two were late maturing with rosette resistance and yields of 3.0 t/ha or better. SAMNUT 21 had rust and leaf spot resistance. SAMNUT 19 was medium maturity with moderate rosette resistance and was recommended for the Sudan Savannah zone. Twenty tons foundation seed and 60 kg breeder seed produced for the 1994 season.

Additionally, selections were being made of possible transformants that have the coat protein gene for the peanut rosette assistor virus and bud necrosis virus.

In Nigeria, a total of 20 tons of foundation seed of medium-duration, rosette resistant and non-resistant, short-duration cultivars were increased in 1994-1995 for distribution to farmers. These varieties filled a much needed niche for farmers and should reduce losses to the rosette virus.

A significant achievement in 1996 was the development of a mechanical inoculation procedure to screen for resistance to GRD. A single inoculation resulted in 100% infection of plants of susceptible genotypes and about 2% of resistant plants that could be distinguished from susceptible ones on the basis of delayed time of first appearance of symptoms and disease severity. The procedure utilized highly infectious inoculum. The consistency and reliability of achieving infection made the procedure particularly effective for inheritance of resistance studies and breeding programs.

Thailand

From Dec. 1992 to April 1993, major peanut production areas in16 provinces were surveyed for viral diseases. The areas were representatives of main production regions, the Northeast, Northwest, and Central. Field symptoms and serological tests were used as diagnostic procedures for incidence assessment. Details of sites, varieties, and planting dates were gathered in farmer interviews. Bud necrosis was the most important virus, a similar virus to TSWV. TSMV was not found very much. PMV and cowpea mild mottle virus was detected in Thailand this past year. Twelve lines of virus resistant germplasm were evaluated.

In Thailand, techniques for identification and manipulation of the peanut viruses had been established by the 1994 season. As the virus surveys were completed, the major emphasis was being placed in various avenues that may lead to disease suppression or control. Some peanut cultivars were identified with low rates of seed transmission of PStV and PMV. Studies were directed to determine if this trait was genetically controlled, and if so, to work with plant breeders to incorporate the resistance into acceptable peanut cultivars. A U.S. peanut cultivar, Southern Runner, had resistance to TSWV, and was tested for resistance to BN and yellow spot, diseases of peanut in SE Asia similar to TSWV. As resistant lines or transformed peanut plants became available from the U.S. project they were tested for effectiveness in SE Asia.

A comprehensive package for virus control on peanut in Asia was developed in Thailand during 1994-95 and the publication was in press. The basic tenants of this package incorporate plant resistance, use of virus free seed and cultural practices such as adjustment of sowing date, using high plant density, and intercropping peanut with fast growing non-host crops. In addition to use in Thailand, this package can be used in regional training proposed for Thailand in the 5-year Peanut CRSP extension.

Philippines

The Bureau of Plant Industry Economic Garden, Los Banos handles the multiplication and distribution of peanut seed to National Cooperators who evaluate breeding materials slated for commercial release. Seed samples were tested by ELISA for PStV. Some of these seed were infected and provided a source of inoculum throughout their distribution system. The Philippines collaborated in 1991 only.

Georgia

Some resistance but not immunity to peanut mottle virus, peanut strip virus and tomato spotted wilt virus (TSWV) were found in the peanuts *Arachis diogoii* and *Arachis helades*.

Studies over three years (1998-90) and summarized in 1991, showed that TSWV reduced the number of seed produced by 67%, average seed weight by 25%, and total yield by 72%.

The thrips vector of TSWV was surveyed in different seasons over a two year period. Brachypterous adults were prevalent during the winter and were being tested as an over-wintering source of the virus.

It was reported in 1994 that the incidence of TSWV infecting peanut was usually indicated by typical symptoms (apparent incidence), but immune-detection of tap roots could indicate hidden incidence. Both apparent and hidden incidence increased linearly with time, but late season total incidence was higher. Total incidence indicated that many TSWV infections did not result in the development of typical symptoms associated with spotted wilt.

Plants were grown in the green house in 1994 that were transformed with the coat protein genes from tomato spotted wilt virus, peanut stripe virus, and peanut chlorotic streak virus and proved to produce fertile seed. All these fertile plants were carried to the third generation, where the progeny were expected to be homozygous for the transformed trait.

Studies were completed in 1995 on the nature of TSWV epidemics in peanut, such as effects on yield, thrips as vectors, virus spread, and field screening of commercial cultivars for resistance. The research also involved the transformation of peanut with the DNA sequence coding for the coat protein of several peanut viruses to which a GUS marker gene were attached. Additionally, selections were made of possible transformants that have the coat protein gene for the peanut rosette assistor virus and bud necrosis virus.

B Processor values

AAM/FT/BF
Of special note, Dr. Bharat Singh died unexpectedly in October 1992 and was replaced as principal investigator by Dr. M. Elena Castell-Perez, food scientist, Alabama A&M University Department of Food Science. The co-principal investigator remains Dr. John Anderson. Alfred Traore continued as Collaborator in Burkina Faso. Ghana was added as a host country in the 1993-94 phase with Kafui Kpodo, Food Research Institute, Accra, Ghana as co-principal investigator.

Burkina Faso

Since flavor was associated with the oil, work was in progress to evaluate the flavor quality of the paste using Gas Chromatography techniques. (Reference: Torres, H. and Castell Perez, M.E. 1996. Rheology and shelf life of reduced-fat peanut butter. Research and Technology Transfer Symposium, TAMU).

Research continued in 1990-1991 on peanut fortified Toe, a West Africa staple, and continued into 1993.

Storage studies showed that polyethylene storage bags were better for defatted flour (85% sorghum-15% peanut) storage compared to clay coated or double waxed paper bags; storage was a problem for processors. Scientists at the University of Ouagadougou assisted a small peanut paste processor to package full-fat peanut paste in tin cans. Quality was good for consistency, acceptability and shelf life, but good advertising was needed. This work continued in 1991-92 as food scientists in Burkina Faso continued to assist the peanut butter processor in the assessment of the product marketability. The product had good quality (consistency, shelf-life, acceptability), but appropriate packaging was needed that is both economical and protective of the product. The tin cans proved to be too expensive.

Food extrusion research began in 1991 and continued in 1992 with full-fat peanut and sorghum. Results showed that peanut should be less than 20% for optimum processing. These results will assist in the formulation of peanut-cereal food products acceptable to West Africa consumers.

In Burkina Faso, peanut paste/butter samples for aflatoxin management studies were collected in 1992 from industrial and traditional, small-scale manufacturers. Aflatoxin levels were higher in the paste from traditional sources. Since the major portion of the paste used is from traditional sources, methods to help these processors reduce aflatoxin content of paste are needed.

In Burkina Faso, an extract of *Allium sativum* was found in 1994 to be an effective inhibitor to the growth of *Aspergillus flavus,* the fungus that produces aflatoxin. Research continued through 1996 to determine the best method for application to peanut in storage. Application of this technology to peanuts in storage can have a tremendous impact on the health conditions of the local population. Similar research was conducted in Ghana with similar results.

Nutritional and microbiological quality of peanut paste from several regions of Burkina Faso was analyzed in 1994. Quality of traditionally made paste was generally inferior to the product manufactured by a local industry. Results encouraged the development of industrial processing plants for manufacture of peanut products. The optimum package size and material were identified by scientists at the University of Ouagadougou, and information delivered to the peanut factory, CITEC-HUILERIE. In particular, thicker plastic bags (slowed rancidity compared to thinner bags) available in markets were studied. Plastic cans were found suitable. Tin cans were earlier found too expensive and caused manufacturers to stop paste production. From among these suitable packaging materials, cost will be the major determining factor on which to use.

The production of weaning foods initiated in Alabama in1994 were extended into Burkina Faso work in 1995-96. Good formulas were developed using maize, sorghum and rice, peanut flour and milk. The products have improved nutritional value (18-20% protein, 10-12% fat, and 2-3% minerals). Other formulas tested used 60% cereal and 40% legumes in combinations of teff, pearl millet, cowpea, and peanut. Fortification and improvement of traditional or staple foods research was completed for peanut-fortified staple foods such as "toe", "marba-tique", and "basi".

In 1994, activities continued in Burkina Faso to help resolve constraints for small to medium size processors of peanut products, including peanut flour supplementation of wheat flour, flavor quality of peanuts, reduced fat peanut butter, extruded snacks, paste packaging and fortified Toe.

Ghana

Work was initiated in 1993-94 in the identification of problems with post-harvest handling of peanuts in Ghana. A survey questionnaire was developed and pre-tested in the Greater Accra region and response was encouraging. Slight modifications were being made before the major survey started by the end of 1994.

The field survey of peanut production in Ghana was competed and summarized in 1996. Five major growing areas were surveyed; Ashanti, Brong-Ahafo, Northern, Upper East, and Upper-West regions. Information obtained from the survey included the general background of peanut farmers, practices for land preparation, planting, harvesting, stripping, drying, shelling, storage, and general problems that hinder peanut production in Ghana. Average area planted per farm is about 1.5 hectares. Most operations were hand done. Drying of peanuts was done in the sun in the field or at home. After hand stripping, peanuts were stored in jute sacks or traditional storage structures until sale, sometimes up to nine months. Most farmers did not know about aflatoxin problems, but sorted the peanuts to get good market price. Buyers of peanut at the farm gate are local traders and middlemen from the urban centers. Problems mentioned included, unreliable rainfall, poor soil fertility, and lack of farming inputs for land preparation, harvesting, stripping (threshing), shelling, and high labor costs.

A nationwide survey covering the ten regions of Ghana was completed in 1996 to study the existing traditional methods for the preparation of peanut butter. The major unit operations identified were winnowing, roasting, dehulling, milling and packaging. Total aflatoxin levels from the Eastern region ranged from 48 to 2024 ppb (mean 663 ppb), and from the Central region 78 to 2014 ppb (mean 727). These were much above the WHO/FAO/UNICEF maximum permissible limit of 30 ppb. The Central, Ashanit, and Volta regions were high; 531, 632, and 710 ppb, respectively. The Greater-Accra region had 133 ppb. The Upper East, Northern, Upper-West, Brong-Ahafo regions ranged from 9 to 88 ppb. These results strongly show that work needs to be done on aflatoxin in locally consumed products, and contributed to the emphasis on aflatoxin and health in the 1996-2001 phase. In addition, protein and fat contents were characteristically high ranging from 27 to 36 % and 40 to 53 %, respectively.

Alabama

In Alabama, optimum conditions for the development of infant weaning foods using mixes of peanut pastes with cowpea, pearl millet, and teff flours were studied in 1994 in relation to application in Burkina Faso. Good products have been made in Burkina Faso using maize, sorghum and rice, peanut flour and milk. The product had improved nutritional value (18-20% protein, 10-12% fat, 2-3% minerals) and higher energy density.

Research was underway in Alabama in 1994 to develop an improved, acceptable low-fat peanut butter. Optimum conditions (roasting, oil extraction procedures, and types of fat replacers) were established for manufacture of a peanut paste with 50% less fat than commercially available products in the USA. Sensory characteristics (color, texture and taste), viscosity and storage stability (shelf-life) were determined. Since flavor was associated with the oil, work was in progress to evaluate the flavor quality of the paste using Gas Chromatography techniques.

GA/FT/TP

Thailand

Product development continued in Thailand in1991 that would be acceptable to processors and consumers. Nutritious and crispy peanut-based snacks for school age children and extruded products were formulated and evaluated.

Attempts in Thailand to produce peanut tempeh from partially defatted peanuts at a cottage industrial scale were very successful in 1991. Tempeh is a yogurt-like product (*Rhizopus oligosporus* fermentation) and has high potential for use in the Thai food system. Supplementation of Thai sausage with 30% dried peanut tempeh resulted in no difference in sensory scores for color, flavor, texture, and consumer acceptability. Replacing dried shrimp with dried peanut tempeh in hot chili pasta resulted in no difference in acceptability between vegetarian and non-vegetarian consumers.

A survey was conducted on peanut harvesting practices in Loei and Srisaket Provinces in NE Thailand in 1994. Peanuts are grown twice during the rainy season in the upland regions. The early-season peanuts are harvested during July and August, while the rainy-season peanuts are harvested during October and November. Survey results from 30 farmers from each province were compiled and analyzed. Average peanut area planted per farmer averaged 1.3 hectares and average yields were 1.3 metric tons/hectare. The average number of household laborers for production was 4.1 persons/family. Harvest was pulling by hand in moist soil with 5.3 days spent in harvest. The peanuts were hand stripped and dried for 4.5 days and then sold to local traders, except those kept for home use and seed. Aflatoxin contamination was of particular interest. Peanut samples were collected at various stages of post-harvest handling and analyzed for aflatoxin contamination. The early season peanuts generally had aflatoxin levels in excess of 20 ppb. These results showed that harvest practices affected quality of peanuts available to processors.

USAID considered Thailand to be a 'graduate' country in 1993 and direct research support was discontinued. The CRSP support was focused on a program for training and technology transfer in cooperation with the food technology and field production programs. The training effort began with a 'Training for Trainers from Indo-China countries: Technology of Peanut Processing", April 18-May 27, 1994. All participants were government officers whose job was related to peanut utilization. Ten students from Cambodia, Laos, Myanmar, Thailand and Vietnam attended the six week course. A Workshop on Training the Trainers from 13 countries on the topic of "Quality Evaluation and Utilization of Food Legumes" was held at Kasetsart University form April 24 to May 27, 1985, which was attended by 20 participants from Tanzania, Fiji Island, Sri Lanka, Republic of Maldives, Bhutan, Bangladesh, Sierra Leone, Laos, Cambodia, Korea, Vietnam, Nepal, and Thailand. All participants were government officers in work related to legume utilization. A Workshop on Training the Trainers on the topic of "Quality Evaluation and Utilization of Food Legumes" was held at Kasetsart University from April 22 to May 24, 1996, which was attended by 13 participants from six countries: Tanzania, Bhutan, Sierra Leone, Laos, Republic of Guinea, and Thailand. All participants were government officers in work related to legume utilization.

In Thailand, design criteria for modification of an existing sheller was developed in 1994 for the Khon Kaen 60-1 variety, which was released with Peanut CRSP support in the Training and Technology Transfer effort. Improved shelling resulted from the modification, which will assist in increased farmer acceptance of the variety. Seed were larger that the common Tainan 9 variety; the shelling problem was one factor discouraging farmers from adopting the new and better variety.

During phase II of the Peanut CRSP, Kasetsart University had trained over 250 villagers (mainly women) on peanut processing and sorting technology. Trained villagers initiated village-level enterprises that are producing aflatoxin-free peanut products with better packing, providing the main cash income of women in these villages. Through regional training efforts, Thailand became a center of excellence for training of trainers. Several workshops, largely attended by women, had been conducted focusing on product development and food safety practices.

Tempeh starters for fermentation of peanut products were prepared using several substrate formulations in Thailand in 1994. Selection of starter was based on efficiency in producing good quality peanut tempeh. The starter was prepared in larger scale and tested before shipping to housewives in Kud Jub District, Udorn-thanee Province. The women are being trained to produce and market peanut products in the Training and Technology Transfer effort.

Philippines

At UPLB in 1991 pilot scale peanut paste and imitation cheese spread from the paste studied, and a cheese-flavored peanut-based spread was developed in Georgia and the Philippines. An acceptability test with 416 respondents in a 6 location survey in the Philippines showed acceptance by the consumer. They would be willing to pay more for the spread than for peanut butter, but less than for a dairy-based spread. Discussions are now underway to work with a private Philippine food processor to commercialize the product.

Curd and yogurt products are also popular in the Philippines and work was underway to use and improve the use of peanut in the products.

In the Philippines, periodic monitoring of aflatoxin in commercial peanut butter samples obtained in sales outlets has been done over the life of the Peanut CRSP. Often excessively high aflatoxin levels have been found. Samples representing eight brands from two cities and three stores were tested in 1991. Notably, only one brand contained over 20 ppb aflatoxin, which indicated the impact of the continued testing for aflatoxin.

Visayas State College of Agriculture (ViSCA), in Baybay, Leyte with Dr. Lutgarda Palomar as principal investigator came into program in 1993-1994. Two women's groups were identified as potential collaborators for setting up village-scale systems for processing, packaging and marketing peanut-supplemented snack foods. These were the Guadalupe Women's Association of Barangay Guadalupe in Baybay and the typhoon Uring victims Women's Association (URIVIC) in Ormoc City, Leyte. Surveys were done to obtain socioeconomic information about residents in the two areas targeted for establishing village-scale peanut utilization technologies. Results indicate that markets exist for selling products, with profits to be gained by the two women's associations. A dryer was designed and fabricated to dry sweet-potato flakes to be used in peanut-sweet potato snacks. Temperature and rate of air flow as well as drying time were optimized. A formulation for peanut-sweet potato cookies was optimized. Studies on the effect of packaging films and storage conditions on maintenance of sensory quality were initiated.

In the Philippines, supplementation and optimization of Lady Finger formulas with peanut was accomplished in Leyte in 1994. Appropriate blends of peanut, wheat flour and cassava flour to give highest levels of sensory quality were defined. Packaging technologies for the baked root crop products extended with peanut were evaluated. Shelf life predictions for various conditions of packaging and storage were established. These technologies support the women's cooperative activities in processing and marketing the products. The product name was changed to Lady Button's to not interfere with the already marketed Lady Finger, per desire of processors. About 20% peanut was acceptable.

In the Philippines in 1995, interdisciplinary and integrated efforts continued to transfer peanut processing technologies to rural women's cooperatives. Training, processing management, and marketing aspects were emphasized.

In 1996 a two-day workshop on "Peanut Processing" and a second workshop on "Aflatoxin Control for the Food Industry" were held in the Institute of Food Science and Technology, Los Banos, Philippines. Representatives from the food industry, government, and academia attended. The aflatoxin training was in response to a request by the food industry, because of a recall by the Bureau of Food and Drug of several brands of peanut butter because they contained more than 20 ppb aflatoxin. Topics covered included aflatoxin control and analysis, sampling methods, and quality and safety procedures. In addition, an information campaign on the health aspects of mycotoxins in foods was targeted toward consumers.

In 1996, the project expanded the number of adopters in Leyte, Philippines by introducing peanut-enriched products to the Bubon Integrated Root Crop Processing Cooperative, the San Agustin Rural Improvement Club, and a private entrepreneur. These training examples indicate the efforts made by the Peanut CRSP to make an impact on the sustainability of economic growth and food availability.

Georgia

In Georgia, new products were developed in 1994. Peanut butter-honey spread containing 7% honey and 1% salt was acceptable. Also, a peanut based beverage was developed and tested with processor interest and market potential.

GA/PH/C

In Belize, a mechanical thresher was further modified and tested in 1991. The local fabrication was more effective and lower cost than imports. An inexpensive kerosene dryer was adapted and now in use in the San Antonio (Cayo) cooperative for peanut and other grains. A laboratory model peanut blancher for larger seeded peanut to produce salted peanut was tested, and consumer tests of the peanuts resulted in good acceptability. A peanut harvester and thresher were made by Urvan Wilson in CARDI/UWI and field tested in Jamaica, with good performance on dry crops and short plants. A mechanical dryer was tested in Jamaica.

In Belize in 1992, the San Antonio Cooperative has successfully adopted dryer and storage technology developed by the Peanut CRSP. The aflatoxin level in peanut was monitored at the farm level in storage and when moved to market. Aflatoxin has not been detected above the tolerance level of 20 ppb in any sample. Moisture content of all stored peanut was recorded at less than 10%.

The "Wilson" harvester, adapted to Jamaica conditions will be tested for heavier clay soils in Belize in 1992.

In Georgia in 1993, a manual is being finalized that provides detailed plans and cost estimate for building the thresher that was modified, tested and now used on farms in the Caribbean. Also, a manual is being developed that will describe plans and estimated costs for construction of storage facilities that have been developed and evaluated in the Caribbean.

The Belize cooperative was still using the dryer in 1993, but in view of lower operating costs there is interest to change from gasoline to electric motor. Storage levels of aflatoxin at farm level remain under the tolerance level of 20 ppb in most cases. Peanut butter improvement in Belize is being sought in cooperative work with the University of Georgia scientists. The harvester useful under Jamaica soil conditions had limited success so far in Belize due to heavy soils.

In Jamaica a study of the socioeconomic aspects of post harvest was planned for 1993 with the Institute of Social and Economic Research. Several field days were held, and half of the participants were women. A workshop on improving Production and Quality of Peanut was held in Mandeville in Jan 1993; there were 60 attendees including farmers, and the private and public sector employees.

At the University of Georgia in 1993, a portable dryer for pickup transport was developed and planned for use in Belize and Jamaica.

The survey in Jamaica was completed in 1994, but not fully analyzed. A main problem noted in production was high labor costs. Case studies in Jamaica show that resistance was coming to the CARDI/Payne cultivar because of testa color (cream colored). It is proposed that NC2 be promoted as an alternative cultivar, but it is not as sweet as either the CARDI/Payne or the Valencia. CARDI/Payne produces highest seed yields.

In Jamaica, CARDI continued to work closely with the United Farmers Multi-purpose Cooperative (UFMC) in 1995. During its three-year life UFMC has used CARDI/Peanut CRSP information and assistance in peanut production, postharvest handling, storage, and marketing. Motorized and hand threshers have been adopted, including designation of a farmer to service and maintain the threshers. The peanuts produced by the farmer's were accumulated by the co-op and marketed in bulk to large and small processors. Also they solar roasted peanuts and made peanut candies, which were sold to schools in the area.

CARDI loaned a commercial plastic bag sealer to the co-op to facilitate proper sealing and storage of processed peanuts. UFMC was marketing its own brand of weaning food called 'Manna', which was produced by Jamaica Cereal Foods, but made from peanuts and corn grown by the co-op. A range of peanut flavored milk drinks were also being prepared by the co-op, which was being done in conjunction with a commercial operator that markets milk solids. UFMC was negotiating a lease on a building for office and processing space. The facility was a major boost to the peanut producers in St. Elizabeth' Parish, which produced most of the peanuts in Jamaica.

During 1995 the year several Field Days were held in Jamaica by the Ministry of Agriculture, Extension Service. In addition to information on general peanut agronomy, the Peanut CRSP developed cultivar, thresher, and sheller were featured or demonstrated.

A socioeconomic study was completed in Jamaica in 1995 and a written report is being developed. The survey details the peanut production, harvesting, post harvest handling, storage, processing, and marketing. Results will aid the extension service in identifying points to intervene in improving the peanut system.

In Belize in 1996, the main emphasis was on the socioeconomic study. The results were used to suggest ways to maintain post-harvest quality and reducing post-production cost through improved post-harvest handling operations including harvesting, threshing/stripping, shelling and storage.

In Jamaica in 1996, the main emphasis was on conducting consumer taste panels and aflatoxin monitoring in peanut and peanut products. Dr. Margaret Hinds, now on a Post-Doctorial appointment at the University of Georgia and earlier received her Ph.D. at the University of Georgia, conducted the training sessions. CARDI/Peanut CRSP worked very closely with the United Farmers Multi-purpose Cooperative and made significant progress in training of personnel and use of post-harvest handling equipment developed or obtained through the Peanut CRSP Post-harvest project.

It was noted that the Jamaica Star News (newspaper), June 27, 2009 reported that a peanut farmers training seminar to teach practices such as land selection, seed preferences, time of planting and other practices was held. This indicates a long-term impact of activities encouraged by the Peanut CRSP some 15 years earlier.

C. Consumer values

TX/MM/S

Senegal

Studies in 1992 of phyllosilicate clays collected from West Africa indicated that the clay, "Smectite 1" (from Thies, Senegal), exhibited a fairly good chemisorption index for aflatoxin. The kaolinites exhibited varying binding strengths, with relatively low chemisorption efficiencies. A chemical modification of attapulgite clay from Senegal resulted in a significant improvement in its aflatoxin binding strength.

In Senegal, surveys were conducted in 1992 on aflatoxin from commercial oil production. Fifty samples of peanut oil and 20 samples of oil cake were analyzed for aflatoxin B1; the oil averaged 54 ppb and cake 67 ppb. In addition, twenty samples of hand-picked roasted peanut from markets did not have detectable levels of aflatoxin.

Ghana

The addition of Ghana as a project participant was notable since it expanded the capabilities and opportunities to study and provide solutions to the aflatoxin problem in foods and feeds into another major peanut producing country in West Africa. An aflatoxin survey in 1994-95 on peanut in Ghana showed that damaged seed contained in excess of 30 ppb (WHO minimum level), while undamaged seed had generally very low levels. This suggested that post harvest storage was a significant source of aflatoxin in peanut and that damaged seed were the primary source. Hand sorting to remove damaged seed prior to processing can be an effective way of reducing aflatoxin levels in seed intended for consumption. This is a similar conclusion to the earlier work done in the Philippines and Thailand.

In Ghana, a nationwide survey was conducted in 1995-96 to determine the extent of contamination of stored peanut by fungi, especially *Aspergillus* spp. and the aflatoxin levels associated with such kernels. A final publication on the work entitled "High incidence of *Aspergillus flavus* and aflatoxins in stored groundnut in Ghana and the use of a microbial assay to assess the inhibitory effects of plant extracts on aflatoxin synthesis" was in press, *Mycopathologia,* 1996.

Work in 1995-96 studied the effects of different plant extracts on *Aspergillus* growth on peanut kernels collected from the local markets in Ghana. Clove powder, *Syzigium aromaticum,* was the most effective product in prohibiting *Aspergillus* growth and subsequent aflatoxin formation.

Texas

Results from a 1990-91 study of the mechanism of aflatoxin chemisorption by hydrated sodium calcium aluminosilicate revealed that chemisorption for various aflatoxin prototypes was similar to that observed with the corresponding parent aflatoxins. These findings indicated that the major site of sorption by the HSCAS for aflatoxin is the B-dicargonyl system of aflatoxin. Other preliminary studies using infrared spectroscopy and X-ray diffraction analysis indicated that the sorption mechanism was predominately a surface interaction (i.e. chelation of metal ions of HSCAS by the B-dicarbonyl).

By 1996 at Texas A&M, the interactions between diverse phyllosilicate clays and aflatoxin were further characterized. The research indicated that the enthalpy of adsorption (chemisorption), and ligand specificity and capacity were critical requirements for optimal reduction in aflatoxin bioavailability and efficacy in animals. All aflatoxin adsorbents are not created equal and should be rigorously tested in vitro and in vivo, paying particular attention to their effectiveness in aflatoxin-sensitive animals and their potential interactions with nutrients, etc. It is important to understand that there may be significant risks associated with the inclusion of a nonselective silicoaluminate (or other adsorbents) in food and feed.

Previous studies in Texas have shown that highly adsorbent clays in the diets of farm animals prevented the deleterious effects of aflatoxins. Studies with rats in 1992 showed similar protection from aflatoxins, and more importantly no new metabolites were found in rats fed the clay-treated diets containing aflatoxin.

A new mini-column method for the rapid detection of aflatoxin M1 in milk was developed in 1992. The new method has a minimum detection level below the action level of 0.5 ppb.

Pathways to aflatoxin development in peanut seed had a focus during the 1991-92 period. The sterigmatocystin/aflatoxin pathway, with the verA gene, was identified as a step in the pathway that could lead to genetic modification to block aflatoxin production. This would be a major contribution to the development of *Aspergillus flavus* and subsequently aflatoxin contamination in peanut.

An effort to extend clay technology in Senegal was made in 1993. Drs. Phillips, Cummins, and Sarr met with the Ambassador of Senegal in W/DC and discussed with him about the transfer of HSCASA and mini-column technology to Senegal. The Ambassador, His Excellency Ibra KA, expressed enthusiasm and reiterated his willingness to help achieve the goals.

Cooperative studies with Dr. Thomas H. Adams (Dept. of Biology, TAMU) in 1993-94 have resulted in a publication describing the cloning, sequencing and characterization of verA, a gene in the sterigmatocystin/aflatoxin pathway of *Aspergillus nidulans*. The study of this and other genes in the aflatoxin pathway should lead to a molecular understanding of what environments, peanut metabolites, etc. result in aflatoxin production in peanuts. Additionally, another gene in the sterigmatocystin/aflatoxin pathway has been identified by gene disruption and this disruption will soon be published.

In Texas, the entire sterigmatocystin (ST) pathway of *Aspergillus nidulans* was identified by 1995. Evidence shows that the ST pathway was functionally equivalent to the aflatoxin (AF) pathway in *Aspergillus flavus* and *Aspergillus* parasiticus and that this ST/AF toxin pathway was conserved as a cluster of genes in all aflatoxin producing Aspergilli. Most importantly, the regulatory gene aflR is found to regulate both the ST and AF pathway in all three *Aspergillus* sp. Efforts will be focused on identifying ways to keep aflR turned off permanently. The study of this and other genes in the ST/AF pathway can lead to a molecular understanding of what environments, peanut metabolites, or other influences result in aflatoxin production in peanuts. Studies to further refine the pathway continued in 1996.

D. Information/Training/Technology Transfer

Information

The *Arachis International Newsletter* was published each year, and has been continuously since 1982.

Training

The second regional Workshop on Training the Trainers was held in Bangkok in April and May 1995, on the topic of "Quality Evaluation and Utilization of Food Legumes". Twenty participants from 11 Asian countries and two African countries attended. The participants were government workers with roles related to legume utilization. Many of the examples used in the Workshop originated from the Peanut CRSP research and outreach activities.

A key factor in food product development and transfer to processors and consumers was sensory quality. Dr. Anna Resurreccion trained staff members of the Food Development Center, the National Food Authority, Ministry of Agriculture in Taguig, Metro-Manila, the Philippines on sensory evaluation methodology, specifically on descriptive analysis techniques and consumer effective testing procedures.

Additionally, training courses on sensory evaluation and quality control and consumer testing of food products were conducted by Dr. Resurreccion in MARDI, Malaysia in November and December, 1994. A total of 105 participants enrolled, 35 from the Philippines and 60 from Malaysia, mostly from the food industry, and a few from government agencies and academic institutions. USAID sponsored the courses along with MARDI and FDC.

The third training workshop on "Quality and Utilization of Food Legumes" was held in April and May 1996 in Bangkok, Thailand. The workshop was attended by 13 participants from six countries in Asia and Africa.

During phase II of the Peanut CRSP, Kasetsart University had trained over 250 villagers (mainly women) on peanut processing and sorting technology. Trained villagers initiated village-level enterprises that are producing aflatoxin-free peanut products with better packing, providing the main cash income of women in these villages. Through regional training efforts, Thailand has become a center of excellence for training of trainers. Several workshops, largely attended by women, had been conducted focusing on product development and food safety practices. (March 30, 2010 personal communication with Dr. Aran Patanothai, Khon Kaen University, former Coordinator, the Thailand Coordinated Peanut Improvement Program)

A number of host country, non-host country, and U.S. students were trained for M.S. and Ph.D. degrees. These will be listed in a summary of all students from 1982-2012, since the beginning and ending dates of many of these cross over program phases. The numbers and country and regional representation of non-U.S. students and the number of U.S. students show the high focus on human capacity development in the Peanut CRSP. A number of students were supported in programs in their own countries. Both the foreign and U.S. students did research for theses and dissertations that benefited both the U.S. and the home countries of the students.

Key to research was short-term training of host country collaborators. Some did not have interest/confidence in language skills and academic background to opt for degree training, but were important to program and long-term contributions to their country, while some had advanced degree training. Participating host country scientists benefited from short-term training visits to the U.S. as well as in long-term contacts with U.S. scientists.

Sustainable agriculture activities

A Pilot Program continued in the Philippines that extended CRSP technology (varieties and IPM) to farmers in the Cagayan Valley of Luzon, which is the major peanut growing region. New peanut varieties are being multiplied in a program, with farmers in Thailand, which will accelerate the adoption of the new varieties on a wide-scale.

An extensive program in Jamaica led by CARDI and the Jamaican Extension Service has caused adoption of the new CRSP developed CARDI/Payne variety by over 10% of the farmers in two years. Yields are 42% higher than the traditional varieties as determined in a socioeconomic survey funded by the CRSP.

E. USAID/Egypt buy in program, summary of Egypt project accomplishments 1991-1994

The following summary of the collaborative program between the Egyptian National Agricultural Research Program and the Peanut CRSP was based on a Progress Report July 1, 1991 to March 1, 1994 that was submitted to a Research Review Team; Dr. A. Abdel Gawad, Faculty of Agriculture, Ain Shams University, and Dr. Curtis Jackson, peanut consultant, USA; March 27, 1994.

Review summary

The collaborative research effort was initiated in July 1991 with the overall objective of strengthening the peanut research programs in each country and to, thus, increase production and utilization of peanut in both countries. The program is composed of three distinct yet inter-related projects; nitrogen-fixation, plant pathology/nematology, and food technology. The nitrogen fixation and plant pathology/nematology projects have long-term goals of increasing peanut yield potentials and yield quality, and to thus provide a superior primary product to the consumers. The food technology project has as its long-term goals the enhanced utilization of the superior primary and secondary products derived as benefits of the nitrogen-fixation and plant pathology/nematology projects.

The program has been a major success with most of the original objectives outlined by each component project being achieved. The nitrogen-fixation projects has demonstrated the importance of improving upon the native rhizobium strains in the new lands of Egypt, selected rhizobium strains from the North Carolina State University collection with potential for significant improvement of biological nitrogen fixation in the high stress environments characteristic of the new lands of Egypt, and has developed research plans for examining the potential of novel legume crops to improve the sustainable productivity of these ecosystems. The plant pathology/nematology project has identified important sources of host plant resistance to the major pathogens and nematodes parasitic on peanut in Egypt and the U.S., has transferred these important germplasm resources to the Egyptian research program, and has begun development of these germplasm resources.

The food technology project has examined the potential for use of processed peanut products by Egyptian consumers, examined the use of peanut hulls as a food additive to increase fiber content, and has designed, fabricated and installed peanut processing equipment to support future research.

In addition to a high degree of success in completing original objectives, each project has achieved a number of additional important accomplishments. Primary among the additional achievements has been the establishment of strong linkages among the scientists of each project. This has been achieved through frequent on-site visits, with Egyptian investigators traveling to the U.S. and with U.S. investigators traveling to Egypt. The effective communication among all investigators has resulted in the development of extremely strong research teams.

Despite the minor initial investment, the collaborative ARC/U.S. Peanut Research Program has become an extremely active and effective research program. If this program can be continued, additional significant achievements will be realized. An additional one year of funding will allow the three component projects of the program to bring to completion several important studies that have the potential to have a significant impact on the Egyptian peanut industry. To terminate this program at this time will make it extremely difficult to realize the full potential of accomplishments made to date.

F. USAID/Mission Buyin. Niger interCRSP project

A number of the CRSPs have been active in West Africa from their inception from 1979-1982. The goal of the USAID "buyin" initiative, was to allow the field missions to avail themselves of expertise in the Global Bureau projects in support of specific country needs. At the invitation of USAID/Niger Agricultural Officer John Mitchell in 1991, a group of the CRSPs, including Peanut, presented a plan for a cooperation effort in Niger-which was not funded. The CRSPs were again approached by the USAID/Niger Agricultural Officer Curt Nissley in late 1994, to reconsider an Inter/CRSP activity. Specifically, the Sorghum/Millet (INTSORMIL), Soil Management (TropSoils), and Peanut CRSP were cited for collaboration. A planning meeting was held in Niamey, Niger in early 1995 that developed work plans and budgets for the activity. The Peanut CRSP received $150,000 in the core 1995-1996 budget to support the Peanut CRSP component of the plan. Dr. Chandra Reddy, Alabama A&M University agronomist with some eight years of experience of project management experience in Niger provided overall leadership for the project and the field activities. Dr. David Cummins, program director, Peanut CRSP, coordinated the areas of infrastructure support and training of INRAN/Niger scientists; Drs. Elena Perez and Victor Nwosu, food scientists, Alabama A&M University, resource personnel for post-harvest activities; Dr. Issaka Mahamane, INRAN, Country Coordinator and Coordinator for Soil Amendment activities; Amadou Mounkaila, INRAN, coordinator for Variety Trials; and Moussa Oumarou, INRAN, coordinator for Post-harvest activities.

The specific goal of the project was to provide assistance to the USAID/Niger mission, to assure that technologies developed by the Peanut CRSP and also from other sources (i.e. the Niger National Program, ICRISAT Sahelian Center) are transferred to farmers and processors. Farmer field trials would be at two levels, researcher management trials on station and farmer managed/on-farm trials (improved varieties, date of sowing, and soil amendments). Post-harvest activities planned were: Village level oil expressers, pickers, and shellers would be demonstrated at the farm level; Decontamination of village produced peanut oil (evaluate Senegal results that sunlight can reduce aflatoxin contamination levels of peanut oil); Training of village women for value adding to peanut; and ELISA equipment for aflatoxin analyses will be purchased for use in the INRAN Crop Quality Laboratory. Major accomplishments follow.

Variety trials in 1995 – Thirty-two on-farm variety trials were successfully conducted. Eighteen improved peanut varieties were grown, and only four yielded less than the commonly grown check varieties. At Mayahi, T177-83 produced 80% more than the control T55-437. At Jiratawa, T169-83 produced 68% and ICGV 87281 produced 403% more than the control T55-437. At Konni, T131-83 produced 48% more than the control 796. At Dakoro, T14-89 produced 99% more than the control 796. At Padaria, T169-83 produced 102% more than the control 55-437. There were 25 farmers that preferred to grow improved varieties in the future. These results show the value of on-farm testing to encourage the adoption of improved varieties.

Agronomic – Calcium fertilization trials – A researcher managed trial was conducted in 1995 at Tanda Watershed with two commonly grown varieties, 55-437 (small-seed size) and 28-206 (medium seed size). There were three levels of gypsum and wood ash to supply calcium (check, 150 kg/ha, and 300 kg/ha). Wood ash averaged over rates improved yields 26% for the small seed size variety and 12% for the medium seed size variety, and gypsum increased yields 38% for the small seed size variety and 44% for the medium seed size variety. At the Konni farm site in 1996, the application of 300 kg/ha gypsum increased peanut yields by 35% and 300 kg/ha rock phosphate increased yields by 30% over the check treatment. It was concluded that gypsum had produced good response in both years with all seed size varieties. While wood ash was responsive it was more erratic than yield response to gypsum.

Infrastucture – Equipment was provided for threshing seed, laboratory analysis for aflatoxin, and simple presses for peanut oil extraction.

Training – Training was provided for use of oil presses and use of the aflatoxin equipment. Consultation for the development of a seed production, multiplication, and distributions system was supported. Moussa Omarou traveled to the U.S. in early 1996. Drs. Reddy, Nwosu, and Cummins accompanied him to the Better World Workshop in Vermont (the producer of the Ram-Oil Press). This was the first time the press had been used on peanut. It proved very satisfactory. The peanuts were heated whole for 8-10 minutes at 160 degrees F. The whole seed were pressed and about 70% of the oil was extracted. Omarou also spent time in the food science laboratory at Alabama A&M to observe aflatoxin analysis and food processing techniques.

Seed production – The Peanut CRSP shared the cost of consultant, Dr. Lee House, to travel to Niger. He participated in workshops and developed recommendations on the development of a seed production, multiplication, and distribution system. Niger was similar to most developing countries in that it was very difficult for farmers to obtain improved varieties of different crop species.

Future plans – Funds for this activity were provided for only one year. Subsequently, USAID/Washington through the Africa Bureau has provided a grant to Virginia Tech University through the IPM CRSP for InterCRSP work in

West Africa. One of the recently approved projects led by Dr. Andrew Manu, Alabama A&M University will have core activities on the Tanda Watershed in Niger. It was anticipated that some of the work started in this project, i.e. gypsum, wood ash and rock phosphate studies, oil extraction demonstrations, introduction of improved peanut varieties, and aflatoxin detection will continue in this follow-on InterCRSP program.

Impediment to progress – In April 1996, just as plans were being made for field activities the Peanut CRSP was notified not to expend any more funds in Niger due to the overthrow of the elected government. When this restriction was lifted, part of the program was salvaged as reported in the accomplishments.

Lessons learned – The results of this brief applied research and outreach effort collaborative between the USAID/Niger mission and the Peanut CRSP showed that mission/CRSP cooperation was a positive effort. This type cooperation of mission buyin to CRSPs should be continued in the future for the benefit of the host country, and for the efficient and effective use of USAID funds.

Pilot studies in farmers fields in the Philippines help transfer technologies.

Chapter 18. Impacts of 1990-1996 grant

Three general aims or thrusts in response to USAID goals were the basis for the Peanut CRSP plan in the 1990-1995 (1996) phase: 1) research to enhance the stability of the production and delivery of food to people in the developing world; 2) resource management research to improve the efficiency of production systems, and 3) communication of outputs to clientele. The paramount goal was to provide valuable information to host country and U.S. farmers, food processors and consumers. As the five-year period ends, there has been substantial attainment of all project objectives resulting in a continuing stream of client information and new technologies addressing all major constraints. Some selected impacts that relate to the USAID goals follow.

Natural resource management

Recent collaboration between the Peanut and Soil Management CRSPs (Niger InterCRSP program) was conducted on soils with a low soil pH and high aluminum content at Bobo. Research was conducted on the same plots both years, and there was a cumulative effect from amendments. In the second year, there was a 221% yield increase from ash treatment, a 46% increase from calcium sulfate, and a 37% from phosphorus.

Under TX/BCP, Tamspan 90 yielded better than Starr in East Texas, but not in Central Texas, which answered concerns by farmers as to the relative merits of the two varieties. Tamspan 90 had earlier shown better yields under irrigation, especially in soils infested with *Sclerotinia minor*, *Pythium myriotylum,* and *Rhizoctonia solani*. Thus Tamspan 90 was more responsive to increased soil moisture.

In the area of sustainability and environmental concerns, on-farm trials of promising shade-tolerant lines were grown under coconut at four locations in the Philippines, and IPB Pn82 82-25 consistently had the highest pod and seed yields. Some six lines continue to show tolerance to highly acidic soil conditions. These findings could contribute to cropping under coconut that could stabilize soils and for peanut to provide nitrogen for the trees, and allow cropping in marginal soil areas.

Sustainable agriculture accomplishments

An extensive program in Jamaica was led by CARDI and the Jamaican Extension Service for farmer adoption of the new CRSP developed CARDI/Payne variety. A socioeconomic study showed that yields of the new variety were 42% higher than traditional varieties and had been adopted by over 10% of farmers in two years. (Survey by Purcell/UGA, Moxley/NCSU, Wheelock/AAMU through special USID funds via Michigan State University, Bean/Cowpea CRSP).

A Pilot Program in cooperation with PCARRD continued in the Philippines that extended CRSP technology (varieties and IPM) to farmers in the Cagayan Valley of Luzon, which is the major peanut growing region. Higher yields with less pesticide inputs promised to enhance sustainability.

New peanut varieties were being multiplied in a program with farmers in Thailand, which will accelerate the adoption of the new varieties on a wide-scale. These varieties promise to maintain higher yields under reduced production costs. From the cropping system/sustainability viewpoint in Thailand, breeding for earliness to develop high yielding peanut lines which mature in 80-85 days for use in short-season cropping systems was making progress.

Under the project UGA/FT, technology transfer to village scale peanut processors at Huay-Bon-Nua, Phroa District, Chiangmai Province, Thailand was fully established in 1992-93. Linkage with Chiangmai University through project investigators a KU facilitated this effort. (Future evaluations of this work showed that the processors and local consumers benefited greatly from this work. This effort contributed to the establishment of Thailand/Peanut CRSP Southeast Asia Outreach and Training Program after Thailand became a USAID "graduate country" and the research program was no longer supported).

Another major emphasis of the project UGA/FT was the training component. Thai, Philippine and American students are pursuing advanced degrees at University of Georgia with support from the project. The M.S. and Ph.D.

programs in the Department of Product Development at Kasetsart University have come into existence in part due to strengthening of the faculty through Peanut CRSP collaboration and to the judicious use of support provided by this project. Undergraduate thesis projects at Institute of Food Science and Technology at the University of the Philippines at Los Banos continued to be supported by the Peanut CRSP. A Postdoctoral Associate from Trinidad (Margaret Hinds), who received her Ph.D. while supported by the AAMU food science project, joined the UGA research team in 1992-93. Workshops on peanut utilization were expected to have even a bigger impact on processing and the nutritional well-being of consumers throughout Southeast Asia in future years as the project achieves fulfillment of its goal to have an impact on the entire region.

Linkage was established with Khon Kaen University via Kasetsart University to conduct research for improving postharvest handling systems in Southeast Asia, particularly peanut growing areas of Thailand. It was concluded from a field survey in irrigated areas of Northeast Thailand that peanut was grown by small farmers with average planted area of 0.6 hectares per family and average production of 0.84 metric tons per family. Harvest and postharvest operations were done by hand labor, which led to drying problems when drying is done in the rainy season that could lower peanut quality. Thus, it is recommended that the quality of peanut be determined at all stages of harvest and postharvest operations.

A similar study by the GA/PH/C project in Jamaica showed that 94% of farmers harvested peanuts by hand pulling, 52 % dried the peanuts in the field, 88% pulled the pods from the plants by hand, and 51% shelled by hand and mechanical shellers usually shared across farms. Farm storage was usually a problem with loss to insects and animal pests, molds, and theft. It was concluded that these post harvest problems are detrimental to the growth of the peanut industry in Jamaica and need to be addressed, which included better access to markets.

A survey on production and postharvest technologies was conducted in Ghana by the AAM/FT project. Little mechanization was used, which may contribute to low production levels due to the high cost of manual labor required for production. There appears to be a need for introduction of more improved varieties, with attention given to farmers regarding their preferences for particular types. Farmers had little knowledge about the aflatoxin problem in peanuts. Therefore there was an urgent need to create more awareness about the problem, the health effects, and ways of preventing or reducing contamination. Formation of peanut cooperatives could be an avenue for dissemination of information. Simple and appropriate technologies for peanut production need to be developed for use by Ghanaian farmers or transferred from other programs and adopted in Ghana. Resolution of production problems would result in subsequent increase in production and utilization.

The overall impacts of the Peanut CRSP from 1990-1996 will be presented in the four sectors adopted in the later phases of the program to facilitate in following impacts across phases for the total program.

A. Producer values

In Senegal, the cultivar Fleur 11 was released in 1992 and was under seed increase for distribution to farmers. It yielded 25% more than current cultivars, larger seeded than the standard cultivar 55-437 which was attractive to the edible peanut processors, and has a 90 maturity cycle adaptable to the shorter rainfall areas. Based on an economic survey, Fleur 11 could increase the annual value of the crop in Senegal by $18 million.

Taiwan 2 x UF71513-1 was identified as a high yielding-boiling type peanut in Farm Trials by the Thailand Department of Agriculture in 1992 and was considered for recommendation as a new cultivar. It was released in 1993 as Khon Kaen 60-4.

"Tamspan" 90 was released as a new cultivar in Texas in 1990 and was resistant to two important soil borne diseases, *Sclerotina* blight and *Pythium* pod rot, and yields 11% more than "Starr" the previous most popular cultivar. It was grown on about 28% of the total peanut area in Texas and Oklahoma in 1992 and 1993 with a net value of about $25 million per year.

"Tamrun 96" formerly identified as Tx896100, a new runner-type peanut adapted for production in the Southwest U.S. peanut production region was released in the late spring of 1996. Seed increases made in 1995 and 1996 brought the total seed supply to approximately 59 tons which was used and sold by the Texas A&M University Foundation Seed Services for multiplication and Registered Seed production. The principal advantages of the new variety included partial resistance to tomato spotted wilt virus, partial resistance to *Sclerotium rolfsii* and some other soil-borne diseases, high yield, and good seed size.

Peanut tends to become rancid during storage, due to a lower oleic acid content compared to linoleic acid, termed O:L ratio. High O:L ratio cultivars would be of great benefit to processors and consumers. Eighteen Spanish families of crosses were compared in 1994 in South, SE, and NW Texas for O:L oil ratios. Lines with higher O:L ratios tended to yield lower. The material was planted again in 1995, particularly looking for stability in lines. In 1995, BC2 high oleic Spanish populations were produced and selections made for the third backcross. Some 84 single and first backcross selections were tested for yield and *Sclerotinia* reaction in Texas and Oklahoma. Also in Texas, runner-type segregates with improved oil chemistry and *Sclerotinia* blight and/or spotted wilt virus resistance have been identified and employed in a back crossing program.

Two new cultivars were released in the Philippines, UPL-Pn10 and UPL Pn12. UPL Pn10 is high yielding, large seeded, resistant to leafhopper, highly resistant to defoliators and moderately resistant to *Aspergillus flavus* infection (aflatoxin producing fungus). UPL Pn12 was a Valencia type with high seed viability after extended storage time, and the long-pod, red seeded market type had a particular market niche, often as roasted/in-pod sales.

The cultivar, CARDI/Payne was released in the previous phase in Jamaica with a recorded yield improvement of 42% over traditional Valencia cultivars and was established on 10% of the peanut areas with an increase of $600,000 in added value to producers. A survey in the present phase showed that resistance was coming to the CARDI/Payne cultivar by processors and consumers because of testa color (cream colored). It is proposed that NC2 be promoted as an alternative cultivar, but it is not as sweet as either the CARDI/Payne or the Valencia. CARDI/Payne produces highest seed yields.

A peanut germplasm line, NCAc343 was identified in the Philippine/North Carolina State University insect management project in the mid-1980s as having multiple insect resistance. Later research, which extended into the present phase, confirmed this breadth of this resistance in West Africa and U.S. research. It was being used in cultivar improvement programs and has enormous potential in resistance breeding programs worldwide.

In the Philippines and Thailand, insect pest control was approached through integrated pest management (IPM) using cultural and biological controls to reduce the need for chemicals based on CRSP research. There was increased farmer acceptance of IPM, and annual workshops on the methods were held to train research and extension personnel. There were excellent prospects for controlling pest populations with reduced pesticide use, reduced environmental impacts, and improved profitability.

Peanut CRSP studies in Burkina Faso showed that early and timely harvest of peanut reduced pod damage from termites and subsequent invasion by *Aspergillus flavus* fungi and subsequent aflatoxin contamination.

Cylindrocladium black rot disease is a major problem for growers in North Carolina. The cultivar, NC 10C, was released in 1987 and saves growers the cost and environmental impacts of chemical control of the disease. In 1992-1993, NC 10C occupied about 20% of the North Carolina-Virginia peanut acreage with a net farm gate value of about $4.5 million per year. A second resistant cultivar, NC-V 11 was released in 1990 for the North Carolina-Virginia growing area.

VA-C92R was a cross between NC Ac 17213 and NC 7 made in 1978 and released in 1992. It was grown in North Carolina from 1992-2003 with a production maximum of 22,900 acres and an average of 11,400. NC 12C was a cross between NC 7 and NC 9 made in 1984 and released in 1996 (T.G. Isleib, principal investigator). It was grown from 1997-2007 with a production maximum of 21,000 acres and average of 12,000.

"Tamspan" 90 was released as a new cultivar in Texas in 1990 and was resistant to two important soil borne diseases, *Sclerotina* blight and *Pythium* pod rot, and yields 11% more than "Starr" previously the most popular cultivar. It was grown on about 28% of the total peanut area in Texas and Oklahoma in 1992 and 1993 with a net value of about $25 million per year.

In North Carolina, an IPM (Integrated Pest Management) program to minimize use of preventive pesticides and to integrate biological and cultural control practices into the system has made significant progress. Coordination with growers organizations have established a working relationship for enhanced on-farm validation of this research. The validation of forecast models for the lesser cornstalk borer and spider mites has proven to be an invaluable tool for pest management. Evaluations of pesticide interactions were increasing the understanding to reduce overall pesticide dependence, minimize the threat from tomato spotted wilt virus, and minimize secondary pest outbreaks. The use of pheromone traps to monitor populations of southern corn rootworm in peanut and applying pesticides only when pest populations reach economic threshold levels, growers can reduce the use by 42 tons per year. When fully implemented, the pheromone trap system can reduce annual peanut production costs in North Carolina and Virginia by about $ 840,000.

Thrips damage among recommended peanut cultivars in Georgia in 1993 was significantly lower on Georgia Runner, GK-7, Southern Runner, and Sunrunner than on Florigiant (commonly grown cultivars). Leafhopper damage was significantly greater for Georgia Runner and NC 9 than of Southern Runner. Yield and value were greater on Georgia Runner, GK-7, and Sunrunner than for NC-7. These results show the value of cultivar selection for insect resistance, which ultimately will decrease the need, use, cost, and environmental effects of insecticides.

Four peanut Groundnut Rosette Virus (GRD) disease resistant varieties were grown in the 1992 cropping season in Nigeria as breeder seed and foundation seed. A total of 100 kg of breeder seed and 0.89 m/tons of foundation seed were produced. Seed are in great demand to supplement the production by the National Seed Service. The varieties grown were SAMNUT 10 (RMP 12), SAMNUT 11 (RMP 91), SAMNUT 14 (55-437) from Senegal, and SAMNUT 16 (M554.76). These four varieties were released in 1993.

In Nigeria, three new varieties, SAMNUT 20 (M412.801), SAMNUT 21 (MDR 8-19), and SAMNUT 19 (K720.78) were released in 1994. The first two were late maturing with rosette resistance and yields of 3.0 t/ha or better. SAMNUT 21 had rust and leaf spot resistance. SAMNUT 19 was medium maturity with moderate rosette resistance and was recommended for the Sudan Savannah zone. Twenty tons foundation seed and 60 kg breeder seed were produced for the 1994 season.

A significant achievement for the Georgia/Nigeria program in 1996 was the development of a mechanical inoculation procedure to screen for resistance to GRD. A single inoculation resulted in 100% infection of plants of susceptible genotypes and about 2% of resistant plants. These could be distinguished from susceptible ones on the basis of delayed time of first appearance of symptoms and disease severity. The procedure utilized highly infectious inoculum. The consistency and reliability of achieving infection made the procedure particularly effective for inheritance of resistance studies and breeding programs.

A comprehensive package for virus control on peanut in Asia was developed in Thailand during 1994-95 and the publication was in press. The basic tenants of this package incorporate plant resistance, use of virus free seed and cultural practices such as adjustment of sowing date, using high plant density, and intercropping peanut with fast growing non-host crops. In addition to use in Thailand, this package can be used in regional training proposed for Thailand in the 5-year Peanut CRSP extension.

B. Processor values

In Thailand, wheat noodles enriched with peanut flour were acceptable to consumers. Market tests revealed that consumers would purchase the new product.

In the Philippines, traditional peanut products were surveyed and recipes published and made available to manufacturers. Encouragement to adopt new processing technologies was being given particularly to cottage scale processors through workshops on product development and marketing. Cheese-flavored spreads with a peanut rather than mild base have been developed and found acceptable.

In Burkina Faso, a private company was assisted in the improvement of packaging of peanut paste. New products such as fruit-peanut paste blends were new marketing strategies. Surveys on market quality of peanut products and research to solve the problems leading to poor quality are becoming standards for quality improvement.

In the Philippines in 1995, interdisciplinary and integrated efforts continued to transfer peanut processing technologies to rural women's cooperatives. Training, processing management, and marketing aspects were emphasized. Supplementation and optimization of Lady Finger formulas with peanut was accomplished in Leyte in 1994. Appropriate blends of peanut, wheat flour and cassava flour to give highest levels of sensory quality were defined. Packaging technologies for the baked root crop products extended with peanut were evaluated. Shelf life predictions for various conditions of packaging and storage were established. These technologies support the women's cooperative activities in processing and marketing the products. The product name was changed to Lady Button's to not interfere with the already marketed Lady Finger, per desire of processors. About 20% peanut in the product was acceptable.

C. Consumer values

In Senegal, a technique has been developed in collaboration with Texas A&M University for detoxification of contaminated peanut meal by use of adsorbent clay enabling the meal to be used for animal feed. Estimates are that $5 million could be contributed annually to the economy by use of this technology.

Development and use of rapid monitoring techniques for aflatoxin detection in the Philippines have resulted in policy interventions by the Food and Drug Administration by identification and withdrawal of aflatoxin contaminated peanut butter and other products from the market.

In Burkina Faso (also cited earlier), timely harvest to reduce termite damage to pods reduces to acceptable levels the aflatoxin content of seed.

D. Information/training/impacts

Information

Network linkages exist with several international groups, including ICRISAT (International Center for Research in the Semi-Arid Tropics), IDRC (International Development Research Centre, Canada), ACIAR (Australian Centre for International Agricultural Research), CIRAD-CA (International Agronomic Research Center for Development-Annual Crops, France), and CARDI (Caribbean Agricultural Research and Development Institute) with synergistic effects for all involved.

For example, the Peanut CRSP participated and co-sponsored the 1991 International Groundnut Workshop in India in cooperation with ICRISAT and CIRAD; the active involvement of both U.S. and host country CRSP collaborators communicate research results to a worldwide audience. Similarly, the Peanut CRSP and ICRISAT have co-sponsored regional Workshops, the last the West Africa regional Groundnut Workshop at the ICRSAT Sahelian Center in Niamey, Niger, with the results being a coordinated, efficient, and productive program of interactive research and development activities.

A training course on quality evaluation and utilization of food legumes and coarse grains was held in cooperation with FAO and the Department of Product Development, Kasetsart University, Bangkok, Thailand (a Peanut CRSP supported institution). Thailand, Philippine, and Georgia collaborators in the University of Georgia/Thailand-Philippine food technology project served as coordinators and trainers for participants from several Southeast Asian countries in a month-long activity. Support for this regional Workshop continued after the direct support for research was terminated by USAID in 1993 because Thailand became a "graduate country" because of economic development.

The continued publication of the *Arachis International Newsletter* cooperatively with ICRISAT was important to the dissemination of scientific information on peanut worldwide. A wide cross-section of peanut scientists published current research information.

Training

During the five-year period under review, 85 students with full- or part-time support from the Peanut CRSP have completed M.S. and Ph.D. degrees. Most are active in research in the host countries, or in non-host countries and the U.S. depending of their origin.

At least six lead collaborators in host countries have received M.S. or Ph.D. degrees in the U.S. under guidance of U.S. collaborators.

As an example of the value of short-term training, Dr. Luthgarda Palomar in 1992 worked at the University of Georgia for two months and after returning to the Philippines became a Peanut CRSP collaborator. She has established a sensory evaluation unit for food analysis, and in addition was working with village women in the development of women's cooperatives to process and market local peanut products.

Impacts (socioeconomic development)

In a Mayan Village in Belize on the fringe of the rain forest, increased profitability from peanut stimulated by the Peanut CRSP supported production and post harvest practices have caused improvement of farming from slash and burn agriculture to sustainable, rotation based farming. Peanut has provided the economic base to enhance the local economy and greatly improved the farmers' lifestyle.

The possibilities of production areas benefiting from added value to the crop by processing have been successfully demonstrated in the Chiangmai Province-Thailand, Leyte-Philippines, and Accra-Ghana through the development of women's cooperatives. Both processing and marketing skills are being learned. A socioeconomic evaluation of the Thailand site revealed an almost two-fold increase in profitability for women farmers who marketed processed peanut.

Peanuts are a desirable food in Phillipines and Thailand.

CHAPTER 19. EXTERNAL EVALUATION PANEL REPORT FOR THE 1990-1996 GRANT

The External Evaluation Panel (EEP) evaluation in 1994 was conducted one year earlier than usual. The phase was to end in 1995, but was extended until 1996, therefore the earlier review generally followed the guidelines followed in 1989.

EEP Members:

- Dr. Bo Bengtsson, professor in international crop production science, Swedish University of Agricultural Sciences, Uppsala, several international activities, especially International Centers (CGIAR).
- Dr. Joseph Smartt, reader in botany and biology, University of South Hampton, United Kingdom. Seven years as peanut breeder in Zambia, and author.
- Dr. Robert Schilling, assistant head of the smallholder food crop programme, CIRAD-CA, Montpellier, France, coordinator of CORAF Crop Research Network for Peanut in some 20 African Countries.
- Dr. David Hsi, recently retired as professor of plant pathology and genetics, New Mexico State University, some 40 years of experience with grains, potatoes and peanuts.
- Dr. John Cherry, director of USDA/ARS Eastern Regional Research Laboratory, Philadelphia, research experience in food biochemistry, processing and product development; also with University experience in research component.
- Dr. Handy Williamson, Jr., professor and head of agricultural economics and rural sociology, University of Tennessee, also, earlier with University Relations, USAID/Washington, consultant in several countries in Africa, Caribbean, Far East and the U.S.
- Dr. Milton Coughenour, professor of sociology, University of Kentucky. Experience in international development and co-investigator on Sorghum/Millet CRSP project in Sudan.

Recommendations

The Collaborative Research Support Program (CRSP) was an exceptionally imaginative concept and, as put into practice by the Peanut CRSP, was extraordinarily successful. The results obtained in its twelve years of operation are an excellent return on the total investment of some $20 million. In view of the success, the external evaluation panel (EEP) strongly supports a five-year extension of the Peanut CRSP and puts forward the following recommendations with a view to reinforcing the success already achieved and with the realistic expectation that an extension of the present program would lead to further success.

USAID should continue to fund those programs that are near completion so that full value may be obtained from past investments. High priority should be placed on the following areas: 1) Incorporation of leaf spot and virus resistance into high yielding, adapted varieties of peanut. Evaluation of crosses made with the NCAc343 line identified by the CRSP that gives broad-based insect resistance; 2) Refinement of biotechnological procedures for introducing new genes into cultivated peanut; 3) Integrated pest management strategies using varietal resistance and bio-control agents to lower chemical requirements; 4) Aflatoxin management through final development and application of tools for screening varieties for resistance, bio-control agents, and decontamination of peanut and peanut products; 5) Development of new and improved uses of peanut with particular emphasis on establishment of women's processing and marketing cooperatives, weaning foods, and interaction with manufacturers.

USAID should continue and enhance support to technology transfer programs to capitalize on the significant achievements of the Peanut CRSP. Particularly these should include: 1) Seed multiplication and distribution that are constraints in developing countries; 2) Reduction of aflatoxin and maintenance of quality in post-harvest handling systems, and 3) Cooperative conduct of workshops, information exchange, and other outreach activities.

USAID should support new programs that concentrate on strategic research, particularly in the following areas: 1) Quantifying and conserving peanut diversity and the diversity of other organisms in the natural communities of wild peanut relatives, and 2) Marketing and socioeconomics of peanut-based farming and product development systems, and impact assessment of research generated.

Those host countries and their participating institutions that are more scientifically advanced should be encouraged to provide more leadership for Peanut CRSP activities in their respective regions. Notable are Thailand as a regional Center for Southeast Asia, and Burkina Faso and Ghana to link francophone and Anglophone West Africa.

Principal Investigators in host countries and the United States should pursue private support and feedback, including joint research planning, to enhance transfer of benefits from the Peanut CRSP studies in the host countries and the U.S.

The administration of the Peanut CRSP should continue with the University of Georgia-based team that has successfully guided this program since its inception.

The global plan proposed for the extension from 1995-2000 (shifted to 1996-2001) is endorsed by the EEP. Regional coordination of multidisciplinary country research teams enhances host country participation in establishing priorities and planning of research to address country and regional constraints. Global response teams allow U.S. collaborators to enhance capabilities of host country researchers, and provide for field response services to USAID missions. The plan also provides for targeted and strategic short-term and degree oriented training and the inclusion of workshops and other recommended outreach or technology transfer activities. Consideration should be given to needs of regions in addition to West Africa, Southeast Asia and the Caribbean (i.e. South America, Southern Africa, and Eastern Europe) and the expansion of U.S. technical resource base.

Clearly, the Peanut CRSP has an important role in contributing to the following: 1) Sustainable and environmentally sound use of land; 2) Increased production of food with improved nutritional value; and 3) A stable source of cash income for both producers and processors. The relative stability of production and the market for peanut provides a reasonably secure basis for further developing this crop.

In conclusion, in the first eight years the Peanut CRSP confirmed two major premises of Title XII, that the production and utilization of the peanut can very effectively be enhanced by a collaborative endeavor between U.S. and host country scientists working in cooperation with local clientele. Secondly, that the initial successes achieved provided a sound basis for the planning of future efforts to safeguard and enhance host country and U.S. food production. This gratifying outcome has been the result of the imaginative and innovative thought that went into the development of the CRSP concept. In practice it has been one of the most productive and cost-effective international agricultural research programs ever. The perceptive insights of the initial planners in making all participants in the program beneficiaries effectively avoided any hint of patronizing the host countries and built up an excellent working partnership of equals. Peanut CRSP has in both the U.S. and the host countries attracted a very capable and highly competent cadre of research scientists and supporting staff. The quality of leadership provided by principal investigators, co-principal investigators, and cooperating scientists was exceptional. Metaphorically speaking, a chain was forged which had few weak links.

Based on this necessary and appropriate review, the external evaluation panel strongly urges that USAID continue, and even increase support for the Peanut CRSP from 1995-2000.

Many of the accomplishments and impacts of the 1990-1995 phase cited by the EEP were listed in the earlier section, and a more expanded discussion of the next phase recommended by the EEP will be included in the following 1996-2001 description (the phase was extended one year for a 1990-1996, six year phase).

CHAPTER 20. DESCRIPTION OF 1996-2001 GRANT

The Peanut CRSP continues to support Title XII legislation that extends to developing countries the land-grant paradigms for education, research and extension to encourage economic development, relieve hunger, and prevent famine, while providing important feedback to the United States. A CRSP activity for peanuts is particularly important to the realization of the goals of USAID because peanut is the most important crop for development in many areas of the developing world, particularly Sub-Saharan Africa. This crop provides an important source of purchasing power to its small-scale farmers, many of whom are women. The peanut is nutritious and versatile and thus promotes health and family welfare and value-adding industries in developing countries. Because local markets exist for peanuts, they provide an essential opportunity for small-scale subsistence farmers to purchase inputs, such as fertilizers, needed to make farming sustainable. As noted in the accomplishments from 1982 to 1996, substantial technical and economic advancement has occurred in many host countries because of collaborative research between U.S. and national scientists. Because of the global nature of the constraints addressed, the U.S. peanut industry has also benefited at least $10 for each dollar invested in the Peanut CRSP, based on variety releases alone.

Improved peanut industries arising from the proposed research were linked directly to and important for the achievement of three of four of USAID's defined global-strategic objectives, and all of the goals of the Global Bureau, Center for Economic Growth, Office of Agriculture and Food Security, Sustainable Production Division were addressed. These were: Economic Growth-adequate quantities and qualities of food to become consistently available to the target population; Environmental Sustainability-adequate access to food by the poor households (through self-production and/or purchasing power); Health and Population-improved agricultural practices that enhance conservation of natural resources. Democracy the fourth Global objective was not addressed directly.

The Peanut CRSP has operated for 13 years. The initial program was designed through extensive consultation with developing countries and other international organizations with a stake in peanut research. Although research was the major focus to resolve priority constraints there was a wide distribution of information to scientists, extension workers, and farmers and processors, and major impact on the strengthening of human capital in both developing countries and the U.S. These accomplishments have been addressed in earlier chapters of this report.

Inherent in the CRSP concept was the need to address constraints that have global implications.

Therefore as a constraint driven program, the Peanut CRSP was designed around a set of constraints to sustainable production and utilization identified during the 1980-1982 Planning process. Based on the numerous advancements achieved by the Peanut CRSP during the 1982-1994 period, the external evaluation panel in 1994 evaluated the continuing validity of the following constraints and found them to be valid as a basic framework for the Peanut CRSP in the near future. With some adjustment in the project designs to address the constraints, the Constraints have remained similar over this period.

1) Low yields because of unadapted cultivars and lack of cultivar resistance to diseases, insects, and drought;
2) Yield losses due to infestations of weeds, insects, diseases, and nematodes;
3) Health hazards and economic losses due to mycotoxin contamination;
4) Food supplies inadequate and lack of appropriate food technologies to exploit a relatively well adapted peanut crop that is not generally considered a primary food source;
5) Physiological and soil microbiological barriers to higher yields;
6) Resource management (agronomic, engineering, economic and sociological) situations preventing efficient production and utilization;
7) Inadequate numbers of trained researchers and support personnel; Lack of adequate equipment to conduct research; Information is not available to beneficiaries for support of production and utilization efforts.

The strategy for the new phase was to use interdisciplinary, collaborative research on priority constraints to generate peanut-related technologies and knowledge that will enhance economic development, increase the efficiency and sustainability of peanut production, improve human health, and raise the value of peanut products. The relevance, complementarity, and dissemination of the research results will be ensured through the establishment and nurturing of close cooperation between national, international, and non-governmental research, educational and trade institutions and organizations. Focus on research with wide applicability, so that although conducted in a few countries it can be adapted in other countries. Scientific capability will be developed and strengthened in developing countries and the U.S. through long- and short-term training.

The research contributed to the USAID Office of Agriculture and Food Security's strategic objectives: 1) Adequate quantities and qualities of food to become consistently available to the target population; 2) Adequate access to food by the poor households (through self-production and/or purchasing power; and 3) Improved agricultural practices that enhance conservation of natural resources.

Major changes in the program were made in the 1996-2001 phase. Based on the 1990-1996 phase (which was similar in program size from 1982-1996), the program expanded from four to ten U.S. universities in eight states, from 10 to 17 host countries, and from 12 to 32 institutions in the host countries. Three world regions were added, Southern Africa (cooperation extended into East Africa toward the end of this phase), Latin America and Eastern Europe to the previous Southeast Asia, West Africa, and the Caribbean regions. Notably, the program was strengthened and broadened globally and focusing on and having potential for impact in five high priority areas. These areas are:

1) Aflatoxin contamination – Outcome expected was improved health, trade and value through decreased or eliminated aflatoxin contamination. The approach to solving the problem is through genetic prevention of aflatoxin production in *Aspergillus*-infected peanuts, pre-harvest and post-harvest management processes, and detoxification of contaminated peanuts and peanut products.
2) Production efficiency – Outcome expected was increased farm prosperity through improved production efficiency and sustainability. The approach was increase in yield through genetic improvement, better management practices through exploitation of Integrated Pest Management, and model-guided management research and policy recommendations.
3) Socioeconomic forces – Outcome expected was more rapid development through the adoption of technologies resulting from more sociologically appropriate research, policy interventions and technology transfer mechanisms. The approach was the determination of gender considerations in research decisions, technology adoption, and production and processing; determination of policy effects on production, marketing and nutritional concerns about consumption; and impact studies to determine the value of adopted technologies.
4) Post-harvest and marketing technologies – Outcome expected was improved health, increased prosperity through marketing, and the processing and consumption of peanuts in safer and more nutritious value-added products. The approach was to better understand the nutritional benefits of peanuts, expand availability of peanut products meeting local preferences, and increase income and employment from production of value-added products.
5) Training, information and program support – Outcome expected was the development and adoption of profitable technologies through increased training, technology transfer, and scientific exchange. The approach was by consolidation and distribution of information, training scientists and development of collaborative linkages and scientists' exchange programs.

These areas fit into the whole-value chain concept that developed as the program moved through this and the following phase to address problems along a continuum including producer values (production efficiency), processor values (aflatoxin contamination that included nutrition), and consumer values (post-harvest and marketing technologies), and including cross-cutting values of information, training, and program support (socioeconomic forces: part were incorporated into the other three value areas, and part into an impact component in the cross-cutting sector as the whole-value chain developed). As done in earlier phases, accomplishments and impacts will be reported in these value areas to facilitate following impacts over the life of the CRSP.

Peanut CRSP Management Structure 1996-2001

The management entity is described including office staff, university international programs advisor, board of directors, technical committee, USAID Program coordinators, and BIFAD Representatives in the management entity project. The project numbers, titles, and goals principal investigators, collaborators, cooperators, U.S., host country institutions are listed below for each project and grouped into sectors.

Management Entity

The University of Georgia management entity Office for the Peanut CRSP was located in the College of Agriculture at the Griffin Campus, Griffin, Georgia. The major role was responsibility to USAID for technical and administrative matters for the Peanut CRSP. Duties include negotiating agreements, fiscal management, technical progress, managing external reviews, and project modifications. Dr. David G. Cummins was program director, Dr. Jonathan H. Williams, associate program director, Grace Hutto, administrative secretary, Amy King, senior secretary, and partial time for Virginia Thomas, accountant, College of Agriculture Business Office, Athens. Support staff: Ted Proffer, College of Agriculture business manager, Dr. Ed Kanemasu, director of International Agricultural Programs. Overall responsibility for programmatic and fiscal accountability for the grant was in the offices of the vice-presidents for research and for business affairs, and the College of Agriculture, with day to day management the responsibility of the management entity office.

Dr. David G. Cummins retired from the University of Georgia June 1, 1998 and as program director of the Peanut CRSP. Dr. Jonathan H. Williams, associate program director, was employed as program director.

Twenty-two projects were supported in the technical area, three projects in information and training area, and three projects in the management area.

Board of directors

- Dr. Ed Kanemasu, University of Georgia
- Dr. Onuma Okezie, Alabama A&M University
- Dr. Richard Gutherie, Auburn University
- Dr. S.K. DeDatta, Virginia Tech University
- Dr. Peter A. Hartman, University of Florida
- Dr. David Knauff, North Carolina State University
- Dr. Edwin Price, Texas A&M University
- Dr. Richard Robbins, North Carolina A&T University
- Dr. David Sammons, Purdue University
- Dr. Farid Waliyar, ICRISAT

Technical committee

- Dr. Tom Isleib, Chair, North Carolina State University
- Dr. Manjeet Chinnan, vice-chair, University of Georgia.

The other four members were U.S. university principal investigators and the individuals varied from time to time.

The USAID program manager was Dr. Terri Hardt, AID/R&D/AGR.

William Fred Johnson was the BIFAD advisor.

Program Support – Financial support will be included in the summary sections.

Projects 1996-2001

The following projects were recommended by the EEP, approved by USAID, and implemented that presented the best opportunity to meet the Global Plan and to provide resolution to the more broad constraints and to the sustainability constraints that limit production and use.

The Peanut CRSP was reviewed by the EEP toward the end of the 1990-1996 grant as described earlier, a plan for this phase developed, request for proposals for participation developed and sent to all qualified universities in the U.S., proposals reviewed and appropriate ones chosen for the new phase. All these activities had necessary and timely approval by USAID and BIFAD. The project descriptions for this phase follow.

Aflatoxin contamination

TAM 33A. Genetic Approaches to Eliminate Aflatoxin Contamination of Peanuts.

Principal Investigator:
- Dr. Nancy Keller, Texas A&M University

Ghana Collaborators:
- Dr. Richard Awuah, University of Science and Technology, Kumasi,
- Dr. William Ellis, University of Science and Technology, Kumasi.

The overall goal of TAM 33A was to develop genetic approaches to eliminate aflatoxin contamination of peanuts utilizing biotechnology techniques.

UGA 01A. Extrusion Cooking of Peanut Meal in he Presence of Lysine to Deactuvate Aflatixub and Improve Nutritional Quality.

Principal Investigator:
- Dr. R.D. Phillips, University of Georgia

Cooperators:
- Dr. Larry R. Beuchat, University of Georgia
- Dr. Manjeet S. Chinnan, University of Georgia.

Ghana Collaborators,
- Sam Sefa-Dedeh, University of Ghana
- F.K Saalia, University of Ghana

The goal of UGA 01A, was based on the hypothesis that extrusion cooking of peanut meal in the presence of lysine may deactivate aflatoxin and improve nutritional quality.

UGA 02A. Management of Aflatoxins in Peanut Production, Storage, and Utilization.

Principal Investigator:
- Dr. David Wilson, University of Georgia;

Malawi Collaborator:
- C.T. Kisyombe, Malawi Ministry of Agriculture, Lilongwe,

Botswana Collaborator:
- F.S. Mpuchane, University of Botswana, Zomba.

The goal of UGA 02A was on using mycotoxin contamination as a quality indicator of pre-harvest and stored peanuts to develop strategies for aflatoxin management in Malawi and other Southern African countries.

UA 22A. Systems Research to Access Risk of Preharvest Aflatoxin Contamination and to Develop Technologies to Reduce Aflatoxin Contamination of Peanut.

Principal Investigator:
- Dr. Keith Ingram, University of Georgia

Cooperators:
- Dr. Gerrit Hoogenboom, University of Georgia,
- Dr. Farid Waliyar, ICRISAT/Mali.

Benin Collaborators:
- J. Detongnon, INRAB, Benin
- Adamou Mustafa, INRAB, Benin,
- B. Ahohouendo, Université de Benin,

Mali Collaborators:
- Bamory Diarra, IER,
- Keita Djeneba-Konate, IER.

The goal of UGA 22A was to develop system models to assess risk of aflatoxin contamination and to develop technologies to reduce aflatoxin contamination of peanut.

Production efficiency

NCS 19P. Improved Production Efficiency through Standardized, Integrated, and Enhanced Research and Technology.

Principal Investigator:
- Dr. Rick Brandenburg, North Carolina State University;

Cooperators:
- Dr. Jack Bailey, North Carolina State University,
- Dr. Thomas Isleib, North Carolina State University,
- Dr. Tom Stalker, North Carolina State University.

Ghana Collaborators:
- Dr. A.B. Salifu, SARI, Tamale,
- Dr. F. K. Tsigbey, SARI, Tamale,
- Dr. S. K. Nutsugah, SARI, Tamale,
- Dr. K.O. Marfo, SARI, Tamale.
- Dr. Mike Owusu-Akyaw, CRI, Kumasi
- Dr. J. Adu-Mensah, CRI, Kumasi
- Dr. B. Asafu-Agyei, CRI, Kumasi
- Dr. F.O. Anno-Nyako, CRI, Kumasi;

Benin Collaborator:
- Dr. B. Ahohendo, Université Nationale du Benin.

The goal of NCS 19P was to develop an integrated pest management program (IPM) for peanut pests in West Africa. Diagnostic pest surveys, crop loss assessment, deployment of resistant peanut germplasm, cultural and biological controls will be utilized in the IPM program, which will utilize GIS to process information for IPM deployment and pest forecasting.

NCS 20P. Utilizing Arachis Species for Peanut Improvement.

Principal Investigator:
- Dr. H. T. Stalker, North Carolina State University (replaced Dr. Thomas Isleib);

Collaborator:
- Dr. Stanko G. Delilostadinov, Institute of Plant Genetic Resources, Sadova, Bulgaria.

The goal of NCS 20P was to utilize interspecific hybridization programs to introduce genes from wild *Arachis* species to the cultivated *Arachis hypogaea*. There are genes for resistance to pests and diseases in the wild species not available in the cultivated species, which makes this an important endeavor.

NCS 34P. Breeding Peanut for Resistance to Foliar Diseases and Arthropod Pests.

Principal Investigator:
- Dr. Thomas Isleib, North Carolina State University;

Peru Collaborator:
- C.A. Salas, Fundacion, Peru

Ghana Collaborator:
- K.O. Marfo, Savanna Agricultural Research Institute, Tamale,

Benin Collaborators:
- M. Adomou, INRAB
- J. Detongnon, INRAB.

The goal of NCS 34P was to breed peanut for resistance to foliar diseases and arthropod insect pests. Peru is the center of diversity for five of the six botanical varieties, and the project will assist Peru in identifying landraces with resistance to rust, and early and late leaf spot. Expectations are also to use these landraces for developing improved germplasm in West Africa and the U.S. NCS 34P later merged with NCS 20P.

TAM 14P. Collection, Preservation and Utilization of Wild Arachis Germplasm from South America.

Principal Investigator:
- Dr. Charles Simpson, Texas A&M University;

Senegal Collaborator:
- Ousmane Ndoye, ISRA/CNRA, Bambey.

Brazil Cooperator:
- CENARGEN/EMBRAPA-Brazil.

The goal of TAM 14P was to collect, preserve, and utilize wild *Arachis* species germplasm from South America. It links with CENARGEN/EMBRAPA-Brazil, since South America is the source of origin of peanut (determined by location with highest diversity in species). U.S. research to use this wild germplasm along with NCS 34P brings into the CRSP the two major U.S. programs to introduce genes from wild species into cultivated species. The project will involve the training of a Ph.D. student (Ousmane Ndoye) from Senegal with a goal to introduce genes for early maturity into germplasm adapted to West Africa; and he will spend the growing season in Senegal to maintain the breeding efforts there.

TAM 17P. Breeding Peanut for Better Productivity and Quality.

Principal Investigator:

- Dr. Olin Smith, Texas A&M University (The untimely death of the principal investigator, Dr. Olin Smith occurred in 1997, and he was replaced by Dr. Charles Simpson as interim);

Senegal Collaborator:
- Ousmane Ndoye, ISRA/CNRA, Bambey.

Burkina Faso Collaborators:

- Dr. Philippe Sankara, University of Ouagadougou,
- Bertin, Institut Nationale de Economiques et Recherche Agricole.

The goal of TAM 17P was to breed peanut for better productivity, disease resistance, and improved oil quality for West Africa with return benefits to Texas.

UFL 13P. Simulation of Peanut Cropping Systems to Improve Production Efficiency and Enhance Natural Resource management.

Principal Investigator:
Dr. Kenneth J. Boote, University of Florida

Benin Collaborators:

- J. Detongnou, INRAB,
- M. Adomou, INRAB.

Ghana Collaborators:

- Dr. J.B. Naab, SARI, Tamale,
- Dr. K.O. Marfo, SARI, Tamale.

The goal of UFL 13P was to adapt the Florida developed PNUTGRO crop growth model to West Africa Conditions. Ultimately, the model will be used in systems analysis to hypothesize genetic and management strategies in technology development, and policy decisions to minimize weather risk and improve resource use efficiency.

UFL 16P. Development and Use of Multiple-pest Resistance to Improve Production Efficiency of Peanut.

Principal Investigators:

- Dr. Fred Shokes (later Dr. D. Zimit), University of Florida,

Cooperators:

- Dr. D.J. Zimet, University of Florida,
- Dr. Jim Todd, University of Georgia,
- Dr. Albert Culbreth, University of Georgia,
- Dr. Roy Pittman, University of Georgia (USDA).

Bolivia Collaborators:

- E. Diego Montenegro, ANAPO,
- Gustavo Pereyra, CIAT,
- Alejandro Tejerina, CIAT.

The goal of UFL 16P was to compare U.S. peanut breeding lines with Bolivian lines for disease and insect resistance. Bolivian germplasm will be evaluated in the U.S. environment and U.S. germplasm in the Bolivian environment, with benefits to both countries.

UGA 28P. Control Strategies for Peanut Viruses: Transgenic Resistance, Natural Resistance, and Virus Variability.

Principal Investigator:

- Dr. Carl M. Deom, University of Georgia

Malawi Collaborator:

- Dr. Allan J. Chiyembekeza, Chitedze Agricultural Research Station, Lilongwe.

The goal of UGA 28P was to develop groundnut rosette disease (for Malawi) and tomato spotted wilt virus disease resistant varieties through transgenic and naturally occurring resistant germplasm.

Socioeconomic forces

AUB 30S. Production Efficiency and Market Development of Peanuts and Peanut Products for Haiti, Dominican Republic, and Jamaica.

Principal Investigator:

- Dr. Curtis M. Jolly, Auburn University

Haiti Collaborator:

- Emmanuel Prophete, CDRA.

The goal of AUB 30S was to survey households in production areas to study farming systems, farmer production constraints, and marketing constraints in order to recommend changes in the systems that would enhance peanut productivity and profits.

UCN 36S. Socioeconomic Impacts of Alternative Peanut Production and Marketing Systems in Senegal.

Principal Investigator:
Dr. Boris Bravo-Ureta, University of Connecticut;

Cooperators:

- Dr. Rigoberto Lopez, University of Connecticut,
- Horacio Cocchi, University of Connecticut,
- Dr. Emilio Pagoulatos, University of Connecticut,
- Dr. Richard Vengroff, University of Connecticut,
- Dr. Lucy Creevey, University of Connecticut.

Senegal Collaborators:

- Aboubacar Sow, ENEA (L'École nationale d'Économie appliquée), Dakar,
- Aly Cisse, ENEA (L'École nationale d'Économie appliquée), Dakar,
- Alioune M'Baye, ENEA (L'École nationale d'Économie appliquée), Dakar.

The goal of UCN 36S was to improve existing procedures used to collect farm level data at ENEA with emphasis on peanut production in order to better analyze changes in the relationship between peanut production and household structure, evaluate the extent to which farm output can be increased by making better use of technologies, evaluate the impact of alternative peanut management practices and farm policies on input use, productivity and farm profitability, and to assess the impact of alternative policies on domestic markets and exports of peanuts in Senegal.

Students active on project research that contributed significantly to the goals were Ibrahima Hathie, Abdourahmane Thiam, and Ibrahima Gaye, ENEA staff at the University of Connecticut.

NCS 07S. Adoption/Diffusion Processes, Persistence, and Socioeconomic Impact of New Inputs and Peanut Varieties.

Principal Investigator:

- Dr. Robert L. Moxley

Cooperator:

- Dr. R.C. Wimberley, North Carolina State University.

The goal of NCS 07S was to work with the Peanut CRSP projects and management entity to identify impacts of implemented research, and measure adoption of new technologies, the persistence of the technologies (how long will they improve production), and the impacts of new technologies (production inputs or new varieties).

VPI 09S. Analysis of Response of Peanut Production in French West Africa: Policy Implications of Currency Devaluation.

Principal Investigator:
- Dr. Michael Bertelsen, Virginia Tech.

Cooperator:
- Dr. George Norton, Virginia Tech.

Senegal Collaborator,:
- Matar Gaye, ISRA/Kaolak.

The goal of VPI 09S was to use a profit function model with supply and input demand functions so that responsiveness to price changes, policies, and other factors could be assessed. An M.S. Student – Ebere Akobunbu, Senegal (completing thesis in August 1997) – contributed to the initiation of the project.

VPI 35S. Peanut production and consumption systems: intra-household and inter-sector transactions.

Principal Investigator:
- Dr. Jeff Alwang, Virginia Tech University.

Cooperator:
- Dr. Sarah Hamilton, Virginia Tech University.

Malawi Collaborator:
- Abdi Edris, Bunda College of Agriculture.

The goal of VPI 35S was centered on (1) production of an annotated bibliography reviewing global published and unpublished research on women's roles in peanut production (labor, knowledge, and decision-making input), processing, and marketing; intra-household resource dynamics affecting these roles; and relevant macro-micro linkages, and (2) identifying and quantifying the impacts of constraints to women's participation in peanut production, processing, and marketing in Malawi. Graduate Students – N. Mwero and Rodwell Chinguwo, M.S. students in Economics/Agricultural Economics, Malawi at Virginia Tech and will assist in project efforts.

Post-Harvest and Marketing Technologies

PUR 10U. Effects of Peanut Consumption on Hunger, Ingestive Behavior, Energy Expenditure and Coronary Heart Disease Risk.

Principal Investigator:
- Dr. Richard Mattes, Purdue University.

Ghana Collaborator:
- Food Research Institute, Accra,

Gambia Collaborator:
- Medical Research Council.

The goal of PUR 10U was to examine the effects of whole and ground peanuts in the diet on hunger, satiety and food intake, and whether it will improve lipid profiles thereby reducing coronary heart disease. The work will also consider peanut consumption effects on body weight, body composition, and energy expenditure.

UGA 04U. Development of Peanut Postharvest Handling and Processing Technologies for the Food Industry.

Principal Investigator:
- Dr. Anna V.A. Resurreccion, University of Georgia.

Cooperators:
- Dr. M.S. Chinnan and Dr. Larry Beuchat, University of Georgia.

Philippine Collaborator:
- Dr. A.O. Lustre, Food Development Centre.

Philippine Cooperators:
- Dr. L.S. Palomar, Visayas College of Agriculture,
- Flor C.F. Galvez, University of the Philippines/Dilliman.

The goal of UGA 04U was to identify new market opportunities for peanut and peanut-based products and to develop and optimize products to meet market needs. Inherent in the goal is to work with interested small- medium- or large-scale processors to assist them in bringing new and acceptable products to the consumers.

UGA 11U. Development and Transfer of Peanut Processing Technologies in Bulgaria.

Principal Investigator:
- Dr. Larry Beuchat, University of Georgia.

Cooperators:
- Dr. W. Florowski, University of Georgia,
- Dr. Anna Resurreccion, University of Georgia,
- Dr. Manjeet Chinnan, University of Georgia.

Bulgaria Collaborator:
- P. Paraskova, Canning Research Institute, Plodiv.

Bulgaria Cooperators:
- J. Jordanov, Canning Research Institute, Plodiv,
- M. Hidutov, Canning Research Institute, Plodiv,
- E. Gentchev, Canning Research Institute, Plodiv,
- V. Boneva, Canning Research Institute, Plodiv,
- N. Penov, Canning Research Institute, Plodiv,
- Nikolov, Canning Research Institute, Plodiv,
- V. Valislevska, Canning Research Institute, Plodiv,
- K. Murgov, Higher Agricultural Institute, Plodiv.

The goal of UGA11U was to identify potential new market opportunities for peanut-based products in Bulgaria through economic, socioeconomic and consumption pattern surveys and to develop, optimize and transfer peanut product development, handling and processing technologies to private small- and medium-scale processors.

ALA 26U. Development of Appropriate Technology for New and Improved Weaning Foods and Aflatoxin Detoxification in Peanuts.

Principal Investigator:
- Dr. V. Nwosu who resigned in first year and replaced by
- Dr. John C. Anderson, Alabama A&M University;

Ghana Collaborator:
- Dr. Wisdom Plahar, Food Research Institute, Accra.

The goal of ALA 26U was to develop extrusion cooking technology for improved weaning foods based on blends of maize, sorghum, peanut, and cowpeas and isolate, purify and characterize active ingredients in *Allium sativum* that inhibit the growth of *Aspergillus flavus,* the fungus that produces aflatoxin.

NCA 32U. Development of Spicy Meat Analogs and Technology Transfer of Value-added Products from Peanuts.

Principal Investigator:
- Dr. Margaret Hinds, North Carolina A&T State University.

Cooperators:
- A.F. Mendonca, NCA&T, University,
- Dr. Curtis M. Jolly, Auburn University.

CARDI Collaborators:
- Dr. J.I. Lindsey, Jamaica,
- Dr. A.K. Sinha, Belize.

The goal of NCA 32U was to develop meat-peanut protein products that meet consumer desires, and to extend exceptable products to the consumers/markets in the Caribbean region and the U.S.

Training, information, and program support

UGA 05I. The World Geography of the Peanut: Global Networking Approach to Social Equity, Environmental Protection, and Technology Exchange.

Principal Investigator:
- Dr. Robert Rhodes, University of Georgia.

Cooperators:
- Virginia Nazerea, University of Georgia,
- Jayanta Kumar Das, University of Georgia,
- Purakayastha Shankarappa Talawar, University of Georgia.

Collaborators:
- Dr. S.N. Nigam, ICRISAT/India,
- Renelle Magaliq, PCARRD/Philippines.

The goal of UGA 05I was to create a global peanut data base available on a Web-site data base, and conduct specific country studies to expand this data base. An initial objective was to product a Global Distribution and Use of Peanut Bibliography.

UGA 37T. Training for SE Asian region.

Principal Investigator:
- Dr. David G. Cummins, University of Georgia;

Thailand Collaborators:
- Dr. Penkwan Chompreeda, Kasetsart University,
- Dr. Sanun Jogloy, Khon Kaen University.

The goal of UGA 37T was to contribute to the continued expansion of peanut production and use in the Asia/Southeast Asia region, through support of and cooperation with Thailand. Thailand became a graduate country in 1993 by USAID standards and no longer was a full participant in CRSP projects. The project was established to enable Thailand to conduct training courses, workshops, and by electronic and other means transfer Peanut CRSP and other sources of technology to customers in the region.

UGA 38T. Long- and Short-Term Training for HC Scientists.

Principal Investigator:
- Dr. David G. Cummins, University of Georgia.

Cooperators:
- Multiple across projects.

The goal of UGA 38T was for the Peanut CRSP to have a more definite training plan to ensure the provision of long- and short-term training support that best fits host country needs and priorities.

UGA 39M. Program Support.

Principal Investigator:
- Dr. David Cummins, University of Georgia.

Cooperators:
- Peanut CRSP board of directors, technical committee, and external evaluation panel.

The goal of UGA 39M was to plan for and provide funding for special-CRSP-wide activities, special publications, particularly meetings of the board of directors, technical committee, and the external evaluation panel.

UGA 40M. InterCRSP Program Management.

Principal Investigator:
Dr. David G. Cummins, University of Georgia.

Collaborator:
Principal investigator of the Peanut CRSP project selected in the West Africa InterCRSP project led by the University of Hawaii.

The goal of UGA 40M was to plan for InterCRSP program participation. In particular, the CRSP Council that provides interaction across all active CRSPs is working with the USAID/Africa Bureau to develop a West Africa InterCRSP Natural Resource Management project.

Management entity

UGA 41ME. management entity.

Principal Investigator:
- Dr. David G. Cummins, Peanut CRSP program director, University of Georgia.

Cooperators:
- Dr. Jonathan H. Williams, associate program director,
- Grace Hutto, administrative secretary,
- Amy King, senior secretary,
- Virginia Thomas, accountant (partial time), College of Agriculture Business Office, Athens.
- (Dr. Cummins retired on June 1, 1998 and Dr. Williams assumed the role of program director).

The goal of UGA 41M is to provide financial and programmatic support for the Peanut CRSP that coordinates with USAID and the participating U.S. and host country institutions. Provisions are that up to 20% of USAID funds can be directed to management entity activities such as personnel, travel, office operation, and reporting.

CHAPTER 21. ACCOMPLISHMENTS OF THE 1996-2001 GRANT

As noted earlier, the accomplishments are arranged according to the Whole Value Chain Concept (namely Producer Values, Processor Values, Consumer Values, and Cross-cutting/Information, Training/Impacts) that developed as the program progressed over the next two phases. Accomplishments are provided for each project.

A. Producer values (production efficiency in grant)

- UPL 13P. Yield gaps data have been accumulated to allow evaluation of production constraints. Soil fertility problems are indicated as a major factor in loss of yield potential. Although the project does no cover post-harvest aspects, it may not need too, but should be closely linked to the aflatoxin projects to allow use of growth models/GIS systems to model aflatoxin risk/management scenarios. The data will contribute to the development of risk management strategies.

- TAM 14P. Germplasm collection was continuing, but transfer of the earliness trait was slow because of the ploidy of the donor species. The project is, of necessity, long-term, however, since it was discovered that the earliness donor, *A. praecox*, has only 18 chromosomes, the progress will be even slower. Good progress was being made in the transfer of seed dormancy into varieties adapted to growing conditions in Senegal. Breeding lines in F7 and F8 are currently being evaluated and Spanish type varieties with seed dormancy selected from this program will soon be available for seed increase and deployment to farmers in Senegal.

- UFL 16P. Initial studies have produced valuable data on cultivars for solving the constraints in the host country, and rust and leaf spot are diseases of major interest. Measures of yield loss are now available, and the benefits of introduced germplasm are now becoming apparent. Farmer field days have been held, extension publications, and grower manuals for farmers were planned. Seed multiplication activities were planned and implemented, and collaboration with ANAPO (Asociación de Productores de Oleaginosas y Trigo), a non-government producer organization has particularly good potential for technology transfer (deployment of superior quality seed and, in time, new cultivars). The development of Tomato Spotted Wilt Virus (TSWV)-resistant genotypes will have very strong applicability for the H.C., as well as in the U.S. and other countries.

- TAM 17 P. Progress has been made in evaluating reaction to foliar diseases, particularly early leaf spot, and identifying early maturing lines with improved agronomic traits. Considerable effort is being made to identify high oleic acid content of the oil that delays rancidity with increased shelf-life. Seed of newly identified varieties are being multiplied for deployment to farmers.

- NCS 19 P. Screening trials and evaluations were completed for thrips, potato leafhopper, Southern corn rootworm, and tomato spotted wilt virus with 40 germplasm entries in the U.S. showing some levels of resistance. Research efforts were continuing. The pest survey and crop loss data being accumulated in Ghana were allowing evaluation of production constraints and developing the foundation for future research. Insects, disease, and nematode samples were collected in more than 30 regions from farmer fields. Pod samples and yield data were also collected. The surveys indicate a wide range of pests with considerable variation in the species and abundance of pests across regions. Needed data on evaluation of a wide range of germplasm for indications of resistance and cultural practices, including planting date variations, were forthcoming to strengthen the achievements for this project.

- NCS 20P. There was not enough exchange of Valencia peanut germplasm from North Carolina and USDA to Bulgaria, the primary peanut type in Bulgaria. The lines exchanged were not adapted. In Peru, the achievements have been good with advanced breeding lines being considered for release. Several *Arachis hypogaea* x diploid *Arachis* species hybrids and interspecific hybrids from ICRISAT appeared to have potential for a breeding program to improve disease resistance. Further work showed that introducing genes from wild species is possible, but extremely difficult and time consuming, because it takes many years to recover fertile progenies.

- UGA 28P. One long-season, rosette virus-resistant variety has already been identified for use in Malawi and will be released shortly. Seed is currently being multiplied. Short-duration rosette virus-resistant germplasm lines have been identified in the ICRISAT/Malawi program. These have been evaluated in on-station trials and are now being evaluated in on-farm trials in Malawi and Zambia. Preparation is being made for multiplying seed for deployment to farmers. The project is collaborating with the ICRISAT/Malawi program, which has USAID funding for seed multiplication. This will greatly facilitate rapid deployment of these cultivars. This project was designed to provide "seed funding" to establish a revolving fund to enable multiplication of future releases.

  In Athens, Georgia, 21 regenerated plants in the greenhouse will be analyzed by PCR, Southern Blotting and Northern Blotting techniques for the Groundnut Rosette Virus Disease-Groundnut Rosette Assistor Virus, coat protein gene and its expression. Selected transformants expressing the assistor virus coat protein gene will then go through seed multiplication and be evaluated in Malawi. Some aspects of the evaluation may also be done at the Scottish Crops Research Institute, Scotland (a non-peanut producing country), where there is a chance for the virus to spread to the U.S. Presently, the rosette virus is confined to Africa.

B. Processor values (post-harvest handling/utilization in grant)

- UGA 04U. The signing of a Memorandum of Agreement for the transfer of technologies for "Vitamin A Fortification of Peanut Butter" and the "Control of Aflatoxin in Peanut Butter Products through Sorting" was held June 23, 1999. The collaborations included the National Food Authority, Food Development Center, Newborn Food Products, Inc., and the University of Georgia. This was made possible largely due to the support of the Peanut CRSP. Press releases of the signing ceremony came out in leading newspapers marking the formal turnover of the technologies to industry collaborators in the Philippines. In a separate activity, samples of Vitamin A fortified peanut butter and aflatoxin-free peanut sauce made by the Peanut-CRSP-supported processing technologies were presented in an exhibit during the recent launching of the "Proper Food Handling Program" by the Philippine Government held at the Food Development Center on July 19, 1999. The launching was attended by members of the Philippine Department of Agriculture and members of the President's Cabinet. A project entitled "A Strategy for Bringing Fortified Foods to the Market" was developed for funding by the under-secretary of the Department of Health and by program officers of UNICEF.

  A major change in processing practices for peanut products was achieved in the Philippines through the development of a Standard Sanitation Operating Procedure Manual and the training of workers was being implemented. Good manufacturing practices were in place. A system for evaluating the impact of this contribution through periodic plant inspections and ratings using the document prepared, will keep companies aware of the new practices to be adhered to, and therefore ensure production of fortified peanut products, such as peanut butter, are of the highest quality. New state-of-the-art food processing laboratories and pilot plants are in place at the Food Development Center. Partnerships with the peanut processing industries are allowing transfer of technologies as they are developed. Research studies include working directly with industries in their processing plants to test and implement technologies. The market-pull concept was in place assuring relevance of research, and the ability of scientists to solve objectives/problems through basic and applied research approaches.

  A survey showed that if the value added peanut product market was strengthened, e.g., peanut butter instead of unshelled or shelled raw and roasted peanut, profits increased, farmers would raise production levels, an incentive for strengthening research on post-harvest and processing technologies. Clearly, the Peanut CRSP is having an impact on post-harvest and marketing of peanut products in the Philippines.

  Consumer demand for Vitamin-A fortified peanut butter was setting industry priorities in food processing to assure nutritious products. This was further emphasized by the news media with popular articles educating the consumer on the importance of nutrition. Food safety, e.g., aflatoxin-free, in the processing plant are being demanded by the Philippine Government and the consumer. These occurrences show the applicability of the Peanut CRSP research programs in the host country, the Philippines. The technologies are also being used to improve ways the peanut was handled and processed in the U.S. The nutritional and food safety data have relevancies, regionally and globally, especially where protein-deficient diets exist.

The work is mainly focused on the disciplines of food processing, food safety, and nutritional sciences. As demand for peanut products grow, studies will become more closely coordinated with breeding programs to assure new cultivars meet food functional, sensory and nutritional qualities. The results of this project were having socioeconomic impacts in the Philippines.

- UGA 11U. A national food consumption survey in Bulgaria (2500 questionnaires, 85% returned) revealed that a demand for peanut products existed in the marketplace. Consumers are aware that peanuts and peanut products are good sources of protein and calories, and they are very fond of peanut flavors and sensorial qualities. The opening of free markets and anticipation of higher incomes with the new economy brought a new and excited interest in peanuts and peanut products in the diet of Bulgarians indicating strong market potential.

  A peanut processing pilot plant was equipped at the Canning Research Institute in Plodiv (sheller, blancher, roaster, fryer, grinder, peanut butter processor, and packaging equipment), along with a sensory and taste panel facility. The host country collaborators are learning processing and sensory techniques in preparation for development of consumer acceptable products identified in the surveys, and to extend them to the private sector.

  A Peanut CRSP exhibit was sponsored at the International Food Fair in Plodiv, Bulgaria, May 3-8, 1999: 50 U.S. products were tasted by over 600 consumers, with a high ranking for roasted peanuts and crunchy peanut butter. Private company personnel are visiting the Canning Research Institute to learn about peanut processing, and companies with diverse lines of confectionary products are interested in adding peanut products to their commercial lines. Businessmen are interested in processing peanut products as independent ventures, and especially through joint partnerships with U.S. companies. A delegation of four Bulgarian food processors traveled to Georgia in 1999 to learn more about peanut processing technologies and to develop linkages with organizations and agencies representing the U.S. peanut industry.

  More specifically the consumer survey showed that 1) consumer attitude toward peanuts was most driven by perceived product attributes including sensory, economic, health and nutritional aspects of peanuts, 2) socio-demographic profiles did not cause differences in attitude toward roasted peanuts, 3) and the actual consumption of peanuts was shaped by sensory and economic attributes of peanuts and socio-demographic characteristics including income, education, age and gender. Attitudes did not differ across household incomes, but income was clearly a major barrier to consuming peanuts. The presence of the roasted peanut taste will play a major role in the acceptance of new peanut products.

- ALA 26U. Some progress has been made in Ghana on extrusion cooking and quality characteristics of experimental weaning blends. From extrusion cooking trials with peanut, maize, and soybean composites, a high protein semi-instant extruded weaning food was developed. The product was found to have good sensory characteristics when reconstituted with hot water or cooked for a short time. The Protein Efficiency Ratio (PER) was 2.4 making the extruded product an ideal weaning food to improve the nutritional status of Ghanaian children and help solve malnutrition problems. The Ghana principal investigator has asked for a reevaluation of the issue with the extruder because of difficulties in attaining reproducible experimental results reemphasizing the inappropriateness of the equipment for research studies. As a result, no meaningful extrusion work is going on presently (2000). Efforts will be made to write a manuscript on the limited data obtained to date. The closing of the food science department at AAMU, which then reorganized and reopened, and resignations leading to four principal investigators during this phase has limited input by the U.S. institution in the project.

- NCA 32U. A consumer survey was conducted in North Carolina to evaluate the feasibility of meat analogs consisting of peanuts cooperatively with AUB 30S. Results indicated that the frequency of consumption as well as the amount of money spent on peanuts and peanut products was low. Interest in meat-peanut analogs was expressed, if the price was comparable to traditional meat products. Preliminary studies were made on extrusion of partially defatted peanut flour.

  Host country (Belize, Jamaica, and Haiti) personnel were trained in aspects of peanut processing, product development, and quality enhancement. Host country activities have produced three major activities supporting development of peanut products as follows. 1) In Jamaica, 46 potential peanut products were displayed to small scale processors at an Agricultural Show. A technical bulletin on these products was being prepared. Processors were particularly interested in manufacturing honey-roasted and hot-and-spicy peanuts. 2) In Haiti, efforts were being made to improve the quality of Mamba (peanut butter-type product). Small-scale processors are manufacturing spicy and non-spicy Mamba. 3) In Belize, plans were under way to develop a protocol for improving the quality of harvested and stored peanuts. This effort was focusing on aflatoxin screening. An aflatoxin screening kit available in the U.S. was identified for use in the studies.

Reorganization efforts at NCA&T and the departure of the principal investigator to another university has hampered progress on the project.

C. Consumer values (food safety and socioeconomic constraints in grant)

- UGA 01. Studies indicated the possibility of destroying aflatoxin at either slightly elevated pH's or in the presence of nucleophiles, or both, either in buffer solution or during extrusion. With aflatoxin-contaminated peanut meal, in the presence of nucleophiles (lysine, glycine or methylamine) there is a significant reduction (84%) in aflatoxins B1, G1, B2, and G2. Residence time in the laboratory-scale extruder used in this research is about 0.5-1 minute. While certain of the cooked, denatured peanut meals might not be useful in food products requiring soluble, native proteins, many other foods made by extrusion and extruded meals may benefit from these ingredients where functionally is less important. A growing concern in Ghana with regard to aflatoxin contamination of foods, specifically peanuts and corn, was increasing support for research studies on this problem. A breakthrough with use of extrusion technologies to reduce or eliminate aflatoxins and assure or create new nutritious food products will have socioeconomic impact in Ghana and worldwide, where aflatoxins in foods are an issue.

- UGA 02. A simplified aflatoxin assay method considered suitable for use in developing countries was available and tested. It does, however, involve sending samples from Southern Africa to Georgia. Field trials have commenced in Malawi and more recently in Botswana. No current impacts are noted, but if the objectives are achieved there should be useful results showing reduction of aflatoxin contamination in the SADC. Development of aflatoxin management practices and selection of germplasm lines/cultivars resistant to fungal invasion of seeds and/or production of aflatoxin could benefit farmers, processors and consumers in all countries where aflatoxin contaminated peanuts are a problem.

- PUR 10. One approach to enhancing the demand for peanuts and peanut products was to provide scientific evidence that they provide health benefits to consumers. Once demonstrated, such data can be used to encourage government-based activities to promote peanut production and consumption. It can also serve as the basis for advertising claims by trade and commercial organizations to stimulate sales. The findings to date have provided new evidence strongly supportive of health benefits associated with peanut consumption. The work has been well received in the scientific, commercial, and consumer sectors and was being widely disseminated by the Peanut Institute, Albany, Georgia. The Peanut Institute has been able to translate the scientific data into consumer friendly messages and the results have been published in just about every major consumer magazine. It is regularly cited in publications and has reached numerous readers with the good news about peanuts. It is also contributing to a growing appreciation by health professionals that high fat foods are not all problematic for health, indeed products rich in monounsaturated fats (e.g. peanuts) have clear health benefits. With additional research, this shift in thinking may well translate into greater acceptance and use of peanuts and peanut products in the future in both the U.S. and around the world.

  The work was mainly focused in the disciplines of nutritional, health, and medical sciences. The results of this project will have socioeconomic impact in Ghana, West Africa and worldwide as an understanding of the role of peanut products on hunger, ingestive behavior, energy expenditure, body composition and lipid profiles are understood. The new research contributed to increased peanut and peanut-product consumption. From crop year 1989 through 1995, U.S. peanut consumption dropped by 269 million pounds or 16%. Surveys and other consumer research studies indicated consumption declined because consumers considered peanuts fattening and unhealthy. When the favorable research studies on the health benefits of peanuts started hitting the news media in 1996, consumption immediately increased. If consumption stays on track through the 1999 crop year it will have recovered 179 million pounds 13%, an unprecedented turnaround. The consumption increase represents a value of over $100 million to the peanut farming and shelling industries. For every 1% increase in consumption, it was estimated that this means, e.g. a $15.9 million boost to the state of Georgia's economy. Based on that multiplier, a 13% consumption increase adds over $500 million to peanut producing communities across the U.S. The work on this project was one of the first major nutrition research efforts with peanuts. It was a vital part of the nutrition research and information package that was doing so much to revitalize the industry.

- UGA 22. Good progress was being made in the U.S. and in West Africa and environmental and crop growth data were being incorporated into models. Additional data from diseases and pests surveys were becoming available. There were excellent prospects for developing explanatory and predictive models to assist in development of crop management practices to eliminate or greatly reduce risk of aflatoxin contamination of peanuts. The results will be relevant to the U.S., the H.C., and to other countries within semi-arid environments.

- TAM 33. The pathway by which *Aspergillus* species produce sterigmatocystin (ST) and aflatoxins (AF) was understood, facilitating research on how the process may be disrupted. The ultimate aim was to transform peanuts by inserting gene constructs that will confer resistance to seed invasion by the fungi and/or to production of aflatoxin. The impact can only be potential at present, but success in this work would have a huge effect on peanut production and utilization in the U.S. and worldwide. The research into use of local peanut products to inhibit aflatoxin production in stored peanut seed in household storage could reduce human exposure to aflatoxins in developing countries.

- NCS 07S. The survey results from the study of the adoption of peanut technologies in Jamaica were generated and published in a final report. The studies determined: 1) that the practice of growing the CARDI/Payne peanut cultivar had shown a pronounced decline due to less desirable market quality; 2) that labor saving technologies introduced by the project (along with the new cultivar) continue to be used by local farmers, that include backpack sprayers, shellers, and skinners for use in growing the Valencia cultivars; 3) the adopters of new technologies tended to be located in the social centrality areas; 4) farmers were suffering from an inelastic market and tended to store the crop in hopes of higher prices; and 5) in some instances, whole communities of farmers switched from peanut to other crops since 1990. It is important to note, however, that Peanut CRSP labor-saving technologies introduced with the cultivar work was impacting the industry in the Caribbean. The researchers completed a second report on the adoption of collateral technologies, which was based on more intensive regression analyses.

  In the Philippines, the focus was on the assessment of factors that determine farmers' propensities to adopt differing levels of technology. The study covered four cultivars that were released with Peanut CRSP support from 1983 to 1995. Noted was that the Peanut CRSP funded research has significantly impacted farmer adoption of improved cultivars and also nearby communities, which were not targeted by the Philippine extension service through their Department of Agriculture. Specifically, there was a 17% adoption during 1994-1995 in targeted areas, and 6.5% adoption in nearby communities. These figures were 35% and 20%, respectively, in 1998-1999. These are excellent developments, a tribute to Peanut CRSP.

- VT 09S. Progress has been slow in finalizing the analyses of data collected from the Kaolak and Fatick regions of Senegal. The data have not met the desired suitability for rigorous analyses. The situation in West Africa, with regard to market structure, price signaling, and household propensities to consume and produce are not synonymous with conditions in the U.S. (the West). Hence, the approach and assumptions heave required some adjustments. The groundnut market in Senegal has not traditionally been an "open" market, and the farmers have usually been price takers, i.e. they sold at whatever price was offered by government buyers. Farmers generally have accepted the government prices and there has been little variation in prices.

- AUB 30S. A farm survey was completed with 842 households in Haiti. The study showed that drought caused low yields and was the major constraint to peanut production. Likewise, the study showed that the major marketing constraints were storage losses and low prices. Other findings were; a) farmers felt that they could sell more peanuts if they were available through increased productivity; b) peanuts generated a substantial portion of household income and were highly competitive with other enterprises for the farmer's resources; and c) by storing their crops and selling six months after harvest, farmers were able to double their net returns.

- VT 35S. The research included a literature review of the situation relating to gender, and a study of gender roles and issues in a selected country, Malawi, where peanut was an important sector of the economy. The achievements fell into four categories: 1) student theses – one student completed an M.S. thesis under the project and three others were near completion; 2) several reports and a referred journal article were completed; 3) a draft of an unpublished data guide on gender and the socioeconomics of peanut production in Malawi were completed, the data were to be used in future analyses and for a graduate student thesis; and 4) several other studies continue and have shown progress. The bibliography on "The Role of Women in Global Peanut Production" was 80% complete.

- UCN 36S. While conducting this research, it was determined that the pricing policies, fiscal practices, and market structure measures followed by the Government of Senegal were not serving the peanut sector or the country well In fact Senegal and West African countries have lost ground in the world markets. Additionally, it was found that the keys to future success will be farm level efficiency, environmental quality, high quality seed, and inputs to enhance productivity. Training on FoxPro Data Management was completed and the local staff was able to code the data directly. The data collection process has been expanded to capture and utilize new information of the farmer's acquisition and use of relevant knowledge. One doctoral student is completing and using the data set to compare productivity differentials across peanut producers. The development of Meta Analysis Models to study developing countries' farmer productivity was successfully initiated, and the preliminary estimates have been completed.

  To complement the ongoing work, profiles of typical farmers representing the different agro-ecological zones have been initiated and are progressing smoothly. An important outcome of the work was the training of students and staff to analyze and interpret data collected by students at ENEA (Ecole National d'Economie Appliquée) on various farm situations in Senegal, and apply them to evaluate the extent to which farm output can be increased by making better use of technologies, and to evaluate the impact of alternative peanut management practices and farm policies on input use, productivity, and farm profitability.

D. Cross-cutting/information, training, and impact (information, technology transfer and management):

- UGA 05. The World Geography of the Peanut: Global Networking Approach to Social Equity, Environmental Protection, and Technology Exchange. Over 400 peanut-specific documents were collected, analyzed and geo-referenced-organized by continent and country. The World Geography of Groundnut Data Base, an annotated publication listing by title, authors, publisher, key words, country, region and abstract was released. The *World Geography of Groundnut Distribution, Production, Use and Trade Atlas* was published by the Sustainable Human Ecosystem Laboratory, University of Georgia. This publication is based on Foreign Agriculture Organization (FAO) data collected during 1963-1991 and to present. Maps of the 25 top peanut growing counties were produced on area harvested and production trends. A Peanut Website is ready to go on line to share these data in a user-friendly way.

- UGA 37. Funds provided to Thailand were supplemented by leveraging from the Thai Government and FAO regional office. Activities were as follows. 1) Technical consultation – "Gender Roles in the Peanut Sector for Household Food Security", June 19, 1998. Seven SE Asia countries represented for training in agricultural production, processing, and consumption; emphasized research, extension, and development. 2) A training workshop on "Quality Evaluation and Utilization of Food Legumes was held April 20-May 22, 1998, with 20 participants from 12 countries in Asia and Africa. 3) Technology on methodology to minimize aflatoxin in peanut product was transferred to a pilot village in Khon Kaen Province in Thailand and was benefitting farmers, processors, and consumers. Good agricultural practices were vastly improving harvest and postharvest techniques of farmers participating in the project. An important result was low levels of aflatoxin contamination in peanuts produced under the pilot project. 4) Ten years of food technology research were collected and placed on an English-Thai language webpage.

- UGA 38. Long- and Short-term Training for Host Country Scientists. The project has supported M.S. and Ph.D. students at Texas A&M University, University of Connecticut, North Carolina State University, University of Georgia, Auburn University, and in Ghana and Malawi. An Asian regional Workshop at ICRISAT/India was sponsored on aflatoxin detection methods. A Product Development Workshop was held at the University of Georgia in cooperation with North Carolina A&T University, where scientists of a number of countries attended. Scientists from Bolivia received training in pathology-breeding at the University of Florida. A Modeling-Cropping Systems Workshop was held in West Africa under the direction of the University of Florida.

- UGA 39. Program management and governance. The project allows support for necessary-CRSP-wide activities not in the scope of the regular ME budget, i.e. board of directors and technical committee meetings were held at least one time annually; and external evaluation panel activities for the 5-year review.

- UGA 40. International Collaboration. The project supported publication of the Arachis International Newsletter biannually in cooperation with ICRISAT. Regional meetings for scientists were conducted in cooperation with ICRISAT in West Africa and India. Support for host country scientists to attend the American Peanut Research and Education Society meetings has provided access to information from the world's leading peanut scientists and to present their own research outputs.

- UGA 41. Management of the Peanut CRSP. The project supports management entity (ME) staff for fiscal and programmatic management and reporting. A computer based data management and reporting system accessible to participants worldwide has been established during this phase by the program director, which has greatly improved management efficiency and access to information by everyone involved.

CHAPTER 22. IMPACTS OF THE 1996-2001 GRANT

The impacts have been summarized from annual reports, EEP reports, publications and other reports. The impacts are outcomes that have or promise to have in the near future contributions to the well-being and economic of peoples. The summaries are arranged according to the later sectors developed; producer values, processor values, consumer values, and cross-cutting values to provide a convenient means to compare the results across the entire Peanut CRSP history.

A. Producer values (production efficiency in grant)

In Senegal, a cultivar, Fleur 11, developed by ISRA scientists in cooperation with the Peanut CRSP project TAM 17P was being adopted by farmers. On farm socioeconomic studies by another Peanut CRSP project (UCN 36S) show that farmers find this cultivar maintains a 25% yield advantage over the established cultivar. Adoption was limited by seed volumes, but the potential impact was estimated at an additional $18 million annually to the peanut farmers of Senegal. The release of a second and improved cultivar was imminent.

In Malawi, Peanut CRSP project UGA 28P, which is focused on developing and exploiting virus resistance, has exploited the testing of lines resistant to the groundnut rosette virus disease developed by ICRISAT. These lines are now being released and multiplied for distribution to farmers, with support from the USAID-Malawi mission. The potential benefits to Malawi farmers are the elimination of rosette epidemics that decimate production every 5-7 years. This will provide greater food stability, higher mean yields, and encourage farmers to produce peanuts since the risks of loss will be decreased.

Studies of groundnut rosette virus (GRV) variability across Africa indicate that resistance based on viral coat-protein of the GRV assistor virus should be stable, and research in Georgia has produced transformants using a synthetic gene.

Research on germplasm of Bolivian origin (project UFL 16P) in Florida, Georgia, and Bolivia has resulted in the identification of new sources of resistance to the Tomato Spotted Wilt Virus (TSWV) disease, which has become one of the most limiting diseases to peanut production in the U.S. These lines also have multiple resistance to foliar diseases and other prevalent diseases in the U.S. as well as having high yield potential. A breeding program to exploit this opportunity has been initiated and advanced lines are now available. In Bolivia, the research has shown that productivity was limited more by management and labor availability than by genetic potential. Labor saving technologies for harvest have been proposed and were being developed. Extension documents to promote improved management have been prepared and production was starting to increase.

B. Processor values (post-harvest and marketing values 1996-2001)

In the Philippines 35% of the children are deficient in Vitamin A. This situation causes blindness and decreases child survival. Market research conducted with Peanut CRSP project UGA 04U support showed that peanut butter is consumed by all sectors of the population, a fact that makes it an ideal vehicle for health interventions. In collaboration with commercial processors in Manila, the scientists supported by the project developed a Vitamin-A fortified peanut butter. This product has been commercialized and now has a 35% market share in the Metro-Manila area and was sold nationwide. Commercial competition was encouraging other peanut processors to develop competing products.

Liver cancer rates in Southeast Asia are 36 times those observed in the U.S. Aflatoxin and hepatic B interact to greatly increase the risk of this cancer in these areas. Researchers in the Philippines with Peanut CRSP project 04U support in cooperation with a peanut-based food processing company have developed sorting techniques to control aflatoxin contamination. This has allowed the company to exploit the export trade market opportunities for ethnic Philippine sauces and expand operations. Production has increased 40% in the year since the technology was deployed. Other companies are positioning themselves to adopt this technology, which will ensure widespread adoption of the technology.

Consumer market research in Bulgaria has shown that a strong market of peanuts and peanut products can be developed. The Peanut CRSP project UGA 11U has helped establish a food processing pilot plant in Bulgaria to allow local industries to scale up their operations, by providing technical training to technicians making them familiar with the major peanut processing technologies.

Scientists in the U.S. on Peanut CRSP project UGA 04 U have transferred the technology of a peanut snack product that is successful in the Philippines to the U.S. market. A North Carolina peanut processing company is test marketing the snack product.

C. Consumer values (aflatoxin, nutrition, socioeconomics)

The research conducted at Purdue University and the Food Research Institute, Ghana under project PUR 10 has shown that the high energy content of peanut was offset by the high satiety value of the commodity. This means that peanut consumers were not at risk for obesity and cardiovascular risk from a high caloric intake of peanuts. The research has also contributed to the body of knowledge showing that peanut oils are healthy (similar to tree nut oils) and have positive cardiovascular health benefits. This research has received attention in the U.S. where it has been used to promote peanut consumption, which has helped reverse a 5-year (18%) decline in consumption due to the above health concerns. One industry representative states that U.S consumption has increased 13% since this research began, and the impact has been estimate by the industry to be worth as much as $500 million annually. In developing countries and for USAID's humanitarian response efforts, the information that peanut is a very hunger satisfying food, with high protein and high energy content suggests that this commodity should be exploited in times of civil crisis and famine, since more hunger prevention is delivered per payload that from the commonly used emergency rations.

Basic research at Texas A&M University under project TAM 33A has identified two genes that are critical to production of aflatoxin by *Aspergillus flavus* fungi. These genes may allow molecular engineering techniques to eliminate or greatly diminish aflatoxin contamination of peanuts when infected by the fungus, thereby reducing the detrimental health aspects of aflatoxin.

Socioeconomic research in Senegal under UCN 36S mobilized the ENEA to focus on economic problems in farm level peanut production. The University of Connecticut has been involved with this development over a 10-year period, one-half with Peanut CRSP involvement. The research has determined that the pricing policies, fiscal practices, and market structure measures followed by the Government of Senegal are not fully serving the peanut sector of the country. Additionally, it has been offered by the researchers that the key to future success will be farm level efficiency, environmental quality, high seed quality, and inputs to enhance productivity. The project has encouraged positive interaction between ENEA (National School for Applied Economics) and ISRA (Senegalese Agricultural Research Institute). This effort has more fully contributed the strengths of ENEA to the agricultural sector.

The socioeconomic Peanut CRSP project NCS 07S has established an ongoing impact assessment procedure. Assessments have shown that in Jamaica a Peanut CRSP cultivar (CARDI/Payne) was adopted, but its use has since diminished. On the other-hand, technologies for production adopted by farmers with the cultivar have continued to be used. In the Philippines, Peanut CRSP cultivars are being planted more in the major peanut region, and their use is a major effort of the Philippine Government agricultural programs.

D. Cross-cutting/information, training, impact (training, information, program support in grant):

When considered from the aspect of resources available, the Peanut CRSP has been very successful with its training efforts. Trainees include: 49 for short-term training, 11 Master of Science candidates, 8 Ph.D. candidates, ad 2 others for a total of 70. In this total, 26 were female and 44 male, a good gender balance. Five workshops/training courses have been held in Ghana, ICRISAT/India, Thailand, Georgia/U.S. and Mali. Should increased resources become available, the EEP would encourage expanding training, and especially important is training in regions such as South Africa where infectious diseases are significantly reducing the work force.

A centralized collection of 'grey' literature recording peanut research in national programs across the world has been started. This information is being made available through a World Wide Web Site accessible database (project UGA 05).

The International Arachis Newsletter published in cooperation with ICRISAT was made available in both paper and electronic/website mediums.

Advancement of research and training interactions are combined in U.S./Host country collaboration.

CHAPTER 23. EXTERNAL EVALUATION REPORT FOR 1996-2001 GRANT

The mandate of the review was outlined in the BIFAD/USAID guidelines and the Peanut CRSP policies and procedures that require an intensive evaluation of the program by an external evaluation panel every five years. The purpose of the EEP was to evaluate the plans, funding and progress of the research program and make recommendations thereon. The members shall be reputed scientists in appropriate areas of expertise. In undertaking an intensive review of the Global Program, site visits to U.S. and host country research sites are made. Recommendations from this review become part of the documentation for program extensions, which may include: addition, elimination or modification of overall objectives, and component projects; and retention, elimination, or addition of new overseas or U.S. sites, or institutions.

The EEP was selected and approved in 1997 to conduct project reviews during the 1996-2001 time frame approved for the Peanut CRSP, and make recommendations regarding a 2001-2006 extension. The EEP members were nominated by the principal investigators, technical committee, board of directors, and management entity. The nominees were approved by BIFAD/USAID. Basic criteria used in the selection process included: 1) a background in and basic understanding of science; 2) experience in international agricultural research and/or development and knowledge of developing country problems; 3) specific experience in peanut research; and 4) an understanding of the U.S. land-grant research system.

The EEP consisted of:

- Coordinator, Dr. John Cherry (expertise in food and agricultural sciences), director, ARS/USDA, Eastern Regional Research Center, Wyndmoor, Pennsylvania
- Dr. Geoffrey Hildebrand (expertise production and plant breeding), Seed Co., Ltd, Harare, Zimbabwe
- Dr. Duncan McDonald (expertise pathology and mycotoxins), retired ICRISAT, Peebles, Scotland
- Dr. Handy J. Williamson (expertise socioeconomics), Agricultural Economics and Rural Sociology Department (formerly head), University of Tennessee, Knoxville, Tennessee
- Jeffrey Johnson (expertise post-harvest and the U.S. peanut industry), Birdsong Peanuts, Inc., Suffolk, Virginia
- Dr. Ron Gibbons (consultant to EEP and expertise production/plant breeding), retired ICRISAT, Bedford, United Kingdom

The review was conducted using published annual Peanut CRSP, EEP and related reports, initial 1996 and following annual work plans, principal investigator self-assessment surveys, site visits in U.S. and host countries institutions, and other pertinent available documentation, and meetings of the EEP to examine and consolidate findings, develop recommendations and write the EEP report for the Peanut CRSP. The EEP expressed appreciation for excellent support throughout the review. Site visits were usually make by two EEP members. Two levels of recommendations were made: general recommendations of overall observations, accomplishments, short-comings, and suggested future directions; and specific recommendations on projects based on a common review and ranking system; and based on these two levels of recommendations the project were categorized in order to recommend for each project continuation, substantive adjustments, or discontinuation and/or replacement. The review was conducted in late 1999 and early 2000, and the report was finalized at a meeting in Griffin, Ga. on March 1-4, 2000.

General recommendations

The Peanut CRSP now has five major constraint-focused areas: 1) Food Safety, 2) Production Efficiency, 3) Socioeconomics, 4) Post-harvest, Processing and Utilization; and 5) Information, Technology Transfer and Training. The EEP recommends that the Peanut CRSP maintain these general areas of research, despite the workload that doing so places on the program.

Peanuts are a critical source of income for women and low income people through both the production and value-added activities that the commodity provides. The peanut is a very important legume crop in the developing world (24 million ha and 31 million metric tons in 1999 compared to soybean's 25 million ha and less that 17 million metric tons (FAO); and over 50% of production is traded to generate cash incomes for the producer and provide ingredients for processors at all levels of operation.

Clearly, resources appropriate to maintaining the importance of this crop as an agricultural commodity are needed. USAID needs to remember the vital importance of peanuts to the economic stability of households in many developing countries.

Both food safety and utilization research are necessary to ensure markets for peanuts. The potential importance of exploiting clay-adsorption technologies as a means to impact human health and child survival world-wide was an exciting prospect and both the Peanut CRSP and USAID should work to prove this technology works for human use and is safe. The significant impact in the U.S. resulting from the research on human health responses to peanut diets justifies continued effort in this area.

Production efficiency and systems research are necessary to maintain profitability of peanuts. Utilization research is of great importance in that peanuts are an important source of value added products for small businesses and women based companies. The model used to deliver health benefits exploiting commercial competition and vitamin A fortification of peanut butter should be noted and duplicated where possible. The EEP urges the Peanut CRSP and USAID to investigate the resolution of child survival issues through agricultural research opportunities with peanuts.

Socioeconomic research is needed to ensure that both production and postharvest research are equally appropriate, and that transfer of technology occurs.

Training is of vital importance to the long-term sustainability of peanut crop development. Given the HIV epidemic in developing countries, especially South Africa, it is of vital importance that the training and mentoring capacity of the Peanut CRSP be increased.

Geographically, the EEP noted that the present program represents a new realignment of activities. The changes established in 1996 remain appropriate to the relative needs for both long-term and short-term peanut research across developing countries, and should be maintained. The new geographic resource allocation represents activity in many new countries and regions. The EEP finds that the geographical distribution of resources in Host Countries agrees with the assessment of need, but the EEP recognizes that problems occur with expansion and has made appropriate recommendations.

New opportunities exist in heath areas. Aflatoxin is detrimental to the health of people in many developing countries, particularly sub-Saharan Africa. The EEP is aware of the high potential for clay additives to feed and/or food through technology developed earlier by the Peanut CRSP. The Peanut CRSP should actively explore ways to test and extend this technology to African food systems in particular, as well as other World regions. Public Health Agencies, Noguchi Memorial Institute for Medical Research-Ghana and IARC-France devoted to cancer research in addition to Peanut CRSP scientists could be potential collaborators. The Peanut CRSP should continue and increase efforts to foster awareness of the nutritional value, food safety issues and allergy problems of peanut. The EEP commends the nutritional work of the Purdue University project (PUR 10) research progress and dissemination of results to consumers.

The Peanut CRSP should continue to foster international research and development through publications (International Arachis Newsletter), cooperative workshops, Web-site information collections, and other outlets.

More cooperation across Peanut CRSP projects, inter- and intra-disciplinary, should be encouraged. This is particularly important in times of scarce funds and time constraints of scientists.

The EEP recognizes that the worldwide geographical distribution of peanut as a crop and commodity presents a special challenge to the Peanut CRSP with the limited resources available. The EEP urges the ME to work to develop additional support from USAID/country missions in areas where peanut is a commodity. The EEP urges USAID missions, particularly in Southeast Asia, to "buyin" into the vitamin A fortification technology, and to support the possible exploitation of clay enterosorption technologies as a solution to aflatoxin-caused liver cancer (Southeast Asian and African liver cancer rates are significantly higher than those in other parts of the world).

The EEP recommends that USAID work to expand the funding resources for the Peanut CRSP.

Specific recommendations

Food Safety – Food safety remains of critical importance to peanut producers and consumers worldwide and to the inclusion of the work in the Peanut CRSP, which includes four projects focused on aflatoxin and one on dietary and satiety consequences of peanut consumption. One project TAM 33A is aimed at preventing aflatoxin contamination through genetic manipulation of biochemical pathways to the productions of aflatoxin in peanuts, and has an element of research on storage technologies that could prevent spoilage. UGA 02A seeks to predict the risk of contamination, and UGA 22A has a goal to develop practices that minimize the risk through production and storage technologies. The fourth project, UGA 01A addresses the possibility of decontamination peanuts to render them safe for consumption. In addition, several projects in the post-harvest/utilization constraints have aflatoxin prevention thrusts. Outside of the aflatoxin problem, the initiation of research to study the dietary consequences of peanut is a very positive step (PUR 10U). The EEP recommends highest priority remain placed on aflatoxin/food safety in peanuts, that future project emphasis needs to move more aggressively toward exploiting the clay technologies to remove aflatoxin from food and feed, and that the abatement of immune depression effects of aflatoxin is important. In one case (UGA 02A) lack of initiative on the part of the H.C. counterpart was noted as an issue for which the recommendation to discontinue the project was made.

Production Efficiency – Seven projects in this area. Given the fact that timing of funding has been problematic for most of these projects, the achievements are encouraging, and the projects in this thrust have, for the most part, made good progress. Four projects – UFL 13P crop modeling/West Africa, UFL 16P pest resistant cultivars/Bolivia, NCS 19P IPM/West Africa, and UGA 28 rosette virus/Southern Africa have made progress and future impacts should be great. TAM 14P for germplasm collection was progressing slowly but was an important effort. The loss of principal investigators in three projects TAM 17P West Africa/Breeding, NCS 34P Genetics/Peru (merged with NCS 20P prior to the EEP review), and NCS 20P Breeding/Bulgaria have hampered progress and required adjustments. NCS 20P – U.S. and HC did not match on peanut types in the programs, and was recommended to be discontinued.

Socio-Economics – Three of the projects are progressing well and provide for socioeconomic activity in a wide range of areas both in the U.S. and HC's.: NC 07S impact assessment, VT 09S production economics/gender, and UCN 36S production economics were progressing well. Two projects, AUB 30S Haiti and VT 35S Malawi, have not had host country support resulting in limited progress, and are recommended to be discontinued. Present projects are to a large part 'free standing', and should be integrated more closely with the production, food safety, and food utilization components. It is noted that at least two projects in the post-harvest handling/utilization thrust have 'built-in' socioeconomic capabilities in their multidisciplinary teams, which have performed well and could be models for the other projects.

Post-Harvest Handling/Utilization – Excellent progress has been made on the development and transfer of peanut processing and product technologies in the Philippines-UGA 04U and Bulgaria-UGA 11U. Market surveys have been a major contributor to understanding what peanut products are desired by consumers. The ALA 26U/Ghana which was a new location, and NCA32U/Jamaica, Haiti, Belize have had U.S. university reorganization problems and loss of principal investigators and progress has been limited, which led to a recommendation to discontinue the projects. It was recommended that new project efforts that replace these projects focus on West Africa.

Information, Training, and Technology Transfer – These projects are all relevant to the effective coordination and utilization of peanut science and technology developed through the Peanut CRSP and its partners worldwide. The progress in this area has been satisfactory for the resources applied, but these projects are all limited by funding, which was severely limited or eliminated in response to the budget cuts that were implemented in 1998. The projects need to be maintained in the future, and receive adequate funding. The global network project UGA 05 has been effective. UGA 37 has continued to support the Training for SE Asian region through Kasetsart University, Thailand with much impact seen. UGA 38 supports long and short-term training efforts. UGA 40 supports international collaboration, such as publication of International Arachis Newsletter in cooperation with ICRISAT, regional Meetings cooperative with ICRISAT, CORAF and other groups, and for host country scientists to attend the American Peanut Research and Education Society annual meetings in the U.S. All projects except UGA 05 are managed by the program director. The projects should continue.

Program Management and Governance – UGA 39 supports necessary meetings of the technical committee, board of directors, and supports the external evaluation panel. This project should continue. UGA 41 covers all costs of the management entity, such as salaries, travel, maintain records and required reporting both financial and technical, and necessary publications, and must be maintained.

The Peanut CRSP was effectively managed at minimal costs. The management office continues to be located at the University of Georgia College of Agriculture Experiment Station, Griffin. Dr. J.H. Williams was the program director and was responsible for the activities in the five projects listed above. A half-time associate director, Dr. William Pannel was added January of 1999 to assist with administrative activities. Sandra Harwood was senior secretary, and Grace Hutto was administrative secretary-half time. Virginia Thomas, Agricultural Business Office, UGA/Athens, was quarter-time accountant. Vijay Mallikarjunan was three-quarter time computer programmer from October 1998, followed by Snehal Trivedi half-time until March 2000, and then Carlos Welch half-time since April 2000. Dr. David G. Cummins retired as program director in 1998 and serves on a consultant basis for special assignments. The management entity has an effective program and the recommendation was to continue the effort. An associate director with expertise in the sciences of the Peanut CRSP would allow more time for the director to visit programs worldwide and give greater commitment to issues.

Based on the EEP review, a 2001-2006 extension proposal was developed, requests for proposals from qualified U.S. universities prepared and circulated, the proposals reviewed by the EEP, and winning projects selected. The projects selected will be described in more detail in the next chapter "Description of 2001-2007" grant (the grant was extended for one year in 2006).

U.S. Scientists assist host country scientists in improvement of research technologies.

CHAPTER 24. DESCRIPTION OF 2001-2007 GRANT

The current Peanut Collaborative Research Support Program (CRSP) began in 1996 as a ten-year plan, which was renewed in 2001 with adjustments made following the 2000 external evaluation panel (EEP) review. The 2001-2006 grant was extended one year until 2007.

The Peanut CRSP used a value-chain approach developed around five thematic/cluster areas: 1) Food Safety and Nutrition; 2) Production Efficiency, 3) Socioeconomics and Policy, 4) Post-Harvest and Utilization; and 5) Information, Training and Technology Transfer and Management.

Program content assured that the Title XII expectations of impact in the host (developing) countries with benefits to the United States (U.S.) would be achieved. Plans were developed to resolve major constraints to the host countries and U.S. peanut sector and to ensure that social and gender issues were addressed.

The Peanut CRSP was designed around a set of constraints based on the CRSP concept to address constraints that have global implications to sustainable production and utilization identified during the 1980-1982 Planning process. Based on the numerous advancements achieved by the Peanut CRSP during the 1982-2000 period, the external evaluation panel in 2000 evaluated the continuing validity of the following constraints and found them to be valid as a basic framework for the Peanut CRSP in the near future. With some adjustment in the project designs to address the constraints, the Constraints have remained similar over this period:

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

The goals of the 2001-2007 Peanut CRSP were to enhance the peanut research capabilities of developing countries and the U.S., and to focus this increased capability on development of technology that will help remove constraints limiting production and utilization.

The Peanut CRSP goals and projects remain relevant to the agricultural strategy of the United States Agency for International Development (USAID) and to its four development goals, and are contributing to their attainment in a positive way. The Peanut CRSP goals were directly relevant to the first three of the four themes of the USAID program at the initiation of this phase which were: 1) economic growth, 2) environmental sustainability, 3) health and population, and 4) democracy. In 2004, USAID has made agricultural development a strategic priority focusing on increasing access to markets and small holder participation in markets, which are also existing priorities for the Peanut CRSP.

The main goals in the USAID program were: 1) to expand trade opportunities and improve the trade capacity of producers and rural industries; 2) to improve the social, economic, and environmental sustainability of agriculture; 3) to mobilize science and technology and foster capacity for innovation, and 4) to strengthen agricultural training and education, outreach, and adaptive research. For the future, the Peanut CRSP was well positioned to continue addressing these development goals, and the broader global Millennium Development Goals (MDG) of poverty reduction, gender equality, environmental conservation, and building partnerships.

The Peanut CRSP implemented five themes based on research opportunities related to the global constraints identified in peanut production and utilization worldwide, and described earlier. The projects built on the past achievements of the program and the accumulated experience and expertise of participating scientists in the U.S. and the host countries. There were 23 research projects, one global information, and two training, projects, and three management-related projects implemented in the 2001-2007 period. Ten projects are multi-country and across regions. The geographic locations were: West Africa (13 projects), Southern Africa (3 projects), Asia (3 projects), Latin America and the Caribbean (2 projects), and Eastern Europe (2 projects). These locations were determined in 2001 by: research opportunities to solve major constraints in production and utilization, complementarity with the peanut projects of its main partner ICRISAT (an International Center under the Consultative Group for International Agricultural Research or CGIAR), and USAID priorities and specific research opportunities. Eight of the top nine peanut producing states in the U.S. participated in the CRSP. Hence, the program is well distributed geographically and is expected to benefit many U.S. producers. There were 11 states and 14 universities participating in the program including two historically black colleges and universities.

United States and host country university and institutional participants 2001-2007

The management entity is described including office staff, university international programs advisor, board of directors, technical committee, USAID program coordinators, and BIFAD representatives in the management entity project. The project numbers, titles, and goals principal investigators, collaborators, cooperators, U.S., host country institutions are listed below for each project and grouped into sectors.

The University of Georgia management entity office for the Peanut CRSP was located in the College of Agriculture at the Griffin Campus, Griffin, Georgia. The major role was responsibility to USAID for technical and administrative matters for the Peanut CRSP. Duties include negotiating agreements, fiscal management, technical progress, managing external reviews, and project modifications. Dr. Jonathan H. Williams, program director, Grace Hutto, administrative secretary, Amy King, senior secretary, and partial time for Virginia Thomas, accountant, College of Agriculture Business Office, Athens. Support staff: Ted Proffer, College of Agriculture, business manager, and Dr. Ed Kanemasu, director of International Agricultural Programs. Dr. David Cummins retired as program director June 1, 1998 and served as part-time associate program director with Dr. Williams for special activities. Overall responsibility for programmatic and fiscal accountability for the grant was in the offices of the vice-presidents for research and business affairs, and the College of Agriculture, with day to day management the responsibility of the management entity office.

The ME coordinated the twenty-three projects in the technical area, three projects in information and training area, and three projects in the management area.

Board of directors

- Dr. David Hogg, University of Wisconsin
- Dr. Harriet Paul, Florida A&M University
- Dr. S. K. DeDatta, Virginia Tech University
- Dr. Mary Duryea, University of Florida
- Dr. Richard Robbins, North Carolina A&T University

Technical committee

The technical committee became inactive in the last two phases of the program.

Coordination with USAID and BIFAD

USAID CTO (cognizant technical officer): Dr. Jiriyis Oweis; followed by Dr. Cheryl Jackson.

Program Support – Financial

In 2001, the Peanut CRSP proposed a total of U.S.$15 million budget to implement the program and projects. The total expenditure from 2001-2005 was U.S.$8.99 million with U.S.$2.55 million provided in 2005-2006 for a total of U.S.$11.54 million of the approved $15 million. An overall budget summary is given in another section.

Projects for the 2001-2007 grant

The projects and goals were the result of the prior accomplishments and impacts, oversight by the management entity, board of directors, technical committee, and the USAID involvement followed by an EEP review and recommendations, after which these groups approved as authorized the projects for 2001-2007.

A. Producer Values (Production Efficiency Research)

UFL 13P: Simulation of Peanut Cropping Systems to Improve Production Efficiency and Enhance Natural Resource Management.

Principal Investigator:
- Dr. Kenneth J. Boote, University of Florida;

Ghana Collaborator:
- Dr. Jesse Naab, Savanna Agricultural Research Institute, Tamale.

Benin Collaborator:
- Adomou Moustapha, Institut National des Recherches Agricoles du Bénin (INRAB), Cotonou.

The goal of UFL 13P was to use systems modeling to improve resource use efficiency in peanut production. The approach was to use field experiments to determine yield gaps, and to use peanut crop growth simulation to evaluate potential yields and to determine reasons for yield gaps. Models could be helpful to evaluate technology development, management strategies, and policy decisions to improve response to weather risks and maximize efficient use of natural resources and minimize negative environmental impact.

UFL 16P: Development and Use of Multiple-Pest Resistance to Improve Production Efficiency of Peanut.

Principal Investigator:
- Dr. Dan Gorbet, University of Florida;

Cooperators:
- Dr. Jim Todd, University of Georgia,
- Dr. Albert Culbreath, University of Georgia,
- Dr. Roy Pittman, USDA/ARS Plant Introduction Station, Griffin, Ga.

Bolivia Collaborators:
- Jaime Hernandez, Asociación de Productores de Oleaginosas y Trigo (ANAPO), Santa Cruz.
- Marin Condori, Asociación de Productores de Oleaginosas y Trigo (ANAPO), Santa Cruz.

The goal of UFL 16P is to improve peanut production efficiency through higher-yielding pest resistant varieties beneficial to Bolivia and the U.S. The approach was to use greenhouse and field experiments of newly introduced genotypes, local crosses and traditional Bolivian peanut varieties, field surveys to determine yield gaps, and level of resistance to diseases, as a basis for recommended interventions.

TAM 17P: Breeding Peanut for Better Productivity and Quality.

Principal Investigator:
- Dr. Mark Burow, Texas A&M University/Lubbock:

Sengal Collaborator:
- Dr. Ousmane Ndoye, l'Institute Senegalais de Recherches Agricoles (ISRA), Bambey.

Burkina Faso Collaborators:
- Dr. Philippe Sankara, University of Ouagadougo,
- Dr. Zagre Bertin, Institut de l'Environnement et des Recherches Agricoles (INERA)..

The goal of TAM 17P is to develop peanut lines and varieties adapted to West Africa, with focus on higher yields, disease resistance, early maturity, oil quality, fresh seed dormancy using traditional breeding techniques and evaluating, preserving and using wild Arachis species from South America as genetic resources.

NCS 19P: Improved Production Efficiency through Standardized, Integrated, and Enhanced Research and Technology.

Principal Investigator:
- Dr. Rick Brandenburg, North Carolina State University.

Co-Principal Investigator:
- Dr. David Jordan, North Carolina State University;

Ghana Collaborator:
- Dr. Mike Owusu-Akyaw, Crops Research Institute, Kumasi.

The goal of NCS 19P was to increase production efficiency through the development and deployment of IPM (Integrated Pest Management) practices with emphasis on diseases and insects, and to integrate aflatoxin risk into the disease and insect management strategies and determine the influence of production and pest management practices on aflatoxin incidence.

UGA 28P: Control Strategies for Peanut Viruses: Transgenic Resistance, Natural Resistance, and Virus Variability.

Principal Investigator:
- Dr. Carl Deom, University of Georgia;

Uganda Collaborator:
- Dr. Charles Busolo-Bulafu, Sere Agricultural and Animal Protection Research Institute (SAARI), Uganda, Serere.

Malawi Collaborator:
- Dr. Charles Mataya, Department of Rural Development, Chitedze.

The goal of UGA 28P was to develop transgenic peanut/groundnut lines with resistance to groundnut rosette disease and spotted wilt disease, to breed naturally occurring resistance to groundnut rosette disease into agronomically important early maturing and/or drought resistant cultivars of *Arachis hypogaea,* and to increase the quantity of seed of high-yielding, groundnut rosette disease resistant groundnut and evaluate the resistant germplasm in Uganda.

UFL 52P: Development of Sustainable Peanut Production Technologies for Amerindian Villages in the Rupununi region of Guyana.

Principal Investigator:
- Dr. Greg McDonald, University of Florida;

Co-Principal Investigators:
- Dr. Bob Kemerait, University of Georgia,
- Dr. E. Jay Williams, University of Georgia,
- Dr. S. Brown, University of Georgia,
- Dr. Glen Harris, University of Georgia.

Guyana Collaborators:

- Clairemont Lye, Beacon Foundation, Georgetown,
- Jerry LaGra, Beacon Foundation, Georgetown.

The goal of UFL 52P was to improve the standard of living and protect the environment in the Rupununi region of Guyana by improving per unit and total peanut production in a sustainable manner, which would include adapted-higher yielding disease resistant varieties, evaluate insect management needs, determine nutrient needs, and evaluate the value of small-scale labor-saving devices and machinery.

The EEP visit in Jan-Mar 2005 noted over production and the need for market development. The Government of Guyana was in the process of establishing a School Lunch Program, which USAID/Guyana was interested in as market development. This resulted in the cooperative work to introduce peanut butter/cassava bread sandwiches into this Lunch Program.

NMX 53P: Valencia Peanut Breeding for High Yield, Early Maturity, and Resistance to Fungal Diseases, and Good Quality.

Principal Investigator:

- Dr. Naveen Puppala, New Mexico State University, Clovis.

Cooperator:

- Dr. Curtis Jolly, Auburn University.

Bulgaria Collaborator:

- Dr. Stanko Delikostadinov, Institute of Plant Genetic Resources, Sadovo.

Bulgaria Co-Collaborator:

- Dr. Nelly Bencheva, Agricultural University, Plodiv.

The goal of NMX 53P was an economic analysis of Valencia type peanut production and its efficiency in Bulgaria, peanut germplasm enhancement with new accessions and traits using molecular marker approach, and investigation of U.S. varieties in Bulgaria and Bulgarian varieties in the U.S. for yield, maturity, and fungal disease resistance.

FAM 51P: Biochemical and Molecular Responses of Peanut to Drought Stress and Their Role in Aflatoxin Contamination.

Principal Investigator:

- Dr. Mehboob Seikh, Florida A&M University;

Bangladesh Collaborator:

- Dr. Shah Alam, Bangladesh Agricultural University.

The goal of FAM 51P was to investigate differential gene expression, and biochemical responses to drought and to use these indicators to evaluate germplasm for drought resistance.

B. Processor values (post-harvest and utilization sector)

UGA 01: Extrusion Cooking of Peanut Meal in the Presence of Lysine to Deactivate Aflatoxin and Improve Nutritional Quality.

Principal Investigator:

- Dr. Richard Phillips, University of Georgia.

Cooperator:

- Dr. Larry Beuchat, University of Georgia.

Ghana Collaborators:

- Dr. Samuel Sefa-Dedeh, University of Ghana, Legon (Accra),
- Dr. Ester Sakyi-Dawson, University of Ghana, Legon (Accra).

The goal of UGA 01 was to develop technologies to detoxify peanut meal during extrusion cooking incorporating clays and other agent, and examine ways to inactivate the allergenic potential of peanut proteins.

UGA 04: Development of Peanut Post-harvest Handling and Processing Technologies for the Food Industry in the Philippines and Southeast Asia.

Principal Investigator:

- Dr. Anna Resurreccion, University of Georgia.

Cooperators:

- Dr. Manjeet Chinnan, University of Georgia,
- Dr. Larry Beuchat, University of Georgia.

Philippine Collaborator:

- Dr. Alicia Lustre, Food Development Center/National Food Authority, Manila.

Philippine Cooperators:

- Dr. Flor Galvez, University of the Philippines at Diliman, Quezon City,
- Dr. Lutgarda, Leyete State University, Baybay, Letye,
- Prof. Lucy Palomar, Leyete State University, Baybay, Letye.

The goals of UGA 04 were to identify new market opportunities for peanuts and peanut products; determine physical, chemical nutritional, functional and sensory properties of products; develop processing technologies for fortified peanut products; transfer the processing technologies; and enhance research capabilities of Philippine researchers to maintain the program.

UGA 11: Development and Transfer of Peanut Technologies in Bulgaria, Eastern Europe.

Principal Investigator:

- Dr. Manjeet S. Chinnan, University of Georgia;

Cooperators:

- Dr. Larry Beuchat, University of Georgia,
- Dr. Wojciech Florowski, University of Georgia,
- Dr. R. Dixon Phillips, University of Georgia,
- Dr. Anna Resurreccion, University of Georgia.

Bulgaria Collaborators:

- Dr. Tana Sapoundjieva, Institute of Cryobiology and Food Technology (ICFT), Plodiv,
- Dr. Pavlina Paraskova, Institute of Cryobiology and Food Technology (ICFT), Plodiv,
- Dr. Nelly Bencheva, Agricultural University, Plodiv.

The goals of UGA 11 were to determine the physical, chemical, nutritional, functional, and microbiological properties of peanuts and peanut-based ingredients; develop appropriate peanut-based products for consumers in Bulgaria and the region; enhance the technological capabilities of ICFT on peanut processing, packaging, quality evaluation; shelf-life prediction; leadership as a Center of Excellence in Bulgaria and the region; and develop business plans to move peanut-based products from the pilot scale to production scale.

NCA 32: Development of Value-added Products from Peanuts and Aflatoxin Detoxification in Senegal and West Africa.

Principal Investigator:
- Dr. Mohamed Ahmedna, North Carolina A&T University, Greensboro, NC.

Cooperators:
- Dr. Ipek Goktepe, North Carolina A&T University,
- Dr. Jianmei Yu, North Carolina A&T University.

Senegal Collaborator:
- Dr. Amadou Kane, Institute de Technologie Alimentaire, Dakar.

The goal of NCA 32 was to develop functional ingredients from peanut and peanut products, and develop value-added products from peanut alone or in combination with fish mince that are optimized for consumers. Select inexpensive treatments such as clay additives to eliminate aflatoxin in the end products.

OKS 55: Use of Chemoprotection in Product Development to Improve Safety and Production of Peanut Products in Ghana, West Africa.

Principal Investigator:
- Dr. Margaret Hinds, Oklahoma State University.

Ghana Collaborator:
- Dr. William Ellis, Kwame Nkrumah University of Science and Technology, Kumasi.

The goals of OKS 55 were to develop formulations and processing protocols for addition of HSCAS clays to remove aflatoxin from popular Ghana peanut-based products, and measure the physical, chemical and nutritional properties of the products; evaluate the sensory attributes and consumer acceptability of the products, and develop protocols and train processors in Ghana to manufacture peanut products containing levels of HSCAS appropriate for chemo-prevention of aflatoxin-induced diseases.

C. Consumer values (food safety and nutrition, socioeconomics and policy)

UAB 56: Aflatoxin Impacts on Immune Systems.

Principal Investigator:
- Dr. Pauline Jolly, University of Alabama at Birmingham;

Ghana Collaborator:
- Dr. William Otoo Ellis, Kwame Nkrumah University of Science and Technology, Kuamsi.

The goal of UAB 56 was to analyze baseline demographic data, information on health history/status, and food consumption habits of study participants, with an end view of establishing the extent of aflatoxicosis and to establish the relationship with diseases induced by depressed immune systems. This involves working with a well-defined volunteer group in Ghana who are continuously exposed to aflatoxin mainly through contaminated maize and peanuts in their diets.

PUR 10: Effects of Peanut Consumption on Hunger, Ingestive Behavior, Energy Expenditure, and Coronary Heart Disease Risk.

Principal Investigator:
- Dr. Richard Mattes, Purdue University.

Ghana Collaborator:

- Dr. Phoebe Lokko, Food Research Institute, Accra.

Brazil Collaborator:

- Dr. Josephina Bressan, Federal University of Viscosa.

The goal of PUR 10 was to determine the health effects of peanut consumption. The results hold implications for individuals with marginal nutritional status and individuals with concerns about over-nutrition. The indices studied are the effects of peanut consumption on appetitive sensations, food choice, energy balance, and cardiovascular disease (CVD) risk.

UGA 22: Systems Research to Assess Risk of Preharvest Aflatoxin Contamination and to Develop Technologies to Reduce Aflatoxin Contamination of Peanut.

Principal Investigator:

- Dr. Gerrit Hoogenboom, University of Georgia.

Mali Collaborator:

- Dr. Bamory Diarra, Insitute d'Economie Rurale, Food Technology Laboratory, Bamako.

Benin Collaborator:

- Dr. Boanventure Ahohuendo, Universite Nationale du Benin.

The goal of UGA 22 was to develop early warning systems for determining aflatoxin risk, based on remote sensing and ground observations. The shift from the last phase was from post-harvest to exclusively on pre-harvest factors. The project has aimed to move away from generation of experimental data to emphasis on computer-based analysis of remote sensing data and modeling. The project analyzed historical yield data for peanuts, and NASA satellite weather data as well as aflatoxin data, if available.

UWI 49. Genetic Approaches to Eliminate Aflatoxin Contamination of Peanuts.

Co-Principal Investigators:

- Dr. Nancy Keller, University of Wisconsin, Madison
- Dr. David Wilson, University of Georgia.

Botswana Collaborator:

- Dr. A. Siame, University of Botswana.

South Africa Collaborator:

- Dr. Binesh Somai, University of Port Elizabeth.

The goals of UWI 49 are divided into two distinct areas: 1) the University of Wisconsin component is working at the molecular level examining the genes controlling aflatoxin synthesis and the symbiotic relationship between the fungus and the peanut plant. Factors that influence the switch-on of genes for aflatoxin production and the extent which plant/fungal interactions can be controlled, which will build a clearer picture of the complex biosynthetic pathways involved in aflatoxin production, and the interaction that occurs between the fungus and the plant; 2) the University of Georgia component is addressing the developing country need for low cost methods for aflatoxin analysis. There are requirements both to screen out highly contaminated peanuts from the food chain. Existing commercial affinity column based semi-quantitative screening methods work extremely well, but are very expensive due to high prices of imported affinity columns.

TAM 50: Sustainable enterosorbent strategies for the protection of African populations from aflatoxin

Principal Investigator:

- Dr. Timothy Phillips, Texas A&M University, College Station.

Cooperator:
- Dr. Jia-Sheng Wang, University of Georgia.

Ghana Collaborator:
- Dr. David Ofori-Adjei, Noguchi Memorial Institute for Health Research.

The goal of TAM 50 was to continue to evaluate more refined Novasil clays for increased aflatoxin adsorption and to select the most effective and least toxic ones for safety and efficacy verification in rats. A long-term objective was to conduct a Phase IIa trial in Ghana to establish the feasibility of clay addition to the diet of humans who are at a high risk for aflatoxin exposure and aflatoxicosis. This study in Ghana would only occur after a Phase I trial with the same clay in the U.S. had established dosimetry and potential adverse effects of treatment in adult participants.

NCS 07. Impact assessment of socioeconomic contextual influences on adoption of Peanut-CRSP-supported new technologies

Principal Investigator:
- Dr. Robert L. Moxley, North Carolina State University.

Cooperator:
- Dr. David Jordan, North Carolina State University.

Philippine Collaborators:
- Dr. Alicia Lustre, Food Development Center of National Food Authority, Manila
- Flor Galvez, University of the Philippines at Diliman, Quezon City.

Thailand Collaborators:
- Dr. Penkwan Chompreeda, Kasetsart University, Bangkok,
- Prof. Vichai Haruthaithanasan, Kasetsart University, Bangkok.

The goal of NCS 07 was designed around three thrusts. First, access the socioeconomic impacts of research led by the University of Georgia in the Philippines that led to the vitamin A fortification of peanut butter. Second, assess the socioeconomic changes and influences on adoption in North Carolina of Peanut-CRSP-supported research at North Carolina State University, with emphasis on new cultivars and integrated pest management. Third, assess the impacts of the Peanut CRSP research conducted by the University of Georgia on peanut related food processing, food science innovations in processing, and enhancing the marketability of peanuts in Thailand.

VT 09. Analysis of Response of Peanut Production in West Africa: Policy Implications of Currency Devaluation.

Co-Principal Investigators:
- Dr. Michael Bertelsen, Virginia Tech University
- Dr. George Norton, Virginia Tech, University.

Senegal Collaborator:
- Dr. Matar Gaye (until 2000) ISRA, Dakar.

Uganda Collaborator:
- Dr. Charles Busolo-Bulafu (from 2000), Serere Agricultural and Animal Protection Research Institute (SAARI), National Agricultural Research Organization.

Malawi Collaborator:
- Tobius Kapewa, Chitedze Agricultural Research Station, Lilongwe.

The goal of VT 09 was to study the following areas: 1) Economic and special equilibrium analysis of domestic and international trade policies in Senegal; 2) Economic surplus analysis of peanut research on: new variety Fleur 11, aflatoxin research, and new rosette disease resistant varieties; 3) policy index analysis; and 4) Experimental economic analysis of environmental benefits of peanut research.

AUB 30. Production Efficiency and Market Development of Peanuts and Peanut Products for Ghana, Benin, and Bulgaria.

Principal Investigator:
- Dr. Curtis Jolly, Auburn University.

Cooperator:
- Dr. Pauline Jolly, University of Alabama at Birmingham.

Ghana Collaborators:
- Dr. Richard Awuah, Kwame Nkrumah University of Science and Technology, Kumasi.

Bulgaria Collaborators:
- Dr. Nelly Bencheva, Agricultural University, Plodiv,
- Dr. Stanko Delikostadinov, Institute of Plant Genetic Resources, Sadovo.

Benin Collaborator:
- Dr. Emmanuel Prophete, Centre de Recherche de Documentation Agricole (CRDA).

The goal of AUB 30 was to evaluate the degree of awareness of the health risks of aflatoxins in peanuts by producers, marketers, and consumers and behavioral changes to minimize these risks; to examine the financial impact of aflatoxin, and evaluation the economic effects of different storage technologies including those to reduce aflatoxin.

UCN 36. Socioeconomic Impacts of Alternative Peanut Production Marketing Systems in Senegal.

Principal Investigator,
- Dr. Boris Bravo-Ureta, University of Connecticut;

Senegal Collaborator:
- Prof. Ibrahima Hathie, L'École nationale d'Économie appliquée, Dakar.

The goal of UNC 36 was development of human capacity for economic and socioeconomic analyses (data collection, analysis, and application). Areas of concern are peanut production and farm efficiency, peanut cultivation and profitability, technology adoption, aflatoxin/gender/health related aspects in peanut cultivation, and farm-level efficiency. Other themes of interest were democracy and decentralization, community development, soil management, and fertilizer use.

VT 54. Gender Issues in Aflatoxin Incidence and Control in Groundnut Production Systems of West Africa.

Principal Investigator:
- Dr. Colette Harris, Virginia Tech.

Co-Principal Investigators:
- Dr. Kathleen Stadler (until 2004), Virginia Tech University,
- Dr. William Eigel, Virginia Tech University.

Senegal Collaborator:
- Not designated, L'École nationale d'Économie appliquée, Dakar.

Uganda Collaborators (project moved to Uganda in 2003):

- Dr. Achieleo Kaaya, Department of Food Science and Technology, Kampala,
- Dr. Margaret Mangheni, Department of Agricultural Extension, Kampala,
- Dr. Connie Kyalislima, Department of Animal Science, Makerere University, Kampala.

The goals of VT 54 were to identify current and traditional practices in peanut growing, harvesting and post-harvest in Uganda related to aflatoxin contamination, educate women farmers and housewives on health risks of aflatoxin and how to reduce levels of contamination, evaluate costs of meeting European Standards for aflatoxin contamination, establish baseline for present human exposure to aflatoxin, survey aflatoxin content of groundnuts for sale in the Kampala market, support farmers to form associations and facilitate contact with European processing firms, support Ministry of Health and relevant Ugandan institutions to carry out information and education campaigns (IEC) on health issues related to aflatoxin, and disseminate findings on aflatoxin levels and protocol to the Bureau of Standards and assist in formulation of a practical approach to the reduction of aflatoxin contamination levels.

D. Cross-cutting, Information, and Training (information, technology transfer, program management)

UGA 05: The World Geography of Peanut: Global Networking Approach to Social Equity, Environmental Protection, and Technology Exchange.

Principal Investigator:

- Dr. Robert Rhodes, University of Georgia.

Co-Principal Investigator:

- Dr. Virginia Nazarea, University of Georgia.

The goal of UGA 05 was to disseminate information concerning peanuts through the Worldwide Web. The data base will include information on peanut production systems, peanut utilization, socioeconomics, production constraints, and food safety. Also, reports on peanut production and use in key countries will be included.

UGA 37: Training for Southeast Asian region.

Principal Investigator:

- Dr. Anna Resurreccion, University of Georgia.

Thailand Collaborators:

- Dr. Penkwan Chompreeda, Kasetsart University,
- Prof, Vichai Haruthaithanasan, Kasetsart University,
- Dr. Juangjun Duangparta, Kasetsart University,
- Dr. Amarda Chinapkuthi, Department of Agriculture, Bangkok.

The goal of UGA 37 was to provide training for both Thai national and Southeast Asia scientists and end-users on post-harvest handling, technologies for processing and utilization, technologies for post-harvest storage and technologies and conditions affecting shelf-life of peanut products. The training can occur at village level or at Kasetsart University.

UGA 38: Long- and Short-term Training for Host Country Scientists.

Principal Investigator:

- Dr. Jonathan H. Williams, University of Georgia.

The goal of UGA 38T was for the Peanut CRSP to have a more definite training plan to ensure the provision of long- and short-term training support that best fits host country needs and priorities.

UGA 39: Program Support.

Principal Investigator:

- Dr. Jonathan H. Williams, University of Georgia.

The goal of UGA 39 was to plan for and provide funding for special-CRSP-wide activities, special publications, particularly meetings of the board of directors, technical committee, and the external evaluation panel.

UGA 40: International Collaboration:

Principal Investigator:
Dr. Jonathan H. Williams, University of Georgia.

The goal of UGA 40 was to provide funding for 1) preparation and distribution of a Peanut CRSP Newsletter and other technical publications, and 2) the conduct of seminars, workshops, and training programs for developing country scientists and technicians. It also allows collaborations with other CRSPs, International Agricultural Research Centers, and non-governmental assistance organizations on research programs of mutual interest.

UGA 41: Management of the Peanut CRSP.

Principal Investigator:
Dr. Jonathan H. Williams, University of Georgia.

The goal of UGA 41M is to provide financial and programmatic support for the Peanut CRSP that coordinates with USAID and the participating U.S. and host country institutions. Provisions are that up to 20% of USAID funds can be directed to management entity activities such as personnel, travel, office operation, and reporting. It must establish and maintain the legal and agreement framework needed for sub-granting to participants of the Peanut CRSP grant; prepare and publish papers, presentations, research results and reports and exploit multiple media for information exchange; conduct board of directors, technical committee meetings and external evaluations; and maintain adequate records on activities and achievements.

Research participants in Jamaica.

CHAPTER 25. ACCOMPLISHMENTS OF THE 2001-2007 GRANT

Major accomplishments were obtained from annual reports, publications, meeting and workshop proceedings, and other sources, and are listed for each individual project. This section is arranged according to the later-adopted value sectors: producer, processor, consumer, and cross-cutting.

A. Producer values

UFL 13. Simulation of peanut cropping systems to improve production efficiency and enhance natural resource management

Data on environmental conditions, including weather, soil, and crop growth data have been collected and have been used together with data from experiments to identify production constraints in order to adapt the PNUTGRO crop growth model to conditions in Ghana. Yield gap data has been accumulated to allow evaluation of production constraints. Soil fertility and disease problems are indicated as a major factor in loss of yield potential. Application of a combination of phosphorus + fungicide has resulted in doubling of yields, a result closely predicted by the CROPGRO-Peanut Model. Data on environmental conditions, including weather, soil, and crop growth data have been collected and have been used together with data from experiments to identify production constraints in order to adapt the PNUTGRO Crop Growth Model to conditions in Ghana. Good progress has been made. Yield losses due mainly to foliar diseases and lack of fertilizer, have been predicted relatively accurate with the PNUTGRO Model. Losses due to pests and diseases can be as high as 50-80%. Work is continuing to collect data that will allow the development of sub-models for PNUTGRO to predict aflatoxin risk and the development of Decision Support Systems for agricultural applications of climate forecasting, and risk/opportunity assessments in Ghana. A number of farmer field days and workshops have been conducted in Ghana and Benin, and farmers appear to very receptive to improved technologies. Extension aids have been developed and distributed, and the field days have had national television coverage. The project is collaborating with a NGO (Plan Ghana) to interact with women's groups.

UFL 16. Development and use of multiple-pest resistance to improve production efficiency of peanut

ANAPO released a new variety (Mairana, a white-seeded type) in 2004, a selection from the earlier introduced U.S. genotypes, and seed production is underway for distribution in the Mairana Valley and other zones. Three potential lines (Accession 32, 72, and 75) are being tested in three zones (Mairana, 26 Agustos, and Saavedra) and a new variety could be released from these lines in 2005. A good range of germplasm has been developed through crossing, both in the U.S. and Bolivia, and some derivatives show potential for resistance to tomato spotted wilt virus in the U.S., and *Aspergillus flavus* (producer of aflatoxin) fungal invasion. A package of improved agronomic practices has been developed by ANAPO researchers to introduce to farmers whose practices are very traditional. These include: 1) planting density, rows closer together and more plants per meter of row, 2) one pre-emergence and one post-emergence herbicide spraying based on weed species and growth intensity, 3) one or two fungicide sprayings based on disease and intensity of inoculum, and 4) zero tillage technology for sustainable peanut production. Prototypes of small-scale machinery for digging, threshing, and sorting peanuts have been developed with support from the Peanut CRSP, and demonstrated to farmers during field days. A National Peanut Program and a Peanut Seed Production Program are in place in Bolivia due to the support of the Peanut CRSP, and the government has recognized ANAPO as the national reference institution for peanut research and development. A consumer's survey showed a lack of commercial processors; peanut soup preferred by 70% of the respondents is generally produced in the home with traditional recipes; and roasted and salted peanuts are desirable. Most peanuts are consumed in the first six months after harvest. This shows the potential for processing to expand the farm production potential.

TAM 17P. Breeding peanut for better productivity and quality

The development of genetic markers for improvement in breeding for resistance to diseases, insects, and biotic stresses has been important to Texas and the U.S. The release of the nematode resistant variety "Nematam" will be important to Southwest U.S. peanut production. The success in the development of high oleic/low linoleic acid germplasm/ varieties is important to the U.S. industry, and a new variety with this trait was released in Texas. New cultivars with disease resistance, seed dormancy, and high oleic/low linoleic oil that delays the development of rancidity and increases shelf life are near release in Senegal and Burkina Faso. Continued exploitation of genes from wild species is important for traits not normally found in the cultivated species. TAM 14 was closed with the retirement of Dr. Charles Simpson, Texas A&M University/College Station, but some of his objectives will continue in this project, i.e. use of wild species.

NCS 19P. Improved production efficiency through standardized, integrated, and enhanced research and technology

In Ghana, the research has developed good survey data on the major pest problems, conducted loss assessment studies, evaluated more than 30 lines of peanuts, conducted trials on control methodologies, including local soaps for leaf spot suppression, and involved participant farmers in peanut/groundnut IPM schools. The most important constraints identified include diseases (leaf spot, rust and rosette), which cause 50-70% yield reduction; soil pests, and weeds. Disease control using local soaps has been effective in reducing losses. Millipedes and termites are particularly important in that pod boring and scarification predisposes pods to invasion by *Aspergillus flavus* that produces aflatoxin. Chlorpyrifos and Furadan have been used to control soil pests. Both are effective, but costs and toxicity consideration favor use of Chlorpyrifos. Marked yield increases have been achieved, two-fold in some cases. This has stimulated production, research and extension. Incomes have been raised; one woman farmer had managed to build a new house and another farmer had managed to buy a new vehicle.
In North Carolina, screening trials and evaluations have been completed for thrips, potato leafhopper, Southern corn rootworm, and tomato spotted wilt virus resistance, and a number of germplasm lines showed some levels of resistance. Pest survey and crop loss data has allowed evaluation of production constraints and interventions have been implemented.

UGA 28P. Control Strategies for peanut viruses: transgenic resistance, natural resistance, and virus variability

The long-season rosette-resistant variety Nsinjiro (ICGV-SM 90704) has been released for use in Malawi. ICG 12991 was released in Malawi as Baka in 2001. ICG 12991 is a short duration (90-110 days to maturation), drought tolerant Spanish-type groundnut earmarked for both rain-fed and residual moisture groundnut production. Over 3 tons of Baka has been multiplied and made available for commercial production under both soil moisture conditions. In Malawi in four years of testing, ICGV-DM 99568 (a short-duration, rosette resistant line) has potential in that it is relatively large-seeded, relatively more stable irrespective of soil moisture status, hence preferred by many farmers. Rosette incidences were low to moderate, ranging from 5-30%. In Uganda ICG 12991was released in 2002 as Serenut 4T (tan-seeded), and ICGV-SM 93530 has been released as Serenut 3R (red-seeded). Seed are currently being multiplied.

In the U.S. the transformation work done has provided new technologies for improving the transformation success rate and should be of benefit for some time to come. This should speed up the transfer of useful genes, and consideration should be given to adding genes to this list. TSWV, nematode resistance, etc. should be on the list. Since 2001, the transformation protocol has been refined that resulted in the generation of a number of transgenic plants carrying the viral sequences for resistance induction. Transgenic plant verification has been by PCR, showing the presence of the transgene in genomic DNA. Northern and Southern blot analyses were conducted. Fifteen transgenic lines are going through a seed increase in the greenhouse. This seed will be used for seed multiplication in the field in 2005. Subsequent seed will be tested for field resistance in the future. Up until 2004 the coat protein gene of GRAV was introduced into AT 120 and Georgia Green, as well as the N gene of tomato spotted wilt virus into Georgia Green. This approach requires a large number of transgenic plants to obtain a few that have high levels of resistance. Resistance being the induction of RNA silencing: the specific degradation of the viral genomic RNA. In 2004 AT 120 and Georgia Green were transformed with RNAi constructs of the GRAV coat protein gene and TSWV N gene. The RNAi technology takes a quicker, more direct and efficient route to silencing-induced resistance. RNAi technology has been shown to be highly effective in the laboratory and will be equally effective in applied situations. With the RNAi approach less transgenic plants need to be generated because the percentage of transgenic plants showing resistance using RNAi are high (generally over 80%).

Improved transformation techniques are resulting in greater recovery of transgenic plants with better fertility. This has improved efficiency, and speeded up progress. The introduction of TSWV resistance has resulted in a wider range of TSWV-resistant germplasm with potential spin-off for U.S. farmers. Future possibilities include the development of transgenics with resistance to foliar fungal diseases, particularly leaf spot.

UFL 52P. Development of sustainable peanut production technologies for Amerindian villages in the Rupununi region of Guyana

New technologies (increased plant density in particular) have resulted in a dramatic increase in peanut production in the Rupununi region, from 300 farmers and 400,000 pounds in 2001 to 700 farmers and an estimated 1.5 million pounds in 2004. Much of the yield increase has been from increased area planted and brush clearing on land that can have negative environmental impacts. The increase in production has exceeded markets and discouraged farmers. In Guyana women are not generally involved in farming, although a few of the larger growers are women (who produce about 30 ha). Individual farmers generally cultivate from 1-3 ha. The research is directed towards increased use of soil amendments, better cultivation practices, and improved varieties (some improved varieties that appear to be adapted have been identified). The farmers are receptive to the new potential for peanut production and the information that the Peanut CRSP will contribute. Attention developed to find ways to utilize the over production of peanuts, with active collaboration between the local collaborator, Beacon Foundation. Equipment for roasting and grinding has been improved, and require a labor intensity that will employ available labor. Women's groups have been trained to use the improved peanut butter processing equipment. Also, labor saving production devices have been acquired and demonstrated, such as planters, diggers, shellers. Women have played a major role in the market-pull efforts that can absorb the over-production, who will be trained in workshops. The demonstrations have introduced the use of the shelling, roasting, de-skinning, and peanut butter grinding technologies. A school lunch feeding program has been identified as a major sales outlet for the peanuts. The making of cassava bread has been demonstrated, and will be sold in the school lunch programs with the peanut butter.

The Beacon Foundation, Peanut CRSP and USAID/Guyana has been supporting development of aflatoxin certification capacity of the Food and Drug Authority in Georgetown, and the training of Guyanese entrepreneurs in improving their products, using best manufacturing processes, and quality control. Traders from Georgetown have shown interest in purchase of peanuts and products from the Rupununi region, which resulted in a 20% increase in net return, but are hampered by poor roads and distance to the production areas. Farmers are being exposed to new technologies through field days and technical workshops along with surveys, which were conducted in 2002 and 2003. Trials and workshops were held in five villages in 2004. There is a high interest in the development of cottage industries to produce peanut butter and cassava bread for school lunch programs. This effort developed into seven villages that were involved in an initial effort to implement the program. Partnerships with Beacon Foundation, USAID, the National Research organizations (NARI and MFCL), Canada through CFLI, women's support from Farmer to Farmer and Partners of the America's organizations and possibly the World Bank all may contribute to the expansion of the school lunch program to many more villages in the Rupunui region.

NMX 53. Valencia peanut breeding for high yield, early maturity, and resistance to fungal diseases, and good quality

Valencia type peanut is the major type for production in both New Mexico and Bulgaria, which has contributed greatly to successes in this project. A good range of Valencia lines were assembled for evaluation in Bulgaria and Bulgarian lines were brought to New Mexico for evaluation. Some new Valencia material appears to be performing well in Bulgaria, but the growth cycle may be too long. In Bulgaria, U.S. Valencia cultivars were compared to Bulgarian cultivars including the standard check variety-Kalina; characteristics assessed included maturity, yield and fungal disease resistance. U.S. accessions were later maturing than Kalina and were also lower yielding (Kalina 4824 kg/ha and the best U.S. cultivar Sunland 3591 kg/ha). *Fusarium* was the most important disease followed by *Alternaria* and *Phyllosticta*. Expertise in processing and food technology of this type peanut in the U.S. will be of benefit to Bulgaria (through cooperation with UGA 11 project).

In the U.S., a good range of Valencia lines has been assembled for evaluation in New Mexico. The Sadova lines are performing well in the New Mexico, however, they are 2-3 seeded (usually 4 in U.S. Valencia's, commonly known as "ball-park" type marketed as roasted in-shell), shorter in stature, and earlier maturing than U.S. types. However S3663 is performing well in the U.S., and has been tested and now grown by a farmer in Nebraska.

Crosses have between NM Val A and C, and Kalina and Rossitzka have been made and tested in Bulgaria and the U.S. Molecular biology techniques and use of cluster analysis has given insight of germplasm grouping, which should help in identifying more widely differing genotypes for hybridization. The U.S. principal investigator, Dr. Naveen Puppala, has benefited by the contact and interaction with Dr. Stanko Deliostadinov the Bulgarian collaborator, because his experience and competence. Dr. Deliostadinov had limited international contact for many years because of travel restrictions, and has greatly benefited from his work with Dr. Puppala and the Peanut CRSP.

FAM 51P. Biochemical and molecular responses of peanut to drought stress and their role in aflatoxin contamination

The project has evaluated a wide range of germplasm and identified a number of genotypes having tolerance to drought. Biochemical responses in these have been characterized. Drought-susceptible genotypes have also been identified, and these include a range of recognized varieties. Both these findings have contributed to the development of improved techniques for selection for drought tolerance. Marker genes will have high potential impact for improvement in drought tolerance both in the U.S. and the host countries. The primary collaboration has been with a university in Bangladesh, but cooperative work has developed with universities in India and with ICRISAT/India.

UCN 36. Socioeconomic impacts of alternative peanut production and marketing systems in Senegal

Interaction with L'École nationale d'Économie appliquée (ENEA) enabled them to practice better collection and use of farm data, including the use of modern coding and data entry techniques. This process became repeatable on a yearly basis and the focus shifted to a more rigorous system of data analysis. This new capability of staff for data management has been significant and used by the staff to increase the production of technical papers to disseminate the results to policy makers. The resulting papers encompass a range of topics, including the impact of technical innovation through the use of new peanut varieties, the pricing and marketing of agricultural products (peanut), optimizing farm planning and poverty levels, technical efficiencies in peanut production/processing, and a range of descriptive analyses.

In the U.S., the project team gained additional experience in collecting, managing, and analyzing data in situations with developing country conditions imposed. This enhanced capability would be transferrable to other countries in the region. This growth in experience has extended to other departments at the University of Connecticut.

B. Processor values (post-harvest and utilization sector)

UGA 01. Extrusion cooking of peanut meal in the presence of lysine to deactivate aflatoxin and improve nutritional quality.

Research has focused on the examination of aflatoxin detoxification during extrusion cooking incorporating clays and other agents to eliminate aflatoxin in foods, and examining ways of inactivating the allergenic potential of peanut proteins. Progress has been made with studies at the University of Georgia during a short-term training period with Dr. F.K. Saalia, Ghana collaborator. There is a need to evaluate the aflatoxin degradation products to determine their toxicological properties, if any. Apparent protection of aflatoxin by lysine when co-extruded rather than destruction was unexpected, and binding with clay during extrusion was less than a solution. Interesting findings have been the bioactive proteins in peanut meal and attempts to prepare hypoallergenic peanut butter from extruded peanut flour, but levels of reduction in allergens, resultant peanut butter quality, and clinical trials are not yet determined.

UGA 04. Development of peanut post-harvest handling and processing technologies for the food industry

The 2001 consumers' preference survey in the Philippines showed that peanut butter was the best-liked product; 66% preferred stabilized peanut butter, and over 90% of respondents were willing to pay more for Vitamin-A fortified peanut butter. Eight new and improved peanut-based products were developed and/or commercialized in the Philippines in partnership with medium-sized private food industry and micro-and small-scale enterprises, mostly owned by women, and farmers cooperatives: 1) natural and stabilized peanut butter (new), 2) Vitamin-A fortified peanut (commercialized), 3) chocolate peanut spread (to be commercialized), 4) peanut-based sauces such as “satay” and “kare-kare” sauces (aflatoxin-free products from hand sorting for removal of contaminated peanuts from producer manufacturing process), 5) peanut praline (commercialized), 6) chocolate peanut bar (commercialized product improved), 7) garlic flavored roasted peanuts (commercialized), and 8) peanut “polvoron” (new and optimized). Improved processing methods for the optimization, sensory profiling, packaging, and shelf-life testing of these peanut-based products was standardized with assistance from the U.S. principal investigator. Collaborating scientists, industry groups, and micro/small business entrepreneurs, who were mainly women, were trained successfully on these processes. These techniques are already adopted by the Philippine participating institutions; including the food industry, cooperatives, and grassroots business organizations (micro- and small-scale enterprises). Workshops, training sessions, and publications were means of technology transfer. Publications were used for technology transfer, such as a manual on hand-sorting technology for aflatoxin removal from peanuts that has significantly reduced aflatoxin content of peanut-based products.

In the U.S., six new/improved peanut-based products were developed and some are being considered for commercialization by a Georgia-based food company (Bell Plantations, Inc.): 1) resveratrol-enhanced peanuts, 2) peanut butter from resveratrol-enhanced peanuts, 3) cheese-flavored cracker coated peanuts, 4) caramel-flavored cracker coated peanuts, and 5) chocolate flavored peanut spread, and 6) roasted peanuts. The chocolate flavored spread was introduced from the Philippines, tested with a private company, and a corresponding product developed and optimized with consideration of the preferences of the American consumer. One U.S. patent for resveratrol-enhanced peanut is provisional and will be final in May 2005.

UGA 11. Development and transfer of peanut technologies in Bulgaria.

The Bulgarian scientists at ICFT (Institute of Cryobiology and Food Technology) have developed and tested six peanut-based products acceptable to Bulgarian consumers, based on an earlier Consumers’ survey carried out in the 1996-2001 phase: 1) peanut butter breakfast tart, 2) low-fat peanut-flour based beverage as a substitute for cow’s milk, 3) peanut snacks, 4) sugar and honey-coated peanuts, 5) honey roasted peanuts, and 6) peanut butter formulations with fructose, Sweet n’Low, and chocolate. This work utilizes the pilot/processing plant established in the previous phase with Peanut CRSP support. ICFT researchers have been trained at the University of Georgia to continue product development and testing to better understand the properties of locally developed peanut products, and to better utilize equipment placed in Bulgaria for determining physical, chemical, nutritional, functional, microbiological, and sensory characteristics. This has allowed the further development of peanut products acceptable to Bulgarian consumers.

NCA 32U. Development of value-added products from peanuts and aflatoxin detoxification

Two high-protein snacks from defatted peanut flour were developed and tested in the U.S. and Senegal: 1) cookies, and 2) chin-chin (a West-Africa snack). Substitution of up to 40% roasted-defatted peanut flour yielded snacks that were most acceptable to consumers. The West Africa test panel gave higher acceptability ratings to peanut-based snacks especially chin-chin compared to U.S. test panels. The high protein-low fat products have positive health implications. Peanut milk from defatted peanut flour is being developed in Senegal by collaborating researchers for testing for acceptability by Senegalese consumers. Assessment of the level of aflatoxin contamination in peanuts and peanut products in Senegal, through sampling, was carried out. The results provided baseline data on health risks to consumers and provided guidance on ways to reduce aflatoxin especially at the village/small-scale processor level.

OKS 55U. Use of chemoprotection in product development to improve safety and production of peanut products in Ghana

The development of formulations and processing protocols for the five peanut products selected by a survey of Ghana consumers has been completed. The products were formulated to include HSCAS clay (Novasil) that adsorbs aflatoxin in the digestive tract. A local cocoa processing company in Tema, Ghana will collaborate in processing, which will allow processing of large volume of products for the human feeding trials. Use of the clay in food products is based on Texas A&M and Texas Tech studies that showed that up to 0.60% clay has no adverse physiological effects on rats (TAM 50). Collaboration is in place with the KNUST collaborator with Noguchi Memorial Institute for Medical Research and the University of Ghana to study the effects of HSCAS clay-supplemented peanut foods of humans exposed to high levels of aflatoxins (TAM 50). Studies in the U.S. have shown that the clay additive to food of up to 0.25% has no effect on texture or flavor and that rancidity and off-flavors are delayed. A finely ground clay in needed to prevent and unacceptable mouth feel. Use of the peanut products with clay for human studies in OKS 55 must await the outcome of the TAM 50 human trials described above.

C. Consumer values (food safety and nutrition, socioeconomics and policy)

UAB 56. Aflatoxin impacts on immune systems.

Aflatoxin B1 adduct levels in plasma and aflatoxin M1 in urine were determined. Additionally, vitamin A and E levels in plasma, hepatitis B, C, and HIV status, as well as cellular immune functions and hepatic functions were determined in a well-defined study group in Ghana. Analysis has been carried out to look for correlations of aflatoxin with both clinical and socioeconomic factors.

This was the first study that has addressed several critical health issues related to aflatoxin consumption; results are as follows. 1) This was the first study that reports on the levels of aflatoxin biomarkers (AFM1 in urine and AFB1 albumin adducts in the blood) for people in the Ashanti region of Ghana, which established a baseline for future research and for intervention studies that address reduction of aflatoxin intake and build-up in humans. 2) This study showed that several variables such as ethnic group, the village in which participants live, and the number of individuals in a household were significant predictors of AFB1 levels. Furthermore, it was established that the association between ethnicity and participants in a village with high AFB1 levels can be explained by food preference, sorting of aflatoxin contaminated peanuts and maize, and preparation practices by the different ethnic groups and the proportion of different ethnic groups living in the villages. This study clearly identified factors that can be targeted, by interventions specifically designed to reduce aflatoxin exposure in people in the study area. 3) The levels of hepatitis B and C infection were measured in the study group. This was the first report of hepatitis C infection rates in this region of Ghana. It has been established that hepatitis B works synergistically with aflatoxin to increase the risk of liver cancer in humans. The high risk of both hepatitis B and C infections and aflatoxin in this region is significant information that will be useful in establishing the relationship between these infections and toxic agents and development of liver cancer and other liver problems. 4) This was the first study anywhere in the world in which flow cytometry measurements of cellular immune status in relation to aflatoxin levels have been conducted. The report of the proportions of leukocytes found the deficiencies in subsets of lymphocytes and monocytes and in monocyte function is the first evidence of the association of high aflatoxin levels and changes in cellular immune status in humans. 5) This study reports on vitamin A and E deficiency in a population with high aflatoxin levels. It found a strong positive correlation between vitamin A and AFM1 levels and an association between high AFB1 levels and low levels of vitamin A in blood. The high level of micronutrient deficiency among study participants concurrent with high AFB1 levels could contribute to unfavorable health outcomes.

PUR 10. Effects of peanut consumption on hunger, ingestive behavior, energy expenditure, and coronary heart disease risk

Research is underway in the U.S., Ghana, and Brazil to confirm preliminary research that approximately 17% of the energy from whole peanuts was lost in the stool, with 7% lost in peanut butter, and 4.5% in peanut oil. If this data is confirmed, peanuts may be included in the diet with little impact on body weight, and further supports the conclusion and FDA claim that peanut consumption is associated with reduced cardiovascular disease risk. Research on the consumption of oils did not show effect on appetitive responses, but whole peanuts tended to satisfy the appetite which suggests that other fractions of the nuts other than lipids are responsible.

In the U.S., HDL-cholesterol/LDL-cholesterol ratios changed in a favorable direction, i.e., towards lower cardiovascular disease risk. In addition no significant weight gain was observed, that was consistent with findings from whole peanuts and supported the recommendations that peanuts may be a healthful component of the diet.

In Brazil, the data suggest that peanut oil had no effect on the cholesterol components and did promote weight gains Additional findings with peanut oil show that this nutrient does not hold stronger satiety properties than other oils rich in monounsaturated or polyunsaturated fatty acids; while significant dietary compensation (45-50% of energy) was observed, daily energy and fat intake were significantly increased with addition of oils to the diet; no differences were observed between countries. In another study, the effects of chronic peanut consumption on diet composition as well as serum lipid, magnesium and homocysteine concentrations in free-living subjects were examined. The results showed that regular peanut consumption lowers serum triacylglycerol, augments consumption of nutrients (tocopherol, copper, arginine, and fiber) associated with reduced CVD risk and increases serum magnesium concentration (risk of CVD increases with low magnesium content); i.e., regular peanut consumption can lead to dietary and biochemical changes associated with reduced CVD risk. New studies are comparing peanut consumption patterns, "with meals" specifically lunch, versus "as snacks," relative to optimal uptake pattern(s) and energy balance. In the peanut meal treatment, hunger during the 2-hour post-lunch interval was suppressed, which suggests peanuts can reduce overall snacking. Snacking prevalence in the U.S.A. adult population has risen 77% to 84% from 1977 to 1996. Mid-afternoon is a common snacking time, therefore including peanut snacks (which have been related to a lower Body Mass Index) in the diet may reduce subjective ratings of hunger and in time reduce Body Mass Index.

UGA 22. Systems research to access risk of preharvest aflatoxin contamination and to develop technologies to reduce aflatoxin contamination of peanut

In Mali, the achievements since 2001 have been somewhat limited due to changes in leadership of the project as well as the redirection and refocusing of the experiments. However, an initial analysis based on data obtained from Mali, has shown that there was scope for the development of an early warning system for aflatoxin risk based on remote sensing and ground observations. In 2004, post-harvest aflatoxin levels were determined for peanuts stored in granaries in several locations in Mali. Initial analysis was done to determine the changes in *Aspergillus flavus* levels and aflatoxin concentrations over time in relation to the environmental conditions of the granaries. An analysis of the relationships between AVHRR satellite information for West Africa, local yields, and local weather showed a correlation between local weather conditions and aflatoxin levels. But more data would still be required to develop an aflatoxin risk early warning system.

UWI 49. Genetic approaches to eliminate aflatoxin contamination of peanuts

In the Georgia-Botswana component of the project, a simple screening method for determining aflatoxin was developed, which used the VICAM column system and replaced the affinity column with a low-cost alumina-based column which can be made with low cost in-country materials. Using acetone extraction, bromination and fluorescence measurement a limit of detection of 5 ppb for total aflatoxins has been achieved and 300-400 samples can be analyzed per day. The approach needs validation. The use of a silica-based material (Protect-It) for use during storage of peanuts to reduce insect damage was studied. The sharp material acts by penetrating the insect shell of hard-bodied insects. The effectiveness of this material has been demonstrated in Botswana and more work is required to get more widespread acceptance.

At the University of Wisconsin, work was at the molecular level examining the genes controlling aflatoxin synthesis and the symbiotic relationship between the fungus and the peanut plant. The project examined factors that influence the switch-on of genes for aflatoxin production and the extent which plant/fungi interactions can be controlled. Key genes in the peanut responsible for the release of oxylipins have been identified, and the role of fatty acids in these interactions, were being investigated. The results of the project were helping to build a clearer picture of the complex biosynthetic pathways involved in aflatoxin production, and the interaction that occur between fungus and plant. It was found that oxylipins (e.g., oxygenated fatty acids including the peanut seed defense compound 13 and 9 HPODE, *Aspergillus* endogenous compounds, psi factor) appear to act as ligands signaling fungal sporulation and, depending on which oxylipin is present, aflatoxin. The work could ultimately help direct construction of bioengineered plants resistant to fungal attack or not triggering aflatoxin biosynthesis, or the development of novel fungicides.

TAM 50. Sustainable enterosorbent strategies for the protection of African populations from aflatoxin

This project initially focused on research in the U.S. to further confirm safety and the minimal effective dose of NovaSil (NS) clay prior to a Phase IIa study in the host country, Ghana. The safety of long-term dietary exposure to NS clay in male and female Sprague-Dawley rats that were fed rations containing up to 2% NS clay for 28 weeks was determined. Various body organs, tissues, and blood were tested. There were no adverse effects of the NS clay on the rats fed five times the clay needed for aflatoxin protection. Results from this study (and other animal studies) supported the further study of NS clay in dietary interventions for populations at high risk for aflatoxicosis. In a Phase I study in Texas, fifty volunteers (20-45 years in age, 23 males and 27 females) were screened for good health and were randomly divided into two groups. The low dose group received six capsules containing 1.5 g/day, and the high-dose group received six capsules containing 3.0 g/day for a period of two weeks. NS clay capsules were distributed to each participant three times per day. Blood and urine samples were taken before and after the study for laboratory analysis, hematology, minerals, vitamins A and E, and concentrations of selected electrolytes. There was no evidence of increased risk to humans from NS clay exposure at levels up to 3.0 g/day confirming the safety of this material for further studies.

AUB 30S. Production efficiency and market development of peanuts and peanut products for Ghana, Benin, and Bulgaria.

An economic analysis of peanut production, was done by Dr. Nelly Bencheva, collaborator at the Agricultural University Plodiv, following training with, Dr. Curtis Jolly the U.S. principal investigator at Auburn University, Alabama. The goal of the analysis was toward the development of a Business Plan to assist investors in developing an economically viable plan to commercialize peanut production. In general terms, the economic analysis showed that current peanut production was now only carried out on very small farms mainly for their own consumption rather than for the market place. Production was inefficient (low yields), there was little scope for mechanization and there was a move to the use of "own seeds or farmer saved seeds" rather than certified varieties. These changes were a result of the break-up of collective farms from Soviet times and it was difficult to see how this could be reversed as small farms were now in private ownership. It seemed very clear that if there was a 'market-pull' in terms of increased demand from the Bulgarian domestic market or the European Union, it could not be satisfied from domestic production using existing practices. It might be more feasible to establish new commercial peanut production in Bulgaria to deliver efficient and cost beneficial supply than to attempt to reverse the changes that are 'fait accompli'. Peanut production in Bulgaria, as a supply route to the European Union, has the potential competitive advantage of delivering products that are aflatoxin-free compared to other parts of the world, and may be able to produce "organic peanuts" for which there may be a "niche" market in the European Union and for which Bulgaria is uniquely able to deliver.

The project has been working in Ghana and Benin in addition to Bulgaria. Three workshops were held in Ghana with about 300 people in each case that followed up on the apparent lack of awareness among professionals of the health problems associated with aflatoxin. These workshops have been successful at the local level, and will facilitate the work of UAB 56 and TAM 50 in terms of intervention studies.

VT 54S. Gender issues in aflatoxin incidence and control in groundnut production systems of West Africa

In Senegal, farm level surveys were carried out in 2002 to collect data on farming, post-harvest processing, storage, and health issues related to aflatoxin. The surveys involved first-year students at ENEA as part of their studies. A report was prepared in 2003. Due to slow progress in identifying collaborators, the project was moved to Uganda in June 2003
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In Uganda, surveys were conducted in 2003 and 2004. Farm level and market surveys showed low levels of aflatoxin contamination immediately after harvest and drying. However, processed peanuts on sale in urban market centers contain aflatoxin levels of 2-3 times higher than the WHO allowable limits and 10 times higher than the EU standards, an indication that aflatoxin contamination occurs during post-harvest handling and processing stages. Results showed that aflatoxin issues were unknown to a vast majority of Ugandan population surveyed, from university professors to farm families. Only health professionals and agronomists knew about aflatoxin contamination and the health effects. The Ministry of Health and the Bureau of Standards appreciated the results of the market survey that showed high level of aflatoxin contamination of peanut products sold in the local markets.

D. Cross-cutting/training/impacts

NCS 07S. Impact assessment of and socioeconomic contextual influences on adoption of peanut-crsp-supported new technologies

Consumers' survey, in neighborhoods with stores selling fortified peanut butter in the Philippines showed that hundreds of Filipinos (15% of children) began consuming the newly Vitamin-A fortified peanut butter. In the long-term, this would result in a reduction in Vitamin A deficiency in the population, which is widespread especially among children.

A case study of Newborn Foods, Inc., the private company partner involved in the production of Vitamin A fortified peanut butter, showed that since its brand is the second largest selling brand of peanut butter in the market, the decision to fortify all its peanut butter produced could have impact in the consuming public, especially children. It also showed that while, a number of additional six employees had to be hired, increased costs were minor compared to the sales increase and the generation of employment that occurred.

A case study of Marigold Commodities, Inc., another private company that adopted sorting technology to eliminate aflatoxin, showed that after being allowed to export "kare-kare" sauce containing peanut to the United States, its share of 'kare-kare" export sauce increased from about 10% in 1999 to 45% in 2001. Also, 17% of Filipino households surveyed consumed the improved sauce that is aflatoxin-free (hand sorted peanuts used in sauce), making a healthy peanut product available widely in the domestic and foreign markets.

In Thailand, plans were made in 2004 to measure the impact of six food technology workshops conducted by the Peanut SATT (Southeast Asian Technology Transfer) Center at Kasetsart University in 2003. Workshop participants were interviewed and site visits were carried out to check the application of skills and technology obtained from the training. Pre-test and post/test information of participants was analyzed to assess immediate new knowledge gained. The questionnaires were designed to incorporate relevant questions in the following areas; demographic information, farming practices, quality, post harvest practices, aflatoxin contamination, and products produced especially peanuts. Mail surveys, telephone interviews, and one-on-one interviews with individuals were made within six months after training. Also, one-on-one interviews were made with three cooperatives – Supachai, Nongno, and Poe Tak and one company at Pitsanuluk. Among other impacts, results indicated that despite some increase in costs and labor, the adoption of the sorting and processing technology enabled the cooperatives and company to significantly improve the quality of their production and subsequently their sales. The members of the cooperative groups had a better life and had time for their family. Technologies gained in the course enabled them to produce good quality, aflatoxin-free products with tastes acceptable to consumers. Positive impacts were noted on the Thailand economy. People not involved in peanut production gained more knowledge on sorting technology, peanut production technology, peanut processing technology, and analysis of aflatoxin, which they shared/transferred to friends, extended family, their students, and others, particularly knowledge about aflatoxin. The study also suggested that peanut processing technology was feasible under the appropriate conditions and should be considered by other cooperatives and companies.

An annotated bibliography of over 200 publications from the Peanut-CRSP-funded research in North Carolina was completed and posted in the Peanut CRSP Website (Peanut CRSP.org).

Preliminary results of a North Carolina peanut farmers' survey showed that of Peanut-CRSP-developed integrated pest management (IPM) practices, weather based advisory for IPM adoption was preferred by farmers with a usage rate of 43-52% in 1999-2003. Of the Peanut-CRSP-developed varieties, American farmers preferred NCV 11 and NC 12C, which showed consistently adoption rated of about 40% in 1999-2003. Perry peanut variety reached this rate in 2002-2003.

VT 09. Analysis of response of peanut production in French West Africa: Policy implications of currency devaluation

The economic analysis methodologies tested/used in the project, especially the poverty index analysis and experimental analysis of environmental benefits, were very good products of this project. These could be used in determining economic impact of Peanut CRSP technologies (i.e., resistant varieties, processing technologies, peanut-based food products) in other world regions where Peanut CRSP had worked for a long time. The policy recommendations resulting from analysis of the data sets collected from selected West African countries would be useful for policy-making and decision-making at the top level of governments. The conclusions would have implications for the West African region.

UGA 05. The world geography of the peanut: Global networking approach to social equity, environmental protection, and technology exchange.

The major outputs from the project are development of the web site entitled "World Geography of the Peanut" and the studies of peanut production systems, utilization, and socioeconomics in specific countries. The web site contains a wealth of information that would be useful to any person seeking information about peanut production and utilization throughout the world. This was a unique and very worthwhile contribution of the Peanut CRSP, education and outreach. The country studies provide excellent, in depth information about peanut production systems in specific countries. These studies are a highly useful compilation and synthesis of existing data and information. The information on aflatoxins is particularly important to health workers.

UGA 37. Training for Southeast Asia.

New and improved post-harvest and processing technologies were introduced to Thailand nationals and Southeast Asian individuals (researchers, extension workers, private processors), and women and men small-scale processors through training. The technologies include the manual sorting of peanuts to reduce aflatoxin contamination, use of Elisa kits for quick analysis of aflatoxin in peanuts, post-harvest storage technologies, and other situations, which would benefit the local food industry and consumers. A significant feature of the training is that it occurs at the village levels and at Kasetsart University. A specific impact of this project was reported above in an impact study conducted by NCS 07S.

UGA 38. Long- and short-term training for host country scientists

This project was not used for disbursing funds for training during this phase.

UGA 39. Program support

Minimal funds were allotted to this project in this phase.

UGA 40. International collaboration

The International Arachis Newsletter was published in collaboration with ICRISAT. A Peanut CRSP Newsletter was published on the web site. The web-based data/project reporting site has facilitated communications with the host country scientists. Support of the attendance of host country participants to the Georgia Peanut Tour has been valuable to the attendees. Web based communication has simplified program fiscal and programmatic management, and has enabled the project investigators to devote more time to research and student training.

UGA 41. Management of the Peanut CRSP

The management philosophy consists of several elements: 1) minimize the administrative burden on principal investigators and the management entity; 2) minimize duplication in reporting accomplishments; 3) making reports and transactions transparent to all; and 4) greater devolution of project responsibilities to principal investigators.

The Peanut CRSP was governed by a 14 member board of directors and a five member technical committee, with advisory members including the USAID program officer and the BIFAD representative. These groups gave programmatic and fiscal advice.

The management entity was dedicated to effective transfer of new discoveries to researchers, producers, processors, and policy makers. There were a number of significant technology transfer activities that resulted in utilization of new peanut varieties, better methods for pest control, better processing methods, and prevention of aflatoxicosis.

CHAPTER 26. IMPACTS OF THE 2001-2007 GRANT

A. Producer values (production efficiency in grant)

A new variety, Mairana, was released in Bolivia. The UFL 16P project has already resulted in increased peanut production, which was expected to stimulate the development and growth of a local peanut industry. The area planted to peanut has increased from 2,000 hectares in 2001 to 11,000 hectares in 2004, and productivity has increased from less than 1.0 metric ton/hectare to 2.0-2.5 metric tons/hectare. Most farmers are small scale producers with from 1-5 hectares per farm. Two varieties from this project have already been entered in UPPT tests in the U.S. for two years, and may result in variety a release in 2006.

The variety, "Nematam", was released in Texas under TAM 17P and was resistant to nematodes.

In Ghana through NCS 19P, farmers that have adopted IPM technologies have increased yields two-fold and there is still room for improvement. The doubling of yield by farmers in Ejura was impressive after just two years of working with farmers. The surveys and documentation of yield loss to various pests and the development of appropriate technologies to manage these pests were well targeted and will continue to pay numerous dividends. Adoption of improved production practices such as careful site selection, minimum tillage using herbicides, seed selection, planting in rows, and IPM practices have led to reduced labor requirements and marked increase in yields and profitability of peanuts. Prices paid for groundnuts (C 700,000 per bag) appeared quite attractive compared to C 350,000 per bag for maize.

In North Carolina under NCS 19P, farmer/extension adoption of the tomato spotted wilt virus (TSWV) index has reduced virus incidence by 50% in a single year. Since adoption of the TSWV index there has only been one year of significant virus incidence. Also, the farmer/extension adoption of the Southern corn rootworm (SCR) advisory index has reduced SCR damage by 50% per year. The SCR treatment of preventive applications of insecticides on a vast portion of the acreage has been reduced to only those acres that are "high risk." This was made possible through an advisory program supported by the Peanut CRSP research.

In Malawi, rosette virus disease resistant ICG 12991 was released as Baka in 2001 with support of UGA 28P. Baka is a short duration (90-110 days to maturation), drought tolerant, Spanish-type groundnut earmarked for both rain-fed and residual moisture production. Over 3 tons of Baka has been multiplied and make available for commercial production both under rain-fed and residual moisture peanut production. However, many farmers expressed reservation to grow Baka, because it small-seeds are difficult to hand-shell.

In Uganda, the rosette virus disease resistant ICG 12991 was released as Serenut 4T in 2002 through UGA 28P. Rosette-resistant varieties were desperately needed for many countries in Sub-Saharan Africa. Potential savings were estimated to exceed $40 million in Malawi and Uganda.

In Georgia, 15 transgenic plants with resistance to GRAV and TSWV were going through seed increases for future field studies. Numerous other transgenic plants tested positive by PCR for the presence of the transgene, and seed increase for further testing was planned under UGA 28P.

In Guyana, peanut production was increased three-fold early in the project phase of UFL 52, largely from expanded area; improved varieties, soil amendments, and better cultivation practices were being studied. The increased production has depressed prices. The Peanut CRSP demonstration of peanut butter processing equipment, and training in 2002-2003 and 2004 has led to initial programs in 5 villages, later 7 villages, to produce peanut butter and cassava bread for sale in school lunch programs supported by the Government of Guyana. Labor saving field equipment has been introduced to farmers. Aflatoxin testing and removal procedures are being developed in cooperation with USAID/Guyana. These initial impacts are significant, and promise to grow, since there is local interest to expand the school lunch program to all the villages in the Rupununi region. The market-pull concept utilized led to an outlet for increased production by farmers and increased prices for processors.

In Bulgaria under NMX 53, improved pest and disease resistance should reduce the use of pesticides and risk of environmental degradation. Cooperation with UGA 11should help expand production, through the expansion of the processing and marketing of peanuts. In the U.S., the Bulgarian lines should introduce disease and pest resistance through hybridization, with increased yields and quality. A Bulgarian variety has already been adapted and grown by a Nebraska farmer.

The potential impact of the Peanut CRSP support to ENEA through UCN 36 goes beyond the demonstrated effects on the data collection process and the subsequent outputs, and the professional growth of the researchers involved. The collaborating linkages between the scientists will potentially become the foundation for future technique and technology transfer between the host country and the U.S. and also between and among the several countries in West Africa. That linkage and institution-to-institution familiarity can also sustain the flow and increase in graduate student education when future resources make that permissible and possible. ENEA as an institution, has long been involved in community development, particularly in rural settings. ENEA scientists have come to the conclusion that much effort was skewed towards analyzing the means of development available to rural populations, with focus on processes. But now recognizes the importance of focusing on the people as the center of every development goal.

B. Processor values

Potential impact from UGA 01 presently lies within the realm of peanut allergens and the development of non-allergenic peanut butter, as well as a better understanding of the proteins involved in allergenicity.

Vitamin-A fortified peanut butter was a most significant impact in the Philippines by UGA 04, as shown by the impact study of the Peanut CRSP project NCS 07 in 2004. There was a 37% increase in peanut butter production in the Metro-Manila area. Newborn Food Products, Inc. (Lily's brand peanut butter) that produces 68% of the peanut butter in the Metro-Manila, now only produces Vitamin-A fortified peanut butter that was not available before 1999. The biggest peanut butter producer in the country (Best Foods, a Unilever company) began producing Vitamin-A fortified peanut butter, after market introduction of Vitamin-A fortified Lily's peanut butter, but their product was not in the impact study. The availability of Vitamin-A fortified peanut butter has implication to children's health in the Philippines. The impact study showed that older children ages 7-12 showed highest consumption, followed by children 2-6, which is the most vulnerable age group for vitamin-A deficiency (impaired vision development, and decreases child survival). The use of hand-sorting technology by Marigold Commodities, Inc. for aflatoxin removal improved the shelf-life of products from 6 months to 1-2 years, resulted in about a 30% increase in the volume of domestic sales, and about a 39% increase in the export share of sales of "Kare-Kare" sauce. Export was primarily to the U.S. that had prohibited import due to aflatoxin levels in the sauce produced by the collaborating company Marigold Commodities, Inc. (NCS 07, 2004). In addition, to the sales expansion of new and improved products, the surveys showed increase in employment by the processing industries.

A major impact of the project UGA 04 was the influence on the market-pull concept. The concept was implemented through the Peanut Industry Incubator Model (PIIM), and was demonstrated in the above impacts of Vitamin-A fortified peanut butter and aflatoxin-free Kare-Kare sauce. The essential steps of the PIIM are: 1) survey of consumers to identify desirable products, 2) research to develop new or improve existing product(s), 3) survey companies for an interested processor, 4) sign an agreement with the interested company to participate in studies to develop, process, package, the product, and 5) to market the product after the training program. In addition to Philippine involvement in the present project phase, the work was initiated in both the Philippines and Thailand in the previous phase, which demonstrates that PIIM has application in countries around the world.

The UGA 11 project has strengthened institutional and human capacity for food technology research and development in Bulgaria. The planned impact study for 2005 will show the benefits of Peanut CRSP technologies, especially to consumers and private small- and large-scale food industry enterprises. Development in the food industry will encourage additional farm production, and potential export the European Union, and Eastern Europe in particular where prior to 1989 significant peanuts were exported. The development of a Business Plan is scheduled for 2005, to assist Bulgaria in implementing an effective food processing and marketing program for Peanuts that would also result in increased farm production. New and improved peanut products have been developed and are being extended to the processing and marketing industry for availability to the consumers.

Potential impacts under OKS 55 were the use of clay for aflatoxin decontamination of human foods that were acceptable to consumers. Five peanut products selected in a survey of Ghana consumers were formulated to include HSCAS clay (NovaSil) to adsorb aflatoxin from the digestive tract. Studies in the U.S. showed that up to 0.5% clay had no adverse effects on rats, and that up to 0.25% clay had no effect on taste, texture, or mouth feel. Collaboration was in place for human tests on the food products in Ghana, following the necessary human studies in Ghana under TAM 50.

C. Consumer values (food safety and nutrition, socioeconomics and policy)

The potential impact of UAB 56 work is great and has applicability beyond Ghana where the original studies were carried out. It also supported the work of Peanut CRSP project TAM 50 in Ghana to determine the safe use of NovaSil clay in humans for removing aflatoxin from the digestive tract and eliminating absorption into the body. The health implications of the project results are very positive and lay out the foundation for critical future follow-up health studies in Ghana and elsewhere in Africa, especially where the problems are more intense.

Aflatoxin B1 adduct levels in plasma and aflatoxin M1 in urine were determined in UAB 56. Additionally, vitamin A and E levels in plasma, hepatitis B, C, and HIV status, as well as cellular immune functions and hepatic functions were determined in a well-defined study group in Ghana. Analysis has been carried out to look for correlations with both clinical and socioeconomic factors. A baseline was established for future research and for intervention studies that address reduction of aflatoxin intake and build-up in humans. It was established that the association between ethnicity and participants in a village with high AFB1 levels can be explained by food preference, sorting of aflatoxin contaminated peanuts and maize, preparation practices by the different ethnic groups, and the proportion of different ethnic groups living in the villages. The high risk of both hepatitis B and C infections and aflatoxin in the Ashanti region was significant information that will be useful in establishing the relationship between these infections and toxic agents and development of liver cancer and other liver problems. The report of the proportions of leukocytes found and the deficiencies in subsets of lymphocytes and monocytes and in monocyte function was the first evidence of the association of high aflatoxin levels and changes in cellular immune status in humans. A strong positive correlation was found between vitamin A and AFM1 levels and an association between high AFB1 levels and low levels of vitamin A in blood. The high level of micronutrient deficiency among study participants concurrent with high AFB1 levels could contribute to unfavorable health outcomes.

A major impact of research in PUR 10 was the contribution to a recent U.S./FDA approved health claim for nuts, including peanuts. The FDA approved qualified health claim states: "Scientific evidence suggests but does not prove that eating 1.5 ounces of most nuts, such as peanuts, as part of a diet low in saturated fats and cholesterol may reduce the risk of heart disease." The research supporting this claim began receiving attention near the end of the last phase ending in 2001 in the U.S. where it has been used to promote peanut consumption, which has helped reverse a 5-year (18%) decline in consumption due to the above health concerns. One industry representative states that U.S consumption has increased 13% since this research began, and the impact has been estimated by the industry to be worth as much as $500 million annually.
The project results have attracted considerable scientific, industry, and consumer attention that has vastly expanded the research efforts at other locations on peanut products described in the project objectives. The U.S principal investigator has conducted dozens of media interviews on the study findings and has presented the data at numerous scientific meetings in the U.S. and worldwide. The message that peanuts can be a healthful component of the diet, even in energy-restricted diets, was being widely disseminated. It was translating into stronger consumer demand for peanuts and peanut products as nutritious and healthy foods.

The potential impact of UGA 22 in the West Africa region would be an early warning system that would identify areas that have higher potential for pre-harvest aflatoxin contamination that would allow local governments to take preventive actions for processor and consumers. This should lower aflatoxin consumption by the population.

Potential impacts of UWI 49 were new, low-cost aflatoxin measurements, and potential gene-blocking means of prohibiting aflatoxin production in peanuts in genetically engineered plants.

Potential impacts and benefits from TAM 50 were enormous in being able to economically ensure that food in developing countries has a low risk of exposing people to aflatoxin. The project initially had to focus on research in the U.S. to prove the safety and efficacy of NovaSil (NS) clay before being tested in the host country, Ghana. In summary, from animal and human studies, there was no evidence of increased risk from NS clay exposure from the diet.

Through research under AUB 30, producers, consumers, and processors (male and female) can have increased knowledge of the prevalence and health impacts of aflatoxin. The stakeholders have gained knowledge of interventions that will reduce the impact and prevalence of aflatoxin at the production, post-harvest handling including drying, sorting and processing, and the product consumption stage, along the commodity chain in the host country environments. Host country scientists and peanut producers have increased their knowledge of the impact of aflatoxin on their expectations for gains from releasing increased quantities of peanuts into the markets. By reducing the quantity of aflatoxin-contaminated products in the local market, host countries would be in a better position to reap benefits from increased utilization. The host countries would also benefit from increased utilization of local production for value added peanut products released into the marketplace.

The research conducted under VT 54 in Senegal provided ENEA students and NGO members' skills in understanding health issues related to aflatoxin in peanuts. The research in Uganda was starting to show initial impact especially from the health aspect. It was expected that reduction of aflatoxin level of peanut on farm and in the market, and processed peanut products in the market would result in overall health improvement of farmers and other consumers. Attainment of this impact would require active participation of more farmers, traders, small-scale processors, private food industry, and public and private extension providers. Peanut CRSP activities in Uganda created greater awareness by farm level population and government staff in the Ministry of Health (on health risks of aflatoxin and health benefits of reduction in aflatoxin exposure), the Bureau of Standards (effect of aflatoxin on food safety), and the Ministry of Agriculture (on farm aflatoxin contamination) from the results of various surveys carried out in 2003 and 2004. For example, the Ministry of Agriculture has hired an M.S. graduate to fill an Agriculture Inspector position. Main beneficiaries in Uganda are farmers and small-scale processors who are mainly women, traders, private medium-scale processing business enterprises, and eventually consumers because of the availability of aflatoxin-free peanut and products. Of interest in Uganda is the link with the National Association of Women' Organizations in Uganda (NAWOU) and their sub-organizations, which has helped access women processors and farmers, and also households for providing aflatoxin and health information, which strengthens the gender related aspects of this project.

D. Cross-cutting/training/impacts

The NCS 07 project improved the awareness of participating food industry companies in the Philippines that there were significant benefits to consumers, especially children, as well as increased economic benefits to themselves, in producing Vitamin A-fortified peanut butter, and aflatoxin-free peanut-based products. It also showed the spill-over to other companies that are now willing to produce similar healthy and safe commercial products. Potential impact of this project was the stronger commitment from policy-makers and high-level government decision-makers once they understand the actual benefits derived from Peanut-CRSP technologies and collaboration in the country. Impact data would provide them with information to facilitate transfer of responsibility for funding and sustaining of initiatives started by the Peanut CRSP. From the research, the food industry should be encouraged to enhance commercialization of Peanut CRSP technologies within the private sector with their own funding and facilitation, a sustainability consideration.

In North Carolina, economic analyses by the NCS 07 project showed the widespread farmer acceptance and economic benefits of peanut IPM practices, and they preferred weather-based advisory for adoption (usage rate of 43-52% from 1999-2003). Also, new peanut varieties (NCV 11 and NC 12C) had an adoption rate of about 40% from 1999-2003; Perry peanut variety reached this rate in 2002-2003. These technologies were produced by the Peanut CRSP collaboration.

The following potential impacts were developed by VT 09 as a result of various policy studies: 1) Policy decisions soon to be made in West African countries, including Senegal, whether to join in an economic partnership with the EU or to enter into a Generalized System of Preferences; the latter is better for the groundnut sector; 2) Breeding research could result to potential savings of about USD 47 million by using Peanut CRSP developed rosette varieties in Uganda; 3) In groundnut producing areas of Uganda, poverty could be reduced by 1.3% resulting from the adoption of Peanut developed rosette resistant varieties; 4) Results of aflatoxin research in Senegal could result in potential savings of about USD 4.0 million, to confectionary groundnut producers, not including health benefits.

The potential impacts from UGA 05 were primarily to provide information regarding the world peanut production sector in an easy to access, user-friendly, and understandable format. A wide variety of users find the web site and country studies very helpful, since this was a “one-stop” location for most of the significant information on peanuts.

There has been an increased capacity of researchers in Thailand and the Asian region resulting from the training courses held in Thailand with partial support of UGA 37. A large number of villagers participated in the training workshops on post-harvest, processing, and packaging technologies. Among the main beneficiaries of training were Thailand scientists, researchers, and extension workers, who have become trainers for the continuing follow-up courses. Asian scientists who are active on peanut research also benefited from the training in Thailand. An impact study on value of the 2002 training courses indicated that despite some increase in costs and labor, the adoption of the sorting and processing technology enabled the cooperatives and company to significantly improve the quality of their production and subsequently their sales. The members of the cooperative groups had a better life and had time for their family. Technologies gained in the course enabled them to produce good quality, aflatoxin-free products with tastes acceptable to consumers. Positive impacts were noted on the Thailand economy. People not involved in peanut production gained more knowledge on sorting technology, peanut production technology, peanut processing technology, and analysis of aflatoxin, which they shared/transferred to friends, extended family, their students, and others, particularly knowledge about aflatoxin. The study also suggested that peanut processing technology was feasible under the appropriate conditions and should be considered by other cooperatives and companies.

Funds for long- and short-term training were not provided through project UGA 38 in 2001-2005.

Minimal funds were allotted for program support under UGA 39 in this phase.

International Collaboration was supported by UGA 40 with primary impact from The International Arachis Newsletter published in collaboration with ICRISAT. A Peanut CRSP Newsletter was published on the web site. The web-based data/project reporting site has facilitated communications with the host country scientists. Support of the attendance of host country participants to the Georgia Peanut Tour has been valuable to the attendees. Web based communication has simplified program fiscal and programmatic management, and has enabled the project investigators to devote more time to research and student training.

An effective and efficient management philosophy was conducted by the ME under UGA 41. It consists of several elements: 1) minimize the administrative burden on principal investigators and the management entity; 2) minimize duplication in reporting accomplishments; 3) making reports and transactions transparent to all; and 4) greater devolution of project responsibilities to principal investigators.

The management entity was dedicated to effective transfer of new discoveries to researchers, producers, processors, and policy makers. There were a number of significant technology transfer activities that resulted in utilization of new peanut varieties, better methods for pest control, better processing methods, and prevention of aflatoxicosis.

CHAPTER 27. EXTERNAL EVALUATION PANEL REPORT FOR 2001-2007 GRANT

An External Evaluation process is an integrated and mandated part of all CRSPs. It is important to a CRSP implementation because it provides independent and periodic evaluation, ensures continuing long-term scientific integrity of the program, and assures objectivity in decision-making on critical program and policy issues.

The external evaluation was carried out in four steps; 1) review project reports and published documents, and develop an evaluation framework and schedule (December 2004); 2) evaluate individual projects in consultation with U.S. project investigators, including visits to participating U.S. universities, and prepare individual project evaluation reports (December 2004-February 2005); 3) visit project sites in selected host countries and update project reports (January 2005-March 2005); and 4) prepare thematic summaries and a consolidated EEP report (April-May 2005). A final draft was due for discussion with the Peanut CRSP board of directors in June 2005 and submission to USAID by the end of June 2005. This report will be the basis for decisions on the Peanut CRSP for the future.

The EEP consisted of seven members with their area of expertise and country as follows: 1) Dr. Dely P. Gapasin, research, development, and extension, Philippines, as Coordinator; 2) Dr. John Gilbert, food safety and nutrition, U.K.; 3) Dr. Darrell Nelson, information and management, U.S.A.; 4) Dr. Handy J. Williamson, Socioeconomics, U.S.A.; 5) Dr. John Cherry, food and agricultural sciences, U.S.A.; 6) Dr. Geoffrey Hildebrand, production and plant breeding, Zimbabwe; and 7) Dr. Howard Valentine, food science/private sector, U.S.A. Two consultants, Dr. David Cummins (agricultural and management specialist) from U.S.A. and Dr. Ron Gibbons (production and plant breeding specialist) from the U.K. assisted the EEP.

Key conclusions of the EEP

The Peanut CRSP has carried out research in the U.S. and host countries through imaginative, challenging, and ambitious multidisciplinary projects. Additionally, there has been strong support from U.S. and host country participants. The Peanut CRSP has been particularly successful in attracting the support of the broad U.S. peanut industry by providing tangible benefits. Many of these accomplishments have been due to the vision and leadership of the management entity and implementation efficiency of committed and dedicated investigators in the U.S. and the host countries. The leverage of funds to extend beyond direct CRSP funding has contributed greatly to the success.

Based on documented results and field visits, the EEP concludes that the Peanut CRSP has: 1) been a highly effective and innovative program; 2) made a difference in the lives of many beneficiaries and increased the institutional capacity of its partner research institutions (particularly in Africa where economic development has been elusive); 3) produced advance technologies that are likely to provide realizable and affordable health benefits to developing countries by reducing impaired nutrition and infectious diseases; 4) developed an industry incubator model for trade and enterprise development and facilitated partnership with the private sector; 5) developed successful production technologies which have been adapted and transferred to improve incomes of farmers in Africa and Latin America; and 6) helped to achieve the mission of USAID and the Millennium Development Goals; reduced poverty, greater gender equity, improved environment, increased access to trade, and development of partnerships.

This program started exploring the role of peanut in human diets before the rest of the industry and this early investment was providing the producers and peanut-based food industries benefits many times greater than the total cost of the Peanut CRSP.

The program has also focused on the connection between agriculture and health (particularly aflatoxin and immunity in humans) now being recognized as important by the World Health Organization (WHO) and the U.S. Centers for Disease Control (CDC). The earlier discoveries of enterosorption of aflatoxin are providing a totally new approach to the management of this problem in developing countries. Major impacts have been realized in the animal feeding industries worldwide and the importance of this research has been recognized by BIFAD.

The program has been successful in adapting cutting edge science to host country problems. Contributions have been made in biotechnology, health science, food technology, and socioeconomic analyses. International exchanges have benefited U.S. agriculture through improved germplasm, integrated pest management, and non-traditional peanut products.

The early decision to work across the full-value chain of the crop was visionary, since the program was already addressing the new USAID strategic plan. One of the lessons learned from the previous five-year plan was to match projects addressing production with projects creating demand.

The extensive list of achievements and benefits/impacts to both the U.S. and the host countries and summarized earlier in 2001-2007 accomplishments and impacts sections was an indication of the quality and commitment of scientists participating in the program. Technology transfer has been achieved through partnerships with multiple stakeholders.

The Peanut CRSP has been very successful in expanding its budget, and in leveraging funds from other sources. However, progress in a number of projects has been limited by the amount of funds allocated. The program should ensure that the number of projects carried out does not fiscally prevent the effective conduct of the full portfolio.

Key recommendations

The Peanut CRSP should continue to work across the whole value chain for peanut, exploiting a cluster of projects from each of the clusters (food safety/nutrition, production, post-harvest, and utilization) on a country/regional basis. In the future, socioeconomic studies should continue addressing the impact, gender, and policy aspects of all projects.

The health benefits provided by peanut should be fully exploited to accelerate development in host country economies. In addition, the initiative to reduce aflatoxin exposure through chemisorption has wider implications than to peanut consumption alone. These efforts will be critical to increasing the trade and market opportunities for the commodity and are of the highest priority to any future Peanut CRSP.

Access to markets requires competitive producers and products. The Peanut CRSP should expand support for research in applied genomics to accelerate breeding for resistance to constraints and better quality with lower production costs. Models should be used to evaluate new cropping strategies and undertake risk evaluations. The peanut industry incubator model (PIIM) needs to be adapted and deployed in more locations to improve the value of peanuts to both producers and consumers.

Socioeconomic, production, health, post-harvest and utilization research should be integrated such that socioeconomic initiatives are fully involved with all projects in the future Peanut CRSP initiatives. Special emphasis should be placed on exploiting the results from projects to inform decision makers on factors such as policy, risk management, social, gender, and environmental issues.

The development of partnerships to facilitate transfer of technologies to as many beneficiaries as possible should continue. Strong collaboration between the components of a project cluster should be fostered.

Information exchange mechanisms, collaboration with other research stakeholders, and training should continue as core functions of the program. The management entity should continue to promote collaboration and efficient use of resources within the program to maximize research and development outputs.

The Peanut CRSP needs to continue responding to USAID priorities, and to complement regional and country mission programs. An analysis of peanut industry research needs across the areas of USAID interest is recommended prior to the bid to renew the program. The good relationships developed with the U.S. peanut industry need to be maintained and strengthened through the selection of research projects that provide mutual benefit to both the host countries and the U.S.

A Peanut CRSP plan for 2007-2012 (the previous grant was extended one year 2006 to 2007 due to situations within USAID), and a request for proposals (RFP) for next phase projects were developed. Both these activities were based on the EEP evaluation. The RFPs were sent out to all eligible U.S. institutions, and the responses were evaluated by EEP members. Those selected, make up the projects in the 2007-2012 phase. USAID changed the CRSPs from grants to cooperative agreements effective for the new phase, which gives USAID more authority in the planning, conduct, and evaluation of the program. The description of the 2007-2012 phase will be described in the following chapter.

Workshop participants in Thailand observe research plots.

CHAPTER 28. DESCRIPTION OF THE 2007-2012 COOPERATIVE AGREEMENT

Background

The 2007-2012 phase of the Peanut CRSP (Collaborative Research Support Program) was designed around a whole-value chain concept to address problems along a continuum including producer values, processor values, and consumer values, and including cross-cutting/information, training and impact. It is one of a number of CRSPs, funded by the U.S. Congress through the United States Agency for International Development (USAID), which contributes to the goal of preventing famine and establishing freedom from hunger through U.S. land-grant universities being involved in international development. The current phase of the Peanut CRSP is supported by USAID cooperative agreement no. ECG-A-00-07-00001-00 to the University of Georgia, as the coordinating institution. The program was structured for a 10-year period, with adjustments based on the recommendations of a mid-term review and approval by USAID, for an extension to 2017. The 2001-2007 phase had particular emphasis on the peanut mycotoxin area through the "Preventing Human Aflatoxicosis" initiative that expanded the Peanut CRSP research to demonstrate the importance of aflatoxin to public health in developing countries, which was supported by special USAID funds. The concerted mycotoxin/aflatoxin effort served as the basis of a number of projects from 2007-2012.

Earlier phases of the Peanut CRSP in 1982-1996 involved Southeast Asia, West Africa, and the Caribbean and emphasized breeding and crop management, but included an investment in aflatoxin management and food technology. Consumer and market issues were important research needs for the expansion of the peanut crop in developing countries to contribute to food security, health and economic growth. The Peanut CRSP contributed to peanut production in all locations of Peanut CRSP activity, and resulted in the expansion of integrated pest or disease management (IPM or IDM). In the U.S. and Philippines, a highly insect resistant germplasm line (from collections with naturally occurring genetic variability) was identified and exploited in the Peanut CRSP and other breeding programs. In cooperation with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), rosette virus resistant varieties were developed and released in West Africa/Nigeria. The development of hand sorting for aflatoxin control and food processing developments for cottage and small-scale processors resulted in strengthening small-scale peanut industries. Commercial bentonite, NovaSil (NS) that had high affinity for aflatoxin in the digestive tract was discovered from this earlier work.

During the 1996-2007 phases, the scope of the Peanut CRSP was expanded to give greater emphasis to nutrition, post-harvest issues, human aflatoxicosis and provided increased focus on the whole peanut value chain. Research studies continued to develop technologies that relieved production constraints like IPM in Ghana. New rosette-resistant cultivars were introduced to Malawi and Uganda and these varieties. In the Philippines and Thailand a market based approach to peanut product development led to a Peanut Industry Incubator Model to identify consumer product-needs and acceptability, develop the indicated products in concert with interested processors, and introduce the products through markets to the consumer. The process was successful to enhance nutrition, demand for peanuts in the market, food supply, and for economic growth. The full value chain (producer, processor and consumer) was expanded through a peanut butter-based school lunch program in Guyana that established cottage industries producing peanut butter.

By 2010, it was reported that Peanut CRSP involved peanut varieties developed in Senegal occupied 400,000 acres in that West Africa country; rosette virus resistant varieties and other varieties developed in Nigeria cover 70% of the peanut acreage; and rosette resistant varieties developed in Uganda covered over 60% of the peanut area. NovaSil (NS) used as a feed additive was making a major contribution to world food supplies in that 60% of world commercial livestock feed included NS as a toxin-binding agent to protect livestock from exposure. However, only in Southeast Asia was significant progress being made at protecting people from dietary aflatoxin.

Studies on the nutritional value of peanuts provided the U.S. Food and Drug Agency (FDA) with information for labeling peanuts along with tree nuts as "Heart Healthy." Peanut sales in the USA have increased by $500 million per year because of these research results. In Texas, high oleic oil peanut cultivars have had a great impact on extending the shelf-life of peanut products.

Program initiatives for 2007-2012

The current phase for 2007-2012 (with a ten-year outlook until 2017) builds on the progress made in the earlier work with strong recognition that development across the whole peanut value chain was important for the production phase of the chain (a market pull concept). In response to the failure in Africa to have technologies that manage aflatoxin adopted, a change in aflatoxin research focus that began in the last phase was extended into the 2007-2012 effort. Consumer value projects directed toward aflatoxin contamination problems as they affect human health and immune systems, and efficient and effective control measures including NS clay research to extend its use to human use were added or strengthened in the portfolio. Strong focus was made on research aimed toward preventing human aflatoxicosis that affects the immune systems and human health, and on exploiting the high nutritional value of this commodity. The result was a program that contributed to the food supply and economic growth of Less Developed Countries (LDC), and that provided feedback to the U.S. peanut sector.

The Peanut Collaborative Research Support Program phase for 2007-2012 was composed of a series of projects addressing production, processing, and consumer values with expectations of capacity development, outreach and gender equity activities from all projects. Projects all have a peanut and/or aflatoxin component, and most projects continued from previous activities, and build upon the historic achievements of the program. Also continued in the current phase of the Peanut CRSP were activities initiated in the previous special purpose award in 2002 (Preventing Human Aflatoxicosis) under the Peanut CRSP.

The Peanut CRSP and its 21 component projects were selected by open competition. The majority of projects were initiated in early 2008, but three projects in the processor sector only received funding in 2009, and an impact assessment project was initiated in 2010 when funds became available. The portfolio of projects was technically relevant to the goals of USAID under the new Feed the Future (FTF) initiative, although some of the locations where the Peanut CRSP worked were no longer priorities for USAID. The major hubs for Peanut CRSP activities (Ghana and Uganda) are FTF focus countries, and the strong emphases on nutrition and food security reinforce the relevance of the Peanut CRSP to the FTF.

Inherent in the CRSP concept was the need to address constraints that have global implications. Therefore as a constraint driven program, the Peanut CRSP was designed around a set of constraints to sustainable production and utilization identified during the 1980-1982 Planning process. Based on the numerous advancements achieved by the Peanut CRSP during the 1982-1994 period, the external evaluation panel in 1994 evaluated the continuing validity of the following constraints and found them to be valid as a basic framework for the Peanut CRSP in the near future. With some adjustment in the project designs to address the constraints, the constraints have remained similar over the 2007-2012 phase:

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

The mission of the Peanut CRSP was the "achievement of sustainable economic and social development through research and capacity development using peanut and related expertise in developing countries and the USA." There were five goals including:

- Greater incomes for participants in the peanut sector (producers and processors)
- Greater value of, and demand for, peanuts in the market place
- Improved public health through enhanced nutrition and quality, including reduced human aflatoxicosis
- A sustainable value chain (produce, processor/market and consumer values) for peanut systems

- Improved capacity of participants to support future development of the peanut sector

The Peanut CRSP has three expected products: (1) knowledge and technology; (2) capacity development; and (3) changed quality of life through technology transfer and impacts.

The 21 projects under the program group around three sectors of the whole-value chain: Production Values, Processor Values and Consumer Values, the latter including Food Safety (Aflatoxins) and Nutrition. A fourth sector is of Cross-cutting projects which communicate technology, assess impact, report training, and support management. In the communication and management activities advanced web-based programs are in place with many participating institutions worldwide to enable ongoing communication of peanut research, training programs and technology transfer to users. Fiscal management is cost effective and accountable. The 21 projects were located in 11 U.S. universities and nine host country (HC) universities and eight HC ministry institutions representing west-central Africa, West Africa, East Africa, Latin America and the Caribbean.

Projects for 2007-2012

The following projects were chosen and implemented in 2007-2012 based on the EEP recommendations.

A. Producer values

Production projects focused mostly on ongoing challenges from the environment, such as water stress and climate warming, diseases, especially rosette viruses, leaf spot, rootworm and rust and increasing yields by managing these factors. The strategies included developing better varieties and farming practices to conserve soil fertility; to reduce the use of costly herbicides, pesticides and fungicides; and the assurance of quality peanuts for consumer acceptance and market expansion. All these projects have a history that goes beyond the start of this phase, so they have materials and results for major impacts in the near-term.

High yields, drought tolerance and reduced diseases would improve competitiveness of peanuts relative to other crops. Sustained breeding programs to enhance drought and disease resistance along with increased yields were major tools used in these endeavors. This includes increased use of wild relatives and early-developed strains based on a wealth of germplasm for the needed crossover of favorable genes into cultivated varieties. Training in breeding techniques, implementing integrated pest management technologies and incorporating good cultural or farming practices through multi-disciplinary collaborating research efforts to end users was the primary focus of the production projects in the Peanut CRSP.

The measureable impacts from this program area included: (1) technologies allowing increased returns to identified production resources; (2) adoption of more sustainable production technologies; and (3) knowledge applied to improve or maintain profitability of peanut operations.

There are eight projects focused on Producer Values located in East Africa (UCN139, UGA136, and NMS172): West Africa (TAM137, NCSI31, and UF150) and Latin America/Caribbean (UF155, UF157).

UCN 139. Improving livelihoods of farm households in peanut based farming systems in East Africa

Principal Investigator:

- Dr. Boris Bravo-Ureta, University of Connecticut.

Cooperators:

- Mary Wairimu Thuo, University of Connecticut.
- Elizabeth Mahan, University of Connecticut.
- Patrick Obeng-Asiedu, University of Connecticut.
- Karen Nye, University of Connecticut.

Kenya Collaborators:
- Felister M. Makini, Kenya Agricultural Research Institute,
- Evelyn N. Okoko, Kenya Agricultural Research Institute,
- Benjamin Musyimi Muli, Kenya Agricultural Research Institute.

Uganda Collaborator:
- David Okello Kulule, National Semiarid Resources Research Institute (NaSARRI), Serere.

The goals of UCN 139 were to improve data collection by establishing standardized procedures for data collection and documentation. The hope was to analyze potential increases to household income through increased peanut production. The project would examine impact of peanut farming systems, including value added activities on resource use and income generation. In cooperation with host country collaborators, the project would develop appropriate training materials and conduct workshops, with particular focus on women.

UGA 136. Strategies for controlling groundnut rosette disease in Sub-Saharan Africa: Breeding for disease resistance, seed dissemination, disease management education, and generation of transgenic groundnut with resistance to groundnut rosette

Principal Investigator:
- Dr. Carl (Mike) Deom, University of Georgia

Uganda Collaborator:
- David Okello Kalule, National Semi-Arid Resources Institute, Serere

The goal of UGA 136 builds on an earlier project based in Malawi (and first located in Nigeria) that continues to improve genetic resistance to groundnut rosette virus resistance, a most important disease of groundnut in Sub-Saharan Africa. Resistance will boost groundnut productivity especially in countries where the disease is endemic.

NMS 172. Global Valencia peanut niche market development program

Principal Investigator:
- Naveen Puppala, New Mexico State University.

Cooperator:
- Dr. Mark Burow, Texas A&M University.

Uganda Collaborator:
- David Okello Kalule, National Semi-Arid Resources Research Institute, Serere.

Other potential collaborating countries include: Thailand, India, Mozambique, and Vietnam. Germplasm source includes the U.S. Department of Agriculture.

The goal of NMS 172 was to improve genotypes and cultivars of Valencia type peanuts to fit niche markets for edible peanuts in participating countries, such as East Africa.

TAM 137. Overcoming abiotic and biotic constraints to yield, and production of high-quality peanuts in West Africa and Texas

Principal Investigator:
- Dr. Mark Burow, Texas A&M University;

Cooperators:
- Dr. Naveen Puppala, New Mexico State University,
- Dr. Kenneth Boote, University of Florida,
- Dr. Rick Brandenburg, North Carolina State University.

Senegal Collaborator:
- Dr. Ousmane Ndoye, ISRA-CNRA.

Burkina Faso Collaborator:
- Dr. Philippe Sankara, University of Ouagadougou,

Ghana Collaborator:
- Dr. Nicolas Denwar, Savanna Agricultural Research Institute.

The goals of TAM 137 were to develop peanut cultivars that overcome constraints to productivity across West Africa. Collaboration with a range of Peanut CRSP projects assures distribution of improved cultivars across the region. Development and deployment of drought tolerant and shorter duration varieties capable of avoiding drought will reduce aflatoxin incidence. Identification of molecular markers will aid in cultivar improvement. Outcomes will have significant impact in the host countries as well as the U.S. with regard to production efficiency, improved quality, and reduction of input costs. Disease resistance will reduce the requirement for costly chemical use and reduce the impact of these on the environment.

NCS 131. Improved West African peanut production for enhanced health and socio economic status through delivery of research-based production systems in Ghana

Principal Investigator:
- Dr. Rick Brandenburg, North Carolina State University;

Cooperators:
- Dr. David Jordan, North Carolina State University,
- Dr. Mark Burow, Texas A&M University,
- Dr. Mike Deom, University of Georgia.

Ghana Collaborators:
- Dr. Emmanuel Moses, Crops Research Institute, Ghana,
- Dr. Awere A. Dankyi, Crops Research Institute, Ghana,
- Dr. Grace E. Bolfrey-Arku, Crops Research Institute, Ghana,
- Dr. Kingsley Osei, Crops Research Institute, Ghana,
- Dr. Joseph N.L. Lamptey, Crops Research Institute, Ghana,
- Dr. Mumuni Abdulai, Savanna Agricultural Research Institute.

The goals of NCS 131were to increase production efficiency through the development and deployment of IPM practices with emphasis on diseases and insects, and to integrate aflatoxin risk into the disease and insect management strategies, and determine the influence of production and pest management practices on aflatoxin incidence.

UF 150. Breeding Peanut for disease resistance valuable to Latin America, the Caribbean, and the United States

Principal Investigator:
- Dr. Barry Tilman, University of Florida

Cooperators:
- Dr. Albert Culbreath, University of Georgia,
- Dr. Noelle Barkley, USDA

Bolivia Collaborators:
- Jaime Hernandez, ANAPO,
- Ruben Mostacedo, ANAPO,
- Rolando Zabala Moreno, ANAPO,
- Diego Badelomar, ANAPO.

Brazil Collaborator:
- Alessandra P. Favero EMBRAPA.

The goals of UF 150 were to breed and release disease resistant germplasm, which will remove many of the constraints to peanut yield, reduce cost of pesticide use, and have beneficial effects on the environment in both the U.S. and host countries.

UF 155. The development of the peanut sector for Guyana and selected Caribbean countries

Principal investigator:
- Gregory E. McDonald, University of Florida.

Cooperators:
- Dr. Steve L. Brown, University of Georgia.
- Dr. Timothy Brenneman, University of Georgia.
- Dr. Robert Kemerait, University of Georgia.
- Earl Williams, University of Georgia,
- Dr. Dan Brown, Cornell University,
- Dr. Patricia Wolff, Food and Meds for Kids, Haiti,
- Thomas Stehl, Food and Meds for Kids, St. Louis, Missouri.

Guyana Collaborators:
- Clairmont Lye, Beacon Foundation,
- Jerry La Gra, Rainforest Guesthouse.

The goals of UF 155 were to improve varieties and extend them through on-farm research along with introduction of improved pest management practices and fertility enhancement; introduction of techniques to increase planting and harvesting efficiency are introduced through mechanization such as using shellers, threshers, etc., in collaboration with the fully belly project; standardization of peanut storage facilities and development of protocols for bagging, pest control in storage, and aflatoxin assessment; and development of a quality assurance protocol for peanut processing and peanut and peanut product storage.

UF 157. Systems approaches to enhance peanut production under resource limitations

Principal Investigator:
- Dr. Kenneth Boote, University of Florida;

Cooperators:
- Zagre Bertin, INERA, Burkina Faso,
- Dr. Jim W. Jones, University of Florida.

Ghana Collaborator:
- Dr. Jesse B. B. Naab, Savanna Agricultural Research Institute.

Burkina Faso Collaborator:
- Dr. Philippe Sankara, University of Ouagadougou.

The goals of UF 157 were to improve peanut productivity and production by increasing yield, reducing losses due to pests, weeds and diseases, and reducing labor inputs. Emphasis on technology transfer, and later, seed multiplication, was a strong point. Mechanical aids to speed up harvesting and processing will lead to reduced losses, improved quality and reduced risk of aflatoxin contamination. Outcomes will benefit resource-poor farmers in improving production efficiency, reduction of input costs and have beneficial effects on the environment.

B. Processor values

Research advances in the development of quality aflatoxin-free peanuts as a food along with growing economies has induced the need for farmers and agribusinesses to know what food products are in high demand by consumers in developing. Studies have shown peanuts and peanut products are highly nutritious, and have several benefits to human health and well being beyond basic nutrition. Consumer-driven, market pull approaches to develop safe, quality peanuts, and peanut products such as processing technologies are being developed by the Peanut CRSP.

Consumer and market surveys have been carried out to identify consumer priorities for selected peanut foods. The information from the peanut value chain have identified peanut product preferences, selected peanut products, and training was being provided on appropriate processing technologies with small and large industries. Products produced will be fit to local consumer/market preferences and economic conditions, while refining safety, sensory and functional properties through food science.

The measurable impacts from this program sector include: (1) increased processing of peanuts through value added activities; (2) companies, cooperatives and entrepreneurs producing value added peanut products; (3) increased presence or maintained value of peanut products in the market place; and (4) greater trade of peanuts and its products. There are three projects specifically focused on the Processor Values program sector (UGA127, UGA165 and UGA166). Projects with major emphasis in other sectors also contribute to this sector. For instance, UF 155 has also utilized the value chain approach to sustain production expansion and COR158 has addressed aflatoxin which has resulted in added processor and nutritional results. These projects have built on the capacity and experiences achieved during the earlier phases of the Peanut CRSP.

UGA 166. Enhancing the peanut value chain, from processing to marketing peanuts and peanut products-product development

Principal Investigator:
- Dr. Anna V. A. Resurreccion, University of Georgia;

Cooperators:
- Dr. Manjeet S. Chinnan, University of Georgia.
- Dr. Wojciech J. Florkowski, University of Georgia.

Ghana Collaborators:
- Daniel Sarpong, University of Ghana-Legon,
- Agnes Budu, University of Ghana-Legon,
- Charles Diako, Food Research Institute,
- George Anyebuno, Food Research Institute.

Uganda Collaborators
- Archileo Kaaya, Makerere University,
- Joseph Rubalema, Uganda Industrial research Institute,
- Margaret Massette, National Agricultural Research Organization,
- Alphonse Candia, National Agricultural Research Organization.

The goals of UGA 166 was to transfer in a team approach the success of the Peanut CRSP program in Southeast Asia, the Philippines and Thailand, that developed the Peanut Industry Incubator Model to Africa. The focus includes the development of instruments for consumer and market surveys for a consumer preference database on which to base, then develop, peanut products and processes, that are targeted for technology development or improvement driven by industry collaboration based on market pull concepts.

UGA 165. Enhancing the peanut value chain, from processing to marketing peanuts and peanut products – economics/marketing (UGA165)

Principal investigator:

- Dr. Wojciech J. Florkowski, University of Georgia.

Cooperators:

- Dr. Manjeet S. Chinnan, University of Georgia,
- Dr. Anna V. A. Resurreccion, University of Georgia.

Ghana Collaborators:

- Daniel Sarpong, University of Ghana-Legon,
- Agnes Budu, University of Ghana-Legon,
- Charles Diako, Food Research Institute,
- George Anyebuno, Food Research Institute.

Uganda Collaborators:

- Archileo Kaaya, Makerere University,
- Joseph Rubalema, Uganda Industrial Research Institute,
- Margaret Massette, National Agricultural Research Organization,
- Alphonse Candia, National Agricultural Research Organization.

The goals of UGA 165 were to provide the consumer and market surveys relevant to the team to produce a consumer preference database on which to base peanut products targeted for technology development or improvement as part of the University of Georgia team.

UGA 127. Enhancing the peanut value chain, from processing to marketing of peanuts and peanut products-processing

Principal investigator:

- Manjeet S. Chinnan, University of Georgia;

Cooperators:

- Wojciech J. Florkowski, University of Georgia,
- Anna V. A. Resurreccion, University of Georgia.

Ghana Collaborators:

- Daniel Sarpong, University of Ghana-Legon,
- Agnes Budu, University of Ghana-Legon,
- Charles Diako, Food Research Institute,
- George Anyebuno, Food Research Institute.

Uganda Collaborators:

- Archileo Kaaya, Makerere University,
- Joseph Rubalema, Uganda Industrial research Institute,
- Margaret Massette, National Agricultural Research Organization,
- Alphonse Candia, National Agricultural Research Organization.

The goals of UGA 165 was to transfer to Africa as part of a team the success of the Peanut CRSP program in Southeast Asia, the Philippines and Thailand, that developed the Peanut Industry Incubator Model. The focus includes the development of instruments for consumer and market surveys for a consumer preference database on which to base, then develop, peanut products and processes that are targeted for technology development or improvement driven by industry collaboration based on market pull concepts.

C. Consumer values

In this sector of the Peanut CRSP projects address gender issues, nutrition and food-safety; the later being focused on aflatoxin and public health through the prevention of aflatoxicosis. In the previous phase a major change in emphasis occurred to focus Peanut CRSP on documenting the overlooked health consequences of neglecting aflatoxin in the diet, and demonstrating an alternate paradigm for the prevention of human aflatoxicosis in food insecure situations. Gender is an important factor in peanut production, marketing and exploitation; in many Peanut CRSP locations this is primarily a women's crop. Women produce, process, and market the majority of peanuts through informal channels. So the importance of the crop is likely to be overlooked since it is seldom well documented as a feature of national economies.

(a) Food safety/Aflatoxicosis

Because of the priority accorded to this topic, a major fraction of the resource was invested to address food safety. Three areas of activity occurred addressing: 1) management of contamination (COR158, AUB163, UGA145, VT134, UF155 and UGA122); 2) consequences of exposure (UAB148), and 3) prevention of human exposure (TAM149, UGA145). In addition the nutrition project (UGA 122) and food processing projects (UGA127, UGA165, and UGA166) described above extend the management of this problem to provide safe foods in the market place.

The measurable impacts from this program sector include: (1) technologies to decrease exposure to aflatoxin contamination; (2) health and food policy changes relating to aflatoxin-modulated health risks; (3) increased social awareness for aflatoxin risks; and (4) increased gender equity. There are eight projects focused on food safety/aflatoxicosis (COR158, UAB148, AUB163, TAM149, UGA145, VT134, UF155 and UGA122), the last two being associated projects.

COR 158. Innovative procedures to protect therapeutic foods from aflatoxins in developing nations

Principal Investigator:
- Dr. Dan L. Brown, Cornell University;

Cooperators:
- Dr. Patricia Wolff, Meds and Foods for Kids, Haiti;
- Thomas Stehl, Meds and Foods for Kids, USA.

The goals of COR 158 were to develop and implement the production of peanut-based ready-to-use therapeutic foods (RUTF) for reversing childhood malnutrition in Haiti and their use is being extended to support HIV-infected individuals. An issue was that peanuts, being an important ingredient in a selected RUTF, can contain harmful amounts of aflatoxins, mycotoxins produced when contaminated by *Aspergillus* species. These carcinogens have anti-nutritive effects causing stunting of growth in children, immuno-suppression and acute liver damage. It is noted that HIV progression could be enhanced by aflatoxins because it plays a role as an immune-suppressant. Research in Haiti has within the goals to establish procedures to exclude aflatoxins in a RUTF, Medika Mamba (a vegetable oil, sugar, milk powder, peanut paste and vitamin/mineral mix).

UAB 148. Association of aflatoxins biomarker level with health status and HIV disease

Principal Investigator:
- Dr. Pauline Jolly, University of Alabama at Birmingham.

Cooperators:
- Dr. Jia-Sheng Wang, University of Georgia,
- Dr. Timothy Phillips, Texas A&M University.

Ghana Collaborator:
- Dr. William O. Ellis, University of Science and Technology, Kumasi.

The goals of UAB 148 were to determine the relationship between aflatoxin biomarker levels and the socio-demographic/economic, health, nutritional, and immune characteristics of people in Ghana with HIV and other infectious diseases including tuberculosis and malaria. Aflatoxins impair the immune system, which could cause more rapid progression of health debilitating diseases, and adversely affect the health pregnant women and their babies. Therefore, UAB 148 also examined the association between AF-ALB levels and health status in pregnant women, and on adverse birth outcomes (low birth weight, pre-term delivery, small for gestational age, stillbirth) in Ghana. The outcome of this project will provide understanding for improved health through reduced aflatoxin exposure.

AUB 163. Aflatoxin financial and health risks along the peanut marketing chain in Ghana

Principal investigator:
- Dr. Curtis M. Jolly, Auburn University

Cooperator:
- Dr. Carel Ligeon, Auburn University

Ghana Collaborators:
- Dr. William O. Ellis, Kwame Nkrumah University of Science and Technology, Kumasi,
- Simon Fialor, Kwame Nkrumah University of Science and Technology, Kumasi.

The goals of UAB 163 were to evaluate the effects of aflatoxin contamination on the profitability of market participants producing and trading peanuts and peanut products in Ghana and Benin; effectiveness and profitability of sorting compared to other methods. Also, studies will compare modified commercial and traditional storage methods for reducing aflatoxin contamination of peanut and determine the specificity and reliability of methods for detecting aflatoxin. Overall, the main issue addressed by the project was aflatoxin reduction in storage of peanut and ways to reduce contamination in the marketing chain.

TAM 149. Enterosorbent intervention therapies for populations at risk for aflatoxins related diseases

Principal Investigator:
- Dr. Timothy D. Phillips, Texas A&M University

Cooperator:
- Dr. Pauline Jolly, University of Alabama-Birmingham
- Dr. Jia-Sheng Wang, University of Georgia

Cooperators:
- Dr. Nii-Ayi Ankrah, Noguchi Memorial Medical Research Institute, Ghana

Ghana Collaborator:
- Dr. William O. Ellis, University of Science and Technology, Kumasi.

The goals of TAM 149 were to determine the safety of NovaSil for human use to diminish human exposure to aflatoxin, confirm if nutrient absorption including vitamins A and E and Fe and Zn were affected, and to study the effectiveness of a more highly refined, uniform particle size NovaSil clay (UPSN) in further clinical trial in Ghana.

UGA 145. Development of methods for establishing a global network for aflatoxin exposure

Principal Investigator:
- Dr. Jia-Sheng Wang, University of Georgia

Cooperators:
- Dr. Timothy H. Phillips, Texas A&M University
- Dr. Pauline Jolly, University of Alabama-Birmingham

Ghana Collaborator:
- Dr. William O. Ellis, Kumasi.

The goals were to broaden the understanding of aflatoxin (AF) exposure and the connection to epidemiology using biomarkers. While contamination by the AF-producing molds may be universal within a given geographical area, the levels or final concentration of AFs in the grain product can vary from < 1 µg/kg (1 ppb) to > 12,000 µg/kg (12ppm). For this reason, many researchers agree that the measurement of human exposure to aflatoxins using biomarkers is more practical than using food contamination and consumption data.

VT 134. Improving the health and livelihood of people of East Africa by addressing aflatoxin and gender-related constraints in peanut production, processing and marketing

Principal investigator:
- Dr. Maria Elisa Christie

Cooperator:
- Dr. Kumar Mallikarjuna, Virginia Tech University.

Uganda Collaborators:
- Dr. Archileo Kaaya, Makerere University,
- Margaret Mangheni, Makerere University,
- Monica Karuhanga, Makerere University,
- Peace Kyamureku, National Association of Women Organizations in Uganda,

Kenya Collaborators:
- Charity Kawira Mutegi, KARI,
- Christopher Munyao Nayamai, University of Nairobi,
- Dr. James K. Gathumbi, University of Nairobi,
- Dr. Richard Jones, ICRISAT, Kenya Office.

The goals of VT 134 were: 1) to conduct surveys on peanut consumption in four major peanut growing regions of Uganda to collect aflatoxin exposure data; 2)develop an HACCP system for small-scale peanut processors and cottage industries to allow trained people to obtain certification/ISO22000 from the government (UNBS) for their peanut products; 3) develop information education and communication materials for aflatoxin awareness campaigns and training of graduate students, researchers, processors and traders, women's groups and government personnel 4) develop non-destructive Rapid Deduction System to test for aflatoxin using Fourier Transformation, Infrared Spectroscopy with Attenuated Total Reflection (FTIR-ATR) or Photo Acoustic Spectroscopy (FTIR-PAS); and 5) carry out ethnographic research in selected households in urban and rural areas in Kenya and Uganda; and develop livelihoods strategies and models to reduce poverty and malnutrition by working with women's organizations.

UF 155. The development of the peanut sector for Guyana and selected Caribbean countries

Principal investigator:
- Gregory E. McDonald, University of Florida.

Cooperators:
- Dr. Steve L. Brown, University of Georgia
- Dr. Timothy Brenneman, University of Georgia
- Dr. Robert Kemerait, University of Georgia
- Earl Williams, University of Georgia.
- Dr. Dan Brown, Cornell University,
- Dr. Patricia Wolff, Food and Meds for Kids, Haiti,
- Thomas Stehl, Food and Meds for Kids, St. Louis, Missouri.

Guyana Collaborators:

- Clairmont Lye, Beacon Foundation,
- Jerry La Gra, Rainforest Guesthouse.

The goals of UF 155 were to evaluate improved farm management such as improved varieties, pest management practices, and fertility enhancement; evaluate mechanization for efficiency of planting and harvesting (shellers, threshers) in collaboration with the full belly project; evaluate improved storage facilities for pest control and lower aflatoxin contamination; and the development of a quality assurance protocol for peanut processing and peanut and peanut product storage.

(b) Nutrition

Nutritional issues for the developing world are evolving and becoming bi-modal. As important as the problem of under-nutrition is in developing countries, it is also apparent now that peanut has a powerful role/opportunity in the emerging epidemic in these countries associated with poor-quality/over-nutrition (non-communicable diseases and obesity) just recognized by the UN.

Peanut is an important nutritional and health-giving food grown over much of the developing world, but research to make this evidence-based and exploit this potential has been neglected. Documentation of the positive nutritional aspects of peanuts remains an important priority for Peanut CRSP to promote increased consumption of peanut and peanut products, thereby promoting public health, the market demand for, and profitability of this crop for farmers.

Nutrition research in an earlier phase documented that peanuts are a heart-healthy food, and because of a satiety factor do not promote weight gain, important for developing countries where these nutritionally modulated health risks have become as important as undernutrition and malnutrition. In addition, research has been supported to produce and test new types of nutritional and aflatoxin-free ready-to-use therapeutic foods (RUTFs) for other vulnerable groups, successfully feeding high risk populations of malnourished adults, young children and infants.

The measurable impact in this area are: (1) increased knowledge and value attached to peanuts for their health properties, (2) use of local nutrition sources to address nutritional needs of vulnerable populations and (3) research is also expected to improve gender equity. There were two projects focused on the nutrition aspects of peanuts (UGA122 and PUR151).

PUR 150. Peanut consumption and human weight management

Principal Investigator:

- Dr. Richard Mattes, Purdue University

Brazil Collaborator:

- Dr. Neuza Maria Brunoro Costa, Universidade Federal de Vicosa.

The goals of PUR 150 were to evaluate in the U. S. and Brazil the nutrition of peanuts and peanut products as they relate to health benefits and satiety sensations. More specifically obesity is a global public health problem that contributes to the onset and manifestation of chronic diseases that compromises the quality of life, and causes an economic burden on health care systems. Work will follow the thesis that peanuts and peanut products do not promote weight gain while producing nutritional health benefits. An understanding of the mechanisms by which these observations occur should increase acceptance of the health benefit findings and enhance peanut consumption by consumers and strengthening marketing advantages.

UGA 122. Aflatoxin-free peanut-based recovery and functional food

Principal investigator:

- Dr. Robert Dixon Phillips, University of Georgia;

Cooperator:
- Dr. Jinru Chen, University of Georgia;

Ghana Collaborator:
- Firibu Saalia, University of Ghana, Legon.

Uganda Collaborator:
- Dorothy Nakimbugwe, Makerere University.

The goals of UGA 122 were to develop techniques to remove aflatoxins from weaning foods and RUTF foods via new and unique processing technologies, including the addition of probiotic cultures and HSCAS (NovaSil) clay. Projected outcomes were to help resolve malnutrition issues affecting adults, children and infants due to food shortages, food insecurity, conflicts, and infectious diseases including HIV/AIDS.

D. Cross-cutting – Information, impact, training, and management

Across the Peanut CRSP, information transfer is achieved through multiple media and venues. A factor contributing to the success of the Peanut CRSP has been the proactive information transfer of its ongoing program developments. As part of advancing communication technologies to strengthen the outcomes of Peanut CRSP goals, efforts are supporting the analyses of not only the scientific impact but the impact of these studies on social benefits, especially helping vulnerable groups. This will encourage project designs that work within the whole value chain for production, processing and marketing of quality, safe and nutritious peanut and peanut products, and showing how the lives of people are improved both health wise and economically.

The training of students and short-term training of scientists has always been a component of the Peanut CRSP. The management entity (ME) has always been forward reaching in supporting work to use the Internet for worldwide communication among project principal investigators and their collaborators and partners. This includes Annual Reports, peanut journal publications, meeting presentations, training and news links, etc. In addition to the scientific community, users include industries, policymakers and the consumers.

There are two projects related to information and impacts (UGA124 and UGA128). The measurable impacts from this program include: (1) knowledge developed and applied to peanut development and problems; (2) networks of peanut researchers/practitioners supported or created around the world; (3) impacts assessed; (4) knowledge relevant to policies generated through analysis and published; (5) policy changes recommended; and (6) policy changes adopted.

Information

UGA 124. A peanut information network and train-the-trainer program (UGA 124)

Principal Investigator:
- Dr. Yen-Con Hung, University of Georgia.

Cooperators:
- Dr. John Beasley
- Dr. Stanley Fletcher
- Dr. R. Dixon Phillips, University of Georgia
- Emory Murphy, Georgia Peanut Commission
- Bruce Kotz, Golden Peanut Company

Ghana Collaborator:
- Dr. Samuel K. Sefa-Dedeh, University of Ghana.

The goals of UGA 124 were to setup an information support program to collect information (such as research results) and make this available to a diverse group of users and beneficiaries (scientists, researchers, students, development workers, extension staff, practitioners, government personnel, policy makers, and others). The project will update the information weekly and revise the PINS website periodically to enhance the system and add new sets of information. Links will be established with international and national research institutions and programs like CRSPs, development projects/programs, universities, NGOs and other institutions as sources of updated peanut related information. There are many common constraints to production, post-harvest and value-adding processes of peanuts worldwide, hence, an information network and training program that address all three major sectors (producer values, processor values, and consumer values) of the peanut value chain would benefit from one common source. A program such as PINS would ensure the quality and timeliness of the information.

UGA 128. Impact assessment for the peanut collaborative research support program

Principal Investigator:
- Dr. Genti Kostandini, University of Georgia

Cooperators:
- Bradford F. Mills, Virginia Tech University
- Velma Zahirovie Herbert, University of Georgia

Africa Collaborators:
- Augustine Langyintuo (Alliance for Green Revolution in Africa/AGRA),
- Johnny Mugisha, Makerere University, Uganda.

The goal was to provide a comprehensive estimate of the magnitude of social benefits generated by the Peanut CRSP activities, as well as an in-depth portrait of impacts on vulnerable groups like poor households and female household members. These will be addressed by impact studies of various Peanut CRSP projects.

Training

There was not a project in the 2007-2012 phase with funds to support training. These funds came from support provided to individual projects.

Management

UGA 110. Peanut CRSP Management

Principal Investigator:
- **Dr. Jonathan H. Williams, University of Georgia**

The purpose of UGA 110 was to provide programmatic and fiscal oversight of the Peanut CRSP. The Management Entity (ME) was responsible for day to day management and response to problems and questions that arose. The University of Georgia was the recipient of the cooperative agreement, and the ME was the responsible entity for UGA to USAID as the provider of the Agreement. The ME was supported by a board of directors, technical committee, and technical officer in USAID. BIFAD provides guidance to CRSPs, and includes the CRSP guidelines developed by BIFAD.

The staff included:

- Dr. Jonathan H. Williams, program director
- Dr. Carolyn Fonseca, associate director since February 2010
- Sandra Harwood, administrative secretary
- Frances Benton, accountant
- Alan Stripling, part-time accountant (full-time upon retirement of Frances Benton in 2012)
- Darryl Tharpe, programmer
- Dr. David G. Cummins, retired program director, part-time assistant for special assignments
- Dr. Ed Kanemasu, director of global programs in agriculture, serves as UGA advisor to the ME

Board and TC members:

- Dr. S. K. DeDatta, followed by Dr. Gene Ball and Mike Bertelsen, Virginia Tech University
- Dr. James Harper, North Carolina State University
- Jeffrey Johnson, followed by Darlene Cowart, Birdsong, Inc.
- Dr. Ed Kanemasu, University of Georgia
- Dr. James Lowenberg-Debour, followed by Dr. K. G. Raghothama, Purdue University
- Dr. Joseph Molnar, Auburn University
- Emory Murphy, Georgia Peanut Commission
- Dr. William Payne, followed by Dr. David Baltenserger, Texas A&M University
- Dr. David Sammons, followed by Dr. Walter Boen, University of Florida

Cognizant Technical Officer: Dr. Joyce Turk followed by Dr. Jennifer Long in 2011.

UGA 111. Peanut CRSP program support

Principal Investigator:
- Dr. Jonathan H. Williams, University of Georgia.

The purpose of UGA 111 was to allot and provide funds for program support, which includes cost of board of directors and technical committee meetings, and for the external evaluation team activities.

Improved resistant to diseases are eveident in these germplasm variety evaluations in the Philippines.

CHAPTER 29. ACCOMPLISHMENTS OF THE 2007-2012 COOPERATIVE AGREEMENT

The intent of this chapter was to describe achievements and impacts for all projects in a thematic fashion that have particular value to the host countries and across regions, and the achievements that have special value to the United States for each project.

A. Production Values

TAM 137. Overcoming abiotic and abiotic constraints to yield and production of quality peanuts in West Africa and Texas

Overcoming multiple constraints and transferring these new technologies on yield and production of high quality peanuts in West Africa and Texas have been the objectives of this project, which is a continuation from earlier phases of the Peanut CRSP. Materials with field measures of improved drought tolerance were found in Texas and crosses are underway to introduce drought tolerance into cultivars from Africa. Early maturing, high-oleic runner and Spanish peanuts were set to be released for the Texas market. One cultivar under the name Schubert that matures one week earlier and yields 10% higher will replace the high oleic cultivar Olin was approved in 2012. Two runner cultivar release proposals were submitted in Texas in 2011, and releases of an early-maturing, high oleic runner and a high-oleic runner with resistance to root-knot nematodes and *Sclerotinia* blight were approved in 2012. Two leaf spot resistant cultivars were set for release in Burkina Faso; a Spanish cultivar (yields 20% higher than the disease susceptible check over 8 years of tests) and a runner cultivar (that out yields the same check 50% and the Nama cultivar by 100%). Progress was being made in germplasm improvement with the potential of development of a leaf spot resistance cultivar in Ghana, and evaluations were being made in cooperation with the NCS 131 and UF 157 projects with goals to improve effectiveness and profitability of the use of fungicides and herbicides. Senegal was in the process of release of two Spanish cultivars with fresh seed dormancy (will reduce yield losses from germination of mature seed when late rains occur prior to harvest) and drought tolerance along with six other early maturing varieties released in 2010 under separate funding.

Crosses to transfer high oleic traits from wild species have been successful. The results are hybrids with alleles closer to cultivated peanuts. Six accessions from previous evaluations were selected and increased for new and underway regional trials of leaf spot-resistant materials with improved yields.

A major accomplishment in this project has been the development of high oleic acid cultivars of peanut in Texas and movement into the West Africa program. The high oleic trait delays rancidity of peanut seed and peanut products during storage, which improves the flavor and value of peanut and peanut products. It was noted earlier that a peanut industry leader stated that high oleic peanut cultivars is the greatest accomplishment ever made by the peanut research community. An increase in oleic acid results in a corresponding decrease in linoleic acid; linoleic acid is responsible for the earlier onset of rancidity.

Research on molecular markers is underway that have the potential of identifying in a much shorter time important traits in peanut germplasm. Mapping of plant genomes is an exacting science, and it is notable that training has been provided to a Burkina Faso scientist in a visit to Texas.

Seed multiplication is a primary objective of the Senegal peanut breeding program. The Peanut CRSP, ISRA and the NGO – ASPRODEB are cooperating to improve seed multiplication and distribution to farmers of both new and formerly released cultivars, which include seven cultivars developed in Senegal with Peanut CRSP assistance that now occupy about 400,000 ha of production. Seed multiplication for farmers is basic to the growth and profitability of the peanut sector. Seed multiplication is an objective in Northern Ghana, with an aim to create awareness among farmers of the benefit of growing leaf-spot resistant cultivars. Field Days will demonstrate to farmers the difference of early leaf loss due to disease and later leaf loss due to maturity of the plants. Scientists from Senegal and Burkina Faso have been trained in topics related to cultivar development and release, mechanization, and seed increase, maintenance, and distribution. Efficient and cost effective systems for seed increase, multiplication, and distribution to farmers is a major constraint to improvement of the peanut sector in many developing countries.

UGA 136. Strategies for controlling groundnut rosette disease in sub-Saharan Africa.

Groundnut rosette disease (GRD) causes the greatest yield losses of any of the peanut viral diseases in Sub-Saharan Africa, including Uganda. This affects economic status of small holder farmers and food manufacturers, and in turn the nutritional needs of the populations. The breeding program developed and released two new cultivars in 2010 that have farmer, processor, and consumer acceptance. The germplasm was introduced through this project in 2003 from the ICRISAT/Malawi program that resulted in earlier releases such as the Spanish cultivar 4T. The cultivars were Serenut 5R and Serenut 6T with resistance to GRD, early leaf spot disease and drought tolerance. Seed increase programs of the desirable cultivars were underway and seed were being disseminated to farmers. These cultivars will help reach a more full adoption of GRD resistant cultivars grown in the country, and will complement the release in the earlier phase of the three GRD resistant cultivars. Serenut 5R was in high demand. New ICRISAT/Mali germplasm obtained in 2008 and 2010 was under test, which will increase the Spanish, Valencia, and Virginia germplasm base for resistance to rosette and other foliar diseases such as late leaf-spot, early (short-season) maturity, drought tolerance, and aflatoxin resistance. The crossing of germplasm with these new and desirable traits (such as seed color, size, and flavor) with local cultivars with the goal of maintaining agronomic traits preferred by farmers and consumers is of priority in the program.

An impact study shows the three earlier cultivars occupy over 60% of the production area and when fully adopted will add $47 million per year to the economy. Demonstration plots, field days, seed fairs and participation in agricultural shows, exhibitions, radio talk shows, workshops and seminars throughout Uganda were educating the farmers in the agricultural practices needed for production of these new cultivars. Included in the cultivar evaluation programs were the six cultivars released under the rosette resistance effort; Serenut1R, Serenut 2, Serenut 3R, Serenut 4T, Serenut 5R, and Serenut 6T. In the annual Source of the Nile Agricultural Show, which attracts farmers, processors and consumers nationwide, and from some adjoining countries, the demonstration of value adding processed products such as peanut butter were included in addition to improved cultivars. Seed of rosette resistant cultivars for multiplication and use by farmers were being shared with Ethiopia, Sudan, Rwanda and other East and Central Africa countries. All six cultivars have been requested by the new country, South Sudan. Earlier Serenut 2, Serenut 3R and Serenut 4T were sent to Ethiopia; Serenut 4T performed best and was in process of release in Ethiopia in October 2011. Development and use of rosette disease resistant varieties in Uganda and other countries in the region is helping to overcome the devastation in peanut production caused by the rosette virus.

Uganda is developing an effective program for seed production, multiplication, and distribution to farmers through seed companies, NGOs, contract farmers, and NaSARRI Serere farm offices. Seed banks in different regions are planned to provide credible sources of new cultivars. Demonstration plots, field days, seed fairs, participation in agricultural shows, exhibitions radio talk shows, workshops and seminars have been used to extend the new technologies.

Improved resistance was observed in transgenic material with active support of the Uganda Government. Approval for testing of the transgenic material was anticipated in 2011, but due to the request for more information by the Uganda approval committee approval was anticipated to allow for 2012 greenhouse tests. All transgenic work for rosette resistance will be done in Uganda. The transgenic lines promise to provide GRD resistance that will not break down as readily with continued heavy disease pressure. Solar panels and batteries have been provided to provide functional laboratories for basic research work.

UF 150. Breeding peanut for disease resistance valuable to Latin America, the Caribbean, and the United States

This project used wild peanut relatives in breeding programs to produce rust and leaf spot resistant peanut germplasm and cultivars. The gene pool of wild species is strong in resistance to many plant diseases. Rust screening began with 48 lines in 2008 and with 90 lines for leaf-spot resistance in 2009. A sub-set of 22 selected lines were tested in Florida in 2010-2012. Seven lines were sent to Guyana and 44 lines to Bolivia for the 2011-2012 seasons. Results are not complete, but are anticipated to improve the germplasm base in all three countries and result in the release of new cultivars. This team of scientists has been successful in bringing these genes into cultivated plants, which is a major step forward in breeding programs working with wild species. The result is two lines displaying little or no rust and very little leaf spot diseases. If confirmed in field test studies in Bolivia where a history of these diseases exist, there should be a significant acceleration in the development of rust and leaf spot resistant cultivars and a greatly improved peanut production. Similarly, lines resistant to rust and leaf spot are being tested in Guyana. In 2011, it was not possible to get the lines into Haiti. A project visit to Bolivia in 2012 shared the project progress with U.S. and Bolivian participants, and the collection and return to the U.S. of seed of several favorite cultivars in Bolivia to add to the U.S. collection of germplasm with necessary quarantine procedures. Discussions with ANAPO personnel included sending a list of wild peanut germplasm and potentially exchanging material that is not available in the U.S. collection. Technology transfer activities included field and laboratory demonstrations by U.S. scientists, such as aflatoxin testing, controlling plant disease, and weed control.

NMS 172. Global Valencia peanut niche market development program

Valencia peanuts are a niche, in-shell, market crop that produce three or more peanuts per pod and have a sweet attribute, and were a preferred type in Uganda, but have diminished in production because of susceptibility to groundnut rosette disease and other diseases. The project has a goal to reintroduce and expand Valencia production. Genetic diversity was shown in the molecular characterization of 114 Valencia peanuts (78 accessions from the U.S. Valencia core and 35 accessions from global mini-core and one control cultivar from ICRISAT) representing various geographical regions of the world. An additional 75 accessions from ICRISAT have been screened for rosette and leaf spot resistance at Serere, in Eastern Uganda, and a few of these lines showed resistance. This genetic diversity was being used in breeding Valencia cultivars for higher yields, drought resistance and reduced diseases. A study growing 80 plant introductions from the U.S. Valencia core collection using full and limited irrigation showed eight that performed better under limited irrigation conditions, a major development in identifying drought tolerant peanut germplasm.

The newly developed breeding lines of Valencia market types are in advanced stages of evaluation prior to their evaluation in the "National Performance Trial" for release in Uganda. Seed increase of the promising lines is underway to provide enough seed stocks once either of the lines in approved for release. Efforts are also underway to combine resistance to late leaf spot and rosette virus diseases into the improved genetic background with Valencia characteristics. About 30 crosses were made involving elite Valencia cultivars from the USA and ICRISAT with local cultivars, and presently there are about 400 populations from these crosses.

New Mexico State University will release its first high oleic acid peanut cultivar "NuMex-01, which originated from a cross between "Valencia-C" and OLin from Texas A&M University. Yields were about 20% higher than the common cultivar. The oleic to linoleic acid ratio ranged from 18-25:1 compared to 1-2:1 in the control, which will provide high market value for the "NuMex-01".

UF 157. Systems approaches to enhance peanut production under resource limitation

In Burkina Faso and Ghana, systems approaches to enhance peanut production include use of new herbicides and fungicides, optimizing use of hand-weeding relative to herbicides use, and using enhanced spraying equipment. Multi-location peanut cultivar trials under Peanut CRSP sponsorship show that because production was of higher value, fungicide use results in 70% pod yield increases and improves labor productivity--even without herbicide use. Research in the 2010 and 2011 seasons showed yields of improved cultivars about double that of the standard, short-season check cultivars. Also during these years, continued fungicide and fungicide trials showed herbicide and fungicide benefits. Results from two locations each in Ghana and Burkina Faso continued to show the clear advantage of the improved lines (near double in yields, 15 days longer to maturity, and greater leaf-spot resistance). There is long enough growing season for the longer maturing material, but farmers will have to accept the longer maturity against shorter season varieties. Two of the lines have been released in Ghana as named cultivars "NkateSari and Gusie Balan". Four herbicides were tested at two locations in Ghana in 2012, and two of them (pendimethalin and basagran) provided near acceptable weed control without hand weeding. Herbicide and fungicide trials in Burkina Faso are providing promising results. The results of the research will form the basis for cropping system models to apply the information across wide regions in the countries.

UF 155. The development of the peanut sector for Guyana and selected Caribbean countries

Protocols were established in Guyana for on-farm packaging, inventory, insect control and aflatoxin assessment to ensure that peanut quality is maintained during handling and storage to processing of peanut butter, including the construction of state-of-the-art storage and processing facilities that address these parameters. Farmers want improved cultivars, and they cooperate in on-farm research to develop practices to produce alternate or intercropped species. The farmers understand the value of the research and how field trials are conducted. A technical manual, with working protocols for the processing equipment and facilities was developed, including training of the cottage industry personnel to control aflatoxin contamination in peanuts through harvest to manufacture of peanut butter. The outcome was the growth of the cottage industry from seven to 43 villages selling high quality nutritious peanut butter in school lunch programs and also in local sales to a consumer driven market, which brings 75 million Guyana dollars annually into the local economy. Production research to maintain a flow of produce to the market is a component of the project, but has been hampered by weather and other factors.

In Haiti, work was initiated to improve farming practices, and reduce aflatoxin contamination in peanuts. Work has addressed new cultivars, along with other production practices. A production guide developed, produced and distributed in Guyana, was translated into Creole and distributed in Haiti. On-farm research continued in 2012 in Haiti with the in-country partner Food and Meds for Kids. The evaluation of peanut germplasm/cultivars for rust resistance continues to be a large and successful effort with rust resistant cultivars from ICRISAT. Aflatoxin continues to be problematic with efforts to address the issues with storage and proper training. Assistance with the processing facility, including fine tuning and efficiency has been provided. The ability to obtain adequate peanut produce continues to be an issue, but locally based cooperatives might be a possibility to collect produce and encourage farmers to increase production.

Cropping system research in 2012 in Guyana successfully intercropped peanut and cassava, but maize was detrimental to peanut probably because of excessive shading. Peanut cultivars introduced are being grown by local farmers, not due to yield, but rather pod architecture and ease of harvest. Smaller plants of the introduced cultivars should contribute to the adoption of mechanical threshers, difficult to use with the large plants in common cultivars. A small gas dryer was well accepted by farmers, and appears to be a valuable asset to farm communities. Even though aflatoxin levels remain low in whole roasted peanuts and peanut butter, better storage and bagging techniques need to be developed. The Grain Pro bags introduced earlier have not been accepted well by farmers; one problem was the difficulty of sealing the large bags by the cottage industry personnel. A streamlined procedure for aflatoxin testing that uses Vicam test kits continues to be developed. Studies to analyze the overall impact of increased peanut production and the associated cottage processing industries and school-lunch program is underway. Economic analysis should provide growers with a better framework to plan an integrated farming approach, which is lacking in many rural Guyana communities.

In 2012, efforts will culminate to provide: 1) updated production guide, 2) economic assessment, 3) posters and tech-packs in several areas of peanut production and utilization, and 4) final survey of social impacts. The project provides an excellent framework to develop an integrated approach centered on peanuts that can be employed in other regions and countries. Utilizing locally grown peanuts and other crops, a facility (cottage industry) to provide value-added products and proper market development are the keys to this success.

UCN 139. Improving livelihoods of farm households in peanut-based farming systems in East Africa

The objective of this project was to improve the likelihood that households will be successful in using the technologies of peanut-based farming systems in East Africa, Uganda and Kenya. The challenges include instituting ways to bring research developments, via training and technology transfer, for better farming practices to conserve soil fertility, promoting advances for increased yields, adding value by improving quality to enhance market expansion, and in doing so, raising peanut output because of increased demand and strengthening participation by women in agricultural programs of the farming communities. Training workshops and application of surveys to gather baseline data on farm practice were valuable to train host country participants in interviews and survey analyses. The U.S. and HC principal investigators have gained greater insight into working with colleagues/teams and communities in both Kenya and Uganda. There have been lessons learned on the implementation of peanut farming systems in both locations, which will benefit expanding efforts in Uganda and Kenya and other geographical locations. For example, a training session was held in Kenya entitled: "Enterprise budgeting, whole-farm budgeting, cost of production estimation, and breakeven and profitability analysis", which trained participants from the Kenya Agricultural Research Institute and the Ministry of Agriculture. A similar activity was held in Uganda on "The Analysis of Cost and Profits for Farm Enterprises". A session on groundnuts/peanuts was organized by the project at the 12th KARI Biennial Scientific Conference in Nairobi. This has resulted in showing the importance of human capacity development, which will have long-term impact of Institute and Ministry personnel to help improve farm enterprise development and profits.

NCS 131. Improved West African peanut production for enhanced health and socio-economic status through the delivery of research-based production systems in Ghana

Pests decrease yield, quality and safety of peanuts for farmers and consumers. The work of this project was to identify, document, and strategize ways to minimize their impact, especially with regard to aflatoxin contamination in the field during harvesting, handling and storage. Via multidisciplinary research efforts, some U.S. information was transferred to Ghana, and has ameliorated the effects of diseases and insects.

IPM practices impact production systems and produce effective, efficient and minimal pesticide use, including application practices that protect workers, the environment, and food supply. Two new cultivars that would contribute to decreased production costs were released in Ghana in 2012, which have greater drought tolerance, and are more competitive against weeds, produce higher yields, and are less susceptible to leaf spot, rust, and insect pests. They also produce a consistent level of yield under varying environmental conditions. The result should be control of *Aspergillus* fungi (the source of aflatoxin) contamination due to soil pest damage of developing pegs, pods and seeds inside pods.

The introduction of the NGO-full belly project's peanut sheller has relieved the burden of hand shelling which should result in increased production through increased planting acreage and better timing of marketing. The shellers have been met by much enthusiasm, and the farmers are discussing the development of their own industry to build them. From 2010-2012, groundnut shellers were fabricated by CSIR-CRI mechanics for distribution to groundnut IPM farmers who participated in the Farmers Field School organized under the Peanut CRSP activities. Shellers were distributed to farmers in six villages in three regions. The quality of peanut in the market is greatly improved with less damage and aflatoxin contamination. The use of planting in rows, germination testing, leaf spot control and timely harvesting are four technologies that added to production, processing and marketing that was vastly improving Ghana's peanut industry, and have been extended to farmers through Farmers Field Schools. Recent socioeconomic studies and a current study document the economic impact of increased cost effective peanut production in Ghana.

Recent focus in North Carolina has been on the development of decision making tools for farmers and refined pesticide use. Current control practices and production methods were surveyed and evaluated as cultural practices to reduce pest problems such as CBR and tomato spotted wilt virus. In 2010 and 2011, several projects focused on pesticide interactions and the development of alternative approaches for old chemistries still in use. This effort was accelerated with the sudden cancelation of the registration for Temik (aldicarb) as an "at-plant, in-furrow" insecticide. At this point no alternative for Temik has been identified that provides the same consistency of control as Temik. A new cultivar, Perry, yields well and is popular with farmers, but is susceptible to tomato spotted wilt virus. But farmers are committed to use IPM practices to control the virus, which enables the use of the cultivar and shows the value of cultivar development and IPM cooperation.

B. Processor values

Due to the fiscal uncertainty over the first 30 months of this agreement, the funds for projects in this area were delayed until clarity was achieved and the program was assured of expanded funding. Thus these projects were initiated in 2011 and their achievements need to be considered within the context of that late start.

UGA 127. Enhancing the peanut value chain, from processing to marketing of peanuts and peanut products-processing
UGA 165. Enhancing the peanut value chain, from processing to marketing peanuts and peanut products – economics/marketing
UGA 166. Enhancing the peanut value chain, from processing to marketing peanuts and peanut products-product development

A suite of three projects (UGA 127, UGA 165 and UGA 166) were established by the University of Georgia principal investigators, as a University of Georgia global peanut product development, processing, and marketing

Team (UGAGP3MTeam). The team established a seamless communication web-site uga.gp3mt@gmail.com. The goal was to transfer their Peanut Industry Incubator Model (PIIM), a successfully developed Peanut CRSP funded protocol in Southeast Asia (in the Philippines and Thailand), to East and West Africa, through collaboration in Uganda and Ghana. The Southeast Asia work included proven successful handling, storage and sorting methods, farm to market, resulting in new and existing aflatoxin-free peanut foods processed by both small and large food manufacturers. Fund limitations delayed the implementation of these three projects until 2010.

The HC collaborating principal investigators in Ghana and Uganda were identified. Information from the Southeast Asia program and published in the Peanut CRSP Monographs and in scientific journals will be used. Identification of potential marketing opportunities for these peanut-based products was continuing with survey instruments, including questionnaires to find out what peanut foods are of most interest to the consumers. The importance of the surveys was to build a baseline to develop a market-pull emphasis of consumer desires, accomplished through collaboration with the food manufacturers. Protocol training for the surveys was carried out. The surveys involved more than 1000 households in both Ghana and Uganda to directly identify market opportunities for new and modified peanut products. The summary of the survey results from Uganda showed the overwhelming preference for peanuts and peanut products; 98% liked them, 92% would eat more if they could, and a 97% preference for peanut paste/butter. Ghana preference was for peanut butter use in soups, while Uganda preference was as peanut butter, which will affect the direction of research in the two countries. Moreover, the surveys showed a strong support for development and use of vitamin A fortified peanut butter (40% of children in the Sub-Saharan Africa and other countries are reported as deficient in vitamin A, which among other things affects eye-sight). Market diversity of products was identified as a concern and aflatoxin content of peanuts was a major problem. Foreign material and rancidity are quality problems identified, along with thickness or viscosity (stabilization) of peanut butter. Based on questionnaires, plans were made to develop three nutritionally enhanced foods, vitamin A fortified and stabilized peanut butter, stabilized peanut butter and chocolate-peanut butter spread. In addition, the project has identified nutritious peanut cookies and fiber-enhanced peanut butter and peanut soup.

Verification of hand-sorting for aflatoxin control in products has been completed in Ghana, and researchers have been trained. Development and commercialization of groundnut cookies, and stabilization of peanut butter was underway in Uganda. As part of the strategy to increase probability of adoption and commercialization by industry partners, early engagement, periodic meetings for updates and inputs was carried out between the host country researchers and the industry partners.

In 2012, working relationships were developed with four research institutions and six industry collaborators for implementing improved peanut products and processes. The Ghana household survey data summary and analysis strongly supported the development of a peanut soup base with the University of Ghana and Nkulenu, the industrial partner, which met domestic and international safety regulations. The household survey in Uganda confirmed high preference for cookies making peanut cookies a nutritious food product that is convenient, shelf-stable and portable. The Vitamin-A fortified chocolate peanut spread manufactured by Food Engravers fits the market niche of the urban consumer in Uganda; the product is nutritious and of high value and fills the need for the product that fits the urban lifestyle focused on convenience in food preparation and consumption. Hand sorting of peanuts to eliminate aflatoxin to promote public health was implemented in the commercial processes. Previous accomplishment in product development and link with processors experienced in the U.S., Southeast Asia and Eastern Europe were extended to Ghana and Uganda, which contributed to more rapid technology transfer. Early engagement of industrial partners was utilized in the survey, selection of potential products, and development of products and moving them to consumers. Host country researchers gained much valuable knowledge and experience in research methodologies for surveys, product development, engaging commercial interests in the process, and marketing to consumers. Food Fairs in Ghana and Uganda were valuable in collecting consumer data and insights for product development and distribution. Management of processing costs and product prices was a major factor in the work.

C. Consumer values

(a) Aflatoxin

COR 158. Innovative Procedures to Protect Therapeutic Foods from Aflatoxin in Developing Nations.

In Haiti, Peanut CRSP supported development of specialized equipped laboratories, trained technicians and implemented farm to market processes in a special coordinated effort to sort and monitor from field to processing removal of damaged, high aflatoxin contaminated peanuts. Results from preliminary questionnaires were used in Port au Prince and the North to create newer, better diet interviews in Creole and French.

Aflatoxin levels of peanut acquisitions were studied for 24 months. Blood samples taken from a clinic indicated that adults were ingesting aflatoxins. The results of the aflatoxin training produced high quality peanuts with aflatoxin profiles at reduced levels to below U.S. and European standards (5ppb) in peanuts and peanut products. The process enabled the NGO-Meds and Foods for Kids to reduce in like manner the aflatoxin content in their peanut-based ready-to-use therapeutic foods (RUTFs), Medica Mambo. The results are reversing childhood malnutrition in thousands of children with a product that does not suppress immunity, interfere with nutrient absorption, and cause liver cancer.

The process began of contacting manufacturers to offer advice on product improvement. A compliant manufacturer in Cap Haitien used acquisition and sorting techniques learned at our collaborating RUTF manufacturer, a small indication that techniques are and will be transferable. Work delayed by the earthquake will continue to determine the extent of aflatoxicosis in pregnant women seeking testing in AIDS clinics, which suggests a nutritional approach to HIV intervention. Although also delayed by the January 2010 earthquake, urine samples have been taken from children to study aflatoxin levels in malnourished children.

Fast, lower cost ways of assessing biomarkers have been developed, some of which can be used in Haiti. Biomarkers for aflatoxin ingestion can be determined in urine from pregnant women and malnourished children.

Research under this project has demonstrated that utilizing Peanut CRSP-recommended practices, and evolving new practices developed with support and guidance from Peanut CRSP-created laboratories and Peanut CRSP-educated technicians result in the safe production of peanut products of very high microbial quality, virtually free of mycotoxins in a country with very few resources, difficult logistical circumstances, from a raw peanut supply with a very high level of contamination. RUTF and other high value products do not need to be imported, they can be made locally, increasing the educational, workforce, and industrial capacity of the country (in this case Haiti) that needs the products to reduce the nutritional consequences of extreme poverty. The cost of monitoring and disposing of subpar quality products are far higher when the major incoming ingredient (raw peanuts from local harvest) is heavily contaminated with mycotoxins than when there are relatively few peanuts to reject. For this reason a major consequence of the results concerning monitoring peanut quality is a shift in emphasis from merely catching contamination at the factory gate and loading dock to preventing contamination with aflatoxin and chemicals needed to control it upstream in the field. Methods have been developed to remove most of the aflatoxin from peanut oil and peanut press cake from seed rejected for probable aflatoxin content.

Evidence was compiled through 2012 that peanuts are the most important source of ingested and metabolized aflatoxin in a Haitian population and that corn contributes as well. Detectible levels of aflatoxin biomarkers in their bloodstream were found in 135 out of 178 subjects tested. Haitian staff, once educated about the importance of aflatoxin control and how to accomplish it, can reduce the concentration of this toxin in the general commercial peanut product stream and virtually eliminate it from high value, medical quality therapeutic foods. Peanut and peanut products continued to be monitored from farms and markets; aflatoxin levels continue to fall where processors have been make aware of the problem, but new processors still sell products with very high levels of aflatoxin and most exceed U.S standards. A few are producing products at or near 20ppb aflatoxin. Infrastructure and personnel are in place, and with continued training and advice, government laboratories could monitor aflatoxin in the food chain; but in general, the laboratories are non-functional. This could be accomplished by the project in a few months for less than $100,000. If the U.S. support groups are serious about transferring research and health functions from NGOs and aid agencies to the Haitian Government, this represents an excellent and viable opportunity.

UAB 148. Association of aflatoxin biomarker levels with health status and HIV disease.

Association was found between aflatoxin exposure and poor health status. In Ghana, the research team established the association between high aflatoxin B1 albumin (AF-ALB) levels in pregnant women, birth outcomes, and anemia. It was found that 100% of the women had AF-ALB in their blood. With regard to birth outcomes, pregnant women with aflatoxin levels in the highest quartile were twice as likely to have low birth weight infants when compared to women in the lowest quartile. There was a trend of increasing risk for low birth weight with increasing aflatoxin levels. This association remained after adjusting for known confounders, including malaria parasitemia, anemia and worm infections. Aflatoxin also increased the odds of pregnant women developing anemia in pregnancy, with an 85% increase from the lowest to very high AF-ALB category, which suggest that the prevalence of anemia among these pregnant women is associated with AF-ALB levels in their blood.

Results showed that high aflatoxin levels appeared to accentuate some HIV-associated changes in T cell phenotypes and B cells in HIV positive people. The loss of T regulatory cells (Tregs) in HIV positive people with high aflatoxin levels may facilitate HIV associated immune hyper-activation and lead to more severe disease and faster disease progression. The intensive, multifaceted studies at clinical and immunological levels along with investigation of disease progression over time are proving extremely valuable in understanding these relationships, and allowing development of appropriate and targeted strategies to decrease the rate of progression of HIV disease in infected people. A short-term biomarker of aflatoxin exposure (AFM1) and fumonisin exposure (FB1) in urine (developed in cooperation with TAM 149) was used to measure the effects on concentrations of vitamin A and E in Ghanaians. The study demonstrated that participants with high AFM1 had significantly lower vitamin A concentrations and marginally lower vitamin E. Conversely, AFB1 was positively associated with vitamin A and vitamin E. These data indicate that aflatoxin may modify plasma micronutrient status. Thus, the prevention of aflatoxin exposure may greatly reduce vitamins A and E deficiencies.

By the identification of the effect of aflatoxin on HIV immune and clinical status, appropriate and targeted strategies can be implemented widely (in Ghana and in developing country populations worldwide) to decrease aflatoxin intake and possibly decrease the rate, and progression, of diseases as noted in 2011 studies. Further, because of the immune suppressive and other health effects of aflatoxin, the effect of antiretroviral therapy (ART) in delaying AIDS may not be as great in populations of developing countries who are exposed to the toxin as it is in unexposed groups. This also raises the question of the benefit of current vaccines (and the benefit of a potential HIV vaccine) to people in aflatoxin exposed regions of the world, since aflatoxin suppresses the immune responses to vaccinations. For all of these reasons, this study of HIV disease progression associated with aflatoxin exposure is a highly significant and urgent area of research.

The investigation on the association between AF-ALB and TB infection demonstrated, for the first time, an association between aflatoxin levels and an increased hazard for developing TB in HIV positive individuals. This increased hazard result represents an important addition to the body of knowledge on the harmful effects of dietary aflatoxin exposure in individuals with HIV.

The longitudinal design of the 2011 study provides certain strengths over previous studies in the project. It will allow bias to be avoided in measuring exposure, determine time sequence between exposure and disease progression, study multiple exposures and multiple outcomes, and calculate progression of disease in relation to level of exposure.

AUB 163. Aflatoxin financial and health risks along the peanut marketing chain in Ghana

In Ghana, aflatoxin management strategies for peanuts during storage were implemented and evaluated for their effectiveness. The findings showed there was increased awareness among project participants in the importance of quality peanuts in the marketing chain, i.e., the effects of aflatoxin contamination on peanut profitability. Interest was not generated in aflatoxin management without the assurance of improved profits. This led to an increased adoption and use of improved storage facilities and many farmers disinfecting their storage facilities. These findings also sent out important signals to policy makers and agricultural officers on policy formulation to encourage fabrication of efficient and affordable storage structures, and to adopt improved storage techniques to reduce aflatoxin contamination in peanuts.

The studies conducted in 2011 showed that a large percent of the farmers already use improved storage technologies. The farmers indicated that most of them had been in contact with Non-Governmental Organizations (NGO's), who assisted them in improving already locally designed storage technologies that enabled them to reduce spoilage and losses by almost 50%. Market participants were willing to pay a premium of up to 33% of the present market price for a cleaner and safer product. These results provided policy makers with new information and incentives to reduce contaminated peanut. Since younger farmers based on the number of years of experience, were more likely to adopt technologies to improve aflatoxin reduction technologies, more effort should be focused on this group of farmers. It was also demonstrated that cooperative membership was an effective means of technology diffusion. Hence, peanut producers should be encouraged to participate in cooperative meetings and workshops. Overall, it is perceived that both producers and consumers will support aflatoxin standards, since producers will not lose profits and consumers will receive health benefits from products with lower aflatoxin levels.

It was shown that women play a major role in food production and safety in Ghana. They also contribute to post-harvest handling of peanuts. However, the women who participated in the study have less formal education and have little knowledge of aflatoxin contamination of peanuts. This sends a message to policy makers that in order to reduce the aflatoxin problem women must be educated on the problems of aflatoxin in peanuts in Ghana.

TAM 149. Enterosorbent intervention therapies for populations at risk for aflatoxin-related diseases

To evaluate aflatoxins management strategies, investigators used both animal and human trials to evaluate the safety, effectiveness and acceptability of a refined Novasil (NS) product for the reduction of aflatoxin exposure in the diet. The investigators first compared effectiveness of numerous edible clays available in Ghana, which showed that the refined clay was the best binder of aflatoxins. Studies demonstrated that Uniform Particle Size NS (UPSN) was more desirable for further work due to uniformity between batches and enhanced palatability. USPN is refined for a food additive to a smaller and more uniform particle size with less quartz and larger particles that might influence palatability. Both animal and human intervention trials indicated that dietary inclusion of UPSN at levels equivalent to 0.25% in the diet did not result in overt toxicity and significantly reduced biomarkers of exposure to aflatoxins from urine and blood. Work in animals and humans has shown that NovaSil and UPSN clays do not have strong interactions with, nor interfere with, the utilization of important vitamins and minerals.

The mineral identification of edible clays collected in different markets in Ghana was completed in 2011, because these clays are suspected to contain higher levels of available heavy metals that could potentially affect human health. The *in vitro* sorption ability of five types of smectites was investigated. Preliminary data indicated that clays from the same mineral group as NS have a similar ability to sorb aflatoxins and fumonisins. NS and USPN, both montmorillonite clays, have been shown to have higher aflatoxin and fumonisin sorption capacities than the kaolinites, attapulgites, and xeolites. It is important to understand the specific characteristics and mechanism(s) of toxin sorption to clay surfaces that make montmorillonites the best enterosorbents for aflatoxin and fumonisin. These differences are discussed in recent publications.

A variety of strategies for reducing aflatoxin contamination in food and feed have been reported from various research sources. These include the use of competitive fungal species, establishing drought resistant crops, food processing and sorting and improved storage processes. However, none of these methods are suitable as therapy to alleviate acute aflatoxicosis and reduce lethality. Toxin enterosorbent intervention with clay has the capability to rapidly impact exposures and rescue individuals suffering from acute and sub-acute aflatoxicosis similar to those reported in Kenya in 2004 (where 317 people were hospitalized and 125 died due to aflatoxin consumption).

UGA 145. Development of methods of establishing a global network for aflatoxin exposure

The biomarker analysis technology previously developed was used to determine aflatoxin biomarker levels in blood serum from subjects in the West African countries of Burkina Faso and Ghana. The technology is a highly sensitive, non-antibody, non-radioactive and non-mass spectrometry based analytical method for rapidly measuring, at low cost, serum and urine aflatoxin B1 (AFB1), lysine (AFB-LYS), and fumonisin (FN) biomarkers using HPLC technologies. One of the novel achievements of the project was the establishment of the capacity for estimation in food, as well as biomarker based, of aflatoxin and fumonisin exposure at the Noguchi Medical Research Laboratory, in Accra, Ghana.

During 2011, animal studies were conducted to validate the newly developed method for measurement of AFB-LYS, and to explore immune toxic effects of aflatoxin exposure in animals treated with single dose and repeated doses. Detailed data analyses reported in 2012 demonstrates that liver GST-P+ cells and foci are sensitive biomarkers for AFB1 toxic effect and correlated with bile duct proliferation and biochemical alterations in F34 rats, which hold promise as potential target for future intervention strategies. AFB1-lysine adduct samples over several years were analyses on samples in Uganda in cooperation with the British Medical Research Council/Uganda Unit and RAKAI Health Program, which clearly demonstrated temporal pattern of aflatoxin exposure in rural human populations in Uganda. Co-contamination of aflatoxin and fumonisin in food and human dietary exposure was determined in residents in three different areas of China, and co-contamination was found in corn, rice, and wheat flour. Based on measured food consumption data, the co-exposure to aflatoxin and fumonisin in residents of rural China may contribute to the etiology of human chronic diseases in high-risk areas.

VT 134. Improving the health and livelihood of people in East Africa by addressing aflatoxin and gender-related constraints in peanut production, processing and marketing

Capacities for estimation of food-based *Aspergillus* fungi growth and aflatoxin contamination were established in Uganda and Kenya. Therefore, aflatoxin contamination data were generated for peanuts and peanut butter products on farm, and at the processor and market place levels in these countries. The aflatoxin contamination data and peanut consumption data determined in Uganda were utilized by the Uganda government agency responsible for standards (UNBS) to set maximum limits (MLs) for management and control of aflatoxins in peanut and peanut products.

In both countries, training processors and traders on Hazard Analysis Critical Control Points (HACCP) was conducted through workshops and the technology implemented for reduction of aflatoxins in peanut based foods. Information, Education and Communication (IEC) materials on management of aflatoxins in peanuts were developed and presented to stakeholders through farmer meetings and distribution of informational materials with the assistance of a key women's organization. Large numbers of people were made aware and trained in aflatoxin-associated problems and management each year of the project in both countries.

In Uganda in 2011, more peanut traders and processors especially those from the Groundnut Eastern Block were interested in implementation of HACCP and have contacted project participants for training. Clean and safer peanuts are sold within the region and the safety of the bentonite clays in Uganda has been established. More women are now registered with NAWOU and can get benefits from this organization, while more scientists are aware of the activities done by the Peanut CRSP on management of aflatoxins. More collaboration has been established with scientists and organizations addressing food safety. One publication on farmer peanut stories from Mubende has been completed and will scale up the impact of the Kamuli stories.

In Kenya, preliminary results indicate that the storage conditions and containers of peanuts significantly influence the quality of peanuts, which will help in creating awareness both at household levels and markets on storage conditions which will help maintain peanut quality during storage. This information would also be useful in planning for intervention strategies. The hands on training in DNA extraction techniques will go a long way in establishing the diversity of cultivated peanuts in Kenya. It may also contribute to the search of peanuts with useable sources of resistance against aflatoxin contamination. Data generated will help in accessing the risk of aflatoxin contamination in the peanut value chain, and will be used to develop a HACCP plan for the cottage industry in Kenya and building capacity of small scale processors to implement HACCP. The study would be equally useful in planning for intervention strategies.

A handbook has been developed for teaching peanut farmers and extension personnel in the ministries of Public Health and Agriculture. A concurrent video will be aired on one of the leading television channels in Kenya. The information provided will sensitize farmers, traders and end users on peanut handling aspects of quality and marketing. Additionally, the information should increase awareness of the health implications of aflatoxin, and the aflatoxin influence on economic development.

In 2012 in Uganda, continued sampling of peanuts in markets show substantial reduction in aflatoxin. This has helped women farmers market their products. Strategies to address aflatoxin problems in Uganda have been shared with scientists within and outside Africa through presentations in scientific meetings, with scientists continuing to appreciate the role Peanut CRSP plays in management of aflatoxins in Uganda. This role has been strengthened by Dr. Kaaya becoming a registered member of the African Mycotoxin Network and Partnership for Aflatoxin Control in Africa. Impact studies by a graduate student reveal that HACCP training for small scale processors facilitated by the Peanut CRSP equipped them with knowledge to implement HACCP plans to produce good quality and safe products. Women in East and Central Africa have continued to participate in the research and education activities of the project, which has enhanced women's sense and capacity for productivity as well as making visible the values of groundnuts/peanuts in daily lives, such as nutrition and economic value.

Together with Uganda Consumer Education Thrust (CONSENT) a draft petition entitled "Millions at risk of death from poison in our food: A wake-up call to stem exposure of vulnerable people to deadly aflatoxin in the food value chain" has been written in 2012. This will be taken to the parliament of Uganda and to other relevant policy makers including Government Ministries and NGOs for possible alliance towards aflatoxin elimination campaigns.

The significance of the research and awareness campaigns can be seen from the potential for larger markets for high quality peanut products from the region, through the reduction of aflatoxin contamination in peanuts and peanut products. Assistance in the implementation of good manufacturing practices through Hazard Analysis at Critical Control Points (HAACP) program will improve product quality that translates to improved livelihoods through the increase of revenue.

UF 155. The development of the peanut sector for Guyana and selected Caribbean countries (associated project from producer values)

In Guyana, Peanut CRSP funds have assisted U.S. and host country (HC) principal investigators and their collaborators to establish on-farm packaging, inventorying, insect control and aflatoxin assessment programs to assure peanut quality is maintained during handling, storage and processing of peanut butter; this includes construction of state-of-the art storage and processing facilities that address these parameters. A technical manual, with working protocols for the processing equipment and facilities was developed, including training of the cottage industry and entrepreneurs for controlling aflatoxin contamination in peanuts through to manufacture of peanut butter. As a result, the cottage industry has expanded from seven to 43 villages in Guyana providing peanut butter for school feeding program, and because of strong market pull from the consumer has resulted in commercial sales in the villages, which create a steady income, thereby enhancing economic growth in Guyana. Over 1400 snacks were produced per day and they generate $75 million Guyana dollars in the region per year. Even though aflatoxin levels remain low in whole roasted peanuts and peanut butter, better storage and bagging techniques need to be developed. A streamlined procedure for aflatoxin testing that uses Vicam test kits continues to be developed.

In Haiti, work was initiated to improve farming practices, and reduce aflatoxin contamination in peanuts. Work has addressed new cultivars, along with other production practices. A production guide developed, produced and distributed in Guyana, was translated into Creole and distributed in Haiti. Aflatoxin continues to be problematic with efforts to address the issues with storage and proper training. Assistance with the processing facility, including fine tuning and efficiency has been provided. The ability to obtain adequate peanut produce continues to be an issue, but locally based cooperatives might be a possibility to accumulate and market the peanuts.

(b) Nutrition

UGA 122. Aflatoxin-free peanut-based recovery and functional food

Low viscosity, drinkable pre-enzyme digested ready-to-use therapeutic foods (RUTFs), highly nutritious, and easily digestible, formulations have been developed in Ghana and Uganda. In Ghana, the formulation is made with peanuts, cowpeas and rice ingredients, all major crops in this country. In Uganda, a number of crops, peanuts, amaranth, orange-fleshed potatoes, cowpeas, sesame, corn millet, sorghum and bananas are included. The nutrient-rich, microbial safe, and stable-long shelf life foods were fortified with vitamins A, C, and zinc. The physical (functional) chemical (including essential amino acids), energy, and sensory properties of the formulations meet international food and nutrition standards for human use. The addition of probiotic cultures and HSCAS clay (NovaSil) to remove aflatoxin contamination are planned for additional nutritional quality. Under the direction of a nutritionist, test feeding studies of the RUTF formulations are underway. Projected outcomes are to help resolve malnutrition issues affecting adults, children and infants due to food shortages, food insecurity, conflicts, and infectious diseases including HIV/AIDS.

There is pending outreach to commercial companies in 2011 that will set the stage for the production of the project formulas for RUTF at distribution scale. Animal and human studies are currently underway to evaluate and confirm the nutritional and health-promoting efficacy of project-developed products, and if confirmed the project will have shown the foundation for the design and production of targeted foods for any at-risk population anywhere in the world.

The establishment of the Mother Administered Nutritive Aid (MANA) company in Georgia has provided an invaluable opportunity to link with a non-profit company, manufacturing peanut butter-based RUTF for sale, to NGOs such as WHO and USAID for distribution in areas with severe malnutrition. The stage is set for a formal agreement between the company and both the Peanut CRSP project and the UGA Food Product Innovation and Commercialization Center. It is anticipated that joint research proposals will provide funding for developing new forms of RUTFs and RUSFs and that UGA pilot plant facilities will be able to produce amounts of these products for evaluation prior to large scale production.

In summary, the research culminated with the production of the RUTF and RUSF (Ready to Use Supplemental Foods) in adequate quantities for chemical-nutritional and sensory analysis as well as a large scale human feeding trial. Results indicate that the overall strategy of designing, producing, and thoroughly evaluating computer generated, nutritionally optimized, least cost products was sound and feasible. These products can be made from indigenous crops in Africa (and elsewhere) without the need for expensive, imported milk or other animal products, although supplementary vitamins, minerals and possibly key amino acids (e.g. lysine) must also be supplied. The resulting products were acceptable, nutritious and producible by available, appropriate technologies such that outreach to entrepreneurs to allow commercialization is now feasible. The training efforts (graduate and short-term) have developed the expertise in Ghana and Uganda to continue the work.

At least twelve different RUTF/RUSF products have been designed and produced by feasible processing technologies and at moderate to large pilot scale in the U.S., Ghana, and Uganda. This information is available to private food companies/entrepreneurs, ministries of health, NGOs, etc. to facilitate the large scale production of these products.

PUR 151. Peanut consumption and human weight management

In Brazil, studies showed that inclusion of peanut butter with breakfast helped control appetite and blood sugar in obese women. Data documenting the mechanisms that account for these findings were helping to reinforce the role peanut ingredients play, and the inclusion of peanut butter with breakfast may help to moderate appetite and glucose concentrations in obese women. Also evidence shows peanuts consumed in moderation do not pose a threat to weight gain allowing the recommendation to consume, in moderation, peanuts and/or peanut products. The improvement of the market perception of the healthiness of peanuts is key to expanding their consumption in the U.S. and worldwide. Preliminary analyses show in U.S. and Brazil studies that peanut consumption was associated with marked reduction in blood pressure. Cardiovascular disease is a pressing health problem globally. If this work is confirmed, it will create a strong demand for peanuts and peanut products.

A study underway in 2011 will explore ways to enhance compliance with recommendations to increase peanut consumption in the population. Questions were raised regarding the impact of sensory monotony on dietary compliance and how this related to different personality traits. The goal was to elucidate these relationships to inform the development of better dietary recommendations to improve health. Implementation will require full analysis of the data, which is expected during the 2012 phase. A new clinical study is underway in Brazil to provide insights on new potential health benefits of peanut consumption, related to antioxidant effects that should reduce cardiovascular disease risk, promote a healthy microflora mix with an array of possible health benefits ranging from reduced obesity to improved micronutrient status and a better understanding of gut permeability with implications for allergy management.

Available findings in 2012 suggest inclusion of peanuts or peanut butter in the morning meal improves day-long blood glucose concentrations and does not contribute to weight gain. Very preliminary results indicate that chronic peanut consumption is well tolerated, thus facilitating greater compliance to public health recommendations to increase peanut consumption. Publication and presentation of the results in professional and public forums distributes the Peanut CRSP supported research to a broader audience, thus should build demand for and increase peanut production. The work also provides clinicians information that may promote their recommendations to patients concerned about cardiovascular disease and diabetes risk to include more peanuts into their diets. This should provide health benefits to the individuals and spur the industry.

D. Crosscutting values – Information and impact analyses

UGA 124. A Peanut information network and train-the-trainer program

A worldwide web-based Peanut Information Network System (PINS), <worldpeanutinfo.com>, was initiated to share ongoing information developed worldwide by the Peanut CRSP and other peanut research organizations, publications, training programs, production practices, peanut -based foods, meetings, workshops and related news and links. Key are links to the research and publication sections of the Georgia Peanut Commissions (GPC), American Peanut Research and Education Society (APRES) journal, International Crop Research Institute for Semi-Arid Tropics journal, the Annual Hot Topics on Peanuts workshop, peanut-specific farming and processing equipment and manufacturers and the USDA germplasm database. Dr. S. K. Sefa-Dedah, HC co-principal investigator, Ghana, has been named to coordinate input from the African countries.

This project has received matching funds ($2000) from the Georgia Peanut Commission on the Hot Topics workshop, and a grant ($7500) from the National Peanut Board through the Southeastern Peanut Research The initiative to study the “Functionality of Peanut Ingredients in Production of Peanut Pancake Instant Mix,” showed the support for this program by the peanut industry. The PINS, during one year had a total of nearly 18,000 visits and over 47,000 hits with an average 49 visits and 130 hits/day. A needs survey was underway to develop an annual Train-the-Trainer program to address peanut production, harvesting and storage practices and constraints. Because of the peanut butter recall from the Peanut Corporation of America, the focus of the speaker presentations on the Hot Topics workshop presented on PINS was on food safety, a topic of worldwide importance.

New information added to PINS in 2011 include; APRES Annual Meeting abstracts from 2003-2010, reports on Georgia Peanut Commission funded research, USDA National Peanut Research Laboratory publications, and increased information in the Producer and Processor Values section. The Hot Topics session during the 2010 Georgia Peanut Tour included presentations on Harvesting and Post-Harvest storage. Seven speakers were on the program and 90 attended the conference. The Georgia Peanut Commission provided $2,500 in matching funds for Hot Topics and a grant from the National Peanut Board provided a grant through the Southeastern Peanut Research Initiative ($17,000) on “Peanut Biscuit Ready Mix as a Nutrient Dense Food”. The 2011 Hot Topics session on the Georgia Peanut Tour was on “Processing and Quality”, with five speakers and 90 people in attendance. The Georgia Peanut Commission provided $2,500 to help support the Session. The principal investigator also received a grant of $5,000 from the Georgia Peanut Commission for “Development of a peanut ice cream mix from peanut flour to increase overall market potential of peanuts.” The 2012 Hot Topics session on the Georgia Peanut Tour focused on “Peanut Diseases” with six speakers and about 100 in attendance and $2,000 in cost shared fund support by the Georgia Peanut Commission. The PINS had a total of 6,013 visits with 11,387 pages viewed from Oct. 1, 2011 to Sept. 30, 2012.

UGA 128. Impact assessment for the peanut collaborative research support program

The achievements of the Peanut CRSP continually generate social benefits and impacts positively on vulnerable groups including poor households and female family members. The project’s objectives, newly underway in 2010, collaborates with principal investigators to specifically document the impact of their ongoing research studies in selected host countries, Bolivia, Ghana, and Uganda. Studies initiated were household surveys in Ghana and Uganda to determine the ongoing benefits of the assigned projects to the poor, medium and rich farmers and female-headed households. This opportunity allows participating principal investigators to include in the outcome of their work not only the science, but also how it is impacting on the lives of the people. Their efforts will include influencing the interests of policy makers.

The research team of this project is expected to provide valuable advice to participating principal investigators and their collaborators on how to collect and analyze impact datasets, including the use of already available data from past projects/phases. The emphasis includes the three Peanut CRSP focus areas, production values, processor values (including aflatoxins and nutrition), and consumer values in the U.S. and selected HCs. This project holds the key to determining if Peanut CRSP projects are successful in meeting the objectives for which they were funded.

In 2011, two household surveys were conducted to document the impacts of the Peanut CRSP as well as intra-household distribution of benefits in Uganda and Ghana. In Uganda, there were 40 villages surveyed with 10 households per village. The survey in Ghana targeted Farmer Field School villages and non-Farmer Field School villages. Second, relevant Peanut CRSP projects were reports and other publications related to work in Bolivia, Ghana, and Uganda to collect the necessary data for ex-post benefits from technology adoption for producers and consumers. Several graduate students were added to do research: 1) study the impact of technology adoption and extension activities; 2) study impacts on food insecurity, and 3) assist in study on benefits of work in Bolivia, Ghana, and Uganda.

Results of the 2011 surveys were analyzed and summarized in 2012.

1) a. In Uganda between 2001 and 2011 the adoption rate of improved groundnut varieties increased from 4.1 to 50 percent. The findings suggest that the cumulative gains since Peanut CRSP began in 2001 are U.S.$41,296,360. Over 70% of the social gains appear in the later period as the adoption rate continued to rise. Overall the research benefits are 50 times the research costs.

1) b. In Ghana, integrated pest management (IPM) practices were introduced since 2002. Estimates amount to a total of U.S.$3,599,459 from groundnut IPM Farmer Field Schools from 2002-2010 both in direct effects on participants and indirect effects of spreading of FFS lessons from participants to neighboring farmers. The ex-ante analysis for the next seven years indicates that consumers benefit more from the decrease in groundnut prices due to increased production than producers gain from having a higher yield. The total surplus for 2011-2017 is estimated to be U.S.$8,828,980 with 33% going to producers and 67% going to consumers.

2) Benefits of IPM FMS in Ghana were evaluated; the two main effects were increased production and input costs (labor, time and pesticide costs). FFS participants had an increased yield of 145 kg/ha in 2010 or an average of U.S.$102 per FFS farmer. The direct impact was U.S.$305,936 in 2010 by groundnut IPM-FFSs. Participants shared information with an average of five other farmers for an indirect impact of U.S.$382,419, which brought the total impact of 2010 FFSs to U.S.$668,355. Beginning in 2002, a consistent flow of farmers participated with a total of 3000 farmers directly impacted and 15,000 indirectly impacted. Data are being separated for impacts in poor, medium, and rich farms.

3) Data from the 2005/2006 Uganda National Household Survey (Uganda Bureau of Statistics) were used to determine factors affecting adoption and distribution benefits of 1248 peanut growers nationwide. The findings indicate that adoption of improved varieties depends on the education of the farmer, number of people residing in the household or labor availability, whether the head of household was married, the type of land tenure, the use of other improved crops, use of extension recommendations, and if he farmer was visited by an extension agent in the last 12 months. There were significant income gains due to an increase in adoption rate. Simulating an adoption rate of 30% nationally results in a 5% increase in the mean household income.

4) The survey in 3 above was used to estimate the difference in poverty status. Results showed that the proportion of the population that is poor is about 5% points lower for adopters of new varieties of peanut than for non-adopters.

5) A household survey in Eastern Uganda in 2011 compared gender effects on adoption of new peanut varieties. Distance to market, research stations, and extension offices affected both male and female farmers. When considering the individual farmer as the unit of observation the adoption decision of female farmers depends on whether Farmer Field Schools are offered in the village and whether they are aware of the availability of improved seeds. Male farmers were more likely to adopt if the distance to extension decreased and if they changed their peanut seed in the last 5-10 years.

6) The effects of Farmer Field Schools in Ghana on peanut production were studied using 2011 household survey data. A primary negative on FFS participation was distance of the farmer from a main road. FFS had a positive

impact on groundnut production; participants produced on average 4.7 bags of peanuts compared to 2.9 bags for non-participants.

7) Data from 2011 household surveys in Ghana and Uganda were used to document the impacts of adoption of improved peanut varieties on food security. Food Consumption Scores (FCS) were based on reported days of adequate food consumption. In Ghana, the villages were on average food secure, with only 5.65 percent vulnerable to food insecurity, and were equal for FFS and non-FFS villages. In Uganda, one region was more food insecure and rated as a poorer region (Teso sub-region), with almost 9% of the households rated as food insecure compared to less than one percent for the other regions. Higher FCS scores were noted with farmers with more education and those who own more land.

E. Management

Project 110. Peanut CRSP management

The new phase was implemented in 2008. Much effort was required to put into place new projects and facilitate funding of awarded projects. Fiscal uncertainty relating to whether the program would be able to support all the projects intended resulted in the delay in the RFP for the processing sector projects, and the impact assessment project. Plans to update the web system were disrupted by staff loss and difficulties in recruiting a replacement programmer. The ME employed a student to undertake scanning of records into electronic format, and to assist the director in undertaking analysis of topics of interest.

Under the topics of interest, an analysis was started which tested the hypothesis that the consumption levels of aflatoxin prone foods would be correlated with the levels of mortality and morbidity associated with infectious diseases. Data was obtained from WHO and FAO and correlation between exposure risk and disease outcomes established. The result was that a strong association was discovered between HIV and maize consumption in Sub-Saharan Africa. Using liver and esophageal cancers as a signature of either aflatoxin or fumonisin, we established that the mostly important factor was fumonisin.

Project 111. Program support

Board of directors, technical committee, and external evaluation team activities were supported.

Project-specific achievements benefiting the USA

This Section describes a select number of achievements in projects that have particular interest to the United States producers, processors, and consumers. Title XII states that CRSP research should provide results important to developing countries, and at the same time provide results that feedback to the United States.

CHAPTER 30. IMPACTS OF THE 2007-2012 COOPERATIVE AGREEMENT

Overall, a wide range of Peanut CRSP projects have been funded with most showing some success, and in some instances potential for high impact. One advantage of the Peanut CRSP was that it has supported long-term research programs, which allow them to evolve and build on advances established by past work. For example, breeding studies are long-term and require time to produce newly developed cultivars with impact. Moreover, additional time is necessary to gain approval of newly released cultivars, increase and distribute seed to farmers, and gain the acceptance of farmers who want assurances that replacement of present cultivars will allow them to maintain or improve their profits.

Technology transfer of successful results was another achievement of the Peanut CRSP. Continuation of the successful approaches developed in Southeast Asia that commercialized processing technologies for new locally adapted peanut products through multiple media has been a major benefit. The results of all these advances are now expanding throughout the Peanut CRSP family. The following is a summary of the major successes to date across the 21 Peanut CRSP projects in this phase.

A. Producer values (resource efficient production)

Production projects focus mostly on ongoing challenges from the environment, such as water stress and climate warming, diseases, especially rosette viruses, leaf spot, rootworm and rust and increasing yields by managing these factors. The strategies include developing better varieties and farming practices to conserve soil fertility, to reduce the use of costly herbicides, pesticides and fungicides, and assuring quality peanuts for consumer acceptance and market expansion. All these projects have a history that goes beyond the start of this phase, so the have results that may require long-term research to fully achieve potential benefits.

High yields, drought tolerance and reduced diseases would improve competitiveness of peanuts relative to other crops. Sustained breeding programs to enhance drought and disease resistance along with increasing yields are major tools used in these endeavors. This includes increasing use of wild relatives and early-developed strains based on a wealth of germplasm for the needed crossover of favorable genes into cultivated varieties. Training in breeding techniques, implementing integrated pest management technologies and incorporating good cultural or farming practices through multi-disciplinary collaborating research efforts to end users was the primary focus of the production projects in the Peanut CRSP.

The measureable impacts from this program area include: (1) technologies allowing increased returns to identified production resources; (2) adoption of more sustainable production technologies; and (3) knowledge applied to improve or maintain profitability of peanut operations.

There are eight projects focused on producer values, located in East Africa (UCN139, UGA136, and NMS172), in West Africa (TAM137, NCSI31, and UF157), and in Latin America/Caribbean (UF155 and UF150).

Research on production values led to the development of improved peanut technologies and good production practices such as new early-maturing and high yielding varieties with resistances to major peanut pests and diseases, high oleic traits and good agronomic characteristics, improved pest and disease management practices, and good harvest practices using mechanical tools. These technologies led to yield/production increases in many HCs where farmers have been trained and have adopted them. Key achievements of the Peanut CRSP are improved varieties and potential germplasm that have gone into the breeding programs in the HCs. Peanut CRSP has also contributed to the international peanut genome project through which future crop improvement will become more efficient.

Basic research activities

Utilization of Bolivian land races (tetraploids), and collection and preservation of wild species has contributed to conservation and exploitation of valuable peanut genetic materials, which have the potential to result in commercial cultivars with improved disease resistance. An expanded range of peanut germplasm has been identified and developed through crossing, and some derivatives show considerable potential for resistance to rust and leaf spot.

Two potential lines showed resistance to both pathogens and are being used as parents in crosses. Intra-specific crossing has progressed well and progenies now require chromosome doubling.

Crosses to transfer high oleic traits from wild species have been successful. The results are hybrids with alleles closer to cultivated peanuts. Six accessions from previous evaluations were selected and increased for new and underway regional trials of leaf spot-resistant materials with improved yields.

In Uganda and New Mexico a wide range of Valencia peanut accessions have been evaluated. A number of these were shown to perform better than the check entry Valencia-C. A total of 114 accessions were characterized and relationships between accessions from different geographical regions are now better understood. This information could be useful in breeding Valencia peanuts for improved yield and resistance to major constraints.

Research on molecular markers is underway that have the potential of identifying in a much shorter time important traits in peanut germplasm. Mapping of plant genomes is an exacting science, and it is notable that training has been provided to a Burkina Faso scientist in a visit to Texas. In the development of molecular techniques to enhance the ability to utilize specific characteristics of peanut germplasm in a shorter time, a high-density oligonucleotide microarray suitable for transcript profiling has been designed for the Valencia type peanut.

Applied research impacts in host countries

Development and deployment of improved varieties has accelerated and six new early maturing varieties have been released in Senegal. In 2012, Senegal was in the process of release of two Spanish cultivars with fresh seed dormancy (will reduce yield losses from germination of mature seed when late rains occur prior to harvest) and drought tolerance. Two leaf spot resistant cultivars were set for release in Burkina Faso in 2012: a Spanish cultivar (yields 20% higher over 8 years of tests than in the disease-susceptible check) and a runner cultivar (which out yields the same check by 50%, and the Nama cultivar by 100%). Progress was being made in germplasm improvement with the potential of development of a leaf spot resistance cultivar in Ghana, and evaluations were being made in cooperation with the NCS 131 and UF 157 projects with goals to improve effectiveness and profitability of the use of fungicides and herbicides. The high oleic acid characteristic to delay rancidity is being moved into the West Africa program. Cultivar development is a long process and in 2012 future impacts are expected.

The Groundnut rosette disease resistant (GRD) germplasm was introduced through this project in 2003 from the ICRISAT/Malawi program that resulted in earlier releases such as the Spanish cultivar 4T. In Uganda, two new lines with high resistance to GRD were released in 2010 as Serenut 5R and Serenut 6T. Serenut 5T was in high demand, and extensive demonstration and information activities were underway for the new varieties. The importance of GRD resistance was shown in impact studies in Uganda, one which projected in 2003 the three earlier cultivars would occupy over 60% of the production area and when fully adopted will add $47 million per year to the economy, and the second in 2012 showed an impact since 2001 of $41 million. GRD resistant lines have been transferred to other countries in the region including Ethiopia, Sudan, Western Kenya, Democratic Republic of the Congo, Rwanda, and South Sudan. In Ethiopia, an "intent to release" document has been submitted to the variety release committee who will evaluate the varieties for release, with first focus on Serenut 4T that performed best. Development and use of rosette disease resistant varieties in Uganda and other countries in the region is helping to overcome the devastation in peanut production caused by the rosette virus.

In the Valencia type improvement efforts in Uganda, resistance to leaf spot and rosette diseases have been found in 75 accessions from the ICRISAT/Mali collection. The newly developed breeding lines of Valencia market types are in advanced stages of evaluation prior to their evaluation in "National Performance Trial" for release in Uganda. Seed increase of the promising lines is underway to provide enough seed stocks once either of the lines in notified for release.

Identification of rust and leaf spot germplasm should expedite development of cultivars useful for regions of South America where production suffers from those diseases and has already expedited breeding efforts that will yield future cultivars. A concerted effort began in 2008 utilizing the wild species germplasm pool to obtain improved disease resistance. Rust screening began with 48 lines in 2008 and with 90 lines for leaf-spot resistance in 2009. A sub-set of 22 selected lines were tested in Florida in 2010-2012. Seven lines were sent to Guyana and 44 lines to

Bolivia for the 2011-2012 seasons. Results are not complete, but anticipated to improve the germplasm base in all three countries and result in the release of new cultivars. In Bolivia, a new variety has been released and seed is being multiplied. A project visit to Bolivia in 2012 shared the project progress with U.S. and Bolivian participants, and the collection and return to the U.S. of seed of several favorite cultivars in Bolivia to add to the U.S. collection of germplasm with necessary quarantine procedures. Discussions with ANAPO personnel included sending a list of wild peanut germplasm and potentially exchanging material that is not available in the U.S. collection. Technology transfer activities included field and laboratory demonstrations by U.S. scientists, such as aflatoxin testing, controlling plant disease, and weed control.

In Guyana a Peanut Field Production Guide was completed based on the results of the research and on-farm demonstration in the Rupununi region and have been distributed widely to farmers; and translated to Creole for a Haiti version. Cropping system research in 2012 in Guyana successfully intercropped peanut and cassava, but maize was detrimental to peanut probably because of excessive shading. Peanut cultivars introduced are being grown by local farmers, not due to yield, but rather pod architecture and ease of harvest.

On-farm research continued in 2012 in Haiti with the in-country partner Food and Meds for Kids. The evaluation of peanut germplasm/cultivars for rust resistance continues to be a large and successful effort with rust resistant cultivars from ICRISAT, and farmers desire to have improved cultivars.

In Ghana, progressing has been made in IPM and crop modeling that was advancing continued development and improvement of peanut cropping systems. Human capacity building among the scientific staff was enhancing the systems development and technology transfer that will last into the future. Results from two locations each in Ghana and Burkina Faso continued to show the clear advantage of the improved lines (near double in yields, 15 days longer to maturity, and greater leaf-spot resistance). Two of the lines have been released in Ghana as named cultivars "NkateSari and Gusie Balan". Four herbicides were tested at two locations in Ghana in 2012, and two of them (pendimethalin and basagran) provided near acceptable weed control without hand weeding. Herbicide and fungicide trials in Burkina Faso are providing promising results.

In Ghana, IPM practices developed in the earlier phase were being implemented and scaled-up by the Ministry of Agriculture. Cropping systems research were refining and extending to farmers the production of peanut with irrigation in the dry season; the present market benefits of this system are that farmers market their peanuts at the time of highest prices. From 2010-2012, groundnut shellers were fabricated by CSIR-CRI mechanics for distribution to groundnut IPM farmers who participated in the Farmers Field School organized under the Peanut CRSP activities. Shellers were distributed to farmers in six villages in three regions.

Seed increase, multiplication, commercialization, and distribution to farmers is a major deterrent many developing countries. Overcoming these constraints have been goals of efforts in Senegal, Burkina Faso, Ghana, and Uganda. In Senegal, the Peanut CRSP, ISRA and the NGO – ASPRODEB have cooperated to improve seed multiplication and distribution to farmers of both new and formerly released cultivars, which include seven cultivars developed in Senegal with Peanut CRSP assistance that now occupy about 400,000 ha of production. Seed multiplication is an objective in Northern Ghana, and Farmer Field Days are important to make farmers aware of new cultivars and seed sources. Uganda is developing an effective program for seed production, multiplication, and distribution to farmers through seed companies, NGOs, contract farmers, and NaSARRI Serere farm offices.

In the effort to survey and evaluate peanut cropping systems in Uganda and Kenya, progress has been made and training provided to the host country scientists. The goal of human capacity has been reached in these areas of study, and will be important to the long-term use of improved technologies identified in the survey and provision of improved farming techniques. This has resulted in showing the importance of human capacity development, which will have long-term impact of Institute and Ministry personnel to help improve farm enterprise development and profits.

Applied research impacts in the United States

An early maturing runner cultivar and a runner cultivar with resistance to root-knot nematodes and *Sclerotinia* blight, both with high oleic traits (which significantly extend shelf-life of peanuts and peanut products) and drought resistance were approved for release in Texas in 2012. In Texas, one high oleic acid cultivar was approved in 2012 under the name Schubert that matures one week earlier and yields 10% higher will replace the high oleic cultivar Olin,

New Mexico State University will release its first high oleic acid peanut cultivar “NuMex-01, which originated from a cross between “Valencia-C” and OLin from Texas A&M University. Yields were about 20% higher than the common cultivar. The oleic to linoleic acid ratio ranged from 18 to 25 compared to 1 to 2 in the control, which will provide high market value for the “NuMex-01”.

In the U.S., excellent results have been achieved in North Carolina on IPM practices that have been profitable to growers in the North Carolina and Virginia peanut growing region, and later efforts were focused on areas were production was moving further south in North Carolina. In 2010 and2011, the cancelation of the registration for Temik (aldicarb as an “at-plant, in-furrow” insecticide led to intensified efforts to identify a replacement chemical. A new cultivar, Perry, yields well and is popular with farmers, but is susceptible to tomato spotted wilt virus that is controlled with IPM practices.

B. Processor values (value added and market development) sector

Research advances in the development of quality aflatoxin-free peanuts as a food along with growing economies has induced the need for farmers and agribusinesses to know what food products are in high demand by consumers. Studies have shown peanuts and peanut products are highly nutritious, having several benefits to human health and wellbeing beyond basic nutrition, which helps stimulate the processor sector. Consumer-driven, market pull approaches to develop safe, quality peanuts, and peanut products such as processing technologies are being developed by the Peanut CRSP.

Consumer and market surveys have been carried out to identify consumer priorities for selected peanut foods. The information from the peanut value chain have identified peanut product preferences, selected peanut products, which supports training on appropriate processing technologies with small and large industries. Products produced will be fit to local consumer/market preferences and economic conditions, while refining safety, sensory and functional properties through food science.

The measurable impacts from this program sector include: (1) increased processing of peanuts through value added activities; (2) companies, cooperatives and entrepreneurs producing value added peanut products; (3) increased presence or maintained value of peanut products in the market place; and (4) greater trade of peanuts and its products. There are three projects specifically focused on the Processor Values program sector (UGA127, UGA165 and UGA166). Projects with major emphasis in other sectors also contribute to this sector. For instance, UF 155 has also utilized the value chain approach to sustain production expansion, and COR158 has addressed aflatoxin, which has resulted in added processor and nutritional results. These projects have built on the capacity and experiences achieved during the earlier phases of the Peanut CRSP.

The suite of three specifically processing projects (UGA127, UGA165 and UGA166) was established in 2010 by the principal investigators at the University of Georgia as the University of Georgia Global Peanut Product, Processing and Marketing Team (UGAGP3MTeam). Partners in these projects included the collaborating HC principal investigators in Ghana and Uganda. The Team established a seamless communication mechanism <uga.gp3mt@gmail.com>, which has vastly enhanced the progress of the collaborative work. The research is building a market-pull emphasis based on food manufacturers being informed by consumer preferences and desires, thereby proceeding to increase production and utilization of peanuts and peanut products (a transfer of the Peanut Industry Incubator Model – PIIM developed in the Philippines and Thailand).

During 2011, significant progress was made in implementing the PIIM model; surveys that involved more that 1000 households in both Ghana and Uganda were made to identity potential products of interest to consumers, interested processors were identified, products chosen, processing protocols developed, and training initiated. The sorting technology for producing aflatoxin-free peanut products was put in place to directly identify market opportunities for new and modified peanut products. This builds a baseline of knowledge to support future investments and a market-pull emphasis of consumer desires working with food manufacturers to increase production and utilization of peanuts and peanut products, a transfer of the Peanut Industry Incubator Model (PIIM) developed in the Philippines and Thailand. Based on Philippine- and Thailand-derived data, three nutritionally enhanced foods—stabilized peanut butter, stabilized peanut butter fortified with Vitamin A, and a chocolate-peanut spread—were selected for development and production. In addition to these three foods, peanut cookies and fiber-enhanced peanut butter, and peanut soup were identified.

In 2012, working relationships were developed with four research institutions and six industry collaborators for implementing improved peanut products and processes. The Ghana household survey data summary and analysis strongly supported the development of a peanut soup base with the University of Ghana and Nkulenu, the industrial partner, which met domestic and international safety regulations. The household survey in Uganda confirmed high preference for cookies making peanut cookies a nutritious food product that is convenient, shelf-stable and portable. The Vitamin-A fortified chocolate peanut spread manufactured by Food Engravers fits the market niche of the urban consumer in Uganda; the product is nutritious and of high value and fills the need for the product that fits the urban lifestyle focused on convenience in food preparation and consumption. Hand sorting of peanuts to eliminate aflatoxin to promote public health was implemented in the commercial processes.

In a related project (UF155) in Guyana, Peanut CRSP in collaboration with the NGO partner, Society for Sustainable Operational Strategies (S-SOS) has linked peanut producers, processors and consumers around school-feeding. The cottage industries in seven villages established in the earlier phase have expanded to 43 villages and provide consistent market demand for peanut production and steady income by marketing peanut butter through the school feeding program and local sales. The cottage industries also contribute to the development of the private sector with over 50% of the income they generated in Aranaputa village coming from private sales. There are now cottage industries capable of producing 25 kg or more of peanut butter per day. Over 1400 snacks were produced per day and they generate $75 million Guyana dollar in the region per year. A state-of-the-art peanut processing and storage facility was built in Aranaputa in collaboration with the NGO partner, (S-SOS). A satellite program was set up to supply peanut butter and provided training to processors in 26 new villages in collaboration with S-SOS.

Evidence was compiled through 2012 that peanuts are the primary source of ingested and metabolized aflatoxin in a Haitian population and that corn contributes as well. Detectible levels of aflatoxin biomarker were found in the bloodstream in 135 out of 178 subjects tested. Haitians staff, once educated about the importance of aflatoxin control and how to accomplish it, can reduce the concentration of this toxin in the general commercial peanut product stream and virtually eliminate it from high value, medical quality therapeutic foods. Peanut and peanut products continued to be monitored from farms and markets; aflatoxin levels continue to fall where processors have been make aware of the problem, but new processors still sell products with very high levels of aflatoxin and most exceed U.S standards. A few are producing products at or near 20ppb aflatoxin.

C. Consumer and social values

In this sector, Peanut CRSP projects address gender issues, nutrition and the food-safety; the later being focused on aflatoxin and public health through the prevention of aflatoxicosis. In the previous phase a major change in emphasis occurred to focus Peanut CRSP on documenting the overlooked health consequences of neglecting aflatoxin in the diet, and demonstrating an alternate paradigm for the prevention of human aflatoxicosis in food insecure situations. Gender is an important factor in peanut production, marketing and exploitation; in many Peanut CRSP locations peanut is primarily a women's crop. Women produce, process, and market the majority of peanuts through informal channels: as such the importance of the crop is likely to be overlooked since it is seldom well documented as a feature of national economies.

Key achievements were reported from most of the projects in the Consumer Values sector.

(a) Food safety/aflatoxicosis

Because of the priority accorded to this topic a major fraction of the resource was invested to address food safety. Three areas of activity occurred addressing: 1) management of contamination (COR158, AUB163, UGA145, VT134, UF155 and UGA122), 2) consequences of exposure (UAB148), and 3) prevention of human exposure (TAM149, UGA145). In addition the nutrition project (UGA 122) and food processing projects (UGA127, UGA165, and UGA166) described above extend the management of this problem to provide safe foods in the marketplace.

The measurable impacts from this program sector include: (1) technologies to decrease exposure to aflatoxin contamination; (2) health and food policy changes relating to Aflatoxin-modulated health risks; (3) increased social awareness for aflatoxin risks; and (4) increased gender equity. There are eight projects focused on food safety/aflatoxicosis (COR158, UAB148, AUB163, TAM149, UGA145, VT134, UF155 and UGA122), the last two being associated projects.

Management of Contamination

Aflatoxin contamination of peanuts during the on-farm production and post-harvest handling, storage, processing and marketing chain is a worldwide financial and/or health risk, especially in developing countries. Financially, the problem is quality loss and waste of produce; and for health issues, findings include nutritional and immunological effects and the associated modulation of infectious diseases, including HIV. Through this effort the Peanut CRSP has elevated aflatoxin to an international development issue. USAID, the African Union, and major development interests now are addressing aflatoxin as a priority. The Peanut CRSP goal is to minimize aflatoxin contamination in the food chain that would impact health and market economics. The Peanut CRSP is progressing well in the health aspects due to some breakthroughs achieved by food safety projects.

Capacity for estimation of food based aflatoxin exposure was established in Uganda, Kenya, Haiti and Ghana. With this capacity, aflatoxin contamination data were generated for peanuts and peanut butter in these countries.

In Haiti, Peanut CRSP supported development of specialized equipped laboratories, trained technicians and implemented farm to market processes in a special coordinated effort to sort and monitor from field to processing removal of damaged, high aflatoxin contaminated peanuts. Training provided for aflatoxin reduction to levels below 5ppb in products enabled the NGO-Meds and Foods for Kids to reduce the aflatoxin content in their peanut-based ready-to-use therapeutic foods (RUTFs), Medika Mambo. The results were reversing childhood malnutrition in thousands of children with a product that does not suppress immunity, interfere with nutrient absorption, and cause liver cancer. A fast, lower cost ways of assessing biomarkers have been developed, some of which can be used in Haiti. Biomarkers for aflatoxin ingestion can be determined in urine from pregnant women and malnourished children. It has been determined and demonstrated that RUTF and other high value products do not need to be imported, but can be made locally, increasing the educational, workforce, and industrial capacity of the country (in this case Haiti) that needs the products to reduce the nutritional consequences of extreme poverty. Methods have been developed to remove most of the aflatoxin from peanut oil and peanut press cake from seed rejected for probable aflatoxin content that would enable it to be used for cattle feed.

Previously, the aflatoxin contamination data and peanut consumption data determined in Uganda were utilized by the Uganda National Bureau of Standards (UNBS) to set maximum limits (MLs) for aflatoxins in peanut and peanut based products. Also in this country, Hazard Analysis of Critical Control Points (HACCP) plans for reduction of aflatoxins in peanut-based food and Information, Education and Communication (IEC) materials on management of aflatoxins in peanuts were developed and communicated to stakeholders. This effort was continued during this phase and has resulted in improving quality of many marketed foods in Uganda. As the project moves into 2011 year, there was an increased interest from processors in adopting HACCP plans that will enable the production of high quality products and eventually improve their livelihoods through revenue increase. Concurrent production of a video and handbook for use in awareness campaigns will enhance various training programs.

Projects established aflatoxin management strategies and evaluated them for their effectiveness. In Ghana, there was increased awareness among project participants in the peanut marketing chain on effects of aflatoxin contamination on peanut profitability. This led to farmers increasing adoption and use of improved storage facilities along with disinfecting them after each use. Subsequently, it was found that consumers would pay up to 33% more than the present prices for aflatoxin safer products, which provides incentives for producing safer products. Women play a major role in food production and safety in Ghana, and contribute to post-harvest handling of peanuts. However, the women who participated in the study have less formal education and have little knowledge of aflatoxin contamination of peanuts, and must be educated on the problems of aflatoxin in peanuts in Ghana. Since younger farmers based on the number of years of experience, were more likely to adopt technologies to improve aflatoxin reduction technologies, more effort should be focused on this group of farmers. It was also demonstrated that cooperative membership was an effective means of technology diffusion. Hence, peanut producers should be encouraged to participate in cooperative meetings and workshops. Overall, it is perceived that both producers and consumers will support aflatoxin standards, since producers will not lose profits and consumers will receive health benefits from products with lower aflatoxin levels. These results provided policy makers with new information and incentives to reduce contaminated peanut.

In Guyana, Grainpro™ storage systems (airtight durable storage bags to prevent moisture accumulation and insect damage) were being supplied to selected villages to ensure reduction in aflatoxin contamination and improved profitability. The Grain Pro bags introduced earlier have not been accepted well by farmers; one problem was the difficulty of sealing the large bags by the cottage industry personnel. A small gas dryer was well accepted by farmers, and appears to be a valuable asset to farm communities. Even though aflatoxin levels remain low in whole roasted peanuts and peanut butter, better storage and bagging techniques need to be developed. A streamlined procedure for aflatoxin testing that uses Vicam test kits continues to be developed.

Prevention of exposure

Two main options are available to prevent exposure of people to aflatoxin. Peanut CRSP has worked both to improve the regulatory approach and to address the protection of consumers where the regulatory approach is not a viable option. The standard approach to preventing exposure is the regulatory paradigm. In Uganda, the CRSP has continued to work with the Bureau of Standards to define and improve the enforcement of sanitary standards. Part of this has been achieved through the development of rapid, non-destructive measurement of aflatoxin in peanuts using Fourier-Transformed Infra-red Reflectance; and in part by training processing companies in Kampala in the HACCP needed for aflatoxin.

In 2012 in Uganda, continued sampling of peanuts in markets show substantial reduction in aflatoxin. This has helped women farmers market their products. Strategies to address aflatoxin problems in Uganda have been shared with scientists within and outside Africa through presentations in scientific meetings, with scientists continuing to appreciate the role Peanut CRSP plays in management of aflatoxins in Uganda. This role has been strengthened by Dr. Kaaya becoming a registered member of the African Mycotoxin Network and Partnership for Aflatoxin Control in Africa. Impact studies by a graduate student reveal that HACCP training for small scale processors facilitated by the Peanut CRSP equipped them with knowledge to implement HACCP plans to produce good quality and safe products. Women in East and Central Africa have continued to participate in the research and education activities of the project, which has enhanced women's sense and capacity for productivity as well as making visible the values of groundnuts/peanuts in daily lives, such as nutrition and economic value.

Together with Uganda Consumer Education Thrust (CONSENT) a draft petition entitled "Millions at risk of death from poison in our food: A wake-up call to stem exposure of vulnerable people to deadly aflatoxin in the food value chain" has been written in 2012. This will be taken to the parliament of Uganda and to other relevant policy makers including Government Ministries and NGOs for possible alliance towards aflatoxin elimination campaigns.

The second approach addresses situations where food security is not assured, and people consume aflatoxin contaminated foods despite the risk of exposure. Studies on exposure generally demonstrate that the majority of people in Africa are exposed and for this second situation the Peanut CRSP has worked to provide a mechanism to protect people despite uncontrollable contamination. The basis of this has been the decision to transfer to human use the sorption technologies so effective in the animal-feed industry. This initiative is unique to the Peanut CRSP and is on track to be exploited as countries recognize the need for immediately available interventions. In addition to the previously identified NovaSil clay for aflatoxin sorption, a more refined type UPSN (Uniform Particle Size NovaSil clay) was more desirable due to a smaller and more uniform particle size with less quartz that might influence palatability. Studies continue to show that the specific characteristics and mechanism(s) of toxin sorption to clay surfaces make montmorillonites the best enterosorbents for aflatoxins and fumonisins, and that the refined clays are superior to locally available clays in sorption capacity. Both animal and human intervention trials indicated that dietary inclusion of UPSN at levels equivalent to 0.25% in the diet did not result in overt toxicity and significantly reduced biomarkers of exposure to aflatoxins from urine and blood. Work in animals and humans has shown that NovaSil and UPSN clays do not have strong interactions with, nor interfere with, the utilization of important vitamins and mine

A variety of strategies for reducing aflatoxin contamination in food and feed have been reported from various research sources. These include the use of competitive fungal species, establishing drought resistant crops, food processing and sorting and improved storage processes. However, none of these methods are suitable as therapy to alleviate acute aflatoxicosis and reduce lethality. Toxin enterosorbent intervention with clay has the capability to rapidly impact exposures and rescue individuals suffering from acute and sub-acute aflatoxicosis similar to those reported in Kenya in 2004 (where 317 people were hospitalized and 125 died due to aflatoxin consumption).

A really important discovery by the Peanut CRSP has been that NS is also effective and provides protection for animals and humans against a second mycotoxin (fumonisin), which is predominantly found in maize and has been connected by the Peanut CRSP to the transmission of HIV in Africa.

Consequences of exposure

Association was found between aflatoxin exposure and health status. In Ghana, a research team established the association between aflatoxin B1 exposure levels in pregnant women and birth outcomes, and anemia. It was found that 100% of the women had aflatoxins-albumin (AF-ALB) in their blood. With regard to birth outcomes, pregnant women with aflatoxin levels in the highest quartile were twice as likely to have low birth weight infants when compared to women in the lowest quartile. There was a trend of increasing risk for low birth weight with increasing aflatoxin levels. This association remained after adjusting for known confounders, including malaria parasitemia, anemia and worm infections. Aflatoxin also increased the odds of pregnant women developing anemia in pregnancy, with an 85% increase from the lowest to very high category, which suggests that the prevalence of anemia among these pregnant women was associated with AF-ALB levels in their blood. In 2011, research led to the question that the benefit of future HIV vaccines may be reduced in aflatoxin exposed regions of the world, since aflatoxin suppresses the responses to vaccinations.

In 2011, an investigation on the association between AF-ALB and tuberculosis infection demonstrated, for the first time, an association between aflatoxin levels and an increased hazard for developing TB in HIV positive individuals. This increased hazard result represents an important addition to the body of knowledge on the harmful effects of dietary aflatoxin exposure in individuals with HIV.

Results showed that aflatoxin accentuated HIV-associated cellular immune changes suggesting that HIV-infected individuals exposed to aflatoxins in the diet may experience faster progression to AIDS. The intensive, multifaceted studies at clinical and immunological levels along with disease progression over time are proving extremely important in understanding these relationships and should allow development of appropriate and targeted strategies to decrease the rate of progression of HIV disease in infected people.

One project developed a short-term biomarker of aflatoxins exposure (AFM1) and fumonisin exposure (FB1) in urine. In related studies in China in 2011 food samples were tested in three different areas of China, and it was found that co-contamination of these two mycotoxins was found in corn, rice, and wheat flour. These data suggest that the co-exposure of rural residents of China to aflatoxin and fumonisin may contribute to the etiology of human chronic diseases in high-risk areas. Animal studies were conducted to validate the newly developed method for measurement of AFB-LYS, and to explore immune toxic effects of aflatoxin exposure in animals treated with single dose and repeated doses. The method demonstrates that liver GST-P+ cells and foci are sensitive biomarkers for AFB1 toxic effect and correlated with bile duct proliferation and biochemical alterations in F34 rats, which hold promise as potential target for future intervention strategies. AFB1-lysine adduct samples over several years were analyzed on samples in Uganda in cooperation with the British Medical Research Council/Uganda Unit and RAKAI Health Program, which clearly demonstrated temporal pattern of aflatoxin exposure in rural human populations in Uganda.

(b) Nutrition

Nutritional issues for the developing world are evolving and becoming bi-modal. As important as the problem of under-nutrition is in developing countries, it is also apparent now that peanut has a powerful role/opportunity in the emerging epidemic in these countries associated with poor-quality/over-nutrition (non-communicable diseases and obesity) just recognized by the UN.

Peanut is an important nutritional and health-giving food grown over much of the developing world, but research to make this evidence-based and exploit this potential has been neglected. Documentation of the positive nutritional aspects of peanuts remains an important priority for Peanut CRSP to promote increased consumption of peanut and peanut products, thereby promoting public health, the market demand for, and profitability of this crop for farmers.

Nutrition research in an earlier phase documented that peanuts are a heart-healthy food, and because of a satiety factor do not promote weight gain, important for developing countries where these nutritionally modulated health risks have become as important as under nutrition and malnutrition. In addition, research has been supported to produce and test new types of nutritional and aflatoxin-free ready-to-use therapeutic foods (RUTFs) for other vulnerable groups, successfully feeding high risk populations of malnourished adults, young children and infants.

The measurable impacts in this area were: (1) increased knowledge and value attached to peanuts for their health properties, (2) use of local nutrition sources to address nutritional needs of vulnerable populations, and (3) research was also expected to improve gender equity. There were two projects focused on the nutrition aspects of peanuts (UGA122 and PUR151).

In Brazil, nutrition studies by PUR151 suggest inclusion of peanuts or peanut butter in the morning meal improves day-long blood glucose concentrations, and helps control appetite. Very preliminary results indicate that chronic peanut consumption is well tolerated, thus facilitating greater compliance to public health recommendations to increase peanut consumption. In the U.S. and Brazil, preliminary analyses showed that peanut consumption was associated with marked reduction in blood pressure, and data documenting the mechanisms that account for these findings are helping to reinforce the role peanut ingredients play. Also evidence shows peanuts consumed in moderation do not pose a threat to weight gain allowing the recommendation to consume, in moderation, peanuts and/or peanut products. Publication and presentation of the results in professional and public forums distributes the Peanut CRSP supported research to a broader audience. Cardiovascular disease, diabetes, blood pressure, and obesity are pressing health problems globally, and the work provides clinicians information that may promote their recommendation to patients concerned about these health risks to include more peanuts in their diets and provide health benefits to the individuals. The improvement in the market perception of the healthiness of peanut is a key factor to spur an expansion of peanut production and consumption worldwide.

UGA122 is seeking to improve nutrition, expand economic activities and expand the demand for peanut by developing low viscosity drinkable RUTFs. Use of RUTFs is presently limited by the cost and dependence on expensive, imported ingredients. These highly nutritious and easily digestible, formulations have been developed in Ghana and Uganda. In Ghana, the formulation is made with peanuts, cowpeas and rice ingredients, major crops in this country. In Uganda, a number of crops, peanuts, amaranth, orange-fleshed potatoes, cowpeas, sesame, corn millet, sorghum and bananas are included. The nutrient-rich and microbial safe, stable, long shelf-life foods were fortified with vitamins A, C, and zinc and iron. The physical (functional), chemical (including essential amino acids), energy, and sensory properties of the formulations meet international food and nutrition standards for special groups (such as HIV infected people, pregnant/lactating women, and children).

Addition of probiotic cultures and NS clay to remove aflatoxin contamination was being studied for additional nutritional quality. Under the direction of a nutritionist, test-feeding studies of the RUTF formulations are underway. Projected outcomes are to help resolve malnutrition issues affecting adults, children and infants due to food shortages, food insecurity, conflicts, and infectious diseases including HIV/AIDS. The project has shown the practicality of designing and producing RUTFs and RUSFs (Ready to Use Supplementary Food), not only in advanced countries, but also by private companies in developing countries.

In summary, the research culminated with the production of the RUTF and RUSF in adequate quantities for chemical-nutritional and sensory analysis as well as a large scale human feeding trial. Results indicate that the overall strategy of designing, producing, and thoroughly evaluating computer generated, nutritionally optimized, least cost products was sound and feasible. These products can be made from indigenous crops in Africa (and elsewhere) without the need for expensive, imported milk or other animal products, although supplementary vitamins, minerals and possibly key amino acids (e.g. Lysine) must also be supplied. The resulting products were acceptable, nutritious and producible by available, appropriate technologies such that outreach to entrepreneurs to allow commercialization is now feasible. The training efforts (graduate and short-term) have developed the expertise in Ghana and Uganda to continue the work.

At least twelve different RUTF/RUSF have been designed and produced by feasible processing technologies and at moderate to large pilot scale in the U.S., Ghana, and Uganda. This information is available to private food companies/entrepreneurs, ministries of health, NGOs, etc. to facilitate the large scale production of these products.

D. Capacity development

The second product of the Peanut CRSP was capacity development. A wide range of activities were included that ranged from Ph.D. and M.Sc. degree programs for both U.S. and HC participants, institutional development for research and technology transfer and development of partnerships, to especially work with the private sector and non-government and civil society organizations such as women's groups. The Peanut CRSP continued to build the capacities of its continuing partners that were improved during the earlier phases of the Program. If funds were increased for capacity development, these achievements could be expanded. The focus in this current phase was the development of the capacity of researchers and practitioners on processing, value addition and market access and in reducing health risks such as aflatoxin contamination and improvement of human nutrition, especially among children and infants.

Statements occur frequently in the accomplishments reported in the various projects related to the increased abilities of host country collaborators to plan, conduct, and extend technology; which reflects a primary goal of CRSPs to provide human capacity development.

A chapter later in the history will describe training in more detail.

Long-term degree programs

The long-term advanced degree program remains an important component of capacity building for researchers and scientists in the Peanut CRSP; 18 or 75% were coming from partner HC institutions. At the mid-term period of the project, 24 students (80% of the planned total scholars) were pursuing their degree programs in the U.S. and HC universities. Seventeen students, (71%) were pursuing their M.Sc. degrees while 7 (29%) were pursuing Ph.D. degrees. The majority (71%) of the students were pursuing specialized topics related to Consumer and Social Values (health, nutrition, social and gender), which is a dominant focus of the current phase of the Peanut CRSP. Because of the difficulty of foreign students to obtain student visas to the U.S., many scholarship slots for degree training were converted to HC universities.

Short-term non-degree training

As in the past, many technicians, laboratory assistants, researchers, extension and health workers and others have undergone short-term training both in the U.S. and HC universities. As of mid-term, about 41 staff had been trained by the Program on laboratory analytical techniques, research methodology, extension methods, and other areas related to the projects.

Training of practitioners

The main focus of the training of practitioners were the collaborating farmers (422 were men and 201 were women) on various topics related to the technologies being transferred resulting from the various projects completed. Training of processors, traders, marketers, consumers and other people in the peanut value chain were also completed. Focus was also given to the publication of media materials such as farmers' brochures, researchers' technical guides, training materials, and to support radio and TV programs. Some examples include:

In VT134:

- Extensive training of women on aflatoxin hazards in foods in Uganda.
- Held a HACCP workshop in 2010 in cooperation with Kenya Bureau of Standards for 19 traders and processors from Nairobi on food safety of peanut products.
- Distributed 1500 Peanut CRSP calendars and 2000 booklets to farmers and extension agents in four districts in Uganda that made them aware of practical activities for aflatoxin management

In NCS131:

- Trained 91 farmers in production practices in 2008 using farmer field school methodology;
- Trained 40 farmers (15 women and 25 men) in IPM practices in 2009;
- Trained men in the fabrication of a sheller to relieve farmers of labor from increased production in four villages in 2010, which is 50 fold more efficient than hand shelling; and
- Trained 30 farmers (6 women and 24 men) on IPM in 2010.

In NMS 172 and UGA 136:

- Trained 63 farmers on Valencia peanut production using FFS in Uganda;
- Held radio talk show extension events 8 times;
- Trained 6 farmers groups trained on rosette virus management; and
- Set up demonstration plots of improved varieties at the Source of The Nile Agricultural Show.

Institutional Capacity Development

Transportation provided for our partners to visit farm sites was critical to the program in Burkina Faso, Ghana, and Uganda. Upgrades of buildings and lab equipment were supported in Haiti, Guyana (together with the USAID mission), NaSARRI/Uganda, University of Ouagadougou/Burkina Faso, Noguchi Memorial proMedical Research Institute/Ghana, and Makerere University/Uganda. The provision of equipment and building infrastructure has been limited, but where it occurred it was important to the achievement of the objectives in several projects. Through another NGO in Guyana (full belly project), UF155 provided threshers, shellers and sorting machines for demonstration and use by the local growers and traders for preparing marketable peanuts. COR158 also provided some upgraded equipment at ILRI in Kenya for aflatoxin analysis.

E. Cross-Cutting: Information, Training, Impacts

Across the Peanut CRSP, information transfer was achieved through multiple media and venues. A factor contributing to the success of the Peanut CRSP was the proactive information transfer of its ongoing program developments. The management entity (ME) has always been forward reaching in supporting work to use the Internet for worldwide communication among project principal investigators and their collaborators and partners. This includes Annual Reports, peanut journal publications, meeting presentations, training and news links, etc. In addition to the scientific community, users include industries, policymakers and the consumers.

As part of advancing communication technologies to strengthen the outcomes of Peanut CRSP goals, efforts supported the analyses of not only the scientific impact, but the impact of these studies on social benefits, especially helping vulnerable groups. The demonstration of impacts will encourage project designs that work within the whole value chain for production, processing and marketing of quality, safe and nutritious peanut and peanut products, and show how the lives of people were improved both health wise and economically.

There are two cross-cutting research projects (UGA124 and UGA128). The measurable impacts from this program include: (1) knowledge developed and applied to peanut development and problems; (2) networks of peanut researchers/practitioners supported or created around the world; (3) impacts assessed; (4) knowledge relevant to policies generated through analysis and published; (5) policy changes recommended; and (6) policy changes adopted.

A worldwide web-based Peanut Information Network System (PINS), <worldpeanutinfo.com>, was initiated in 2007 to share ongoing information developed worldwide by the Peanut CRSP on peanut organizations, publications, training programs, production practices, peanut-based foods, results of meetings and workshops, and related news links. Matching funds have been received from donors to support the PINS (including from the Georgia Peanut Commission for the Hot Topics workshop). The PINS has about 18,000 visits and over 47,000 hits annually from people all over the world. New information and new sections have been added to PINS in 2011. This project was based on an earlier University of Georgia project, The World Geography of Peanut: Global Networking Approach to Social Equity, Environmental Protection, and Technology Exchange. The 2011 Hot Topics session on the Georgia

Peanut Tour was on “Processing and Quality”, with five speakers and 90 people in attendance. The Georgia Peanut Commission provided $2,500 to help support the Session. The principal investigator also received a grant of $5,000 from the Georgia Peanut Commission for “Development of a peanut ice cream mix from peanut flour to increase overall market potential of peanuts.” The 2012 Hot Topics session on the Georgia Peanut Tour focused on “Peanut Diseases” with six speakers and about 100 in attendance and $2,000 in cost shared fund support by the Georgia Peanut Commission. The PINS had a total of 6,013 visits with 11,387 pages viewed from Oct. 1, 2011 to Sept. 30, 2012.

A new project was initiated in 2010 to specifically document the impact of ongoing research in three selected HCs, (Bolivia, Ghana, and Uganda). In 2011, surveys were conducted in Uganda and Ghana to determine intra-household impacts of the Peanut CRSP. In Uganda, forty villages with ten households each were surveyed; in Ghana Farmer Field School villages and non-FFS villages were surveyed (six villages, six households each). Results of the 2011 surveys were analyzed and summarized in 2012.

In Uganda between 2001 and 2011, the adoption rate of improved groundnut varieties increased from 4.1 to 50 percent, with cumulative gain since the Peanut CRSP began in 2001 of U.S.$41,296,360. Overall the research benefits are 50 times the research costs. Adoption of improved varieties depends on the education of the farmer, number of people residing in the household or labor availability, whether the head of household was married, the type of land tenure, the use of other improved crops, use of extension recommendations, and if he farmer was visited by an extension agent in the last 12 months. The proportion of the population that is poor is about 5% points lower for adopters of new varieties of peanut than for non-adopters. The adoption decision of female farmers depends on whether Farmer Field Schools are offered in the village and whether they are aware of the availability of improved seeds. Male farmers were more likely to adopt if the distance to extension decreased and if they changed their peanut seed in the last 5-10 years.

In Ghana, integrated pest management (IPM) practices were introduced since 2002. Estimates amount to a total benefit of U.S.$3,599,459 from groundnut IPM Farmer Field Schools (FFS) from 2002-2010 both in direct effects on participants and indirect effects of spreading of FFS lessons from participants to neighboring farmers. FFSs in Ghana; participants produced on average 4.7 bags of peanuts compared to 2.9 bags for non-participants. FFS participants had an increased yield of 145 kg/ha in 2010 or an average of U.S.$102 per FFS farmer. The direct impact was U.S.$305,936 in 2010 by groundnut IPM-FFSs. Participants shared information with an average of five other farmers for an indirect impact of U.S.$382,419, which brought the total impact of 2010 FFSs to U.S.$668,355. Since, 2002 a total of 3000 farmers directly impacted and 15,000 indirectly impacted.

The ME also has an information and analytical role. Analysis by the ME focused on the socioeconomic impacts of the Guyana peanut value chain project and on the role of mycotoxins on public health. In a widely reported (BBC, Reuters) publication the connection between maize consumption and HIV transmission in Africa was discovered, providing a new potential intervention in the HIV epidemic. This was an unplanned result emerging from analysis seeking to document the connection between infectious diseases and aflatoxin-prone commodities.

In PUR 151, research showed that inclusion of peanut butter with breakfast helped control appetite and blood sugar in obese women. Also, evidence shows peanuts consumed in moderation do not pose a threat to weight gain allowing the recommendation to consume, in moderation, peanuts and/or peanut products. Preliminary analyses of new studies show that peanut consumption was associated with marked reduction in blood pressure. Cardiovascular disease is a pressing health problem globally, and if this work is confirmed, this will improve the market perception of healthiness and create a strong demand and expansion of the market for peanuts and peanut products. The negative sense of the high fat peanut is difficult to overcome, but with more research to support the effectiveness of peanuts as a means to improve satiety without weight gain is extremely important. Dissemination of the results of this work in more commercial media will help even more to improve perception of peanut consumption, and increase the production and used of peanuts

In TAM 137 materials with field measures of improved drought tolerance were found in Texas. Early maturing, high-oleic runner peanuts are set to be released for the Texas market, which is of high processor and consumer interest for increasing shelf-life of products. Crosses to transfer high oleic traits from wild species have been successful. The results are hybrids with alleles closer to cultivated peanuts. Six accessions from previous evaluations were selected and increased for new underway regional trials of leaf spot-resistant materials with improved yields.

Funds from the Peanut CRSP is critical to accelerating the important discoveries of markers for drought, early maturity, and some of the primary peanut diseases, because of the increasingly limited funds available from public and private sources in Texas. One cultivar under the name Schubert that matures one week earlier and yields 10% higher will replace the high oleic cultivar Olin was approved in 2012. Two runner cultivar release proposals were submitted in Texas in 2011, and releases of an early-maturing, high oleic runner and a high-oleic runner with resistance to root-knot nematodes and *Sclerotinia* blight were approved in 2012.

In UF 150, the development of disease resistant cultivars is important to Florida and the adjoining Georgia and Alabama area where production conditions are similar and information is shared. A strong germplasm base is available including wild species (that have a different chromosome number and require special breeding techniques to introduce the desired resistance characteristics into new cultivars), which will contribute to the cultivar improvement. Crosses with wild species were made in 2008 and 22 lines were tested in Florida in 2010-2012 with anticipated resistance to rust and leaf-spot transferred to future cultivars. In 2012, the collection and return to the U.S. of seed of several favorite cultivars in Bolivia added to the U.S. collection of germplasm, and was done with necessary quarantine procedures. Discussions with ANAPO personnel included sending a list of wild peanut germplasm and potentially exchanging material that is not available in the U.S. collection.

Improvements that are being made in the clay technology for aflatoxin adsorption in the digestive tracts in TAM 149, such as a more refined UPSN, will advance the use of the clay. In Texas, the clay in feeds is very important in reducing aflatoxin in milk.

NCS 131 has provided the technology for a highly efficient and productive IPM program in North Carolina to reduce the insect and disease impact on the peanut crop. New efforts are directed toward new insecticides to replace a standard one (Temik-aldicarb as an "at-plant, in-furrow insecticide), registration for which was suddenly taken off the market, but in 2012 no replacement chemical had been identified. Tomato spotted wilt virus, leaf spot and *Sclerotinia* blight, and *Cylindrocladium* black rot are important diseases to the farmers. Advisory systems developed to alert farmers to IPM problems have produced documented increased in peanut yields. Also, the work is developing IPM practices for new areas of peanut production in North Carolina. A new cultivar, Perry yields well and is popular with farmers, but it is susceptible to tomato spotted wilt virus and IPM practices are being adapted to enable use of the cultivar (a value of cooperation between science to develop new cultivars and IPM practices).

NMS 172 is focused on the improvement of a Valencia type peanut with a particular niche market of roasted-in-shell peanuts. Most Valencia peanuts in the U.S. are produced in New Mexico. The project is utilizing molecular marker techniques to speed up the development of improved cultivars with higher yield potentials, as well as insect and disease resistance. As reported in 2012, New Mexico State University will release its first high oleic acid Valencia peanut cultivar "NuMex-01," which originated from a cross between "Valencia-C" and OLin from Texas A&M University. Yields were about 20% higher than the common cultivar. The oleic to linoleic acid ratio ranged from 18-25:1 compared to 1-2:1 in the control, which will provide high market value for the "NuMex-01".

UGA 136 is directed toward virus resistance in peanuts, a problem in Georgia and U.S. peanut production. Contributions are being made by this project in transgenic technology to improve the ability to breed virus resistance cultivars.

UF 157 uses production models to identify constraints to production (i.e. yield potential of varieties, losses to diseases and insects, drought stress, etc.), and to develop recommendations for overcoming these constraints. Reduced costs and time for field studies to provide the recommendations should occur.

Overall in the development of new cultivars, there is the need to develop cultivars with drought tolerance and significant resistance to the diseases *Sclerotinia*, CBR (*Cylindrocladium* black rot), early leaf spot, and white mold, and for resistance to aflatoxin contamination. If a coordinated effort continues to be made by the Peanut CRSP to focus these programs, they can also make even more substantial contributions to the U.S. peanut industry.

CHAPTER 31. EXTERNAL EVALUATION TEAM REPORT FOR THE 2007-2012 COOPERATIVE AGREEMENT

The cooperative agreement did not mandate the external evaluation panel review as did all the past grants. Under the grant agreements the CRSP was mandated to plan and supervise the review with appropriate approvals of BIFAD/USAID. USAID was more involved in management activities under the cooperative agreement, one area was to conduct the External Evaluation, but had not planned a review at the beginning of the fourth year which was the normal time that earlier reviews had been conducted. USAID planned and conducted a review December 2011 to February 2012.

This EET Review Report includes an evaluation of the research progress, technology development, and impacts at mid-term of the implementation (2007-2010). The EET was provided the first three years annual reports, a principal investigator survey that responded to ten questions pertaining to project activities, a management entity observation statement, and additional information provided as needed by scientists, the management entity and the EET coordinator. There were no site visits made either in the host countries or the U.S., due to financial limitations. The USAID plans to conduct a review as an External Evaluation removed it as a budgeted item in the management entity budget.

The EET consisted of nine experts representing various fields in the key areas addressed in the Peanut CRSP program sectors. They represented a wide range of institutions including U.S. universities, international and national research institutes and authorities, development agencies and private sector companies. They also represented the various regions where on-going projects were located and where there were active research teams working on Peanut-CRSP-supported projects.

- Dr. John P. Cherry, retired, former director USDA/ARS Eastern Regional Research Center, Arthurdale, West Virginia. Expertise is in the area of food technology, food processing, food physicochemistry, functional properties and product processing, and nutrition, chemical and microbial food safety. He has a U.S. background.

- Dr. David Cummins, retired, former Peanut CRSP program director, and rehired part time for special assistance to Peanut CRSP Management Team. Cookeville, Tennessee; served as EET Coordinator. He has a U.S. background.

- Dr. Dely Pasqual Gapasin, retired senior agriculturalist, World Bank, Pleasant Hill, CA 94523. Expertise is in agricultural research, development and extension; and extensive experience in program development, implementation, and evaluation. She has a Philippine background.

- Dr. Wallace Hayes, DABT, FATS, FIBiol, FACFE, ERT, Harvard University, Harvard School of Public Health, Andover, MA 01810. editor-in-chief of Food and Chemical Toxicology, principal science advisor for Spherix Health Science Consulting. His expertise is in toxicology and health, including implications of aflatoxin. He has a U.S. background.

- Dr. Geoffrey Hildebrand, Progene Seeds Limited, Rattray Arnold Research Station, Mount Pleasant, Harare, Zimbabwe. His expertise is in both public and private groundnut breeding with particular emphasis on disease resistance including rosette virus disease. He has a South Africa/Zimbabwe background.

- Dr. Martin E. Kimanya, Tanzania Food and Drugs Authority, Mabibo External, Mandela Road, Dar es Salaam, Tanzania. An authority on the influence of dietary mycotoxins in human diets with a number of key publications. He has a Tanzania background.
- Dr. Bonny Ntare, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)

- BP 320 Bamako, Mali. Expertise in groundnut breeding and working with international donors. He has a Uganda background.

- Dr. Howard Valentine, The Peanut Foundation, 10625 Big Canoe, Jasper, GA, 30143. Expertise in industry and foundation activities in most areas of the U.S. the peanut industry, particularly in post-harvest and peanut product interests. He has a U.S. background.

- Dr. Farid Waliyar, ICRISAT director for West and Central Africa, ICRISAT BP 320, Bamako, Mali. His research expertise is in plant pathology, with particular interest in aflatoxins. He has an Afghanistan background.

- Dr. Handy Williamson, University of Missouri, vice provost for International Programs and Strategic Initiatives, Columbia, Missouri 65203. His expertise is in agricultural economics and rural sociology, with extensive program/project review experience in Africa. He has a U.S. background.

Each project was reviewed by two-four EET members and reports prepared. Reviewers provided their comments and observations to the sector coordinator who developed a consensus report on each project and a value-sector summary. The summaries were prepared, with the following leadership: 1) Production values – Dr. Ntare; 2) Processor values – Dr. Cherry; 3) Consumer values – Aflatoxin section Dr. Kimanya, Nutrition section Dr. Cherry; 4) Cross Cutting values – Dr. Cherry; 5) Host Country Achievements and Impacts – Dr. Williamson; and 6) Achievements and Impacts of particular U.S. interest – Dr. Valentine.

Dr. John Cherry and Dr. Dely Gapasin developed and edited an overall executive summary with assistance from Dr. David Cummins. The addition of comments by the program management and formatting of the final report was undertaken by the management entity. The individual project accomplishments and impacts, and major sector impacts presented earlier reflect the EET review.

EET Endorsement and Recommendations

The EET recommended that USAID extend the implementation of the Peanut CRSP for the next five years (2012-2017) as per its original design. Although designed to respond to the goals of the IEHA, the program does respond strongly to FTF and has a wide range of activities where the full impact and contribution to FTF will only be achieved with the additional time available through an extension of the award. While the program has relevance to FTF, the results also have relevance to the majority of developing countries, because of the aflatoxin work undertaken from the peanut platform, which is relevant to any source of exposure.

The recommendation was for USAID to support the program with adequate funding to maximize return on investments through working on the full value chain, This holistic approach will realize the benefits of research leading to increased production and economic activity, improved nutrition and gender equity, and improved public health through reduced human aflatoxicosis.

The EET found that the Peanut CRSP aligns well with the expressed development objectives of the U.S. and USAID Feed the Future (FTF) program initiative. The results being gleaned from the Peanut CRSP projects provide contributions to the realization of the short-term FTF program initiative goals. Support for outreach activities and future plans that address ending hunger and improving health among underfed/malnourished populations is well justified. The outcomes being obtained or likely to result from the Peanut CRSP include developing and extending technologies to small and large farmers, commodity handlers, food manufacturers and marketers to process and market quality, safe, and nutritious foods responding to consumer preferences. Policy recommendations relating to the problem of aflatoxicosis have been realized, but much still has to be achieved to fully capture the benefits of these investments. In this area a disruption of the program would be particularly harmful to momentum that has been established.

The program has experienced problems associated with the fiscal/accounting conditions established for the award. The EET recommended that USAID modify the recommended extension such that a performance-based payment model, that is the recommended mode for USAID awards, replaces the present cost re-imbursement paradigm (as suggested in the ME commentary and the principal investigator surveys). Host country Institutions have found this process and requirement difficult to follow and this has affected the technical achievement, particularly in Uganda and Ghana, where multiple projects are being implemented.

The EET analyzed the program relative to the Feed the Future (FTF) initiative of USAID and believe that the Peanut CRSP can be further refined to correspond to FTF with relatively minor adjustments. The strong emphasis on nutrition and food security through addressing the aflatoxin in the whole diet make the Peanut CRSP and the accomplishments to date mesh well with the FTF goals.

The Peanut CRSP is compatible with the FTF research theme II (increasing food supply) by:

- Advancing the Productivity Frontier – cropping systems to increase productivity, expanding yield potential of crops, technology adoption by farmers through farmer training and other cooperative efforts with the host country collaborators, partnering with NGOs

- Transforming Key Production Systems – models to identify production constraints, IPM systems to efficiently control diseases and insects, disease and pest resistance varieties, information transferred to farmers with many peanut farmers being women

- Enhancing Food Safety and Nutrition – strong focus and accomplishments on aflatoxins and its effect on health/immune systems/communicable diseases, means to reduce or prevent agricultural and food safety threats from aflatoxin, at the household level making women aware of the hazards of aflatoxin in the food supply, processing systems to produce healthy peanuts will contribute to both health and income since peanut is the most readily marketable of crops

The Peanut CRSP also responds to Part III of the FTF document that addresses Gender Equity. In addition to commonly being a crop produced, processed and marketed by women in the informal economy the Peanut CRSP also is proving highly relevant to gender-biased health concerns: by documenting how aflatoxin impacts on pregnant women, and is related to low birth weights of babies and anemia in the mothers. Concerted efforts to inform policy makers and women of aflatoxin hazards to health are a need for the future activities of the CRSP.

Part IV of the FTF strategic document identifies the need for 'Accountability and Impact'. The Peanut CRSP broadly is progressing in accord with key indicators developed in the documents for the 2007-2012 phase. Examples of impacts are documented, such as the deployment of the rosette virus resistant varieties released in Uganda and their rapid spread to growers, which is bringing back production lost to the devastating disease.

The Peanut CRSP is working to better document the high order impacts needed for FTF but it should be noted that the intensive monitoring required on an annual bases leaves of a number of impacts undocumented.

CHAPTER 32. PEANUT CRSP FISCAL SUPPORT BY USAID FROM 1982 TO 2012

Budget (overall, by phases):

July 1982-June 1985	$5,059,276	Grant # DAN-4048-G-SS-2065-00
July 1985-June 1990	$8,199,098	Grant # DAN-4048-G-SS-2065-00
July 1990-June 1996	$9,335,768	Grant # DAN-4048-G-00-6041-00
July 1996-June 2001	$7,573,300	Grant # LAG-4048-G-00-6013-00
July 2001-June 2007	$11,904,401	Grant # LAG-G-OO-96-90013-00
July 2007-June 2012	$13,473,096	Cooperative Agreement # ECG-A-00-07- 00001-00
Total (30 years)	**$55,544,939**	

Project years were normally July to June, and Programmatic Reports followed those dates. Budget years are also listed in the above summary as July to June for convenience in summarizing the 30 years phase-by-phase summary. Earlier program years fit more the July-to June-years, but as years progressed, financial allotments fit more the Federal Government Fiscal Year of Oct. 1 to Sept. 30. Allotment dates sometimes changed to time of appropriation by Congress. In the 1986 period the Gramm-Rudman-Hollings initiative in Congress reduced the budget 18% of the planned budget. About 1988, Federal Budget stresses caused the CRSP to extend operations from 12 to 18 months without extra funding. The June 1990 phase ending was extended to June 1991 and the June 2006 phase extended to June 2007, or six years for each phase, due to USAID program adjustments. The budget year ending July 2012 in the above budget illustration actually was scheduled for Sept. 30, with an extension to Dec. 31, 2012 as the Peanut CRSP was ending (as were all CRSPs with a newly formed Program being initiated). Expenditures were to be finalized and the program closed by Feb. 28, 2013.

An important factor built into CRSP budgets was a Cost-Sharing requirement of the Participating United States University that received sub-grants from the USAID budget. The Cost Share was 25% of the portion expended in the U.S. in each sub-grant or project with some exceptions. These are not added into the above phase budgets and grand total, but total in the range of $9,000,000. Cost Share funds were from a range of support that were provided by the University, such as participating scientists and support staff salaries, and laboratory and field support for research. This cost share support was indicative of U.S. university interest and commitment to developing country food supply and economic growth, and much more fiscally that the 25% reporting that was required. Management entity funds were not required to be cost shared. To illustrate the Cost Share support, in Phase 1 above USAID provided $5,059,276 with $1,127,103 Cost Shared by the U.S. universities. U.S. research supported activities that resulted in information that enhanced host country research and supported host country graduate and short-term training in the U.S., and well as providing feed-back of information important to the U.S. (a component built into the CRSP concept). U.S. and host country institutions were able to charge indirect costs for a portion the funds expended in each of the institutions.

Overall, it is safe to conclude that the cost of Peanut CRSP operations (and of all CRSPs) provide returns much greater that the direct funds contributed by USAID to the programs.

CHAPTER 33. TRAINING, INFORMATION, AND MANAGEMENT

Training

The training will be divided into host country, non-host country, and United States masters and doctoral level training, short-term training mostly for participants that were non-U.S., and sabbatical-leave-type training. The training is presented by region, country, whether production, processing, or consumer values, and by project. An extra description of a number of host-country trainees will be emphasized to show the value of training. Similar observations could be made for many trainees, but is beyond the scope of the history presentation.

1. Peanut CRSP Country Degree Training

West Africa

Senegal

A. Production values

TX/BCP Smith/Simpson
Ousmane N'Doye, Senegal, (1984 – Completed DEA in cytophysiology at University of Dakar in conjunction with ISRA), M.S. 1988 and Ph.D. 2001, Plant Breeding, Texas A&M University, peanut breeder ISRA, male, full support. 1985, September – began language training and studies toward M.S. in plant Breeding in January 1986; completed 8/12/88. Completed M.S. in plant breeding at Texas A&M University supported by the Peanut CRSP/Senegal breeding project with Dr. Olin Smith. 1988-1993 – peanut breeder at ISRA/Nioro Station, Peanut CRSP collaborator. 1993-1998 – Peanut program manager and peanut breeder ISRA/CNRA/Bambey Station, Peanut CRSP collaborator. 1998-2001 – Completed Ph.D. in Plant Breeding at Texas A&M University, Peanut CRSP/Dr. Smith. 2001-2002 – Peanut breeder at ISRA/CNRA/Bambey Station, Peanut CRSP collaborator. 2002-2009 – director, CNRA, continued Peanut CRSP collaboration. 2009-2011 – director, ISRA/CERAAS station at Theis. 2011-present – CORAF/WEFARD (West African Council for Agricultural Research and Development as Manager of its Non Staple Crops Program.

In collaborative research with Peanut CRSP (first with Dr. Olin Smith and then Dr. Charles Simpson and Dr. Mark Burow, Texas A&M University as principal investigators), Dr. Ndoye has been instrumental in releasing seven peanut varieties in Senegal that now occupy almost one million acres of production

Dr. Ndoye commented that "The most valuable accomplishment of this project is by far the people trained and working for their country; I am a living example. When I first came to the U.S., I hardly understood the language. It was difficult to speak a full sentence. Now you can judge. The friendship with U.S. scientists is also a valuable accomplishment." In: O. Ndoye, O.D. Smith, and A. Ba. 'Fleur 11' Impacts in Senegal. Impacts and Scientific Advances through Collaborative Research on Peanut, Symposium and Workshop, Arlington, VA, 29-31 March, 1995.
He also stated that the "a long-lasting effect of the Peanut CRSP was the investment made to train students who returned to their home countries, regions, or continents and continued in research important to food production and economic development."
(Email letter to David Cummins).

TAM 17 Burow

- Issa Faye, Doctorate Agronomy, Université de Dakar, 2007.

B. Processor values

NCA 32 Ahmedna

- Nimsate Kane, Senegal, M.S. in 2004 and Ph.D. in 2007 in Food and Nutritional Sciences at North Carolina A&T University, full support, female.

C. Consumer values

VT 09 Bertelsen

- Eberechukwo Akobundu, Senegal, M.S. in 2003 in Social Science at Virginia Tech University, female, partial support.

UCN 36 Bravo-Ureta

- Aly Cisse, Senegal, M.S. Agricultural and Resource Economics in 2000 at the University of Connecticut, full support (cooperative with the Department of Agricultural and Resource Economics and Office of International Affairs at UConn and Bureau of Educational and Cultural Affairs-BECA-U.S. State Department, male
- Abdourahmane Thiam, Senegal, Ph.D. Agricultural and Resource Economics in 2003 at the University of Connecticut, partial support (cooperative with UConn Office of International Affairs), male
- Ibrahima Hathie, Senegal, Ph.D. Education in 2003 at the University of Connecticut, full support (cooperative with University of Connecticut Office of International Affairs), male
- Gorgui Ndiaye, Senegal, M.S. Agricultural and Resource Economics in 2004 at the University of Connecticut, full support, male
- Sophie Diagne, Senegal, M.S. Agricultural and Resource Economics in 2004 at the University of Connecticut, supported by UConn Department of Agricultural and Resource Economics, female
- Oureye Seck, Senegal, M.S. International Studies in 2004 at the University of Connecticut, partial support (cooperative with UConn-ENEA BECA project), female
- Albina Mmao, Senegal, M.A. International Studies in 2003University of Connecticut, not supported but research connected with CRSP, female
- Abdou Ndoye, Senegal, Ph.D. Education, University of Connecticut in 2003, partial support, male
- Ibrahima Gaye, Senegal, MPA in 2003 at ENEA/Dakar, partial support, male.

TX/MM Pettit

Bashir Sarr, Senegal, M.S. 1985-1988, Ph.D. 1988-1992, and Post-Doctoral 1993 in Veterinary Public Health/Aflatoxins at Texas A&M University (Research assistant in Aflatoxin Management, Institute of Food Technology (ITA), Dakar), male, full support. He completed his M.S. and Ph.D. under the direction of Dr. Timothy Phillips, Department of Veterinary Public Health, Texas A&M University. His graduate research provided key information in the development of Dr. Phillips research on the use of processed sorptive montmorillinite clay, NovaSil, to remove aflatoxin from the digestive tracts of animals, which in later studies was applied to human use and health Dr. Sarr returned to Senegal and worked for a period with ITA. In 2012 he was with UNESCO/Dakar.

Burkina Faso

A. Production values

GA/IM Lynch

- Solibo J. Arsene Some, Burkina Faso, M.S. Entomology at the University of Georgia in 1985, male, full support. Returned to University of Ouagadougou as collaborator. Ph.D. in Agronomy, 1993, University of Georgia with full support. He became the collaborator on the Peanut CRSP Entomology project in Burkina Faso, and later worked with an NGO near Ouagadougou to enhance agricultural productivity. He now is in an agronomy teaching position at the Université Polytechnique de Bobo-Dioulasso (established in 1995), Burkina Faso.
- Idrissa Dicko, Burkina Faso, Ph.D. Entomology in 1989 at the University of Georgia, male, full support. Served as collaborator at the University of Ouagadougou, Burkina Faso. Key research on the relationship of termite damage to peanut shells prior to harvest and the increase in aflatoxin contamination. From 1997-2010, Dr. Dicko served as country director of the hunger project/Burkina Faso, and in 2010 was appointed vice-president, Africa programs of the hunger project (based in New York City).
- Albert Patoin Ouedraogo, Burkina Faso, Ph.D., Entomology in 1991 at the Université de Rabelais, Tours, France, male, partial support. Prof. Ouedraogo continued employment in entomology at the University of

Ouagadougou and is now retired. Note: One of his students, Sanon Antoine is leading the entomology laboratory, a second generation effect of Peanut CRSP training.

Trained eight fifth cycle (M.S. equivalent) students from Burkina Faso in entomology from1986-1990 at University of Ouagadougou with partial Peanut CRSP support, males; Hubert Bathomo, Hamado Tapsoba, Karim Traore, Hamado Sawadago, Sanou A. Ntoine, Issoufou Ouedraogo, Daouda Thiam, Adama Zare.

TX/BCP Smith/Simpson (after 1998)

The following Third Cycle (comparable to Bachelor of Science level in the U.S.) were trained with Peanut CRSP support at the University of Ouagadougou, Burkina Faso.

- Guetina, Burkina Faso, third cycle, Disease Evaluation, 1986.
- Justin Yawemba, Burkina Faso, third cycle, Disease Evaluation, 1987, male.
- Barnadette P. Wiminga, Burkina Faso, third cycle, Disease Evaluation, 1988, female.
- Pauline Kima, Burkina Faso, third cycle, Disease Evaluation 1988, female.
- __Pazisma, Burkina Faso, third cycle, Disease Evaluation, 1988.
- __Kabore, Burkina Faso, third cycle, Disease Evaluation, 1988.
- Mahama Ouedraogo, Burkina Faso, M.S. 1990 and Ph.D. 1995 in Plant Breeding at Texas A&M University, male full support. Dr. Ouedraogo returned to Burkina Faso and was Co-collaborator for the project. Presently, he is director of SAFGRAD, a project coordinated by the African Union.
- Yanogo Philippe, Burkina Faso, fifth cycle (M.S. level) in 1995 in Agricultural Engineering at the University of Ouagadougou, male, partial support.

TAM 137 Burow

- Fidele Neya, Burkina Faso, Doctorate in Breeding in 2013 at the University of Ouagadougou, male partial support.
- Denise Ilboudou, Burkina Faso, M.Sc. Pathology in Breeding in 2007 at the University of Ouagadougou, male, partial support.

B. Processor values

AAM/BF Singh

- Philippe Nikiema, Burkina Faso, Doctorate in 1993 in Food Technology, male, partial support. Assistant Professor in Department of Biochemistry and Food Sciences at the University of Ouagadougou. In 2010 was at the University of Georgia on a Fulbright Scholarship to pursue a Ph.D. in mycotoxins (aflatoxins).
- Dr. Alain N. Sawadogo, Burkina Faso, Doctorate in 1993 in Food Technology at the University of Ouagadougou, male, partial support.
- Alain Traore, Burkina Faso, fifth cycle in 1993 in Food Science at the University of Ouagadougou, male, partial support.
- Darouda G. Traore, Burkina Faso, fifth cycle in 1993 in Food Science at the University of Ouagadougou, male, partial support.
- Simeon Nanema, Burkina Faso, fifth cycle in 1992, Doctorate in1994 in Food Science at the University of Ouagadougou, male, partial support. Later Ph.D. at Cornell University, and now employed by United Nations in Chad.
- Rufin Simde, Burkina Faso, Doctorate 1994 in Food Science at the University of Ouagadougou, male, partial support. Now director of SONAGESS (La Société Nationale de Gestion du Stocks de Sécurité) formerly Cereals Management Office in Ouagadougou.
- Ashok Misra, Burkina Faso, Ph.D. in Food Technology in 1993 at Alabama A&M University, male, full support.

Students for food technology degrees at the University of Ouagadougou were directed by Dr. Alfred Traore: Peanut CRSP lead collaborator in the food technology project, and leader of the Food Science Department, later president of the University of Ouagadougou, and now director of CRSBAN (Regional Centre of Food Science and Biotechnology) at the University of Ouagadougou. Email note by Prof. Traore in 2010: "Thanks to the project, we built up new curricula in food sciences and technology. More than 200 students have been trained coming from West and Central Africa countries." (Added by D. Cummins – This is an important example of the capacity building efforts of Peanut CRSP. Upper Volta/Burkina Faso independence in 1960, University of Ouagadougou founded in 1974, and Peanut CRSP Food Science project began in 1988).

Nigeria

A. Producer values

GA/PV Demski

Phindile Olorunju from Nigeria began a Ph.D. program in breeding/virology at the University of Georgia in September 1985. She returned to Nigeria in 1988 to evaluate for rosette virus resistance peanut crosses made at the University of Georgia, which comprised her dissertation work. She completed her Ph.D. in December 1989. Originally a technician, she returned as peanut breeder, Institute for Agricultural Research, Amadou Bello University, Nigeria. From 2000-2010, professor and director of research and innovation at the University of Venda, Thohoyandou, South Africa, full support.

Dr. Olorunju returned to Nigeria as the primary collaborator, and carried out a program of breeding for resistance to rosette virus. Other studies were to get resistance into a range of season lengths, develop state trails and demonstration plots to assess disease and agronomic performance at a range of sites, and to show farmers that resistant cultivars prevent epidemics of rosette virus (the 1975 epidemic discouraged farmers and greatly reduced interest in growing peanuts with a large area decrease). Important to the program, in addition to Peanut CRSP collaboration, was a close collaboration with the ICRISAT Sahelian center for dissemination of ideas and information, and the sharing of breeding materials with rosette resistance. The varieties developed and released through 2000 were largely due to her efforts. In about ten years or 2010, ICRISAT estimated that four of the nine varieties released by Dr. Olorunju occupied about 70% of the Nigerian groundnut area.

B. Processor values

AAM/FT Singh

- Abraham Idowu, Nigeria, M.S. in Food Technology in 1988 at Alabama A&M University, male, partial support.
- Francis Agbo, Nigeria, M.S. in Food Technology in 1988 at Alabama A&M University, male full support.
- John U. Anyanwu, Nigeria, M.S. in Food Technology in 1989 at Alabama A&M University, male, full support.
- Dike Ukuku, Nigeria, M.S. in Food Technology in 1990 at Alabama A&M University, male full support.
- Tunde Koleosho, Nigeria, M.S. in Food Techology in 1992 at Alabama A&M University, male, partial support.

C. Consumer values

UAB 148 Jolly

- Faisal Shuaib, Nigeria, Ph.D. Public Health in 2010 at the University of Alabama at Birmingham, male, partial support.

Ghana

A. Producer values

TAM 137 Burow

- Nicholas Denwar, Ghana, Ph.D. in Breeding in 2011 at Texas A&M University, male full support. Returned to SARA/Tamale, Ghana as peanut breeder.

UF 157 Boote

- Stephen Narh, Ghana, Ph.D. in Agronomy in 2013 at the University of Florida, male, supported by University of Florida Alumni Foundation and GTZ-ICRISAT grant.

NCS 10 Brandenburg

- Francis Tigsbey, Ghana, Ph.D. in Plant Pathology in 2007 at the University of Florida, male, full support
- Dr. Denwar, Narh, and Tigsbey have returned to their research positions in Central and Northern Ghana. They fill important roles in peanut breeding, diseases, and production, and stand to have important impacts in Ghana peanut production.

B. Processor values (no one trained)

C. Consumer values

UGA 01

- Enyonam Quist, Ghana, M.S. in Food Technology in 2005 at the University of Ghana/Legon, male partial support.
- K. Saalia, Ghana, Ph.D. in Food Safety/Technology in 2001 at the University of Georgia, male, full support.

OKS55

- Saritha Gedela, Ghana, M.S. in Plant Pathology/Aflatoxins in 2006 at Kwame Nkrumah University of Science and Technology, female, partial support.
- Kwabena Frimpang, Ghana, Ph.D. in Plant Pathology/Aflatoxins in 2007 at Kwame Nkrumah University of Science and Technology, male, partial support.

VT09 Bertelsen

- Louis Boakye-Yiadom, Ghana, M.S. in Social Science in 2004 at Virginia Tech University, male, partial support.

AUB 163 C. Jolly

- Michail Agyekum, Ghana, Ph.D. in Agricultural Economics and Rural Sociology in 2012 at Auburn University, male, partial support.

TAM 50 Phillips

- Evans Afriyie-Gyawu, Ghana, Ph.D. in Toxicology in 2005 from Texas A&M University, male, full support.

PUR 10 Mattes

- Phoebe Lokko, Ghana, Ph.D. in Food Science/Nutrition in 2000 at the University of Ghana/Legon, female, partial support.
- Linda A. Boateng, Ghana, M.Phil. in Food Science/Nutrition in 2001 at University of Ghana/Legon, female, partial support.
- Anna Larety, Ghana, Ph.D. in Food Science/Nutrition in 2003 at University of Ghana/Legon, female, partial support.
- Margaret Amar-Klemesu, Ghana, M.Sc. in Food Science/Nutrition in 2003 at University of Ghana/Legon, female, partial support.
- Anna Kuevi, Ghana, M.Sc. in Food Science in Food Science/Nutrition in 2004 at University of Ghana/Legon, female, partial support.
- A.C.R.F. Cruz, Ghana, M.Sc. in Food Science/Nutrition in 2004 at University of Ghana/Legon, female, partial support.

COR 158 Brown

- Joseph Ashong, Ghana, Ph.D. Nutrition/Toxicology at Cornell University in 2014, male, 2014.

UGA 127 Chinnan

- Dongdem Achillis, Ghana, M.Sc. in Food Science/Nutrition at University of Ghana-Legon in 2013, male, partial support.

VPI 09 Bertelsen

- Aurora Pepaj, Ghana, M.Sc. in Agricultural Economics at University of Ghana/Legon in 2008 female, partial support.

East Africa

Sudan

A. Processor values

AAM/FT Singh

- Ahmed Il Murtada, Sudan, M.S. in Food Technology in 1988 at Alabama A&M University, (Food Technologist, Food Research Center, Khartoum), male full support.
- Ismeldin Hashim, Sudan, M.S. in Food Technology in 1988 at Alabama A&M University, male full support. Later a Ph.D. Program at the University of Georgia.

Uganda

A. Producer values

UGA 136 Deom

- David Kalule Okello, Uganda, Ph.D. in Plant Breeding at Makerere University/Uganda in 2015, partial support, male.

UCN 139 Bravo-Ureta

- Cresensia (Betty) Asekenye, Uganda, M.S. in Agricultural and Resource Economics in 2012 at the University of Connecticut, female, partial support.

NMS 172 Puppala

- Rachel Nalulgo, Uganda, M.Sc. in Plant Breeding at Makerere at University/Uganda in 2012, female, full support.
- Wilber Wambi, Uganda, M.Sc. in Plant Breeding at Makerere University/Uganda in 2012, male, full support.
- Julius Kwesiga, Uganda, M.Sc. in Agronomy at Makerere University/Uganda in 2012, male, full support.

B. Processor values

AAM/FT Singh

- Mike Ogwal, Uganda, M.S. in Food Technology at Alabama A&M University in 1990, male, full support.

VT 134 Christie

- David Turnwesige, Uganda, M.Sc. in Food Science and Technology at Makerere University/Uganda in 2013, male, partial support.
- Lydia Nakagiri, Uganda, BSc in Food Science and Technology at Makerere University/Uganda in 2009, female, partial support.

NMS 172 Puppala

- Joseph Mulindwa, Uganda, M.Sc. in Food Science at Makerere University/Uganda in 2012, male, full support.

C. Consumer values

VT 134 Christie

- Sophie Nansareko, Uganda, MSc. in Applied Human Nutrition at Makerere University/Uganda in 2012, female, full support.
- Rose Kabagynei, Uganda, M.Sc. in Agricultural Extension Education at Makerere University/Uganda in 2012, female, full support.
- Sylvia Tereka, Uganda, MA in Women and Gender Studies at Makerere University/Uganda in 2009, female, partial support.
- Caroline Bazarrabusa Horn, Uganda, MA in Women and Gender Studies at Makerere University/Uganda in 2009, female, partial support.
- Ruth Muwesa, Uganda, MA in Women and Gender Studies at Makerere University/Uganda in 2009, female, partial support.

VPI 09 Bertelsen

- Sibusiso Moyo, Uganda, M.Sc. in Agricultural Economics at Makerere University in 2007, male, partial support.
- Jackline Bonabana-Wabbi, Uganda, Ph.D. in Agricultural Economics at Makerere University in 2007, female, partial support.

VT54 Christie

- Beatrice Namaloba, Uganda, M.S. in Extension Education at Makerere University/Uganda in 2005, female, partial support.

Kenya

A. Producer values

UCN 139 Bravo-Ureta

- Mary Thuo, Kenya, M.S. 2006, Ph.D. 2011 in Education at the University of Connecticut, full support, female.

C. Consumer values

VT 134 Christie

- Charity Mutegi, Kenya, Ph.D. in Food Security at University of Kwazulu/Natal/South Africa in 2010, female, full support.
- Ndung'u J. Weru, Kenya, M.Sc. in Food Science and Nutrition at Jomo Kenyatta University/Kenya in 2012, male, full support.
- Rosina Wanyama, Kenya, collaborative M.Sc. in Agricultural and Applied Economics at Edgerton University/Kenya in 2012, female, full support, female.
- Winifred Nyambura Selle, Kenya, M.Sc. in Genetics at Jomo Kenyatta University/Kenya in 2012, male, full support.

UAB 148 Jolly

- Nelly Yatich, Kenya, Ph.D. Public Health at University of Alabama at Birmingham in 2009, female, partial support.

Southern Africa

Malawi

A. Producer values

NCS/BCP Wynne

- Charles T. Kisyombe, Malawi, M.S. in Breeding at North Carolina State University in 1984, male, partial support.

C. Consumer values

VT 35 Alwang

- N. Muero, Malawi, M.S. in Social Science at Bunda College of Agriculture in 1999, female, partial support.
- Abdi Edris, Malawi. M.S. in Social Science at Bunda College of Agriculture in 2000, male, partial support.

Botswana

UWI 49 Wilson

- Fingani Mphande, Botswana, M.Sc. in Microbiology at the University of Botswana in 2002, male, partial support.
- David Nkwe, M.Sc. in Microbiology at the University of Botswana in 2003, male, partial support.
- Tuduetso Maswabi, M.Sc. in Microbiology at the University of Botswana 2003, male. partial support.
- Sejakhosi Mohale, M.Sc. in Microbiology at the University of Botswana in 2004, male.
- Benoit Gnonlonfin, M.Sc. in Microbiology at the University of Botswana in 2006, male, partial support.

Southest Asia

Philippines

A. Producer values

NCS/BCP Wynne

- Victoria Matalog, Philippines, M.S. in Plant Breeding at North Carolina State University in1987, female, full support. Entered Ph.D. program at Clemson University.
- Vermando Aquino, Philippines, M.S. in Plant Pathology at North Carolina State University in 1987, male, full support. Entered Ph.D. program at the University of Florida.

TX/BCP Smith

- Julius E. Fajardo, Philippines, Ph.D. in Plant Pathology at Texas A&M University in 1992, male, full support.
- Rodante Tabien, Philippines, M.S. Breeding at Texas A&M University in 1992, male, full support.

UGA/PV Demski

- Araceli Pua, Philippines, Ph.D. in Plant Pathology/Virology at the University of Georgia in 1991, male, partial support.

B. Processor values

UGA/FT Beuchat

- Sonia Rubico, Philippines, M.S. in Food Technology at the University of Georgia in 1987, female, full support
- Bernadita Santos, Philippines, M.S. in Food Technology, University of Georgia in 1987, female, full support

- Kathleen Muego, Philippines, M.S. in Food Technology at the University of Georgia in 1991, female, no support
- Flor C. Galvez, Philippines, Ph.D. in Food Technology at the University of Georgia in 1990, female, no support
- Therese Malundo, Philippines, M.S. in Food Technology at the University of Georgia in 1992, female, partial support
- Rocelle Clavero, Philippines, M.S. in Food Technology at the University of Georgia in 1991, female, partial support
- Grace Divino, Philippines, M.S. in Food Science, University of Georgia in 1995, female, partial support. Entered Ph.D. program at Kansas State University.
- Agustin Ramos, Philippines, M.S. Food Science at the University of Georgia in 1995, male, partial support
- Raul Divina, Philippines, Ph.D. in Food Technology at University of the Philippines at Los Banos in 1992, male, partial support

Thailand

A. Producer values

Sanon Jogloy, Thailand, M.S. 1986 and Ph.D. 1988 in Plant Breeding at North Carolina State University, male, full support. Following training under by Dr. Johnny Wynne, he returned to a peanut breeding position at Khon Kaen University, where he has remained and is now the lead peanut breeder for Thailand. Four varieties have been released that occupy much of the 158, 000 acres of peanuts in Thailand with high quality, consumer acceptable peanuts responding to market-pull inputs of the Peanut CRSP Food Technology Program.

NCS/BCP Wynne

- Surapong Charoenrath, Thailand, Ph.D. in Plant Breeding at North Carolina State University in 1989, male, full support, peanut breeder, Department of Agriculture, Khon Kaen
- Anan Hirunsalee, Thailand, Ph.D. in Plant Breeding at North Carolina State University in 1994, male, full support
- Dilok Saikrang, Thailand, M.S. in Crop Science at Khon Kaen University in 1989, male, partial support
- Sirirat Chetsumon, Thailand, M.S. in Crop Science at Khon Kaen University in 1989, female, partial support
- Samarn Chombutsi, Thailand, M.S. in Crop Science at Khon Kaen University in 1991, male, partial support
- Rungsan, Tepnoak, Thailand, M.S. in Crop Science at Khon Kaen University in 1990, male, partial support
- Pobpone Yingtongchai, Thailand, M.S. in Crop Science at Khon Kaen University in 1991, male, partial support
- Panupong Tanklang, Thailand, M.S. in Crop Science at Khon Kaen University in 1991, male, partial support
- Somsak Idhipong, Thailand, M.S. in Crop Science at Khon Kaen University in 1991, male, partial support
- Sopitra Chatcharoantong, Thailand, M.S. in Crop Science at Khon Kaen University in 1991, female, partial support
- Yuwadee Chooprapawan, Thailand, M.S.in Plant Pathology, Khon Kaen University in 1993, female, partial support
- Nikul Choungam, Thailand, B.S.in Crop Science at Khon Kaen University in 1990, male, partial support
- Ratchanee Fangsrikam, Thailand, M.S. in Crop Science at Khon Kaen University in 1990, female, partial support
- Tinakorn Khomsa-art, Thailand, M.S. in Crop Science at Khon Kaen University in 1991, male, partial support
- Yuparas Kongnen, Thailand, M.S. in Crop Science at Khon Kaen University in 1991, female, partial support
- Visit Tressuwanwat, Thailand, M.S. in Crop Science at Khon Kaen University in 1992, male, partial support
- Rungrat Sawadirat, Thailand, M.S. in Plant Pathology at Khon Kaen University in 1994, female, partial support

- Ratchadaporn Palanasirimong, Thailand, M.S. in Plant Pathology at Khon Kaen University in 1994, male, partial support

NMS 172 Puppala
- Mahakosse Supattra, Thailand, M.Sc. in Plant Breeding at Khon Kaen University/Thailand in 2013, female, full support.

NCS/IM Campbell
- Turnjit Satayavirut, Thailand, Ph.D.in Entomology at North Carolina State University in 1988, female, full support. Became a leading peanut research entomologist in the Department of Agriculture, Bangkok.

UGA/PV Demski
- Mandhana Sukorudhaman, Thailand, Ph.D. in Plant Pathology/Virology at the University of Georgia in 1987, male, full support. Served on the Science and Development Board, Bangkok.

TAM/BCP Smith
- Rodante Tabien, Thailand, M.S.in Plant Breeding, Texas A&M University in 1992, male, partial support.

B. Processor values

UGA/FT Beuchat
- Anuwat Changchat, Thailand, M.S.1985 Food Technology at Kasetsart University in 1985, UGA/FT, male, partial support
- Kamolwan Suknark, Thailand, M.S. in Food Technology at KU in 1985, female, partial support
- Woranuch Suvanich, Thailand, M.S. in Food Technology at KU in 1986, male, partial support. Employed in the Food Industry in Bangkok
- Yuwadee Wongwithoonwid, Thailand, M.S. in Food Technology at KU in 1986, female, partial support. Employed in the Food Industry in Bangkok
- Rattikorn Saokum, Thailand, M.S. in Food Technology at KU in 1987, male, partial support, employed in the Food Industry in Bangkok.
- Surapong Sukhumsuvun, Thailand, M.S. in Food Technology at the University of Georgia in 1987, male, full support. Employed in the Food Industry in Bangkok
- Sompoche Poppanapimol, Thailand, M.S. in Food Technology at Kasetsart University in 1991, male, partial support
- Tippawan Areeswangkij, Thailand, M.S. in Food Technology at Kasetsart University in 1991, female, partial support
- Thiongchai Suwonsicho, Thailand, M.S. in Food Technology at Kasetsart University in 1992, male, partial support
- Sujinda Suwannakij, Thailand, M.S. in Food Technology at Kasetsart University in 1992, female, partial support
- Witoon Prinyawiwatkul, Thailand M.S.in 1992 and Ph.D. in 1996 in Food Science at the University of Georgia, male, full support
- Anuvat Jangchud, Thailand, Ph.D. in Food Science at the University of Georgia in 1995, male, full support
- Rudeepan Wattanapat, Thailand, M.S. in Food Science at the University of Georgia in 1992, male, full support
- Wiwat Wattanatchariya, Thailand, M.S. Food Technology at Kasetsart University in 1993, male, partial support. Employed in a Research Position at Chaingmai University
- Siri Pussayaipaiboon, Thailand, M.S. Food Technology, Kasetsart University in 1993, female, partial support. Employed in family snack factory
- Sumet Amnuaysirisuk, Thailand, M.S.in Food Technology at Kasetsart University in 1994, female, partial support. Employed at Technical College of Bangkok
- Witida Chantrapornchai, Thailand, M.S. in Food Technology at Kasetsart University in 1994, female, partial support. Employed in Department of Product Development, Kasetsart University

- Tanawit Kitumnuaypong, Thailand, M.S. in Food Technology at Kasetsart University in 1994, male, partial support. Private food industry, Bangkok
- Anuvat Jangchud, Thailand, Ph.D. in Food Technology at the University of Georgia in 1996, male, full support
- Panuwat Suppakul, Thailand, M.S. in Food Technology at Kasetsart University in 1996, male, partial support.
- Wimolsiri Thanavisuthra, Thailand, M.S. in Food Technology at Kasetsart University in 1996, female, partial support. Resumed teaching position at the Faculty of Biotechnology, Rungsit University, Bangkok
- Supang Reungchay, Thailand, M.S. in Food Technology at Kasetsart University in 1996, female, partial support. Lecturer at the Department of Food Technology, Faculty of Science, Ramkamheang University in Bangkok.

AAM/FT Nwosu

- Iwan Surjawan, Thailand, M.S. in Food Technology at Alabama A&M University in 1994, male, partial support
- Wichayada Intaratip, Thailand, M.S. in Food Technology at Alabama A&M University in 1994, male, partial support.

C. Consumer values

UGA22 6 Ph.D. 4M 2F

- Janjira Puntare, Thailand, Ph.D. in Plant Pathology/Aflatoxins at the University of Georgia in 2004, female, partial support.

Latin America/Caribbean

Trinidad

A. Processor values

AAM/FT Singh

- Margaret Hinds, Trinidad, M.S. in 1987 and Ph.D. in 1991 in Food Technology at the University of West Indies, Trinidad, female, full support. Directed by Dr. Bharat Singh, Alabama A&M University.

UGA/PH Chinnan

- Urvan Wilson, Jamaica, M.S. in Food Engineering at the University of the West Indies in 1990, male, full support.

Jamaica

A. Processor values

- Everal Miller, Jamaica, M.S. in Food Technology at Alabama A&M University in 1988, male, full support.

Boliva

UF 150 Tillman

- Pablo Navia, Bolivia, M.S. in Plant Pathology at the University of Georgia in 2012, male, partial support

Brazil

A. Producer values

UGA 28 Deom

- Luciana Cordeiro do Nascimento, Brazil, M.S. in Virology at the University of Georgia in 2007, female, partial support

B. Consumer values

PUR 10 Mattes

- Denise Mourao, Brazil, Ph.D. in Nutrition at Universidade Federal de Viçosa, Brazil in 2004, female, partial support
- Regine Lopes Sales, Brazil, Ph.D. in Nutrition at Universidade Federal de Viçosa, Brazil in 2005, female, partial support

PUR 151 Mattes

- Maria do Camo Gouveia Pelusio, Brazil, Ph.D. in Nutrition at Universidade Federal de Viçosa, Brazil in 2009, female, full support
- Viviane Silva Macedo, Brazil, Ph.D. in Nutrition at Universidade Federal de Viçosa, Brazil in 2009, female, full support
- Tatiana Fiche Salles Teixeira, Brazil, Ph.D. in Nutrition at Universidade Federal de Viçosa, Brazil in 2010, female, full support
- Raquel Alves Durate Moreira, Brazil, Ph.D. in Nutrition at Universidade Federal de Viçosa, Brazil in 2010, female, full support
- Ana Paula Boroni Moreira, Brazil, Ph.D. in Nutrition at Universidade Federal de Viçosa, Brazil in 2010, female, full support
- Cristiane Goncalves de Oliveira, Brazil, M.S. in Nutrition at Universidade Federal de Viçosa, Brazil in 2011, female, full support
- Caio Eduardo Goncalves Reis, Brazil, Ph.D. in Nutrition at Universidade Federal de Viçosa, Brazil in 2011, male, full support
- Daniela Neves Ribeiro, Brazil, Ph.D. in Nutrition at Universidade Federal de Viçosa, Brazil in 2011, female, full support

Eastern Europe

Bulgaria

No degree training, only short-term (listed below).

2. Non-Peanut CRSP Country Degree Training

A. Producer values

Through 1990, at least 24 students from non-Peanut CRSP countries were trained at the M.S. or Ph.D. levels in U.S. participating institutions. In concurrence with the BIFAD CRSP guidelines, the U.S. should get return benefits from the program; students in the graduate research efforts conduct research that benefits both U.S. and international development. They received full or partial support and did thesis or dissertation research on CRSP projects.

TAM/BCP

Yolando Lopez, Columbia, M.S. 1990-1994, Ph.D. 1994-1998 in Plant Breeding at Texas A&M University, female, full support. Graduate research core to the development of four high oleic oil peanut varieties (increased shelf-life of stored or processed peanuts), a major impact peanut industry in Texas. These varieties occupy nearly one-third of the Texas acreage. Through later work in TAM 137, Mark Burow continued to expand the number of cultivars in the United States and introduced high oleic germplasm into West Africa.

- Kadima Ngeleka, Zaire, M.S in Plant Pathology at Texas A&M University in 1990, male, funded by USAID, NCS/BCP Wynne, Isleib
- E.J. Monteverde-Penso, Venezuela, Ph.D. in Breeding at North Carolina State University in 1986, male, partial support
- Setyo Dwi Utomo, Indonesia, M.S., in Breeding at North Carolina State University in 1990, male, partial support

- Tin Htut, Burma, M.S. in Breeding at North Carolina State University in 1990, male, partial support
- Keerthi Hettiarchchi, Sri Lanka, M.S. in Breeding at North Carolina State University in 1990, male, partial support
- Uta Grieshammer, Germany, M.S. in Breeding at North Carolina State University in1990, female, partial support
- Naazar Ali, Pakistan, Ph.D., in Breeding at North Carolina State University in 1991, male, partial support
- Nong Alwi, Indonesia, Ph.D. in Breeding at North Carolina State University in 1987, male, partial support
- Charles T. Kisyombe, Malawi, M.S. in Plant Pathology at North Carolina State University in 1984, male, partial support
- Kamariah Mohamed, Malaysia, M.S. in Breeding/*Rhizobium* at North Carolina State University in 1985, male, partial support
- T. Mekontchou, Cameroon, M.S.in Breeding at North Carolina State University in 1987, male, partial support
- Garcia, Argentina, Ph.D. in Crop Science at North Carolina State University, male, total support
- Menon, India, Ph.D. in Crop Science at North Carolina State University, male, total support
- Utmo, Indonesia, Ph.D. in Crop Science at North Carolina State University, male, total support, NCS/SM Elkan
- Cecillia Bianchi, Argentina, M.S. 1988, Microbiology, NCSU, NCS/SM
- Tulio Cassini, Brazil, Ph.D. 1988, Microbiology, NCSU, NCS/SM
- John B. Byalebeka, Uganda, Ph.D. 1987, Microbiology, NCSU, NCS/SM

TX/MM Pettit
- Hassan Azaizeh, Israel, Ph.D. 1987, Plant Pathology, TAMU, TX/MM

UGA/PV Demski
- Dulce Warwich, Brazil, Ph.D. in Virology at the University of Georgia in 1987, male, partial support

NCS/BCP Isleib
- C. M. Bianchi-Hall, Argentina, Ph.D. in Crop Science at North Carolina State University in 1993, female, partial support. M.S. earlier
- T. Rau, India, Ph.D. in Crop Science at North Carolina State University in 1993, male, partial support
- G. Garcia, Argentina, Ph.D. in Breeding at North Carolina State University in 1995, male, full support
- G. Menon, India, Ph.D.in Breeding at North Carolina State University in 1996, male, full support
- T.P. Shyamalrau, India, Ph.D.in Breeding at North Carolina State University in 1993. male, partial support
- C.A. Salas, Peru, Ph.D. in Breeding at North Carolina State University in 1996, male, partial support
- S. Utomo, Indonesia, Ph.D. in Breeding at North Carolina State University in 1996, male, partial support. M.S.

TX/MM Pettit
- Rudeina Baasiri, India, Ph.D. in Plant Pathology at Texas A&M University in 1996, female, partial support

TAM 17 Burow
- Amade Muitia, Mozambique, M.S. Plant Breeding at Texas Tech University in 2005, male, partial support

UF 157 Boote
- Maninderpal Singh, India, Ph.D. Plant Pathology, University of Florida in 2012, male, (non-CRSP student of Dr. John Erickson, research supportive of CRSP)

UF 150 Tillman
- Imana Power, Suriname, Ph.D. in Plant Pathology at the University of Georgia in 2013, female, partial support

B. Processor values

GA/FT Beuchat

- Yun-Yun Hao, Taiwan, M.S. in 1987 and Ph.D. 1990 in Food Technology at the University of Georgia, male, partial support
- Y.Y. Chiou, Taiwan, Ph.D. in Food Technology at the University of Georgia in 1985, male, partial support
- Chan Lee, South Korea, Ph.D. in Food Technology at the University of Georgia in 1990, male, partial support
- Vivek Gnanasekharan, India, M.S.1989 in Food Technology at the University of Georgia in 1990, male, partial support
- Deepa Pendalwar, India, M.S. in Food Technology at the University of Georgia in 1989, male, partial support
- Zhang Zhong, China, M.S. in Food Technology at the University of Georgia in 1997, male, partial support

AAM/FT Singh, Nwosu

- Hossana Soloman, Ethiopia, M.S. in Food Technology at Alabama A&M University in 1986, male, partial support
- Rose Muatine, Kenya, M.S. in Food Technology at Alabama A&M University in 1989, female, partial support
- Xiaoyong Yan, China, M.S in Food Technology at Alabama A&M University in 1991, male, partial support
- Nelly Duarte, Columbia, M.S. in 1991 and Ph.D. in 1996 at Alabama A&M University, food technology, female, partial support
- Ashok Mishra, India, M.S. in Food Technology, Alabama A&M University in 1993, male partial support
- Bin Pan, India, M.S. in Food Technology at Alabama A&M University in 1994, male, partial support
- Samir Kumar, India, M.S.in Food Technology at Alabama A&M University in 1993, male partial support
- Surendra K. Singh, M.S. in Food Technology at Alabama A&M University in 1996, male, partial support

NCA 32 Ahmedna

- Djaafar Rehrah, Algeria, M.S. in Food Science at North Carolina A&T University in 2006, male, partially supported

C. Consumer values

TX/MM Pettit

- Hassan Azaizeh, Israel, Ph.D. 1987, Plant Pathology, TAMU, TX/MM

VT 54 Harris

- Sibusiso Moyo, Zimbabwe M.S. in Social Science at Virginia Tech University in 2004, male, full support

VT 09 Bertelsen

- Widad Soufi, Tunisia, M.S. in Agricultural Economics at Virginia Tech University in 2001 female, partial support.

TAM 33 Keller

- D. Pinero, Puerto Rico, Ph.D. in Plant Pathology/Aflatoxins at Texas A&M University in 1999, male, partial support
- Yuan Jin, China, M.S. in Plant Pathology/Aflatoxins at Texas A&M University in 2001, male, partial support

UCN 139 Bravo-Ureta

- Aizhen Li, China, M.S. in Agricultural and Resource Economics at the University of Connecticut in 2010, female, partial support

- Angelista Kihaga, Tanzania, M.S. in Agricultural and Resource Economics at the University of Connecticut in 2011, female, partial support
- Grace Lemunge, Tanzania, M.S. in Agricultural and Resource Economics at the University of Connecticut in 2011, female, partial support

UGA 165 Florkowski

- Teng Meng, China, Ph.D. in Agricultural Economics at the University of Georgia in 2014, female, partial support
- Anand Nambiar, India, M.S. completed earlier and Ph.D. in Agricultural Economics at the University of Georgia in 2014, male partial support
- Anna Sheremenko, Ukraine, M.S. in Agricultural Economics at the University of Georgia in 2013, female, partial support
- Victoria Yoo, Argentina, M.S. in Agricultural Economics at the University of Georgia in 2014, female, partial support

VT 134 Christie

- Hande Kaya Celikar, Turkey, Ph.D. in Biological Systems Engineering at Virginia Tech University in 2011, female, full support
- Helene Nyirahakizimana, Rwanda, M.Sc. in Microbiology at Moi University/Kenya in 2011, female, full support

NCA 32 Ahmedna

- Djaafar Rehrah, Algeria M.S. in Food Science at North Carolina A&T University in 2006, male, partial support

3. United States Student Training

Through 1990, the Peanut CRSP trained at least 35 U.S. students at the M.S. and Ph.D. levels. They received partial or full (33%) support and did research on CRSP subjects. William Anderson (Thailand visit) and Michael Fitzner (Philippines visit) were supported by the North Carolina State breeding project and did their research in the host countries in 1984-1985. Lucy Branch in Food Technology at the University of Georgia assisted in important research on the effect of hot water blanching of peanuts on aflatoxin levels and storage properties. Dale Rachmeler obtained a Ph.D. in Plant Breeding at North Carolina in 1988 with 100% support, and was soon working with USAID/Niamey, Niger. Other graduates were going for Ph.D. degrees, working with federal and state experiment stations, in the private agricultural sector, and overseas development (i.e. CIDA/Canada). Moreover, the research support these students provided to their major professors, Peanut CRSP participants, allowed for an expansion and impact of the institutions in the Peanut CRSP host country and U.S. feedback activities.

A. Producer values

NCS/BCP Wynne

- L. C. Mercer, M.S. in Breeding at North Carolina State University in 1988, male, partial support
- C. C. Green, Ph.D. in Breeding at North Carolina State University in 1985, male, partial support
- S. Arrendell, Ph.D. in Breeding at North Carolina State University in 1987, female, partial support
- Pamela Reece, M.S. in Breeding at North Carolina State University in 1988, female, partial support
- Stephanie Fore, M.S. in Plant Pathology at North Carolina State University in 1987, female, partial support.
- Dale Rachmeler, Ph.D. in Plant Breeding at North Carolina State University in 1988 male, full support
- William Anderson, M.S. in Plant Breeding at North Carolina State University in 1985, male, full support
- Michael Fitzner, Ph.D. in Breeding at North Carolina State University in 1990, male, full support
- Tracy M. Halward, Ph.D. in Breeding at North Carolina State University in 1990, female, partial support
- C. S. Johnson, Ph.D. in Breeding at North Carolina State University in 1985, male, full support
- Gale E. McIntyre, M.S. in Breeding at North Carolina State University in 1990, male, full support
- Mark D. Ricker, M.S. in Breeding at North Carolina State University in 1984, male, full support
- Stephen B. Walls, M.S.in Breeding at North Carolina State University in 1984, male, full support.

TX/BCP Smith

- Park, Ph.D. in Breeding at Texas A&M University in 1989, male, full support
- G. B. Parker, Ph.D. in Breeding at Texas A&M University in 1987, male, partial support
- Lisa Wildman Currie, M.S.in Breeding at Texas A&M University in 1990, female, partial support
- Jason Goldman, M.S. in Breeding at Texas A&M University in 1994, male, partial support
- Patrick Pace, M.S. in 1994 and Ph.D. 1997, Breeding, Texas A&M University, male, partial support
- Justin Tuggle, Ph.D. in Breeding, Texas A&M University in 1997, male, partial support, NCS/IM Campbell
- Thomas Keeley, M.S. in Entomology at North Carolina State University in 1987, male, partial support
- Joseph Browde, M.S. in Entomology at North Carolina State University in 1987, male, partial support

NCS/SM Elkan

- George Allen, Ph.D. at Microbiology at North Carolina State University in 1988, male partial support
- Daniel Grimm, Ph.D. in Microbiology at North Carolina State University in 1988, male, partial support
- Laura Vasquez, M.S. in Microbiology at North Carolina State University in 1987, female, partial support
- Seanne Udell, Ph.D. in Microbiology at North Carolina State University in 1990, male, partial support
- Terrence Miller, Ph.D. in Microbiology at North Carolina State University in 1990, male, partial support
- Steven Wagner, M.S. in Microbiology at North Carolina State University in 1984, male, partial support
- Mark Barbour, Ph.D. in Microbiology at North Carolina State University in 1988, male, partial support

TX/SM Taber

- Timothy Riley, M.S. in Microbiology at Texas A&M University in 1985, male, partial support
- J. Stephen Neck, Ph.D. in Microbiology at Texas A&M University in 1990, male, partial support
- Randall Garber, Ph.D. in Microbiology at Texas A&M University in 1990, male, partial support
- Russelyn Henson, M.S. in Plant Pathology at Texas A&M University in 1990, female, partial support
- Young Yang, Ph.D. in Plant Pathology at Texas A&M University in 1990, partial support

FAM51 6 M.S., 3 Ph.D. listed in 1997-2007 Students conducted CRSP related research, but were not supported by CRSP funds.

UF 16 Gorbet

- Sarah Gremillion, Ph.D. in Plant Pathology at the University of Georgia in 2007, female, partial support

UF 157 Boote

- Philip Alderman, Ph.D. in Agronomy at the University of Florida in 2013, male, partial support

UF 155 MacDonald

- Alyssa Cho, Ph.D. in Agronomy at the University of Florida in 2014, female, partial support. In 2012-2013 spent one year in Vietnam on a Borlaug Fellowship

NCS 19 Brandenburg

- Rob Hummel, M.S. in Entomology at North Carolina State University in 1994, male, full support
- Lloyd Garcia, Ph.D. in Entomology at North Carolina State University in 1999, male, partial support
- Jim Barbour, Post-Doctoral in Entomology, North Carolina State University in 1991-1992, male, full support
- Jeff Scott, M.S. in Entomology at North Carolina State University in 2001, male, full support
- Christie Hurt, M.S. in Entomology at North Carolina State University in 2003, female, full support
- Steve Riniker, M.S.in Entomology at North Carolina State University in 2006, male, full support

UGA 22 Ingram

- George Patena, M.S. in Crop and Soil Sciences at the University of Georgia in 1999, male partial support

B. Processor values

UGA/FT Beuchat

- Shona Holt, M.S. in Food Technology at the University of Georgia in 1990, female, partial support
- Lucy Branch, M.S. in Food Technology at the University of Georgia in 1984, female, full support
- Donald W. Schaffner, Ph.D. in Food Technology at the University of Georgia in 1985, male, full support
- Eric Line, Ph.D. in Food Technology at the University of Georgia in 1993, male, partial support
- Doris D'Souza, Ph.D. in Food Science at the University of Georgia in 1996, female, partial support

UGA 04 Resurreccion

- Glencia Walker, M.S. in Food Science at the University of Georgia in 2005, female, partial support
- Christine Chu, M.S. in Food Science at the University of Georgia in 2005, female, partial support
- Jamie Ruldolf, M.S. in Food Science at the University of Georgia in 2005, female, partial support

UGA 11 Chinnan

- Antonio Zenere, Ph.D. in Food Technology at the University of Georgia in 2005, male, partially supported
- Joy Dubost, M.S. in Food Technology at the University of Georgia in 2005, female, partially supported

AAM/FT Singh and Nwuso and M. Elena Castell-Perez

- Wanda Kelker, M.S. in Food Technology at Alabama A&M University in 1984, female, partial support
- Obi Warren, M.S. in Food Technology at Alabama A&M University in 1990, female, partial support
- Brent Jones, M.S. in Food Technology at Alabama A&M University in 1995, male, partial support
- Rolfe Bryant, Ph.D.in Food Technology at Alabama A&M University in 1995, male, partial support.
- Linda Griffith, Ph.D. in Food Technology at Alabama A&M University in 1996, female, partial support

OKS 55 Hinds

- Saritha Gedela, M.S. in Food Technology at Oklahoma State University in 2006, female, partial support

UGA 11 Chinnan

- Vandana Totlani, M.S. in Food Science at the University of Georgia in 2002, female, partial support
- Rashmi Despande, M.S. in Food Science at the University of Georgia in 2004, female, partial support
- Antonio Zenere, M.S. in Food Science at the University of Georgia in 2005 male, partial support
- Joy Dubost, M.S. in Food Science at the University of Georgia in 2005, female, partial support

NCA 32 Ahmedna

- Carlyn Ray, M.S. in Food and Nutritional Sciences at North Carolina A&T University in 2001, female, full support
- Vivian Ray, M.S. in Food and Nutritional Sciences at North Carolina A&T University in 2001, female, full support
- Kendra Matthews, M.S. in Food and Nutritional Sciences at North Carolina A&T University in 2003, female, full support
- Alexandria Proctor, M.S. in Food and Nutritional Sciences at North Carolina A&T University in 2003, female, full support
- Pauline Ireh, M.S. in Food and Nutritional Sciences at North Carolina A&T University in 2004, female, full support

C. Consumer values

NCS 07 Moxley

- Gretchen Thompson, Ph.D. in Social Sciences at North Carolina State University in 2002, female, partial support

VT09 Bertelsen

- James Gray, Ph.D. in Social Sciences at Virginia Tech University in 2002, male, full support
- Jason Bergold, M.S. in Social Sciences at Virginia Tech University in 2001, male, full support

TX/MM Pettit

- Russelyn Henson, M.S. 1990, Plant Pathology at TAMU in 1990, TAM/MM
- Young Yang, Ph.D. 1990 Plant Pathology at TAMU in 1990, TAM/MM
- J. Stephen Neck, Ph.D. in Plant Pathology at Texas A&M University in 2006, full support, male, 2006
- Randall Garber, Ph.D. in Plant Pathology at Texas A&M University in 2006, full support, male, 2006.

UWI 49 Wilson

- Joao Augusto, M.S. in Plant Pathology at the University of Georgia in 2004, partial support, male, 2004

UAB 56

- Deepak Aggarwal, M.C. in Public Health at University of Alabama at Birmingham in 2007, male, partial support

UWI 49 Keller

- James Scott, M.S. in Microbiology at University of Wisconsin in 2007, male, partial support
- Dimitrios Tsitsigiannis, Ph.D. in Microbiology at University of Wisconsin in 2007, male, partial support

UAB 148 Jolly

- John Keenan, Ph.D. in Epidemiology, University of Alabama at Birmingham in 2013, male, partial support. (Epidemiologist with Arizona State Department of Health)

COR 158 Brown

- Megan Filbert, M.S. in Nutrition/Toxicology, Cornell University in 2011, female, partial support
- Jeremy Schwartzbord, in Ph.D. Nutrition/Toxicology, Cornell University in 2014, male, partial support

UGA 124 Hung

- Brian Waters, Ph.D. in Food Science at the University of Georgia in 2013, male, full support

UGA 128 Kostandini

- Eric Carlberg, M.S. in Agricultural Economics at the University of Georgia in 2012, male, full support
- Anthony Murray, M. S. in Agricultural and Applied Economics at Virginia Tech University in 2012, male, full support
- Darren Enterline, M. S. in Agricultural and Applied Economics at Virginia Tech University in 013, male, full support

PUR 10 Mattes

- Corinna Alper, Ph.D. in Nutrition at Purdue University in 1997, female, partial support
- Sarah Kirkmeyer, M.S. in Nutrition at Purdue University in 1997, female, partial support
- Amy Devitt, Ph.D. in Nutrition at Purdue University in 2001, female, partial support
- Smita Iyer, M.S. in Nutrition at Purdue University in 2001, female, partial support
- Carole Traoret, M.S. in Nutrition at Purdue University in 2001, female, partial support
- Fiona McKieman, M.S. in Nutrition at Purdue University in 2006, female, partial support.

PUR 151 Mattes

- Joshua Jones, Ph.D. in Nutrition at Purdue University in 2014, male partial support

UGA 05 Rhodes

1 MS student (name not available.)

4. Short-term, Non-Degree Training

As an example of short-term, non-degree training accomplished by the Peanut CRSP, the 1985 Annual Report noted that, in the 1985-1986 Fiscal Year, U.S. collaborating scientists participated in 323 days (1.25 man years) of overseas collaborative and support work and 19 host country scientists visited the U.S. on short-term training efforts. These efforts are valuable to both the U.S. and host country participants, and continued year to year throughout the course of the Peanut CRSP..

West Africa

Senegal

TX/BCP

- Aly N'diaye, Breeding project coordinator, ISRA/Bambey/Senegal, two weeks in each 1984, 1985 and 1986 for project planning and training at Texas A&M University
- Ibra Fall, Research Assistant in Breeding at ISRA/Bambey/Senegal, two months training at Texas A&M University in 1984

TX/MM

- Bashir Sarr, collaborator in Microbiology/Aflatoxins at Institute of Food Technology/Dakar, one month training at Texas A&M University in 1984
- Amadou Ba, principal investigator in Microbiology at Senegalese Institute for Agricultural Research/Kaolak, three months in 1984, one month in 1985, and four months in 1986 for training at Texas A&M University
- Amangone N'Doye, Research Assistant in Microbiology/Aflatoxins at Institute of Food Technology/Dakar, one month training at Texas A&M University in 1985

NCA 32 Ahmedna – Dr. Amadou Guiro, Senegal, ITA director, FDA Mycotoxin Workshop in Maryland, July 2002 and visit to NCA&T principal investigators in June 2004.
NCA 32 – Dr. Amadou Kane, attended 2005 American Peanut and Education Society Meeting.
UFL 16 Gorbet – Marlin Condori, ANAPO breeder, at University of Florida and University of Georgia for breeding techniques training in 2001-2002.

Burkina Faso

TX/BCP
Philippe Sankara, pathologist and principal investigator Breeding project, ISP, University of Ouagadougou, Burkina Faso, two weeks training in each of 1984, 1986, and 1987 at Texas A&M University. From1982 to present, Dr. Sankara supported breeding program especially in disease resistance and was instrumental in encouraging the cooperation between breeding, entomology and food science efforts of the Peanut CRSP/Burkina Faso program.

UGA/IM

- Solibo Some, collaborator in entomology at University of Ouagadougou, Burkina Faso, laboratory and field research training at the University of Georgia in 1984
- Albert Patoin Ouedraogo, collaborator in entomology at University of Ouagadougou, Burkina Faso, two weeks training in each of 1984 and 1987 at the University of Georgia
- Olle Kam, collaborator on entomology project at the University of Georgia for one month in 1993 for training in aflatoxin analysis

AAM/FT

- Alfred Traore, principal investigator at University of Ouagadougou/Burkina Faso, two weeks food technology training at Alabama A&M University and University of Georgia in 1988

Niger

- Amadou Mounkaila, principal investigator for Breeding project at INRAN/Niger, two weeks in 1986 and eleven weeks in 1989 for training at Texas A&M University

Mali

- Sadio Traore, Research Assistant for Breeding project at IER/Mali, two weeks training at Texas A&M University in 1986

Benin

UFL 13 Boote

- Moustapha Adomou, Benin principal investigator, visited University of Florida March 1-31, 2004

Ghana

TX/MM

- Dr. Richard Awuah completed a training session in mycotoxins at Texas A&M University September and October of 1994
- Kafui Kpodo completed a training session in mycotoxins at Texas A&M University in April 1995

UFL 13 Boote

- Dr. Jesse Naab, Ghana principal investigator, visited University of Florida, March 4-April 4, 2004

UGA 129 Chinnan, 165 Florkowski, and 166 Resurreccion

- Dr. Daniel Sarpong, Ghana, to UGA in 2011 for training on data analysis

AUB 163 C. Jolly

- Stephen McJohn Tansie, M.S. student at Kwame Nkrumakh University of Science and Technology/Kumasi/Ghana trained for two weeks in data collection and survey techniques. 2010
- Albert Bepaapugr Paaga, M.S. student at Kwame Nkrumakh University of Science and Technology/Kumasi/Ghana trained for two weeks in data collection and survey techniques. 2010

UF 157 Boote

- Dr. Jesse Naab, Ghana, visit to U.S. for American Peanut Society meeting and meeting with U.S. principal investigators at the Peanut CRSP investigators meeting in Griffin, Ga. 2008

UF 157 Boote

- Dr. Jesse Naab, Ghana, visit to University of Florida for work on data with U.S. principal investigators, January-February 2010

UGA 122 Phillips

- Dr. Firibu K. Saalia, Ghana, one month at University of Georgia on RUTF work, June 2009
- Dr. Dorothy Nakimbugwe, Uganda, visited and worked with principal investigator at University of Georgia and attended the Annual Institute of Food Technology meetings in June 2009 and July 2010
- Deborah Nabuuma, Uganda, graduate student at Makerere University to conduct research with project team, six months, August 2009-January 2010

Nigeria

UGA/PV

- Steve Misari, Nigeria, principal investigator in virology at Institute of Agricultural Research, Amadou Bello University, three months in 1983 and three months virology training at University of Georgia in 1986
- Okon Ansa, Nigeria, collaborator in virology at Institute of Agricultural Research Ahmado Bello University, one month at Scottish Crops Research Institute in 1984 and one month at West German Virus Institute in 1987 for training in rosette virus laboratory research (important that rosette virus could be worked on in those countries because of no peanut crop; could not do in U.S. because of concern of introducing the new virus)

East Africa

Sudan

AAM/FT

- H. Isag, project coordinator at the Institute for Food Technology, two weeks training at Alabama A&M University in 1985

Uganda

VT 134 Christie

- Dr. Kaaya, Uganda, to Georgia Peanut Tour and visit principal investigators at the University of Georgia and Virginia Tech University, September 2009

Southest Asia

Thailand

- Montein Sompee, project coordinator at Department of Agriculture, Khon Kaen, Thailand, two weeks research management training at North Carolina State University in 1988
- Montien Somabhi, administrative coordinator deputy director, Field Crops Research Institute, Khon Kaen, Thailand, two research management training at North Carolina State University in 1987
- Vichitr Benjasil, administrative coordinator director of Field Crops Research Institute, Khon Kaen, Thailand, two weeks of research management training at North Carolina State University in 1984

NCS/BCP

- Aran Patanothai, CRSP Breeding coordinator at Khon Kaen University, Thailand, one month in 1984 and six months training at North Carolina State University in 1986-1987
- Tharmmasak Sommartaya, collaborator at Kasetsart University, Thailand, six months Plant Pathology training at North Carolina State University in 1984
- Aree Waranyuwat, collaborator at Kasetsart University, Thailand, three weeks breeding training at North Carolina State University in 1983
- Preecha Surin, collaborator at Department of Agriculture, Khon Kaen, Thailand, two weeks training in plant pathology at North Carolina State University in each year, 1987 and 1988
- Nark Potan, collaborator Department of Agriculture, Bangkok, Thailand, two weeks Breeding training at North Carolina State University in each year, 1987 and 1988
- Wootisuk Butranu, collaborator spent one year in Plant Pathology training at North Carolina State University in 1992-1993

NCS/IM

- Manochai Kerati-Kasikorn, collaborator at Khon Kaen University, three weeks in 1983 and three weeks in 1986 for Entomology training at North Carolina State University
- Sathorn Sirisingh, collaborator at Department of Agriculture, Bangkok, two weeks in 1983 and three weeks in 1987 for Entomology training at North Carolina State University,

NCS/SM

- Nantakorn Boonkerd, collaborator at Department of Agriculture, Bangkok for Soil Microbiology/*Rhizobium*, four weeks training at North Carolina State University in 1985
- Bayong Toomsan, collaborator at Khon Kaen University for Soil Microbiology/*Rhizobium*, four weeks training at North Carolina State University in 1985
- Yenchai Vasuvat, collaborator at Department of Agriculture, Bangkok for Soil Microbiology/*Rhizobium*, four weeks training at North Carolina State University in 1984
- Omsub Nopamornbodi, principal investigator in Soil Microbiology/*Rhizobium* at Department of Agriculture, Bangkok, two weeks each in 1984, 1985 and 1987

UGA/PV

- Sopone Wongkaew, collaborator at Khon Kaen University for Virology, one month training at the University of Georgia in 1992

GA/FT

- Penkwan Chompreeda, collaborator at Kasetsart University, six months Food Technology training at the University of Georgia in 1986-1987
- Chintana Oupadissakoon, principal investigator for Food Technology at Kasetsart University, one month in 1985 and one month in 1986 for training at the University of Georgia
- Vichai Haruthaithanasan, collaborator for Food Technology at Kasetsart University, two weeks training at the University Georgia in 1989

Thailand

Dr. Chintana Oupadissakoon and Vichai Haruthaithanasan, Kasetsart
University, 1982-1993. Dr. Penkwan Chompreeda joined group in 1984 after Ph.D. in Food Science at Kansas State University, and spent six-months training at the University of Georgia Food Science Department in food processing, computer, and sensory technology. Involved with a Peanut CRSP/Thai program that developed a successful product incubator program to connect food processing research with industry to develop/improve products and introduce to village level and small to medium scale processors. High impact has occurred through the training of a number of Thai graduate students at Kasetsart University that have usually came from and returned to industry and enhanced the Thai food industry. In 1993, after Thailand became a graduate country a regional Training and Outreach Program was developed with Thai and Peanut CRSP that has trained numerous food scientists through short-term research and development activities. Quotation from
Dr. Chompreeda: "The Peanut CRSP was instrumental in the development and success of my career."

Philippines

- Ricardo Lantican, coordinator for projects at University of the Philippines at Los Banos, one week at Thailand Workshop in 1986
- Danilo Cardenas, CRSP Coordinator for the Philippines at Philippine Council for Agricultural Research and Resources Development, one week at Thailand Workshop in 1986

NCS/BCP

- Remedios Abilay, collaborator at University of the Philippines at Los Banos, Philippines, six months Breeding training at North Carolina State University in 1986, one month in 1992, and one week in 1994
- Edilberto D. Redona, collaborator at University of the Philippines at Los Banos, Philippines, two weeks training in Breeding at North Carolina State University in 1983
- Aracelia Pua, collaborator at University of the Philippines at Los Banos, two weeks training in Plant Pathology/Breeding at North Carolina State University in 1984
- Randy Hautea, collaborator in Breeding at the University of the Philippines at Los Banos, one week at Thailand CRSP Workshop in 1986
- Delfinia del Rosario, collaborator for drought tolerance breeding at the University of the Philippines at Los Banos, one week at Thailand CRSP Workshop in 1886

NCS/IM

- Candida Adalla, collaborator at the University of the Philippines at Los Banos, Philippines, one week of Entomology training at ICRISAT in 1984
- Eliseo Cadapan, collaborator at the University of the Philippines at Los Banos, three weeks in 1983 and two weeks in 1985 and one week in 1993 for Entomology training at North Carolina State University, and one week at Thailand CRSP Workshop in 1986
- Virginia Ocampo, collaborator at the University of the Philippines at Los Banos, one week training at North Carolina State University in 1992

NCS/SM

- Erlinda Paterno, collaborator for Soil Microbiology at the University of the Philippines at Los Banos, Philippines, Thailand CRSP Workshop, one week in 1986
- Lina Ilag, collaborator for Soil Microbiology at the University of the Philippines at Los Banos, Philippines, two weeks at North Carolina State University in 1985 and Thailand Workshop in 1986

UGA/FT

- Sonia Rubico, research assistant in food technology at the University of the Philippines at Los Banos, one year training at the University of Georgia, 1986-1987
- Virgilio Garcia, principal investigator in food technology at the University of the Philippines at Los Banos, two weeks training at the University of Georgia in 1987
- Reynaldo Mabesa, co-principal investigator in food technology at the University of the Philippines at Los Banos, two weeks at the University of Georgia in 1989
- Ricardo R. del Rosario, co-principal investigator in food technology at the University of the Philippines at Los Banos, two weeks training at the University of Georgia in 1988
- Elias Escueta, principal investigator in food technology at the University of the Philippines at Los Banos, one month training at the University of Georgia in 1985
- Pia Real, research assistant in food technology at the University of the Philippines at Los Banos, six months of aflatoxin analysis/detoxification at the University of Georgia in 1989
- Dr. Luthgarda S. Palomar, Department of Agricultural Chemistry and Food Science at Visayas State College of Agriculture, Baybay, Leyte, Philippines, two months training in 1992 for modeling and optimizing formulation for peanut product development
- Dr. Luthgarda Paloma from the Philippines had two months training in 1992 in methods for modeling and optimizing peanut formulation for product development in Food Science at the University of Georgia, and became a Peanut CRSP collaborator after returning to Visayas State University, Leyte
- Dr. Flor Galvez from the University of the Philippines had a Ph.D. in Food Science from the University of Georgia
- Dr. Alicia Lustre of the Food Development Center/National Food Authority, Manila, Philippines had short-term training and was the Philippine principal investigator for UGA 04 from 1997-2007. This team together with the leadership of the U.S. principal investigator
- Dr. Anna Resurreccion of the University of Georgia and coordination with the Thailand project investigators, key research and development was done that led to the market pull concept or PIIP (Peanut Industry Incubator Model) for food product introduction into the processor and consumer market

Latin America/Caribbean

Jamaica

AAM/FT

- Hope Kerr, acting director of Food Technology Institute/Jamaica, two months training each in 1986 and 1987 at Alabama A&M University
- Althea Townsend, director of Food Technology Institute/Jamaica, two months training at Alabama A&M University in 1986\5/1986
- B. K. Rai, principal investigator at CARDI/Belize, two weeks training each in 1985 and 1986 at Alabama A&M University
- Laxman Singh, principal investigator at CARDI/Antigua, two weeks training at Alabama A&M University in 1985
- Brian Cooper, principal investigator at CARDI/Antigua, two weeks training at Alabama A&M University in 1986
- Horace Payne, principal investigator at CARDI/Jamaica, two weeks training at Alabama A&M University in 1985
- Margaret Hinds, Ph.D. student at University of West Indies related to project, two months training at Alabama A&M University in 1987

UGA/PH

- Joscelyn E. Grant, principal investigator at CARDI/Jamaica, two weeks training in equipment fabrication at the University of Georgia in 1988

Haiti

COR 158 Brown

- Maguey Louis, Haiti, trained in aflatoxin screening in Haiti, 2008
- Dumel Loues, Haiti, trained in aflatoxin screening in Haiti, 2008
- Darleen Aurilean, Haiti, trained in aflatoxin screening in Haiti, 2009

Boliva

- UF 150 Tillman – Diego Baldelomadr, Bolivia principal investigator, three months at University of Florida, 2010
- UFL 16 Gorbet – Marlin Condori, ANAPO breeder, at University of Florida and University of Georgia for breeding techniques training in 2001-2002
- UFL 16 Gorbet – Ruben Mostacedo, agronomist at ANAPO visited U.S. principal investigators in 2003
- UFL 16 Gorbet – Diego Montenegro, ANAPO Manager, visited U.S. principal investigators

Eastern Europe

Bulgaria

- Dr. Dida Iserliyska, Bulgaria, 9 months at UGA in 2004 (Chinnan UGA 11)
- Nikolina Milcheva, Bulgaria, 6 months at UGA in 2004 (Chinnan UGA 11)
- Dr. Tana Sapoundjieva, Bulgaria, UGA in 2005 (Chinnan UGA 11)

5. Sabbatical Leave Assignments

Peanut CRSP Staff

- William Campbell – Sabbatical leave August 1986-February 1987 from North Carolina State University to collaborating institutions, Khon Kaen University and Department of Agriculture, Thailand. Principal Investigator in Insect Management Project.
- David Cummins – Joint Career Corp appointment, April 1986-April 1988, USAID/Manila. Served as agricultural research advisor. On leave from the University of Georgia, program director of the Peanut CRSP

ICRISAT Staff

- Ron Gibbons, ICRISAT groundnut program leader/breeder, 1983-1984, North Carolina State University
- Phil Moss, ICRISAT/cytologist, 1985-1986, North Carolina State University
- S. M. Nigam, ICRISAT/breeder, 1989-1990, North Carolina State University
- Pala Subrahmanyam, ICRISAT/pathologist, 1984-1985, Texas A&M University
- D.V.R. Reddy, ICRISAT/virologist, 1983, University of Georgia
- V. K. Mehan, ICRISAT/pathologist, 1986, Senegal, Peanut CRSP site
- T. Rau, ICRISAT/breeder, North Carolina State University, 1987, tissue culture research for Ph.D. Dissertation
- Jonathan H. Williams, ICRISAT/pathologist, 1986-1987, Oregon State University. While not a Peanut CRSP collaborating university, the experiences were valuable to Dr. Williams when he began work with the Peanut CRSP in 1995 through his tenure as program director

The ICRISAT scientists enhanced their own capabilities for research, strengthened the Peanut CRSP scientists at U.S. and Senegal sites, and built on already significant cooperation between U.S. and ICRISAT peanut scientists.

6. Other Examples of the Training Impacts of the Peanut CRSP

Training summary from 1996-2007, Final Report total numbers:

- **Short term:** 103 male and 54 female, 1 not named by gender
- **Master of Science:** 19 male and 29 female, 1 not named by gender
- **Ph.D.:** 14 male and 11 female,
- **Post Doctoral:** 3 male and 3 female
- **Workshops:** 858 male and 871 female, 949 not named by gender
- **Other:** 7 male and 2 female
- **Total:** 3225

The training component of the Peanut CRSP showed a significant number of trainees, a total of 3225. Training contributed to both capacity building institutionally and in training farmers and processors in producing, processing and marketing peanuts and peanut products. Extension activities by CRSP partners reached a very large audience in Ghana where Television and Radio broadcast information for extension to users based on CRSP research.

Short-term training included individuals trained in laboratory or field techniques, and were primarily host country participants. The M.S., Ph.D., and post-doctoral trainees were both host country and U.S. individuals. Workshops included field and laboratory training. The Workshop numbers not named/divided by gender were largely farmer and cottage processing trainees in Guyana, and were not divided by gender in the count.

Gender comparisons across major categories showed more women trained than men, and were higher in most categories. When separated in the counts, 55% of trainees were women and 45% men.

From 1982-1990, there were 46 U.S. principal investigators and cooperators on projects that made multiple trips to the various host countries to advise and work with the host country collaborators in the research efforts.

7. Workshops/Trainings

Meetings, Workshops, and Symposia sponsored or co-sponsored by the Peanut CRSP

1993 The project for transferring peanut roasting and marketing technologies at Huay Bong-Nua Village north of Chaingmai continues. Monitoring of activities in made on a regular basis by project investigators at Kasetsart University and by the Extension Specialist in the Huay Bong-Nua region.

1996 Leyte village work trained small-scale processors in quality products.

Consultative group meeting to discuss collaborative research on groundnut rosette virus disease,was held at the University of Georgia, Georgia Experiment Station, Experiment, Georgia, in May 1983. Participants were present from Georgia, Nigeria, West Germany, and ICRISAT (International Crops Research Institute for the Semi-Arid Tropics).

Consultative group meeting for Asian regional research on grain legumes, ICRISAT/India, December 1983: meeting of researchers and research managers to discuss the coordination of Asian grain legume research.

Consultative group meeting to discuss collaborative research on Groundnut Rosette Virus Disease, April 13-14, 1985, Cambridge, England. Assembled researchers from the Peanut CRSP (U.S. and Nigeria), ICRISAT, Australia, Scotland and West Germany to discuss needs and plans for collaborative research.

Agrometeorology of groundnut, and international symposium, ICRISAT Sahelian Center, Niamey, Niger, Aug. 21-26, 1985: assembly of an international group to consider meteorological organization, food and agricultural organization of the United Nations and the Peanut CRSP.

Workshop on storage, utilization, and nutritional aspects of grain legumes and grains, June 1985, Experiment, Georgia: meeting of researchers form Bean/Cowpea CRSP, International Soybean Program, Nutrition CRSP, Peanut

CRSP, and Sorghum/Millet CRSP to discuss areas of mutual interest in post-harvest problems: coordinated by the Peanut CRSP and Bean/Cowpea CRSP investigators.

First national peanut consultation and Peanut CRSP review, Feb. 7-8, 1985, PCARRD. Los Banos, Laguna, the Philippines. Assembled researchers, extension specialists, and farmers to review research and determine future research needs. Reviews are held annually; a second major consultation scheduled for 1989.

Peanut CRSP workshop, Khon Kaen, Thailand, Aug. 19-21, 1986: included researchers from the Philippines, Thailand and the United States to review present research and outline a consensus of ideas for future program direction.

Consultative group meeting to discuss collaborative research on groundnut rosette virus disease, March 8-10, 1987, Lilongwe, Malawi. Added representatives from England and France to Cambridge meeting (above) to evaluate progress and plan future research.

Consultative group meeting to discuss research needs on peanut Stripe Virus in Southeast Asia, June 9-11, 1987, Malang, Indonesia: planning meeting with CRSP representatives from Georgia, Thailand and the Philippines (both later involved in the Peanut CRSP virus project), and researchers from Australia, Indonesia, ICRISAT and Japan.

7th World Congress of Food Science and Technology: workshop on peanut utilization, Sept. 28-Oct. 2, 1987, Singapore. Symposium sponsored by the Peanut CRSP, with participation from Georgia, the Philippines, and Thailand.

International workshop on aflatoxin contamination of groundnut, Oct. 8-9, 1987, ICRISAT Center, Hyderabad, India: peanut CRSP participants included representatives from Nigeria, Georgia, Alabama, Sudan and Texas.

West Africa region groundnut scientists meeting, Sept. 14-17, 1988, Niamey, Niger: peanut CRSP researchers from the United States, Burkina Faso, Niger, Nigeria, Senegal, and scientists from Benin, Cameroon, Gambia, Ghana, Guinea, Mali, Chad, Togo, FAO (Rome), ORSTROM (France) and IRHO (France) participated in the meeting to discuss present research and establish goals for regional research. The meeting was organized with ICRISAT and Peanut CRSP cooperation and continued bi-annually for seven times until 2000.

Asian region groundnut scientists meeting, November, 14-17, 1988, Malang, Indonesia. Peanut CRSP scientists from the United States, the Philippines and Thailand, and scientists from India, Indonesia, Korea, Malaysia, Nepal, China, Vietnam, Australia (ACIAR),and ICRISAT participated in the meeting to discuss present research and establish goals for regional research.

International workshop on peanut entomology and breeding for tolerance to shade and acid soils, held at PCARRD in Los Banos, the Philippines in March 1990. Sponsored by the Peanut CRSP.

Second Regional Groundnut Meeting for West Africa, held at ICRISAT Sahelian Center, Niger, in Sept. 1990. Co-sponsored by the Peanut CRSP.

Second international groundnut workshop, Nov. 25-30, 1991, held at ICRISAT, Hyderabad, India. Co-sponsored by the Peanut CRSP.

Third Regional Groundnut Meeting for West Africa, held at University of Ouagadougou, Burkina Faso, in Sept. 14-17, 1992. Co-sponsored by the Peanut CRSP.

Workshop on improving production and quality of peanut was held in Mandeville, Jamaica, Jan. 12-14, 1992. Attended by individuals across the peanut sector from farmers, processors, researchers and extension agents.

Workshop on "Transfer of Peanut Production and Utilization Technologies" at Kasetsart University, Thailand, March 23-24, 1993. The proceedings (128 pages) summarize ten years of Peanut CRSP research in Thailand.

1994

The fourth Regional Groundnut Meeting for West Africa was held in Accra, Ghana, Nov. 18-22, 1994. The meeting was co-sponsored by ICRISAT, CIRAD-CA/France and the Peanut CRSP.

Southern African region workshop, 1991-1992, travel noted in AR.

Groundnut virus disease working group meeting held in Dundee, Scotland, Aug. 15-19, 1993. Co-sponsored by ICRISAT, Scottish Crops Research Institute and Peanut CRSP.

Review and planning workshop on Peanut Integrated Pest Management (IPM) was held at PCARRD, Los Banos, the Philippines, Jan. 17, 1994.

The Regional Groundnut Meeting for West Africa was held in Accra, Ghana Nov. 18-22, 1996. The meeting was co-sponsored by ICRISAT, CIRAD-CA/France and the Peanut CRSP.

A Workshop for training the trainers was held by the CRSP collaborating Department of Product Development, Kasetsart University, Bangkok, Thailand April 18-May 27, 1994. Ten participants from Cambodia, Laos, Myanmar, Viet Nam and Thailand were trained in peanut utilization. All participants were government officers whose jobs related to peanut utilization.

Second annual workshop for training the trainers was held in by the CRSP collaborating Department of Product Development, Kasetsart University, Bangkok, Thailand, April 24-May 27, 1995. Twenty participants from 13 countries were trained on the topic of "Quality Evaluation and Utilization of Food Legumes." These were Tanzania, Fiji, Sri Lanka, Republic of Maldives, Bhutan, Bangladesh, Sierra Leone, Laos, Cambodia, Korea, Vietnam, Nepal and Thailand.

Products developed by the Peanut CRSP food technology project were examples used. The Peanut CRSP cooperated with the Department of Technical and Economic Cooperation, Office of the Prime Minister under the Thai-AID project to facilitate the workshop/training course. The effort grew form a training program developed for Southeast Asia after Thailand was determined as a graduate country by USAID in 1993, when normal projects could not be funded. It was planned as an annual effort with minimal support by the Peanut CRSP.

A two-week training course on peanut and other legume viruses was held in Khon Kaen University, Thailand, during February 1995, and supported by the Peanut CRSP, FAO, ICRISAT and a Belgium project. Participants from 10 Southeast Asia counties attended.

The Peanut CRSP sponsored a symposium in Washington, March 29-31, 1995, entitled "Peanut CRSP Symposium, Impacts, and Scientific Advances through Collaborative Research on Peanut." The life of the program was covered with particular emphasis on the 1991-1995 phase. All projects were covered with both U.S. and host country scientists present.

Technology transfer activities were held in Kud-Jub District, Udorn-thanee Province, Thailand, to peanut processing technologies to housewives. Cooperators at the Guadalupe Women's Association and URIVAC were trained in processing management and marketing of peanut-extended snacks by the Peanut CRSP investigators at ViSCA, Baybay, Leyte, the Philippines, with sessions at ViSCA and in rural areas. These programs of 1996 were important in the development of the PIIP method of extending technologies to processor,

In conjunction with an international virus working group in March 1996, a two-week training course on viruses affecting peanut and other legumes was held in Pretoria, South Africa. Partial support was provided by the Peanut CRSP and ICRISAT.

A workshop on training the trainers on "Quality Evaluation and Utilization of Food Legumes" was held in Bangkok, Thailand, from April 22 to May 24, 1996. Thirteen participants from six countries attended. Partial support was provided by the Peanut CRSP.

A Seminar /Workshop on Aflatoxin Control for the food industry was held May 13-14, 1996, at the Institute of Food Science, University of the Philippines at Los Banos. It was co-sponsored by the Peanut CRSP, Bureau of Food and

Drugs, Department of Health, and the Food and Nutrition Research Institute/Department of Science and Technology and attended by 13 representatives from the food industry.

Sixth West Africa region Workshop was held in Bamako, Mali, in November 1998, and co-sponsored by ICRISAT and Peanut CRSP.

Seventh West Africa region Workshop was held in Benin in November 2000, and co-sponsored by ICRISAT and Peanut CRSP.

8. Information

Information outreach from the Peanut CRSP comes in a number of ways including the examples that follow.

The International Arachis Newsletter

The International Arachis Newsletter was planned and co-published with ICRISAT every year from 1983 to 2010. This fulfilled a plan in the Peanut CRSP planning grant for 1980-1982 that a publication would be developed by the Peanut CRSP for publication of short notes on current peanut research and available to any scientist. Discussions with ICRISAT staff led to the joint effort. It became the leading international, non-journal, peanut research publication.

World Wide Web and PIN

These two means of information dissemination were funded through two Peanut CRSP projects; UGA 05 Rhoades 1996-2001 and 2001-2007 and UGA 124 Hung 2007-2012. A website was developed and maintained to provide publishing or referencing on line information related to peanut research and development. These projects are more fully discussed in the report earlier on these three phases of the Peanut CRSP.

Publications

Numerous publications were released from 1982-2012 and were numbered by category to the extent feasible; listing by title was not possible.

Publication Type	1982-1990	1991-1996	1997-2008	Total
Journal Articles	193	224	351	768
Workshop Proceeding	99	271	287	657
Bulletins	10	34	28	72
Abstracts	190	162	187	539
Theses/Dissertations	46	56	55	157
Miscellaneous	79	49	139	267
Book Chapters	9	13	103	125
Book	6	6		
Total	**626**	**809**	**1156**	**2591**

Note: Closeout report for 1997-2007 was completed in 2008 and included publications for 2008; the source for publication summary for those years. Complete listing for 2008-2012 not available at the time of the completion of this report.

9. Management

Based on the grant or cooperative agreement documents, responsibility for the Peanut CRSP management comes from USAID with BIFAD advice to the USAID Office of Agriculture (names changed through the years but generally in same tier of responsibility), to the University of Georgia Office of the Vice President for Research, to the management entity office. Various levels of advice and support come at the university level as well as to participating U.S. and host country institutions for research project management. At the management institution level, UGA, the program director has direct management programmatic and fiscal responsibility for the Peanut CRSP. Support comes at from the management entity office staff, College of Agriculture leadership and staff, the staff of the Office of Vice President for Research, the university office of business affairs for budget support, and similar offices in the participating U.S. universities that manage sub-grants. Direct line of the management office to the U.S. universities was through the board of directors and technical committee. Responsibility for programmatic and fiscal management is given and accepted to the host country collaborating institutions. Information from these levels is accumulated and provided to USAID that monitors program management both programmatic and fiscal, and uses it for various reports to show CRSP value to the intended host country beneficiaries and that feedback is coming to the U.S., and to show value to Congress and to support future fiscal support.

There can be problems identified and discussed that have deterred timeliness and depth of progress, but in few or no cases were there significant problems, such as misappropriation of funds. Through the six phases of the Peanut CRSP from 1982 to 2012 (and the 1980-1982 planning grant), the external evaluation panels have spoken well for all the above levels of management.

At the primary level of responsibility, the Peanut CRSP program director, there has been a good record of out of responsibilities. There have been three individuals that have served in this role. Dr. David Cummins served as program director from 1982-1998 with two-year sabbatical leave in the Philippine USAID Office in 1986-1988. He also served as associate director of the planning grant in 1980-1982. Cummins had served as a crop scientist in research at the University of Georgia, College of Agriculture Experiment, Station, Griffin since 1963. During 1986-1988, Dr. Tommy Nakayama, University of Georgia food scientist and Peanut CRSP Food science project leader at the Georgia station in Griffin served as program director. At the retirement of Cummins in 1998, Dr. Jonathan H. Williams became program director. Williams came through the Zimbabwe Agricultural research system, the Peanut Research Program at ICRISAT India and Niger/West Africa, 1995-1996 in the program director office with ICRISAT support, and appointment as associate director of the Peanut CRSP 1996-1998. These three individuals served the CRSP well with mostly good comments and few problems with their service. After retirement in 1998, Cummins served as part-time associate director though the end of the program phase ending in March 2013 assisting Williams in various capacities.

Some comments on CRSP Management follow.

1985 External Evaluation Report: "Overall, the external evaluation panel gives the ME and its appointed director, Dr. Cummins, very high marks for an efficient and economically operated management program for the Peanut CRSP. All evidence presented and reviewed points to a high degree of efficiency and effectiveness for the standpoint of fiscal responsibility. University of Georgia staff concerned with providing support to, and oversight of, the program are fully familiar with its characteristics. Dr. Cummins has clearly established lines of communication and understanding that have led to the minimization of bureaucratic delays in progress implementation."

1989 External Evaluation Report: "In fact, one of the strengths of the Peanut CRSP has been the low turnover of management personnel, members of the board of directors, technical committee, U.S. and host country participating scientists. To a considerable degree, this has been due to the quiet, efficient administrative abilities of Dr. Cummins. Peanut CRSP has always been a "bottoms up" research planning operation rather than "top down." Warm personal relationships and high *esprit de corps* exist at all levels of the Peanut CRSP, which we again attribute to the democratic style of management promoted by Dr. Cummins. U.S. university administrators often made the point to the EEP that Peanut CRSP was operating as a model of efficiency and throughout its life had generated fewer problems necessitating their attention than other CRSP programs which the university was involved."

2005 External Evaluation Report: "The Peanut CRSP has carried out research in the U.S. and host countries through imaginative, challenging, and ambitious multi-disciplinary projects. Additionally, there has been strong support from both U.S. and host country participants. The Peanut CRSP has been particularly successful in attracting the support of the broad U.S. peanut industry by providing tangible benefits. Many of these accomplishments have been due to the vision and leadership of the management entity (Dr. Williams, program director) and implementation efficiency of committed and dedicated principal investigators in the U.S. and the host countries. The leverage of funds to extend beyond direct CRSP funding has contributed greatly to the success."

2012 External Evaluation Report: "In the communication and management activities [developed and led by Dr. Williams, program director, advanced web-based programs are in place with many participating institutions worldwide to enable ongoing communication of peanut research, training programs and technology transfer to users. Fiscal management is cost effective and accountable."

CHAPTER 34. ABBREVIATIONS AND ACRONYMS

ACIAR	Australian Centre for International Agricultural Research
AF	Aflatoxin
AF-ALB	Aflatoxin B1 albumin
AFB1	Aflatoxin B1
AFB Lysine	Aflatoxin B lysine
AF-M1	Aflatoxin exposure biomarker
AGRA	Alliance for a Green Revolution in Africa
AL	Alabama
AAM/AAMU	Alabama A&M University
AAM/FL/FT	Alabama A&M U and U of Florida Food Technology
afiR	Aflatoxin regulatory gene in peanut
AIDS	See: HIV/AIDS
ANAPO	Asociación de Productores de Oleaginosas y Trigo (Bolivia)
APREA	American Peanut Research and Education Association
APRES	American Peanut Research and Education Society
ARC	Agricultural Research Center/Egypt
ASPRODEB	Association Sénégalaise pour la Promotion du Développement à la Base
AUB	Auburn University
BBC	British Broadcasting Corporation
BIFAD	Board for International Food and International Development
BMGF	Bill & Melinda Gates Foundation
BNF	Biological nitrogen fixation
CAADP	Comprehensive Africa Agricultural Development Program
CAR	Caribbean
CARDI	Caribbean Agricultural Research and Development Institute
CARICOM	Caribbean Community
CBR	Cylindrocladium black rot disease
CDC	Center for Disease Control
CD4 count	Cluster of differentiation cells/type of white blood cells that fight infection and their count indicates stage of HIV or AIDS in a patient
CENARGEN	National Center for Genetic Resources and Biotechnology/Brazil (in English)
CFLI	Canada Fund for Local Initiatives
CFC	Common Fund for Commodities
CGIAR	Consultative Group on International Agricultural Research
CIAT	International Research Center for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Center
CIP	International Potato Center
CIRAD-CA	International Agricultural Research Centre for Development-Annual Crops-France
CITEC-HUILERIE	Peanut Processing Company in Burkina Faso
CNRA	Centre national de Recherches agronomiques (Senegal)
CODEX	Alimentarius Commission (System for Approval of Food Additives)
COR	Cornell University
CORAF	Conference des Responsables de Recherche Agronomique/Africa.
CRSP	Collaborative Research Support Programs
CRDA	Centre de Recherche de Documentation (Benin)
CRI	Crops Research Institute (Ghana)
CROPGRO	Statistical model to predict crop growth
CSIR	Council for Scientific and Industrial Research/Ghana
CTO	Cognizant Technical Officer (Responsible in USAID for CRSP)
CVD	Cardio-vascular disease
DOA	Department of Agriculture (Thailand)
DLF	Development Loan Fund
DNA	Deoxyribonucleic acid
EEP	External evaluation panel
EET	External evaluation team
ELISA	Enzyme-Linked Immunosorbent Assay
EMBRAPA	Empresa Brasileria de Pesquisa Agropecuaria (Brazilian Enterprise for Agricultural Research in English)
ENEA	École nationale d'économie appliquée (Dakar, Senegal)

EU	European Union
FAM	Florida A&M University
FAO	Food and Agricultural Organization
FARA	Forum for Agricultural Research in Africa
FB1	Fumonisin exposure biomarker
FCS	Food consumption scores
FDA	United States Food and Drug Agency
FDC	Food Development Center/Philippines
FFS	Farmers Field Schools (Ghana)
FHI	Food for the Hungry International
FN	Fumonisin
FRI	Food Research Institute/Ghana
FTF	Feed the Future
FTIR-ATR	Fourier Transformational Infrared-Attenuated Total Reflection Spectroscopy
FTIR-PAS	Fourier Transformational Infrared-Photo Acoustic Spectroscopy
GA/IM	Georgia (UGA) Insect Management
GA/INPEP	Georgia (UGA) International Peanut Evaluation Program
GA/PH/CAR	Georgia (UGA) Post Harvest/Caribbean
GHESKIO	The Haitian Group for the Study of Kaposi's Sarcoma and Opportunistic Infections
GIS	Geographic information system
GM	Genetically modified
GMP	Good management practices
GPC	Georgia Peanut Commission
GRAV	Groundnut rosette assister virus
GRD	Groundnut (or peanut) rosette disease
GRV	Groundnut rosette virus disease
HACCP	Hazard analysis of critical control points
HB/HC	Hepatitis B, Hepatitis C viruses
HC	Host country/ies
HIV/AIDS	Human immunodeficiency virus/Acquired immune deficiency syndrome
HPLC	High Pressure Liquid Chromatography
HSCAS	Hydrated Sodium Calcium Aluminosilicate clay
IAN	International Arachis Newsletter
IAR	Institute of Agricultural Research/Nigeria
ICA	International Cooperation Administration
ICFT	Institute of Cryobiology and Food Technology, Plodiv, Bulgaria
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDM	Integrated Disease Management
IDRC	International Development Research Centre, Canada
IEC	Information, Education, and Communication
IEHA	Initiative to End Hunger in Africa
IER	Institut d' Economie Rurale-Mali
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IITA	International Institute for Tropical Agriculture
ILRI	International Livestock Research Institute
IMF	International Monetary Fund
INERA	Institut de l'Environement et des Recherches Agricoles/Burkina Faso
INRAB	Institut National des Recherches Agricoles du Benin
INRAN	Institut National de Recherches Agronomiques du Niger
INTSORMIL	International Sorghum and Millet Collaborative Research Support Program
IPB	Institute of Plant Breeding/Philippines
IPM	Integrated Pest Management
IRD	Institut de Recherche pour le Développement, Burkina Faso
IRHO	Institut de Researches pour les Huiles et Oleagineaux, France
IRRI	International Rice Research Institute
IPB	Institute of Plant Breeding/Philippines
ISNAR	International Service for National Agricultural Research
ISP	l'Institut Superieur Polytechnique, Upper Volta/Burkina Faso
ISRA	Institut Senegalais de Recherches Agricoles
ITA	Institut de Technologie Alimentaire /Dakar, Senegal
ITTU	Intermediate Technology Transfer Unit/Ghana

JCAD	Joint Committee for Agricultural Development/USAID-BIFAD
JCARD	Joint Committee for Agricultural Research and Development, USAID-BIFAD
JRC	Joint Research Committee/USAID-BIFAD
KARI	Kenya Agricultural Research Institute
KKU	Khon Kaen University (Thailand)
KNUST	Kwame Nkrumah University of Science and Technology/Ghana
KU	Kasetsart University/Bangkok/Thailand
LDC	Less developed country
LLC	Limited Liability Corporation
MANA	Mother Administrated Nutritive Aid (produced by Georgia Food Company)
MARDI	Malaysia Agriculture Research and Development Institute
ME	Management entity (for CRSP grant at the university)
MFCL	Ministry of Fisheries, Crops, and Livestock/Guyana
MFK	Meds & Food for Kids
MLs	Maximum limits
MOA	Ministry of Agriculture
MOU	Memorandum of Understanding
MSA	Mutual Security Act
MS/MSc	Master of Science Degree
NARI	National Agricultural Research Institute/Uganda and Guyana
NARO	National Agricultural Research Organization/Uganda
NaSARRI	National Semi-Arid Resources Research Institute, Serere, Uganda
NAWOU	National Association of Women's Organizations in Uganda
NC	North Carolina
NCA	North Carolina A&T University
NCS/NCSU	North Carolina State University
NCS/IM	NCS Insect Management
NCS/TX/SM	North Carolina State U/Texas A&M U Soil Microbiology
NC/VA	North Carolina Virginia peanut growing area
NGO	Non-government organization
NM	New Mexico
NMS/NMX	New Mexico State University
NovaSil	Commercial form of HSCAS
NRC	National Research Council
NS	NovaSil Clay (commercial HSCAS)
ODA	Overseas Development Agency, Great Britain
OKS	Oklahoma State University
O:L	Oleic to linoleic acid ratio in peanut oil
PBMC	Peripheral Blood Mononuclear Cell
pH	Measure for acid and base content
PCARRD	Philippine Council for Agriculture and Resources Research and Development
Peanut CRSP	Peanut Collaborative Research Support Program
PEPFAR	President's Emergency Plan for AIDS Relief
Ph.D.	Doctor of Philosophy
PI	Principal Investigator
PIIM	Peanut Industry Incubator Model
PINS	Peanut Information Network System
PIWG	Peanut Improvement Working Group
PMV	Peanut mottle virus
PNUTGRO	Statistical model to predict peanut crop growth
PStV	Peanut stripe virus disease
PUR	Purdue University
PVCA	Peanut Value Chain Analysis
R&D	Research and development
RFP	Request for Proposal(s)
RJR Nabisco	RJ Reynolds Nabisco/a food manufacturing company
RNAi	Ribonucleic acid interference
RUSF	Ready-to-use supplemental foods
RUTF	Ready-to-use therapeutic foods
SADC	Southern Africa Development Community
SAFGRAD	Semi-Arid Food Grains Research and Development/Africa
SANREM	Sustainable Agriculture and Natural Resources and Enivronmental Management CRSP

SARI	Savanna Agriculture Research Institute/Ghana
SAARI	Sere Agricultural and Animal Protection Research Institute, Uganda
SAT	Semi-Arid tropics
SATT	Southeast Asia Technology Transfer Center/Kasetsart Univ., Thailand
SCR	Southern corn rootworm
S-SOS	Society for Sustainable Operational Strategies
SSA	Sub-Saharan Africa
ST	Sterigmatocystin
TAM/TAMU	Texas A&M University
TROPSOILS	Tropical Soil Management CRSP
TSWV	Tomato spotted wilt virus
TX	Texas
TX/BCP	Texas A&M breeding and cultural practices
TX/MM	Texas A&M mycotoxin management
UAB	University of Alabama at Birmingham
UCN	University of Connecticut
UCONN	University of Connecticut
UFMC	United Farmers Multi-purpose Cooperative/Jamaica
UF/UFL	University of Florida
UGA	University of Georgia
UGAGP3M	UGA Global Peanut Product Processing Marketing Team
UGARF	UGA Research Foundation
UIRI	Uganda Industrial Research Institute
UN	United Nations
UNBS	Uganda National Bureau of Standards
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Program
UNICEF	United Nations
UPLB/UPL	University of the Philippines at Los Banos
URIVIC	Uring (typhoon) Victims Women's Association, Ormac City, Leyte, Philippines
USAID	United States Agency for International Development
UPPT	Uniform Peanut Production Trials (cooperative across states in U.S.)
UPSN	Uniform Particle Size NovaSil
USD	United States dollar
USDA	United States Department of Agriculture
USDA/ARS	United States Department of Agriculture/Agricultural Research Service
USDA/CSRS	United States Department of Agriculture/Cooperative State Research Service
USDA/IED	United States Department of Agriculture/International Economics Division
U.S./USA	United States of America
UST	University of Science and Technology/Ghana (see KNUST)
UWI	University of the West Indies/Trinidad
UWI	University of Wisconsin
VA	Virginia
VICAM	Column for analyzing aflatoxin content in food materials and products
ViSCA	Visayas State College of Agriculture/Leyte/Philippines
VT/VTU/VPI	Virginia Technological University (previously VPI/Virginia Polytechnic Institute)
W/DC	Washington/District of Columbia
WECARD	West and Central African Council for Agricultural Research
WGS	Women and Gender Studies/Makerere University, Uganda
WHO	World Health Organization
WMO	World Meteorological Organization

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